# Dunlin Alpha to Cormorant Alpha Pipeline CA

## Comparative Assessment Report - PL5 Export Pipeline

**Fairfield Betula Limited**

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# CONTENTS

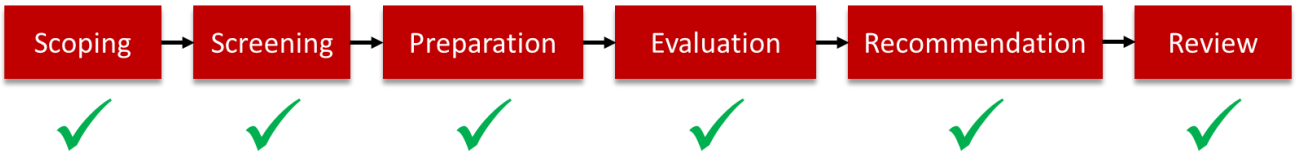
# EXECUTIVE SUMMARY

Fairfield Betula Limited (Fairfield) has completed a Comparative Assessment (CA) of the decommissioning options for the Dunlin Alpha to Cormorant Alpha Export Pipeline (PL5) infrastructure, which includes the pig launcher/receiver located on Dunlin Alpha and Cormorant Alpha topsides respectively, PL5 risers and pipeline, tie-in spools, anode skids and pipeline deposits (mattresses and grout bags) as listed in the Pipeline Works Authorisation held by the Oil & Gas Authority (OGA).

The purpose of this document is to present the outcomes of the CA on which the Draft Decommissioning Programme (DP) for the PL5 pipeline will be based.

The CA was conducted to assess all feasible options across multiple criteria following an industry proven process and framework to enable an informed decision to be made which was supported by scientific evidence and underpinned by key stakeholder participation. This CA Report forms a record of the process and collective decision for the proposed fate of the PL5 pipeline and its associated component parts.

The following steps from the Oil and Gas UK CA Guidelines have been completed:




This CA Report presents the methodology employed, defines the decisions which were required to be taken, references the preparation works carried out, and presents the outcomes (emerging recommendations) from the internal and external stakeholder workshops.

The 24-inch concrete coated rigid export pipeline, PL5, extends approximately 34.3km from Dunlin Alpha to Cormorant Alpha and is tied-in to the platforms through surface laid rigid spools. The majority of the pipeline was laid within an open trench below Mean Seabed Level (MSBL) and has since accumulated varying depths of natural backfill cover.

Deposits associated with the pipeline have been sub-categorised into three distinct groups for the purposes of the CA; partially buried deposits, buried deposits and deposits used for pipe support. Most of these deposits are associated with pipeline span rectification works conducted in 2013 and 2014.

Due to low cathodic protection readings noted during the 2009 survey an anode skid was installed in 2011 at the Dunlin Alpha pipeline end. A similar but smaller skid had been installed at Cormorant Alpha before 2009. These skids are made up of a steel framed structure with anode banks and connected to the main pipeline to provide protection against external corrosion mechanisms.

The screening for the PL5 Decommissioning Programme identified four groups (deposits of varying status/description and the trenched pipeline) which would be subject to full evaluation. All other groups associated with the PL5 pipeline were confirmed at the CA Scoping and Screening stage to be either fully removed from the field or decommissioned under the Dunlin Alpha Topsides Decommissioning or the Dunlin Alpha CGBS Decommissioning programmes (see table notes below). Infrastructure and equipment associated with Cormorant Alpha (topside pipework, rigid riser etc.) will be considered as part of the Cormorant Alpha Decommissioning Programme and is excluded from this scope.

A comprehensive body of supporting technical and environmental studies and analyses was conducted to provide detailed, scientific and quantitative data in support of the evaluation of the selected options.

The conclusion of the CA process has resulted in the following recommendations detailed overleaf.

| Decommissioning Group | Infrastructure Description | Recommendation |
|---|---|---|
| 1 – Structures | 2 anode skids | Full Removal |
| 2 – Deposits (Partially Exposed) | Partially buried concrete mattresses (6x3x0.15m) | Full Removal |
| 3 – Deposits (Buried) | Buried concrete mattresses (6x3x0.15m)<br>Buried grout bags (25kg) | Leave *in situ* - No Intervention |
| 4 – Deposits (Pipeline Support) | Grout bags used for pipeline support (25kg bag) | Leave *in situ* - Minimal Intervention |
| 5 – Dunlin Alpha Platform Pipework, Valves & Control Items | PL5 topsides pipework, pig launcher, associated valves and controls | Note 1 |
| 6 – Dunlin Alpha Riser within CGBS | 24" rigid riser within Dunlin Alpha platform leg | Note 2 |
| 7 – Surface Laid Spools | 24" rigid spools at Dunlin Alpha and Cormorant Alpha | Full Removal |
| 8 – Trenched Pipeline PL5 | 24" concrete coated rigid pipeline 34.3km long | Leave *in situ* - Minimal Intervention |

Note 1: This group was not subject to CA under the PL5 scope. These items reside on Dunlin Alpha and shall be removed as part of the platform topsides removal scope.

Note 2: This group was not subject to CA under the PL5 scope. The PL5 riser is integrated within the Dunlin Alpha CGBS and will be covered under the Dunlin Alpha Decommissioning Programme.

Note 3: The decommissioning approach (full removal) for the PL5 surface laid spools at the Cormorant Alpha end will require prior agreement with TAQA and/or Brent Systems.

# 1 INTRODUCTION

## 1.1 Purpose

The purpose of this document is to present the outcomes of Comparative Assessment (CA) for the Dunlin Alpha to Cormorant Alpha Export Pipeline (PL5), herein referred to as PL5 pipeline. It is produced in satisfaction of the requirement to perform a CA for subsea equipment as detailed in the BEIS Decommissioning Guidance Notes [1], and has followed the methodology detailed in the Guidelines for Comparative Assessment produced by Oil and Gas U.K. (OGUK) [2].

It describes the field infrastructure addressed, the decommissioning options considered, the CA methodology used and the emerging recommendations from the CA process. This report covers the Subsea Infrastructure only.

## 1.2 Background

PL5 pipeline currently exports partially stabilised Thistle Alpha and Northern Producer crude oil via Dunlin Alpha to Sullom Voe Terminal (Shetlands) through the Brent Pipeline System via Cormorant Alpha.

The 24-inch concrete coated rigid export pipeline, PL5, extends approximately 34.km from Dunlin Alpha to Cormorant Alpha and is tied-in to the platforms through surface laid rigid spools. The majority of the pipeline was laid within an open trench below Mean Seabed Level (MSBL) and has since accumulated varying depths of natural backfill cover, as presented in Table 1-1.

Deposits associated with the pipeline have been sub-categorised into three distinct groups for the purposes of the CA; partially buried deposits, buried deposits and deposits used for pipe support. Most of these deposits are associated with pipeline span rectification works conducted in 2013 and 2014.

Due to low cathodic protection readings noted during the 2009 survey an anode skid was installed in 2011 at the Dunlin Alpha pipeline end. A similar but smaller skid had been installed at Cormorant Alpha before 2009. These skids are made up of a steel framed structure with anode banks and connected to the main pipeline to provide protection against external corrosion mechanisms.

Following conditioning and flushing operations, PL5 was due to be taken out of service from 19th August 2017, however, an extension of service to 30th June 2019 has been agreed with PL5 partners. PL5 will be decommissioned upon receipt of an approved Decommissioning Plan (DP).

PL5 is presented below in Figure 1-1 and a summary of the pipeline status, based on cumulative length, is presented in Table 1-1.

| Parameter | Dunlin Spools | | Trenched Pipeline | | Cormorant Spools | |
|---|---|---|---|---|---|---|
| | (km) | % | (km) | % | (km) | % |
| **Surveyed (2016)** | 0.065 | 100% | 34.218 | 100% | 0.082 | 100% |
| Trenched (ToP < MSBL) Note 1 | 0.000 | 0% | 31.724 | 93% | 0.014 | 18% |
| Un-Trenched (ToP > MSBL) Note 1& 2 | 0.065 | 100% | 2.494 | 7% | 0.068 | 88% |
| Burial Height > 0.6m ToP Note 3 | 0.000 | 0% | 1.131 | 3% | 0.005 | 6% |
| Burial Height > 0.3m ToP Note 4 | 0.000 | 0% | 4.526 | 13% | 0.008 | 10% |
| Burial Height 0m < 0.3m ToP Note 4 | 0.0110 | 17% | 12.549 | 37% | 0.009 | 12% |
| Exposed < 0m ToP Note 4 | 0.0540 | 83% | 16.012 | 47% | 0.060 | 78% |
| Rock Cover | 0.000 | 0% | 0.755 | 2% | 0.017 | 22% |
| Free Span | 0.017 | 26% | 1.083 | 3% | 0.015 | 19% |

Note 1: The pipeline is considered to be in a trench where the top of pipe is below the mean seabed level. Conversely, the pipeline is considered un-trenched where the top of pipe is above the mean seabed level.

Note 2: Approximately 500m on approach to Dunlin Alpha and 700m on approach to Cormorant Alpha is un-trenched. The remaining total of un-trenched pipeline consists of several isolated un-trenched sections along the pipeline route.

Note 3: Satisfies the Department for Business, Energy and Industrial Strategy (BEIS) guidance that a minimum of 0.6m top of pipe cover is suitable in most cases for in-situ decommissioning of pipelines and umbilicals.

Note 4: Pipeline burial has also been assessed against varying cover depths less than 0.6m. Pipeline is considered exposed where the depth of cover is less than the top of pipe.

Table 1-1: Pipeline Status Summary from 2016 Survey

The Dunlin Alpha platform is a fixed installation located in the Dunlin field, which lies within the East Shetland Basin of the northern North Sea, originally serving as a manned production facility for the Dunlin, Dunlin South West, Osprey and Merlin fields. The installation stands in 151 metres of water, 506km north-north-east of Aberdeen in block 211/23a of the UK sector of the continental shelf. The installation is orientated 20° west of true north.

Termination of Production from the Greater Dunlin Area was announced by Fairfield on 9th May 2015, following achievement of Maximum Economic Recovery (MER) from these oilfields. Approval for Cessation of Production (CoP) was received from the Oil & Gas Authority (OGA) on 15th January 2016, with CoP confirmed to have occurred on 15th June 2015.

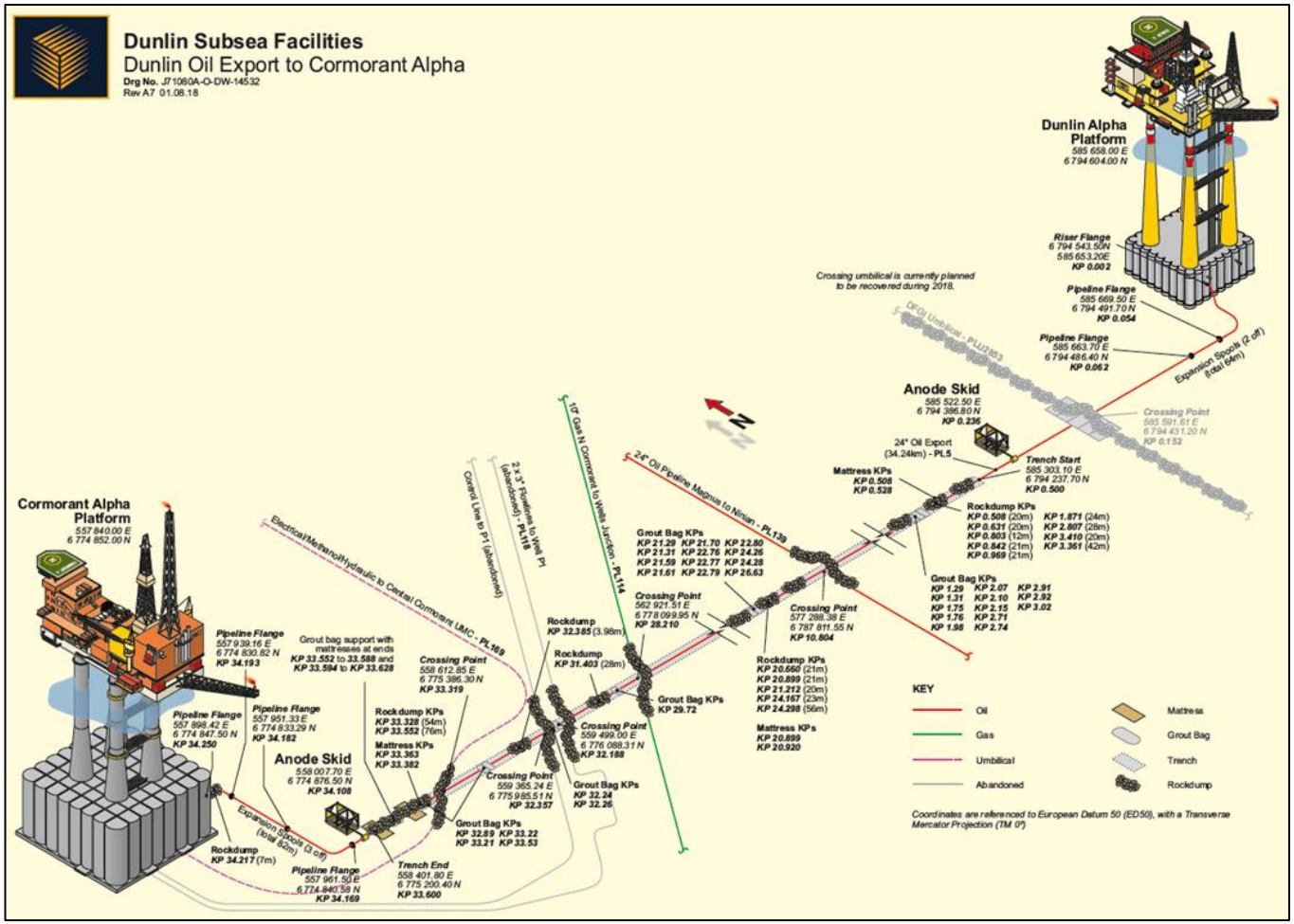



Figure 1-1: Dunlin Alpha to Cormorant Alpha Export Pipeline (PL5) Overview Schematic

## 1.3 Report Structure

This CA Report contains the following:

- Section 1 An introduction to the document and project, including acronyms and references;
- Section 2 An overview of the CA process and methodology adopted;
- Section 3 An overview of the scoping outcomes;
- Section 4 An overview of the CA conducted for Group 8 – Deposits (Trenched Pipeline PL5);
- Section 6 An overview of the CA conducted for Group 2 – Deposits (Partially Exposed);
- Section 7 An overview of the CA conducted for Group 3 – Deposits (Buried);
- Section 4 An overview of the CA conducted for Group 4 – Deposits (Pipeline Support);
- Section 8 A discussion of the evaluations conducted against the groups and the outcomes obtained;
- Appendix A An explanation of the evaluation methodology adopted;
- Appendix B Stakeholder CA Workshop Minutes;
- Appendix C-F The detailed CA Evaluation outcomes for all groups.

## 1.4 Regulatory Context

The decommissioning of offshore oil and gas installations and pipelines on the UKCS is controlled through the Petroleum Act 1998. Part IV of the 1998 Act provides a framework for the orderly decommissioning of disused offshore installations and offshore pipelines on the UKCS. It has been amended a number of times since coming into force, most notably by the Energy Act 2008 and the Energy Act 2016.

The Energy Act 2008 amended Part IV of the Petroleum Act 1998 strengthening the powers of the Secretary of State in relation to financial assurances.

The Energy Act 2016 established the OGA as an independent Government Company and Regulator tasked with Maximising Economic Recovery of offshore UK petroleum. The 2016 Act inserted into the 1998 Act new powers for, and obligations on, the OGA and others in terms of consulting the OGA, regarding decommissioning.

Decommissioning is also regulated under the Marine and Coastal Access Act 2009 and Marine (Scotland) Act 2010 (the Marine Acts). The UK's international obligations on decommissioning are primarily governed by the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (the OSPAR Convention). The responsibility for ensuring compliance with the Petroleum Act 1998 rests with the Department for Business, Energy and Industrial Strategy (BEIS - formerly DECC). BEIS is also the Competent Authority on decommissioning in the UK for OSPAR purposes and under the Marine Acts.

In its consideration of pipeline decommissioning, the BEIS Decommissioning Guidance Notes [1] details the mandatory requirement to perform a CA where operators propose to decommission a pipeline *in situ*. This assessment is conducted to satisfy this requirement and the outcome of which is detailed within this CA Report.

## 1.5 Terms, Abbreviations and Acronyms

| | |
|---|---|
| “ | inches (pipe diameter) |
| AACE | American Association of Cost Engineers |
| AHP | Analytical Hierarchy Process |
| BEIS | Department of Business, Energy and Industrial Strategy |
| CA | Comparative Assessment |
| CGBS | Concrete Gravity Base Substructure |
| $CO_2$ | Carbon Dioxide |
| CSV | Construction Support Vessel |
| dB | Decibels |
| DECC | Department of Energy and Climate Change |
| DoC | Depth of Cover |
| DoL | Depth of Lowering |
| DP | Decommissioning Programme |
| DSV | Diving Support Vessel |
| FAR | Fatal Accident Rate |
| GBP | Great British Pound |
| HSE | Health and Safety Executive |
| JNCC | Joint Nature Conservation Committee |
| k | thousand |
| km | kilometre |
| m | metre |
| MCDA | Multi-Criteria Decision Analysis |
| MER | Maximum Economic Recovery |
| MFE | Mass Flow Excavation |
| MS | Much Stronger |
| MSBL | Mean Seabed Level |
| MW | Much Weaker |
| N/A | Not Applicable |
| OD | Outside Diameter |
| OGA | Oil and Gas Authority |
| OGUK | Oil and Gas United Kingdom |
| OSPAR | Oslo or Paris |
| PL | Pipeline |
| PLL | Potential for Loss of Life |
| QRA | Quantative Risk Assessment |

| | |
|---|---|
| S | Stronger |
| SEPA | Scottish Environment Protection Agency |
| SFF | Scottish Fishermen's Federation |
| ToP | Top of Pipe |
| UKCS | United Kingdom Continental Shelf |
| $TPa^2s$ | Terra Pascals$^2$seconds |
| VMS | Very Much Stronger |
| VMW | Very Much Weaker |
| W | Weaker |

# 2 METHODOLOGY

## 2.1 Overview

CAs are conducted widely in engineering to ensure robust and justified decision making. Industry guidance has been published [2] on the preferred approach to CA for decommissioning and these guidelines recommend a seven step CA process which are introduced in Table 2-1, along with a status and commentary to demonstrate the project's current position. As such, CA forms a core part of the overall decommissioning planning process being undertaken by Fairfield for the subsea infrastructure of the PL5 pipeline.

| Title | Scope | Status | Commentary |
|---|---|---|---|
| Scoping | Decide on appropriate CA method, confirm criteria, identify boundaries of CA (physical and phase). | ✓ | PL5 Decommissioning Inventory [3] prepared for subsea infrastructure.<br>Battery limits defined; CA methodology and criteria established for Screening and revisited following Screening to ensure appropriate to evaluation phase. |
| Screening | Consider alternative uses and deselect unfeasible options. | ✓ | Screening workshops held Q4 2017 with internal project team.<br>Screening outcomes documented in Screening Report [4] |
| Preparation | Undertake technical, safety, environmental and other appropriate studies. Undertake stakeholder engagement. | ✓ | Studies identified during screening phase undertaken to inform the evaluation of the remaining options. Studies completed detailed in Section 2.4. |
| Evaluation | Evaluate the options using the chosen evaluation methodology. | ✓ | Internal workshops held during Q3 2018.<br>Evaluation methodology described in Section 2.5 and outcomes detailed in Section 4, 5, 6 and 7. |
| Recommendation | Create recommendation in the form of narrative supported by charts explaining key trade-offs. | ✓ | The emerging recommendations for the decommissioning options selected were as identified during the Stakeholder CA Workshop. |
| Review | Review the recommendation with internal and/or external stakeholders. | ✓ | The Stakeholder CA Workshop, was held with key external stakeholders (JNCC, SFF, Marine Scotland, BEIS, and OGA) prior to formal CA submission. |
| Submit | Submit to BEIS as part of / alongside Decommissioning Programme (DP) | Q4 2018 | The CA Report is to be submitted in support of the DP. Initial draft DP was submitted to BEIS during Q3 2018 |

Table 2-1: CA Process Overview and Status

## 2.2 Scoping

The scoping phase of the CA process addresses the following elements:

- Boundaries for CA;
- Physical attributes of equipment;
- Decommissioning options;

These are addressed in the following sub-sections.

### 2.2.1 CA Boundaries

The boundaries (battery limits) adopted by Fairfield for the subsea infrastructure of the PL5 pipeline are as follows:

- The Dunlin Alpha topsides pipework, valves and control items;
- Flange tie-in between 24" rigid spools and riser at Cormorant Alpha.

The following equipment is included:

- All subsea structures including their foundations;
- The PL5 rigid subsea pipeline;
- All spools;
- All mattresses / grout bags and deposits.

Infrastructure and equipment associated with Cormorant Alpha (topside pipework, rigid riser etc.) will be considered as part of the Cormorant Alpha Decommissioning Programme and is excluded from this scope.

### 2.2.2 Physical Attributes of Equipment

All subsea equipment within the scope of the PL5 pipeline is listed in the PL5 Decommissioning Inventory [3].

### 2.2.3 Decommissioning Groups

Once the equipment to be decommissioned and their attributes were captured, they were grouped appropriately into common attribute classifications to allow the CA process to be streamlined. These groups and their features are summarised in Table 3-1.

### 2.2.4 Decommissioning Options

With the decommissioning groups established, all potential decommissioning options for each of the groups were identified. The base case for all groups was full removal as per BEIS Decommissioning Guidance Notes [1]. Alternative decommissioning options were considered only where full removal was not considered the only justifiable decommissioning option.

Alongside full removal options, the following partial removal scenarios were considered as specified in the BEIS Decommissioning Guidance Notes [5].

- Pipelines:
  - Re-use;
  - Minimal Intervention i.e. exposed end removal;
  - Minor Intervention i.e. exposed end / spans / exposure removal;
  - Major Intervention i.e. full re-trench or rock cover.

The proposed decommissioning options for the groups where alternative options are considered in addition to full removal are summarised within the following sections:

- Section 4.2 for Group 8 – Trenched Pipeline PL5.
- Section 5.2 for Group 2 – Deposits (Partially Exposed);
- Section 6.2 for Group 3 – Deposits (Buried);
- Section 7.2 for Group 4 – Deposits (Pipeline Support);

## 2.3 Screening

The CA screening phase considers each feasible decommissioning option against the main criteria, as defined within the BEIS Decommissioning Guidance Notes [1].

| Main Criteria |
|---|
| 1. Safety |
| 2. Environment |
| 3. Technical |
| 4. Societal |
| 5. Economic |

Table 2-2: CA Main Criteria

The screening phase was carried out through two workshops held in Q3 2017. The methodology adopted, workshop attendance and outcomes obtained are detailed fully in the Screening Report [4]. The methodology is briefly summarised below:

1. Review decommissioning groups and identify those for full removal;
2. Review BEIS Decommissioning Guidance Notes;
3. Review proposed decommissioning options for each remaining group;
4. Assess decommissioning options against the main criteria and record assessment and outcome in screening worksheets;
5. Document recommendation for evaluation phase of comparative assessment;
6. Record actions required to support retained decommissioning options;
7. Compile Screening Report.

The screening assessment was performed using a coarse, Red / Amber / Green method.

| Rating | Description |
|---|---|
| 1 | Most Preferred |
| 2 | Moderate |
| 3 | Least Preferred |
| 0 | Neutral |

Table 2-3: Screening Assessment Ratings

The outcomes for each group are summarised in Table 4-2, Table 5-2, Table 6-2 and Table 7-2.

## 2.4 Preparation Phase

During the preparation phase, detailed studies and analyses were conducted to provide information to support the evaluation phase of the CA. The studies produced were identified early in the CA process and were supplemented by additional work identified during the screening phase of the CA.

The deliverables produced during the preparation phase of the CA process to support the evaluation are as follows:

| | |
|---|---|
| > Common Scope Report [6] | This report provides information related to execution methodology, schedule, cost, environment and materials to support the evaluation phase of the CA. |
| > Specific Scope Technical Note [7] | This technical note presents the findings from three specific studies in support of the evaluation phase of the CA, namely:<br>> Recovery Feasibility Study;<br>> Trenching & Backfill Feasibility Study;<br>> Long Term Materials Degradation Study. |
| > Option Selection Methodology [8] | This report provides an overview of the option selection methodology that was applied to the CA. |
| > Fisheries QRA [9] | Prepared by Anatec, this report assesses the fishing vessel activity in the proximity of the PL5 pipeline and the crossing frequency between fishing vessels and the pipeline. It develops a value for risk to fishermen, in terms of Potential Loss of Life (PLL)[1], associated with each decommissioning option and thus is used in support of the evaluation phase of the CA. |
| > Commercial Fisheries Baseline [10] | Prepared by Xodus Group with input from SFF Services Limited, this report documents the findings from a desk top study considering the fishing activity around the subsea infrastructure of the PL5 pipeline and its subsea components. It informs the baseline against which potential impacts of the options for decommissioning will be assessed within the CA. |

The key information obtained from these studies / analyses, used during the evaluation phase are provided in attributes tables included in Appendix C to Appendix F.

## 2.5 Evaluation Phase

The evaluation phase of the CA is where the remaining decommissioning options for each group are assessed against each other. Evaluation was conducted according to the OGUK Guidelines [2] and employed the data obtained during the preparation phase as described above.

The evaluation phase incorporated a number of workshops attended by the decommissioning project team, where each of the remaining decommissioning groups was assessed individually, with options scored against five key criteria and their respective sub-criteria (see Appendix A.2 for detailed descriptions).

Options were scored against each other on a pair-wise basis, using the qualitative terms Neutral, Stronger, Much Stronger, Very Much Stronger, Weaker, Much Weaker and Very Much Weaker. By this means the assessment team was able to debate the strengths and weaknesses of each option at the sub-criteria level

[1] Explanation regarding definition of PLL can be found in Appendix A.2.

and reach a consensus without having to apply quantitative scoring. The preferences were processed within the worksheet to produce a percentage split for each sub-criterion and this was cumulatively displayed to provide a score for each option.

### 2.5.1 Criteria and Sub-Criteria Weightings

The main criteria have been weighted equally. Given the differing, and sometimes conflicting, considerations that are represented by the criteria it was considered appropriate that they be weighted equally to one another to avoid favouring any particular aspect or group. Similarly, the sub-criteria have been weighted neutrally within their primary criterion.

More detail of the methodology adopted for the evaluation phase for the PL5 pipeline is detailed in Appendix A.

## 2.6 External Review

The review phase entailed the presentation of the emerging recommendations for each group to key external stakeholders followed by discussion. Formal minutes of the discussion were taken and relevant feedback captured. These minutes are included in Appendix B of this CA Report.

During the review of the emerging recommendations, a number of challenges were made to the evaluation conducted and thus the potential validity of the emerging recommendations obtained. These challenges were addressed by running sensitivities within the evaluation tool and recording the impact that these adjustments had on the outcomes obtained. These adjustments were done ‘live’ during the workshop.

These sensitivities are discussed in detail in the discussion and recommendations in Section 8.

# 3 COMPARATIVE ASSESSMENT - SCOPING OUTCOME

## 3.1 Decommissioning Groups

The subsea infrastructure was arranged into groups, as detailed within the CA Scoping Report [11]. All feasible decommissioning options for each group were considered and those options which were not considered feasible were screened out, as detailed within the Screening Report [4].

The requirement or otherwise to comparatively assess each identified group is summarised within Table 3-1 below.

| Group | Description | Decommissioning Approach |
|---|---|---|
| 1 | Structures | Full removal |
| 2 | Deposits (Partially Exposed) | Subject to full CA |
| 3 | Deposits (Buried) | Subject to full CA |
| 4 | Deposits (Pipeline Support) | Subject to full CA |
| 5 | Dunlin Alpha Platform Pipework, Valves & Control Items | Note 1 |
| 6 | Dunlin Alpha Riser within CGBS | Note 2 |
| 7 | Surface Laid Spools | Full removal - Note 3 |
| 8 | Trenched Pipeline PL5 | Subject to full CA |

Note 1: This group was not subject to CA under the PL5 scope. These items reside on Dunlin Alpha and shall be removed as part of the platform topsides removal scope.

Note 2: This group was not subject to CA under the PL5 scope. The PL5 riser is integrated within the Dunlin Alpha CGBS and will be covered under the Dunlin Alpha Decommissioning Programme.

Note 3: The decommissioning approach (full removal) for the PL5 surface laid spools at the Cormorant Alpha end will require prior agreement with TAQA and/or Brent Systems.

Table 3-1: Groups and Decommissioning Recommendation

# 4 CA OUTCOME - GROUP 8 – TRENCHED PIPELINE

Group 8 – Trenched Pipeline is addressed first in this document as it was the first group addressed during the evaluation workshops. The rationale for addressing Group 8 first was that the other remaining decommissioning groups i.e. the various types of deposits and support materials, have a strong functional relationship with the pipeline in that they only exist because of the pipeline. In addition, from the preparatory work conducted, it was clear that Group 8 would require the greatest scope in terms of quantity of material and resources required to address the decommissioning options.

## 4.1 Group Characteristics

The trenched pipeline group considers the 34.218km by 24" diameter concrete coated pipeline between the Dunlin Alpha and Cormorant Alpha platforms. The extent of the pipeline considered within Group 8 is up to the tie-in spools at either platform and is highlighted in orange in Figure 4-1. By way of summary, the key characteristics are presented in Table 4-1.

| Group No. | Group Details | Coating Details | Length (km) | OD (mm) | WT (mm) | Weight (Te/m) |
|---|---|---|---|---|---|---|
| 8 | 24" Concrete Coated Pipeline | 6.5mm Asphalt Enamel<br>51mm Concrete | 34.218 | 609.5 Note 1 | 15.9 Note 1 | 0.507 |
| Note 1: of the rigid steel pipe wall. | | | | | | |

Table 4-1: Group 8 Items

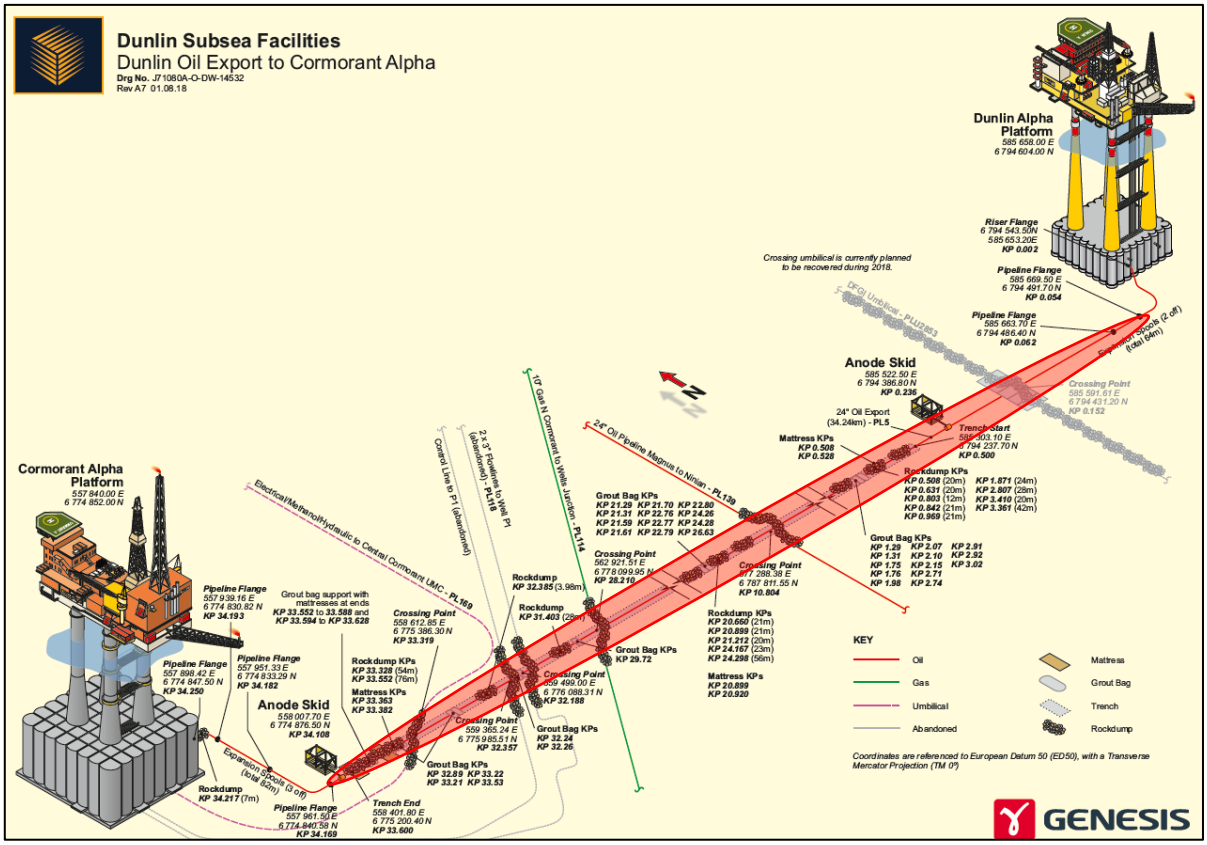



Figure 4-1: Group 8: Trenched Pipeline Schematic

## 4.2 Decommissioning Options & Screening Outcome

The decommissioning options identified for Group 8 – Trenched Pipeline are detailed in Table 4-2.

The colour coding indicates the outcome from the CA Screening process [4].

Green indicates that the option was carried through to evaluation, whereas grey represents options that were screened out.

In this case, four options were retained for evaluation.

| Group 8 – Trenched Pipeline | | |
|---|---|---|
| **Category** | **Option** | **Description** |
| Leave *in situ* – Minimal Intervention | 1 – Remove and recover exposed ends and rock cover snag hazards. | Based on the current installed condition showing no evidence of significant interaction and low level of seabed mobility, it was recommended to carry this option forward to evaluation. |
| | 1a – Trench and bury exposed ends and rock cover snag hazards | Option 1 (Alternative 2) considered trenching and lowering the exposed pipeline ends into the seabed rather than removing for onshore disposal as proposed in Option 1 (Alternative 1). When compared to Option 1 (Alternative 1) this option adds additional technical challenges and achieves similar results. As such, it was recommended not to progress this option. |
| Leave *in situ* – Minor Intervention (Partial Removal) | 2 – Remove and recover exposed ends and snag hazards, spot rock cover on cut ends. | When compared to Option 1 (Alternative 1) this option was found to be more energy and resource intensive with marginal increase in safety risk to offshore and onshore personnel. As this option provided no material benefit over Option 1 (Alternative 1) it was recommended that this option not be carried forward. |
| Leave *in situ* – Major Intervention | 3a – Remove and recover exposed ends and rock cover entire remaining line. | When compared to Option 1 (Alternative 1) full remedial rock cover is found to be more energy resource intensive with marginal increase in utilisation of both onshore and offshore personal during execution phase. However, the end state of this option would limit the potential for future hazards to other users of the sea, therefore, it was recommended to carry this option forward to evaluation. |
| | 3b – Remove and recover exposed ends and re-trench and bury entire remaining line. | When compared to Option 1 (Alternative 1 & 2) and Option 2 the full re-trench is found to be more energy resource intensive and adds additional technical challenges. Option 3 (Alternative 2) aims to lower the pipeline into seabed, this would limit the potential residual risk to other sea users. As such, it was recommended to carry this option forward to evaluation. |
| Full Removal | 4 – Reverse S-Lay | The end state of Option 4 and Option 5 are similar and considering Option 4 having significant technical challenges therefore, it is recommended not to carry this option forward. |
| Full Removal | 5 – Cut and Lift | When compared to Option 1 (Alternative 1) and Option 3 (Alternative 1 & 2) the cut and lift option carries a high safety risk, a significant level of technical complexity during material handling and a high cost of execution. In comparison to Option 4 (Reverse S-Lay) the cut and lift proposal is achievable with existing technology and methods. As such, it was recommended to carry this option forward to evaluation. |

Table 4-2: Group 8 Decommissioning Options

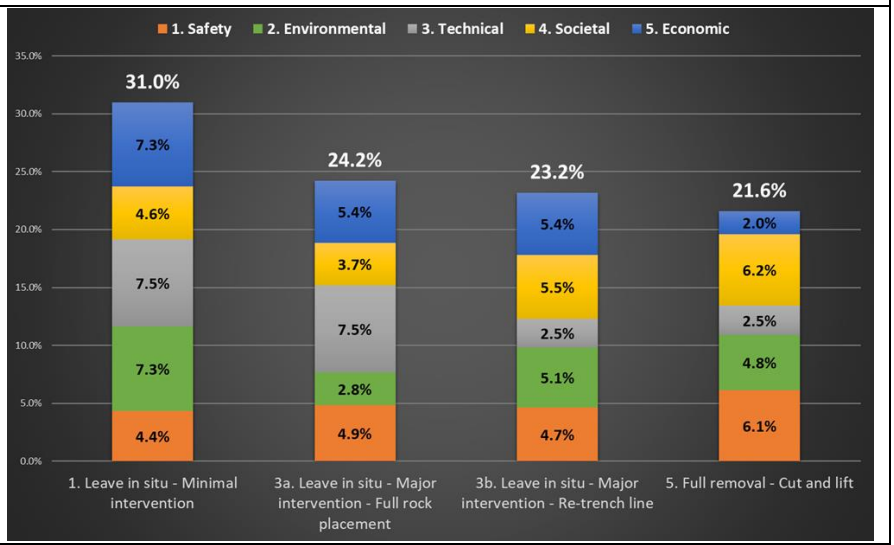
## 4.3 Decommissioning Options for Evaluation

The decommissioning options for Group 8 that remained after screening and which were taken forward to the evaluation phase were:

- Leave *in situ* (minimal intervention);
  - 1 – Disconnect / remove ends and rock cover snagging hazards.
- Leave *in situ* (major intervention);
  - 3a – Disconnect / remove ends and rock cover entire remaining pipeline;
  - 3b – Disconnect / remove ends and re-trench entire remaining pipeline.
- Full Removal;
  - 5 – Cut and recover entire pipeline and return to shore for recycling.

A summary of the evaluation results is provided in Section 4.4 overleaf.

## 4.4 Evaluation Summary

<table>
<tr><th colspan="6">Group 8 – Deposits (Pipeline Support)</th></tr>
<tr><td rowspan="2">Screening</td><td colspan="2">1 – Leave in situ (Minimal Intervention) Disconnect / remove ends. Rock cover snag hazards.</td><td colspan="2">1a – Leave in situ (Minimal Intervention) Trench & bury ends. Rock cover snag hazards</td><td>2 – Leave in situ (Minor Intervention) Disconnect / remove ends & snag hazards. Spot rock cover on cut ends.</td></tr>
<tr><td colspan="2">3a – Leave in situ (Major Intervention) Disconnect / remove ends. Rock cover entire remaining pipeline.</td><td colspan="2">3b – Leave in situ (Major Intervention) Disconnect / remove ends. Re-trench entire remaining pipeline.</td><td>4 – Full Removal Reverse S-Lay</td><td>5 – Full Removal Cut and Lift</td></tr>
<tr><td colspan="6">Note: for full attributes tables and assessment see Appendix C</td></tr>
<tr><td rowspan="4">Evaluation</td><td>Safety</td><td colspan="4">Option 1 is preferred from a risk to Operations Personnel perspective as it requires fewer operations than the other options and thus the personnel risk is lower for Option 1.<br>All options are equally preferred to Option 5 from a risk to Other Users perspective due to the much higher number of days of working with this option.<br>From a Legacy Risk perspective, Option 5 is preferred as the snag hazard associated with the other options is higher.<br>Overall, Option 5 is assessed as the preferred option, dominated by legacy risk</td></tr>
<tr><td>Environment</td><td colspan="4">Option 1 is preferred from an Operational Marine Impacts perspective. This is due to the lower impact from the small area of rock cover versus larger areas of rock cover for Option 3a and large areas of trenching or MFE deburial for Option 3b and Option 5. Whilst there are differences in the noise profile for the options, the impact from a noise perspective was assessed as insufficient to express a preference. Additionally, the impact from the additional vessels and durations for Option 5 and the releases from cutting the line were considered minimal.<br>From an Atmospheric Emissions and Consumptions perspective, Option 3b is preferred. This is due to it having similar emissions and consumptions to other options but less requirement for rock cover.<br>All options other than Option 3a are equally preferred from a Legacy Marine Impact perspective due to the long-term impact associated with the large amount of rock cover for Option 3a.<br>Overall, Option 1 is assessed as the preferred option.</td></tr>
<tr><td>Technical</td><td colspan="4">Options 1 and 3a are preferred from a Technical Risk perspective as these are considered largely routine operations. There are challenges associated with the trenching for Option 3b and the cut and lift for Option 5.<br>Overall, Option 1 and Option 3a are assessed as equally preferred.</td></tr>
<tr><td>Societal</td><td colspan="4">Option 5 is preferred from a Societal – Fishing Industry perspective as the pipeline is fully removed.<br>All options are equally preferred from a Societal – Other Groups perspective as there are similar materials returned with Options 1, 3a and 3b. Whilst there is more material returned under Option 5, the negative aspects of this are offset by the larger job creation / retention provided by the greater scope.<br>Overall, Option 5 is assessed as the preferred option.</td></tr>
<tr><td>Economic</td><td colspan="4">Option 1 is preferred from an Economic perspective due to it being less expensive to deliver than Option 3a and 3b and significantly less than Option 5.<br>Overall, Option 1 is assessed as the preferred option.</td></tr>
<tr><td>Summary</td><td colspan="2">Overall, Option 1 is selected as the preferred option.<br>It is the preferred option against the Environmental equally preferred against the Technical criteria. Whilst Option 5 is preferred against the Safety and Societal criteria, this was insufficient to alter the assessment.<br>Including the economic criteria strengthens the preference for Option 1.</td><td colspan="3"> 
</td></tr>
</table>

# 5 CA OUTCOME – GROUP 2 – DEPOSITS (PARTIALLY EXPOSED)

## 5.1 Group Characteristics

Group 2 – Deposits (Partially Exposed) comprise of eight concrete mattresses that were installed as part of span rectification works and are partially buried by rock material. The mattresses are located at KP 0.505, KP0.525, KP20.922, KP33.363, KP33.380, KP33.556, KP33.587 and KP33.593. Approximate locations of these mattresses are highlighted in orange in Figure 5-1 and illustrated further in Figure 5-2. By way of summary, the key characteristics are presented in Table 5-1:

| Group No. | Group Name | Group Details | Quantity | Weight (Te) |
|---|---|---|---|---|
| 2 | Deposits (Partially Exposed) | Partially buried concrete mattresses (6 x 3 x 0.15m) | 8 | 54 |

Table 5-1: Group 2 Materials

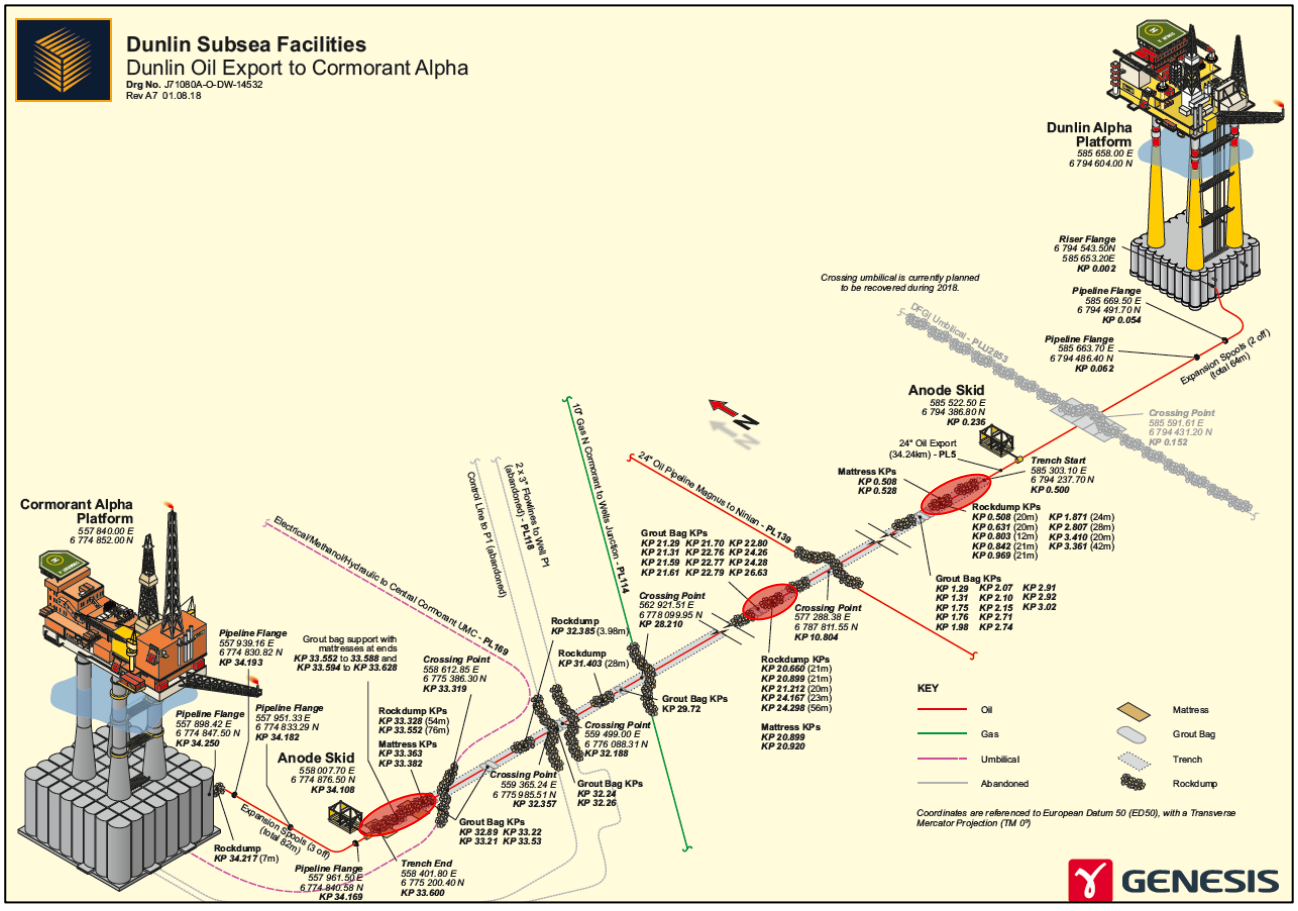



Figure 5-1: Group 2: Deposits (Partially Exposed) Schematic


Figure 5-2 Typical Mattress Coverage - 2016 Survey Footage

## 5.2 Decommissioning Options & Screening Outcome

The decommissioning options identified for Group 2 are detailed in Table 5-2.

The colour coding indicates the outcome from the CA Screening process.

Green indicates that the option was carried through to evaluation, whereas grey represents options that were screened out.

In this case, both options assessed were retained for evaluation.

| Group 2 – Deposits (Partially Exposed) | | |
|---|---|---|
| **Category** | **Option** | **Description** |
| Leave *in situ* | 1 – Leave *in situ* | No change to current status. |
| Full Removal | 2 – Full Removal – Lift / Recover | Expose the items, removal and recovery of concrete mattresses, spot rock cover over snag hazards to provide over-trawlable berm profile. |

Table 5-2: Group 2 Decommissioning Options

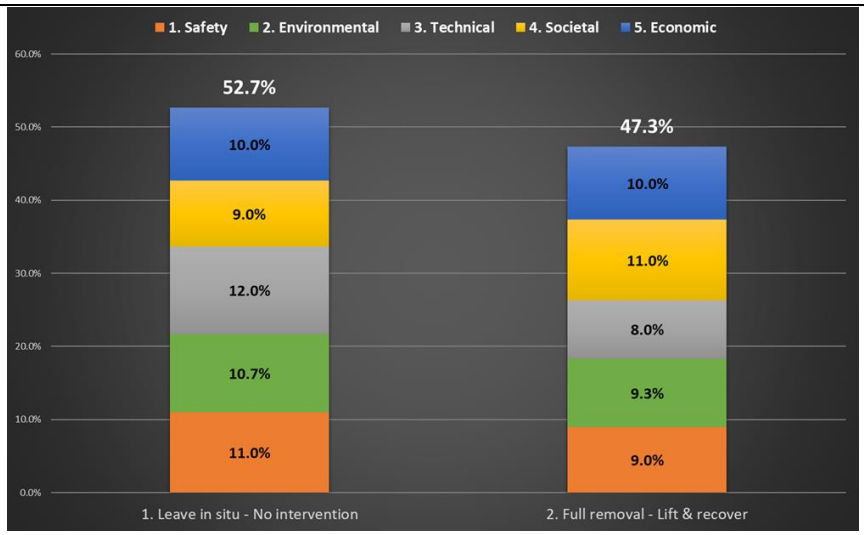
## 5.3 Decommissioning Options for Evaluation

The decommissioning options for Group 2 that remained after screening and which were taken forward to the evaluation phase were:

- Leave *in situ* (minimal intervention)
  - 1 – No change to current status
- Full removal
  - 2 – Full removal – lift / recover

A summary of the evaluation results is provided in Section 5.4 overleaf.

## 5.4 Evaluation Summary

<table>
<tr><th colspan="3">Group 2 – Deposits (Partially Exposed)</th></tr>
<tr><td>Screening</td><td>1 – Leave in situ</td><td>2 – Full Removal – Lift / Recover</td></tr>
<tr><td colspan="3">Note: for full attributes tables and assessment see Appendix D</td></tr>
<tr><td rowspan="5">Evaluation</td><td>Safety</td><td colspan="2">Option 1 is preferred from a risk to Operations Personnel perspective as it requires fewer operations than Option 2 and thus the personnel risk is lower for Option 1.<br>Each option is equally preferred from a risk to Other Users perspective as, whilst the operations for Option 2 are longer duration, the impact to Other Users is considered minimal for both options.<br>From a Legacy Risk perspective, Option 2 is preferred as the mattresses are removed and replaced with rock cover, thus reducing the snag risk.<br>Overall, Option 1 is assessed as the preferred option.</td></tr>
<tr><td>Environment</td><td colspan="2">Option 1 is preferred from an Operational Marine Impacts perspective. This is due to the impact from the area of short-term seabed disturbance associated with Option 2. The impact from a noise perspective was assessed as insufficient to express a preference. All other Operational Marine Impacts were largely similar.<br>From an Atmospheric Emissions and Consumptions perspective, both options were equally preferred, with similar emissions and the small amount of rock required for Option 2 considered insufficient to express a preference.<br>Both options are also equally preferred from a Legacy Marine Impact perspective with the impact from leaving the mattresses in situ to degrade over time and the small area of permanently altered seabed from the rock cover being considered largely similar.<br>Overall, Option 1 is assessed as the preferred option.</td></tr>
<tr><td>Technical</td><td colspan="2">Whilst both options are considered technically achievable, the potential challenges associated with recovering mattresses which may become damaged and the potential for requiring a revision of the decommissioning programme to leave them in situ and rock cover was considered sufficient to indicate a preference for Option 1.<br>Overall, Option 1 is assessed as the preferred option.</td></tr>
<tr><td>Societal</td><td colspan="2">Option 2 is preferred from a Societal – Fishing Industry perspective to the removal of the snag hazard (resulting in loss of fishing equipment).<br>Both options were equally preferred from a Societal – Other Groups perspective as the materials returned with Option 2 were considered to have insignificant negative or positive societal impacts.<br>Overall, Option 2 is assessed as the preferred option.</td></tr>
<tr><td>Economic</td><td colspan="2">Both options were equally preferred from an Economic perspective. Whilst there is a small differential in the costs, this was insufficient to express a preference.<br>Overall, both options are equally preferred.</td></tr>
<tr><td>Summary</td><td colspan="2">Overall, Option 1 is selected as the preferred option.<br>It is the preferred option against the Safety, Environmental and Technical criteria.<br>Option 2 being preferred from a Societal perspective is insufficient to alter the overall outcome.<br>Including the economic criteria, given that the options are equally preferred, does not alter the outcome.</td><td> 
</td></tr>
</table>

# 6 CA OUTCOME - GROUP 3 – DEPOSITS (BURIED)

## 6.1 Group Characteristics

The buried deposits group comprise nine concrete mattresses and an estimated 1,840 grout bags that were installed as part of span rectification works and are buried by rock material. Approximate locations of these mattresses are highlighted in orange in Figure 6-1. By way of summary, the key characteristics are presented in Table 6-1:

| Group No. | Group Name | Group Details | Quantity | Weight (Te) |
|---|---|---|---|---|
| 3 | Deposits (Buried) | Buried concrete mattresses (6 x 3 x 0.15m) | 9 | 60.8 |
| | | Buried grout bags (25kg) | 1,840 | 46 |

Table 6-1: Group 3 Materials

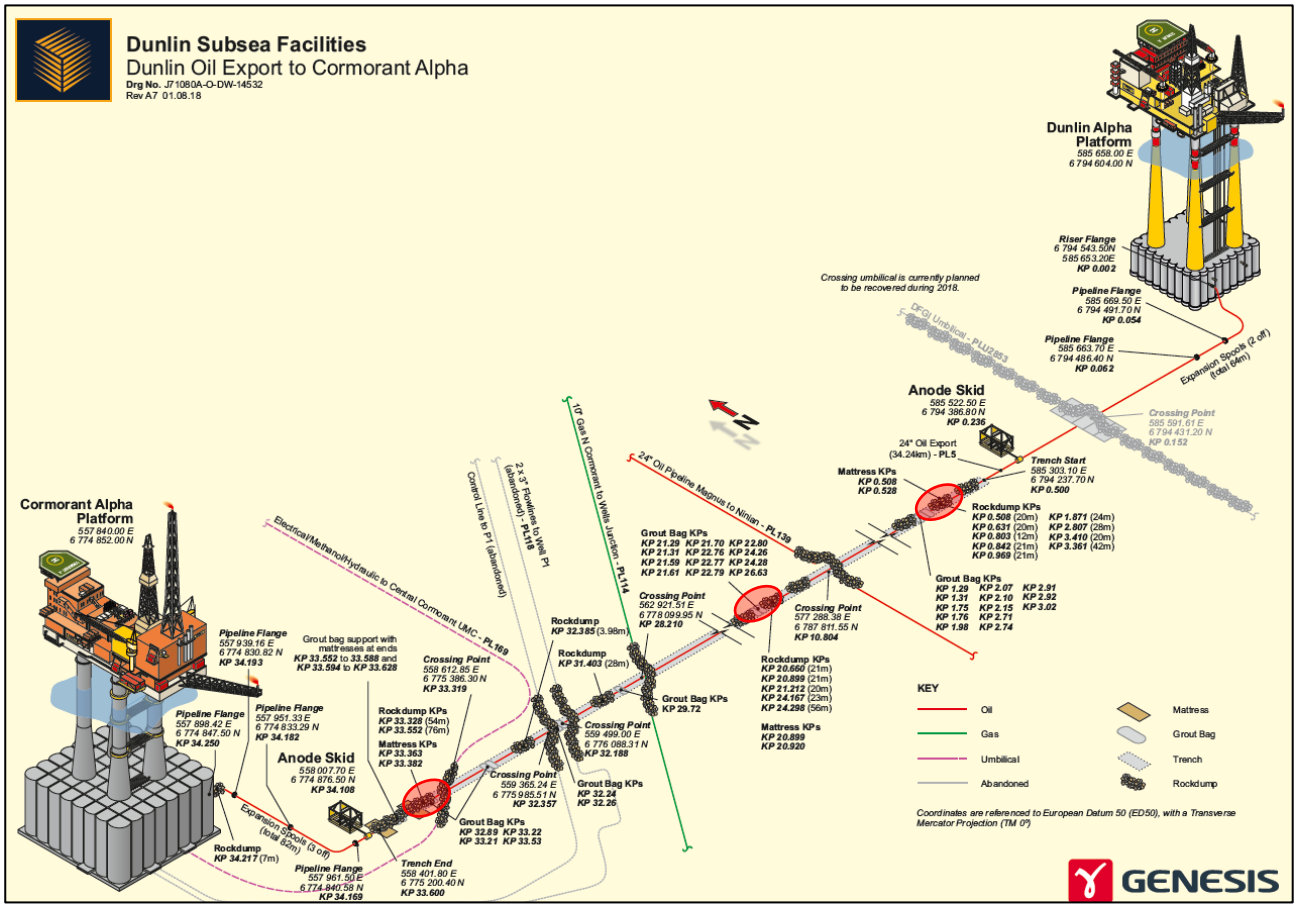



Figure 6-1: Group 3: Deposits (Buried) Schematic

## 6.2 Decommissioning Options & Screening Outcome

The decommissioning options identified for Group 3 are detailed in Table 6-2. The colour coding indicates the outcome from the CA Screening process [4].

Green indicates that the option was carried through to evaluation, whereas grey represents options that were screened out.

In this case, both options assessed were retained for evaluation.

| Group 3 – Deposits (Buried) | | |
|---|---|---|
| **Category** | **Option** | **Description** |
| Leave *in situ* | 1 – Leave *in situ* | No change to current status. |
| Full Removal | 2 – Full Removal – Lift / Recover | Expose the items, removal and recovery of grout bags and concrete mattress, spot rock cover over snag hazards to provide over-trawlable berm profile. |

Table 6-2: Group 3 Decommissioning Options

## 6.3 Decommissioning Options for Evaluation

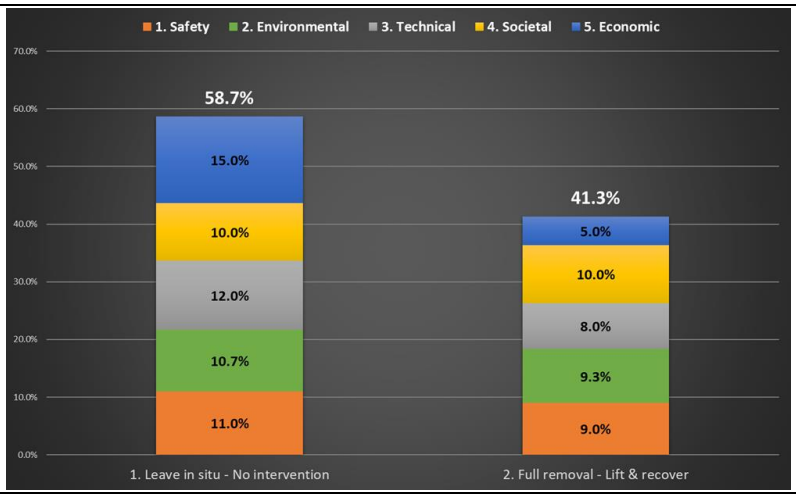
The decommissioning options for Group 3 that remained after screening and which were taken forward to the evaluation phase were:

- Leave *in situ* (minimal intervention)
  - 1 – No change to current status
- Full removal
  - 2 – Full removal – lift / recover

A summary of the evaluation results is provided in Section 6.4 overleaf.

## 6.4 Evaluation Summary

<table>
<tr><th colspan="3">Group 3 – Deposits (Buried)</th></tr>
<tr><td>Screening</td><td>1 – Leave in situ</td><td>2 – Full Removal – Lift / Recover</td></tr>
<tr><td colspan="3">Note: for full attributes tables and assessment see Appendix E</td></tr>
<tr><td rowspan="5">Evaluation</td><td>Safety</td><td colspan="2">Option 1 is preferred from a risk to Operations Personnel perspective as it requires significantly fewer offshore operations than the recovery of the buried mattresses and grout bags under Option 2. There is also less onshore processing required as no material is returned.<br>Neither option is preferred from a risk to Other Users perspective as, whilst the operations for Option 2 are longer duration, the impact to Other Users is considered minimal for both options.<br>From a Legacy Risk perspective, Option 2 is preferred as the mattresses / grout bags are removed and replaced with rock cover. This does reduce the snag risk, however the reduction is small as the deposits are already buried.<br>Overall, Option 1 is assessed as the preferred option.</td></tr>
<tr><td>Environment</td><td colspan="2">Option 1 is preferred from an Operational Marine Impacts perspective. This is due to the impact from the area of short-term seabed disturbance associated with the deburial of the deposits and introduction of rock cover for Option 2. Additionally, MFE deburial has the potential to damage the plastic grout bags through abrasion of the outer bag and to disperse plastic into the water column. The impact from a noise perspective was assessed as insufficient to express a preference. All other Operational Marine Impacts were largely similar.<br>From an Atmospheric Emissions and Consumptions perspective, both options were equally preferred, with similar emissions and the small amount of rock required for Option 2 considered insufficient to express a preference.<br>Both options are also equally preferred from a Legacy Marine Impact perspective with the impact from leaving the mattresses and grout bags in situ to degrade over time and the small area of permanently altered seabed from the rock cover being considered largely similar. It was noted that the ability for plastic to enter the water column over time was mitigated by the deposits being buried.<br>Overall, Option 1 is assessed as the preferred option.</td></tr>
<tr><td>Technical</td><td colspan="2">Whilst both options are considered technically achievable, the potential challenges associated with recovering mattresses / grout bags which may become damaged and the potential for requiring a revision of the decommissioning programme to leave them in situ and rock cover, was considered sufficient to indicate a preference for Option 1.<br>Overall, Option 1 is assessed as the preferred option.</td></tr>
<tr><td>Societal</td><td colspan="2">Both options are equally preferred from a Societal – Fishing Industry perspective as the deposits are currently buried.<br>Both options are also equally preferred from a Societal – Other Groups perspective as the materials returned with Option 2 were considered to have insignificant negative or positive societal impacts.<br>Overall, both options are equally preferred.</td></tr>
<tr><td>Economic</td><td colspan="2">Option 1 is preferred from an Economic perspective due to it being significantly less expensive to deliver than Option 2 which is 5 times more expensive.<br>Overall, Option 1 is assessed as the preferred option.</td></tr>
<tr><td>Summary</td><td colspan="2">Overall, Option 1 is selected as the preferred option.<br>It is the preferred option against the Safety, Environmental and Technical criteria and equally preferred from a Societal perspective.<br>Including the economic criteria strengthens the preference for Option 1.</td></tr>
</table>



# 7 CA OUTCOME - GROUP 4 – DEPOSITS (PIPELINE SUPPORT)

## 7.1 Group Characteristics

The pipeline support deposits group comprise an estimated 2,500 grout bags that were installed as part of span rectification work (without rock cover). The approximate locations of these grout bags are highlighted in orange in Figure 7-1 and illustrated further in Figure 7-2. By way of summary, the key characteristics are presented in Table 7-1:

| Group No. | Group Name | Group Details | Quantity | Weight (Te) |
|---|---|---|---|---|
| 4 | Deposits (Pipeline Support) | Grout bags (25kg) used for pipeline support | est. 2,500 | 62.5 |

Table 7-1: Group 4 Materials

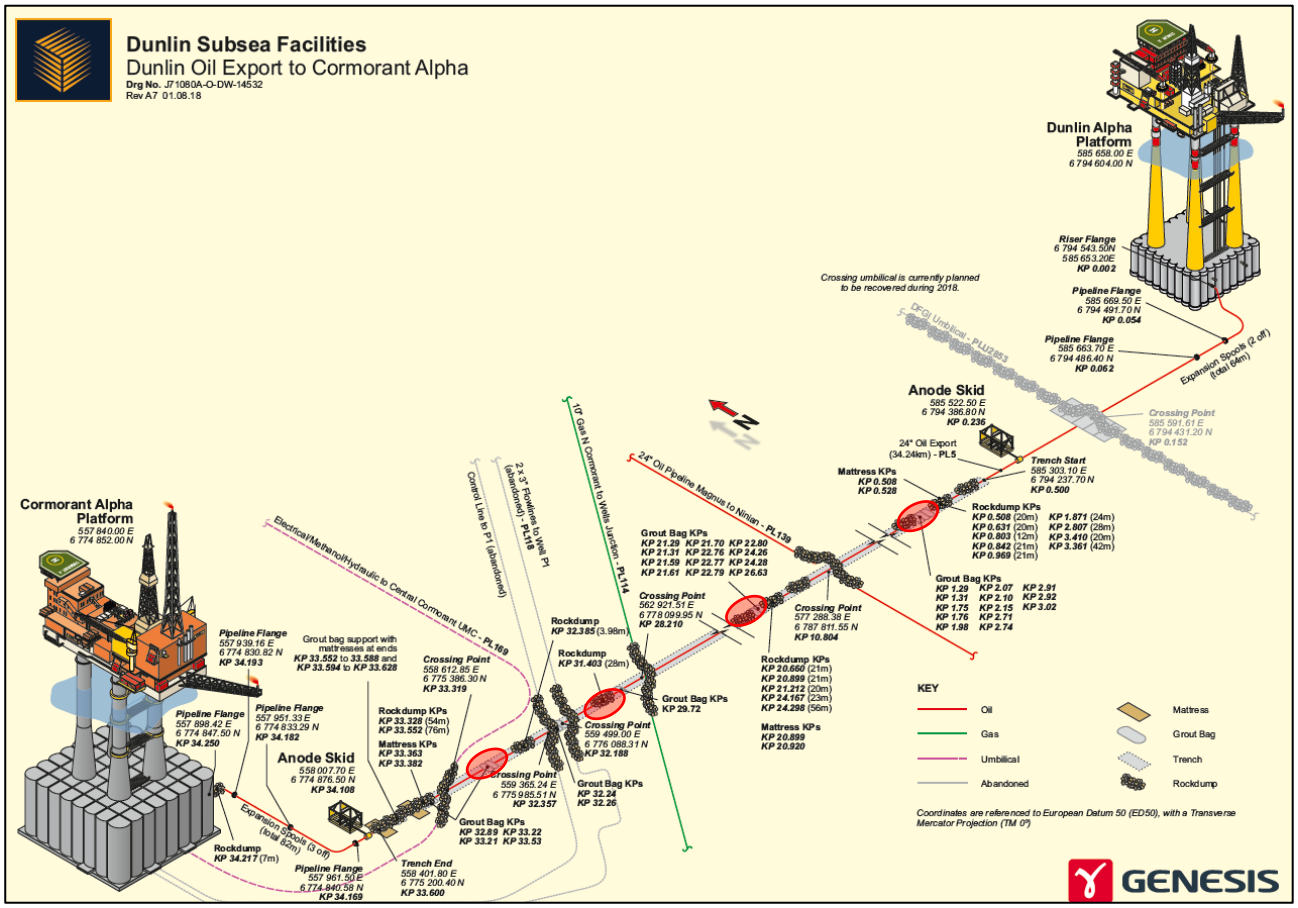



Figure 7-1 Group 4: Deposits (Pipeline Support) Schematic


Figure 7-2 Typical Deposits (Pipeline Support) - 2016 Survey Footage

## 7.2 Decommissioning Options & Screening Outcome

The decommissioning options identified for Group 4 – Deposits (Pipeline Support) are detailed in Table 7-2.

The colour coding indicates the outcome from the CA Screening process.

Green indicates that the option was carried through to evaluation, whereas grey represents options that were screened out.

In this case, both options assessed were retained for evaluation.

| Group 4 – Deposits (Pipeline Support) | | |
|---|---|---|
| **Category** | **Option** | **Description** |
| Leave *in situ* | 1 – Leave *in situ* | Spot rock cover over snag hazards to provide over-trawlable berm profile. |
| Full Removal | 2 – Full Removal – Lift / Recover | Removal and recovery of grout bags, spot rock cover over snag hazards to provide over-trawlable berm profile. |

Table 7-2: Group 4 Decommissioning Options

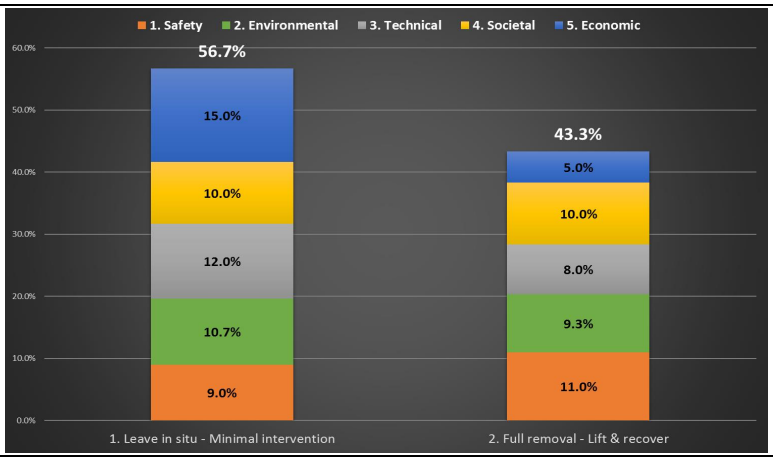
## 7.3 Decommissioning Options for Evaluation

The decommissioning options for Group 4 that remained after screening and which were taken forward to the evaluation phase were:

- Leave *in situ* (minimal intervention)
  - 1 – Spot rock cover over snag hazards to provide over-trawlable berm profile.
- Full removal
  - 2 – Removal and recovery of grout bags, spot rock cover over snag hazards to provide over-trawlable berm profile.

A summary of the evaluation results is provided in Section 7.4 overleaf.

## 7.4 Evaluation Summary

<table>
<tr><th colspan="4">Group 4 – Deposits (Pipeline Support)</th></tr>
<tr><td>Screening</td><td colspan="2">1 – Leave In Situ</td><td>2 – Full Removal – Lift / Recover</td></tr>
<tr><td colspan="4">Note: for full attributes tables and assessment see Appendix F</td></tr>
<tr><td rowspan="5">Evaluation</td><td>Safety</td><td colspan="2">Option 1 is preferred from a risk to Operations Personnel perspective as it requires fewer operations than Option 2 and thus the personnel risk is lower for Option 1.<br>Neither option is preferred from a risk to Other Users perspective as, whilst the operations for Option 2 are longer duration, the impact to Other Users is considered minimal for both options.<br>From a Legacy Risk perspective, Option 2 is preferred as the deposits are removed and replaced with rock cover, thus reducing the snag risk.<br>Overall, Option 1 is assessed as the preferred option.</td></tr>
<tr><td>Environment</td><td colspan="2">Option 1 is preferred from an Operational Marine Impacts perspective. This is due to the impact from the greater area of short-term seabed disturbance associated with the deburial of the deposits and increased introduction of rock cover for Option 2. Additionally, Mass Flow Excavation (MFE) deburial has the potential to damage the plastic grout bags through abrasion of the outer bag and to disperse plastic into the water column. The impact from a noise perspective was assessed as insufficient to express a preference. All other Operational Marine Impacts were largely similar.<br>From an Atmospheric Emissions and Consumptions perspective, both options were equally preferred, with similar emissions and the small increase in the amount of rock required for Option 2 considered insufficient to express a preference.<br>Both options are also equally preferred from a Legacy Marine Impact perspective with the impact from leaving the grout bags in situ to degrade over time and the small area of permanently altered seabed from the rock cover being considered largely similar. It was noted that the ability for plastic to enter the water column over time was mitigated by the deposits being buried.<br>Overall, Option 1 is assessed as the preferred option.</td></tr>
<tr><td>Technical</td><td colspan="2">Whilst both options are considered technically achievable, the potential challenges associated with recovering grout bags which may become damaged was considered sufficient to indicate a preference for Option 1.<br>Overall, Option 1 is assessed as the preferred option.</td></tr>
<tr><td>Societal</td><td colspan="2">Both options are equally preferred from a Societal – Fishing Industry perspective as the deposits buried with rock cover or removed with replacement rock cover are considered largely similar.<br>Both options are also equally preferred from a Societal – Other Groups perspective as the materials returned with Option 2 were considered to have insignificant negative or positive societal impacts.<br>Overall, both options are equally preferred.</td></tr>
<tr><td>Economic</td><td colspan="2">Option 1 is preferred from an Economic perspective due to it being significantly less expensive to deliver than Option 2 which is more than 3 times more expensive.<br>Overall, Option 1 is assessed as the preferred option.</td></tr>
<tr><td>Summary</td><td colspan="2">Overall, Option 1 is selected as the preferred option.<br>It is the preferred option against the Environmental and Technical criteria and equally preferred from a Societal perspective. It is not the preferred option against the safey criterion but this is insufficient to offset the other preferences.<br>Including the economic criteria strengthens the preference for Option 1.</td><td> 
</td></tr>
</table>

# 8 CA RECOMMENDATIONS

The outcomes obtained from performing the CA of the decommissioning groups and decommissioning options for the Subsea Infrastructure of the PL5 pipeline are summarised here.

Two groups were identified at Scoping where full removal was the recommended decommissioning approach without any further consideration:

- Group 1 – Structures;
- Group 7 – Surface Laid Spools.

There were two groups whose fate was dictated by the results of the Dunlin Alpha CGBS comparative assessment:

- Group 5 – Dunlin Alpha Platform Pipework, Valves & Control Items;
- Group 6 – Dunlin Alpha Riser within CGBS.

The full CA process was applied to the four remaining decommissioning groups. The discussion and recommended decommissioning option for each of these groups is described below.

## 8.1 Group 8 – Trenched Pipeline PL5

The outcome from the CA showed that Option 1 (Leave *in situ* – Minimal Intervention) was the preferred option for Group 8 – Trenched Pipeline PL5. A discussion of the relative merits of the options against each of the primary and sub-criteria are provided in the following sub-sections.

### 8.1.1 Safety

| Option | Description |
|---|---|
| Option 1 | Leave *in situ* – Minimal Intervention (Remove exposed ends and rock cover snag hazards) |
| Option 3a | Leave *in situ* – Major Intervention (Remove exposed ends and rock cover entire line) |
| Option 3b | Leave *in situ* – Major Intervention (Remove exposed ends and re-trench entire line) |
| Option 5 | Full Removal (Cut and Lift) |

**Operations Personnel**

Both the offshore and onshore work scope and thus operations personnel risk exposure was the lowest for Option 1 making this the preferred option. Option 3a and Option 3b were assessed as slightly less preferred than Option 1 as the work scopes and hence the risk exposure is marginally greater. Option 5 is much less preferred than the other options due to the extended work scope and associated increase in personnel risk exposure.

**Other Users**

The impact on other users of the sea from a safety perspective was assessed as minimal for Options 1, 3a and 3b and these options were equally preferred accordingly. The much longer duration of the work scope for Option 5 results in an increase in the number of vessel transits and greater presence of vessels in various locations along the pipeline than any of the other options. Whilst it was recognised that although this only presents a small increase in the risk posed to other users, it was accepted that this would be less preferred than the other options.

**Legacy Risk**

Option 1 was considered the least attractive option from a legacy risk perspective due largely to the potential residual snag hazard for fishing vessels. Options 3a and 3b are preferred over Option 1 as the snag hazard is mitigated further by the full rock cover or retrenching and burial of the line which provides a sufficient level

of cover over the pipeline to mitigate against snag hazards. Option 5 was the clear preferred option due to the line being fully removed and therefore the legacy risk would be eliminated.

During the Stakeholder CA Workshop, where the emerging recommendations were reviewed with the stakeholders, there was a challenge raised against the score between Option 3a and Option 3b. These options were scored as neutral to each other from a legacy risk perspective and it was proposed to run a sensitivity (Sensitivity 1) where Option 3a was considered weaker than Option 3b. This was to reflect the view that the potential for residual snag hazard was higher with the rock cover option when compared to the re-trench option. This sensitivity was conducted 'live' in the workshop and resulted a small reduction in the preference for Option 3a (rock cover) and a small increase in the preference for Option 3b (re-trench). These changes had no impact to the Group 8 recommendation. The revised evaluation charts for Sensitivity 1 are included in the minutes of the Stakeholder CA Workshop in Appendix B.2.

**Safety Overall**

Overall, Option 5 is the preferred option from a safety perspective. This is due to it being assessed as being the most attractive from a legacy risk perspective, which offsets it being the least preferred option from an operations personnel perspective. There are only small preferences between the remaining options with Option 3a being marginally preferred to Option 3b, which is again marginally preferred over Option 1, which is the least preferred option overall.

### 8.1.2 Environment

| Option | Description |
|---|---|
| Option 1 | Leave *in situ* – Minimal Intervention (Remove exposed ends and rock cover snag hazards) |
| Option 3a | Leave *in situ* – Major Intervention (Remove exposed ends and rock cover entire line) |
| Option 3b | Leave *in situ* – Major Intervention (Remove exposed ends and re-trench entire line) |
| Option 5 | Full Removal (Cut and Lift) |

**Operational Marine Impacts**

The main influencing factor in terms of operational marine impacts was the short-term environmental impact on the seabed from performing the decommissioning options. Other elements were considered such as marine noise impact and both planned and unplanned discharges from vessels whilst performing the decommissioning options. These were assessed as being similar enough across all options, that no preference could be indicated.

Option 1 is preferred from an operational marine impact perspective as the area of seabed impacted is much smaller than that impacted by Option 3a. It is also a much smaller area of impact in comparison to Option 3b and Option 5. The impact from these options is further exacerbated by the decommissioning operations (trenching and backfilling / deburial using MFE) having a higher short-term environmental impact on the seabed.

Option 3a is assessed as marginally preferred over the other remaining options, again due to the more intrusive nature of Options 3b and 5 from a short-term seabed disturbance perspective.

Whilst assessing the options against the operational marine impacts criterion, a challenge was raised regarding the score between the rock cover option versus the re-trench and full removal options. This was initially scored as stronger on the basis that the short-term environmental impact of introducing the rock cover was less significant than the short-term impact from trenching or performing deburial operations using MFE. Sensitivity 3 was conducted to reduce this score from stronger to neutral to address the concern that the introduction of the rock cover would have a similar impact in the short-term. Sensitivity 3 resulted in a small increase in the preference of option 3b and option 5 with a corresponding reduction for option 3a, but these adjustments were insufficient to change the order of preference and therefore had no impact on the Group 8 outcome. The revised evaluation charts for Sensitivity 3 are included in the minutes of the Stakeholder CA Workshop in Appendix B.2.

**Atmospheric Emissions and Consumptions**

The main factor used in determining the preference against the atmospheric emissions and consumptions criterion was the consumption of rock for rock cover purposes. Although where the differences in the emissions generated or fuel consumed were significant, these were also taken into account.

Fuel consumption and atmospheric emissions for Options 1, 3a and 3b were all similar but higher for Option 5 due to the increased vessel operations. Option 3b was the most preferred option and was preferred over the other options as it had the lowest requirement for rock cover, which was only needed for the third-party crossings which would remain. Option 1 and 5 had a similar preference, with the greater rock cover requirements for Option 1 being offset by the greater fuel consumption / atmospheric emissions required for Option 5. Option 3a was the least preferred due to the much greater requirement for rock cover.

**Legacy Marine Impacts**

The main factor influencing the assessment of the options from a legacy marine impact perspective was the long-term environmental impact on the seabed from performing the decommissioning options. Additional legacy environmental elements such as the impact from residual materials, the planned and unplanned discharges from any vessels require to monitor any remaining infrastructure were considered but deemed insufficient to express a preference between the options.

The legacy marine impact associated with options 1, 3b and 5 were largely similar, with the minor benefit from recovering the entirety of the asphalt coated pipeline under option 5 insufficient to influence the assessment. These options were equally preferred accordingly. Option 3a was considered the least preferred option due to the permanent alteration of the seabed habit from the introduction of a large area of rock cover.

**Environmental Overall**

Overall, Option 1 is the preferred from an environmental perspective as it is the most or equal most preferred option against each of the sub-criteria. There is a significant gap between option 1 and the next most preferred option, Option 3b. This is closely followed by option 5, with option 3a being by far the least preferred option.

Whilst assessing the options against the environmental sub-criteria, a challenge was raised regarding the equally weighted environmental sub-criteria. A sensitivity was conducted (Sensitivity 2) to test the outcome where the legacy marine impact became the dominant sub-criteria. This involved a move from the equal weighting of 6.67% for each environmental sub-criteria (summing to 20%) to 5% for both operational marine impacts and atmospheric emissions and consumptions and 10% for the legacy operational impact criterion, again summing to 20%.

Sensitivity 2 resulted in small adjustments to the relative preferences for each of the options from an environmental perspective, but these were insufficient to change the order of preference. Notably, Options 1 and 3a reduced slightly in preference with Options 3b and 5 increasing slightly, reflecting the greater weight applied to the legacy environmental element. In summary, Sensitivity 2 had no impact on the Group 8 outcome. The revised evaluation charts for Sensitivity 2 are included in the minutes of the Stakeholder CA Workshop in Appendix B.2.

### 8.1.3 Technical

| Option | Description |
|---|---|
| Option 1 | Leave *in situ* – Minimal Intervention (Remove exposed ends and rock cover snag hazards) |
| Option 3a | Leave *in situ* – Major Intervention (Remove exposed ends and rock cover entire line) |
| Option 3b | Leave *in situ* – Major Intervention (Remove exposed ends and re-trench entire line) |
| Option 5 | Full Removal (Cut and Lift) |

The technical criterion addressed elements such as the technical maturity of the option, the existing track record, the availability of technology to deliver the project, the technical risks involved and the consequences should failure to deliver the option as specified occur.

Option 1 and 3a were the equal most preferred options due to the minimal intervention proposed and the consideration that rock cover operations are largely routine. Option 3b and 5 were considered significantly less preferred from a technical perspective. In the case of Option 3b this was due to the challenges associated with re-trenching the 24" diameter pipeline, which is at the limit of technology for trenching. There was also evidence that retrenching of the NW Hutton pipeline, which was 20" in diameter, had experienced challenges and significant schedule overruns. In the case of Option 5, the requirement for deburial along the 34km length of pipeline to facilitate individual cuts to be performed was considered challenging due to the long durations involved and the lack of track record for performing these operations over these distances. Additionally, the potential that the failure to cut and lift sections of pipeline in certain areas would lead to alternative decommissioning methods being needed and as such would require a resubmission of the decommissioning programme.

The assessment that Option 3b and Option 5 were similar from a technical perspective was challenged and Sensitivity 5 was conducted to test the outcome should Option 3b be considered more technically challenging than the Option 5. This was conducted by adjusting the score between Option 3b and 5 from neutral to weaker. Sensitivity 5 reduced the preference for Option 3b and increased the preference for option 5 but these adjustments were insufficient to change the order of preference and therefore had no impact on the Group 8 outcome. The revised evaluation charts for Sensitivity 5 are included in the minutes of the Stakeholder CA Workshop in Appendix B.2.

### 8.1.4 Societal

| Option | Description |
|---|---|
| Option 1 | Leave *in situ* – Minimal Intervention (Remove exposed ends and rock cover snag hazards) |
| Option 3a | Leave *in situ* – Major Intervention (Remove exposed ends and rock cover entire line) |
| Option 3b | Leave *in situ* – Major Intervention (Remove exposed ends and re-trench entire line) |
| Option 5 | Full Removal (Cut and Lift) |

**Fishing Industry**

The key elements considered against the fishing industry criterion were the impact of the decommissioning options on commercial fishing (specifically demersal) operations and the area impacted.

Option 5 was the most preferred option as the full removal of the pipeline would result in a clear seabed and thus would have a positive impact by returning this area for fishing operations. Option 3b was slightly less preferred. Whilst the re-trenched pipeline effectively leaves a clear seabed, given the *in situ* nature, there is the potential for future deburial and as such this was less preferred. Option 1 was less preferred again, as the pipeline would be left in an open trench with varying degrees of burial, although it is noted that snag hazards would be addressed. The least preferred option is Option 3a as rock cover would be proud of the seabed and create a 34km rock berm which could impede demersal fishing operations.

**Other Groups**

The impact of the decommissioning option on other groups from a societal perspective addresses various elements such as the positive and negative impacts from returning materials on communities and amenities. The assessment focussed on the quantity of material being returned and the reuse, recycling or waste paths for those materials. Consideration was also given to the impact of the transport of these materials and also the positive impact from a job creation or retention perspective for the options.

All options were assessed as being largely similar against this criterion and thus equally preferred. The impact from Option 1, 3a and 3b is similar as the materials returned in each of these options is the same. The additional impact of the rock cover required for Option 3a was not considered to have a significant societal

impact. Whilst the material returned under Option 5 is much greater, the negative impacts of this were judged to be offset by the much greater volume of work associated with delivering Option 5.

The judgement that the increased volume of material from the concrete coating of the pipeline going to landfill under Option 5 was fully offset by the job creation / retention was challenged during the workshop. Sensitivity 4 was conducted where Option 5 was scored as weaker than the other options rather than neutral to reflect this. This increased the preference for Options 1, 3a and 3b and reduced the preference for Option 5. These adjustments were insufficient to change the order of preference and therefore had no impact on the Group 8 outcome. The revised evaluation charts for Sensitivity 4 are included in the minutes of the Stakeholder CA Workshop in Appendix B.2.

**Societal Overall**

Overall, Option 5, full removal is the preferred from a societal perspective, driven by it being the most preferred option against the fishing industry criterion. Option 3b, re-trench is next most preferred, followed by Option 1 with Option 3a being the least preferred.

### 8.1.5 Economic

| Option | Description |
|---|---|
| Option 1 | Leave *in situ* – Minimal Intervention (Remove exposed ends and rock cover snag hazards) |
| Option 3a | Leave *in situ* – Major Intervention (Remove exposed ends and rock cover entire line) |
| Option 3b | Leave *in situ* – Major Intervention (Remove exposed ends and re-trench entire line) |
| Option 5 | Full Removal (Cut and Lift) |

The assessment of the options against the economic criterion addresses both short-term operational costs and the long-term costs associated with legacy monitoring and potential future remediation. Consideration was also given to the cost risk or uncertainty associated with the estimated short and long-term costs.

Option 1 was the most preferred option as it has the lowest combined short and long-term costs. Options 3a and 3b were equally preferred although Option 3b, had slightly lower costs, this was considered a less certain estimate and was therefore assessed as largely similar from an economic perspective. Option 5 was the least preferred option as the cost was significantly higher than the other options.

### 8.1.6 Summary

| Option | Description |
|---|---|
| Option 1 | Leave *in situ* – Minimal Intervention (Remove exposed ends and rock cover snag hazards) |
| Option 3a | Leave *in situ* – Major Intervention (Remove exposed ends and rock cover entire line) |
| Option 3b | Leave *in situ* – Major Intervention (Remove exposed ends and re-trench entire line) |
| Option 5 | Full Removal (Cut and Lift) |

The overall assessment that Option 1 is the preferred option is driven by the strong preference shown for Option 1 against both the environmental and technical criteria. These strong preferences were sufficient to offset the less preferred assessment against the safety and societal criteria, where the differentials between the options were smaller. Once the assessment against the economic criterion is included, this strengthens the preference for Option 1 due it being the least expensive option to deliver.

## 8.2 Group 2 – Deposits (Partially Exposed)

The outcome from the CA showed that Option 1 – Leave *in situ* – No Intervention was the preferred option for Group 2 – Deposits (Partially Exposed). A discussion of the relative merits of the options against each of the primary and sub-criteria are provided in the following sub-sections.

| Option | Description |
|---|---|
| Option 1 | Leave *in situ* – No Intervention |
| Option 2 | Full Removal |

### 8.2.1 Safety

Option 1 was preferred over Option 2 from an operational personnel perspective as the work scope and thus operations personnel risk exposure was much lower for Option 1.

Both options were equally preferred from an impact to other users perspective as, whilst there are more offshore operations associated with Option 2, the differential was insufficient to indicate a preference from a safety impact to other users perspective.

The legacy risk associated with leaving the small number of partially buried mattresses *in situ* was deemed to be higher and thus less preferable than removing them.

Overall, Option 1 was marginally preferred to Option 2 due to the increased risk exposure from performing the removals marginally outweighing the legacy risk associated with leaving these items *in situ*.

### 8.2.2 Environment

From an environmental perspective the assessment showed that there was little to separate the leave *in situ* and full removal options. A minor preference for option 1 was indicated from an operational marine impacts perspective, mainly due to the negative environmental impact associated with the seabed disturbance caused by recovering the mattresses and replacing them with rock under Option 2.

No preference was indicated from an emissions and consumptions perspective as the impacts are largely similar. The rock required for option 2 was considered insufficient to express a preference.

Again, no preference was indicated from a legacy marine impact perspective. The impact from the polypropylene ropes remaining *in situ* associated with these 8 mattresses under Option 1 was judged to be negated by the negative environmental impact associated with the permanent habitat change from the rock cover introduced to replace the mattresses with Option 2.

Overall, a minor preference for Option 1 over Option 2 was indicated.

### 8.2.3 Technical

Against the technical criterion, there was a minor preference indicated for Option 1 over Option 2. This reflects the view that there may be potential challenges in retrieving the mattresses and that there may be a need perform an alternative decommissioning method (such as rock cover) should the mattresses prove unrecoverable.

### 8.2.4 Societal

There was a minor preference expressed for Option 2 over Option 1 from a commercial fishing perspective due to the potential for the mattresses getting snagged or caught up in fishing nets during demersal fishing operations. No preference was indicated in the area of other groups as the quantities concerned are minimal.

### 8.2.5 Economic

No preference was indicated from an economic perspective as both options have relatively small scopes of work and thus result in relatively small cost estimates, with the size of the differentials being judged as insufficient to indicate a preference.

### 8.2.6 Summary

| Option | Description |
|---|---|
| Option 1 | Leave *in situ* – No Intervention |
| Option 2 | Full Removal |

The overall outcome from the CA showed that Option 1 was preferred against the Safety, Environmental and Technical criteria. It was not the preferred option against the Societal criterion, but this was insufficient to offset the outcome. The inclusion of the Economic criterion maintained the preference for Option 1. During the workshop, no sensitivities were identified.

It should be noted that despite the outcome of the CA for Group 2 – Partially Exposed Deposits, it would be Fairfield's intention and the intention of the decommissioning programme to remove these 8 off partially buried mattresses. The rational is that of the 8 mattresses, 6 off them are placed over the sections of the PL5 pipeline that are to be removed as part of preferred option for Group 8. As such, it makes sense to remove these mattresses as part of that scope. The remaining 2 mattresses are midline on PL5 and will be removed as part of the preparation for delivering the preferred option for PL5.

## 8.3 Group 3 – Deposits (Buried)

The outcome from the CA showed that Option 1 – Leave *in situ* – No Intervention was the preferred option for Group 3 – Deposits (Buried). A discussion of the relative merits of the options against each of the primary and sub-criteria are provided in the following sub-sections.

| Option | Description |
|---|---|
| Option 1 | Leave *in situ* – No Intervention |
| Option 2 | Full Removal |

### 8.3.1 Safety

As with Group 2, Option 1 was preferred over Option 2 from an operational personnel perspective as the work scope and thus operations personnel risk exposure was much lower for Option 1.

The similarities continued from an impact to other users perspective with both options being equally preferred, again, due to the differential between the options being insufficient to indicate a preference from a safety impact to other users perspective.

The legacy risk associated with leaving these buried deposits (mattresses and grout bags) *in situ* was again deemed marginally higher and thus less preferable than removing them.

Overall, Option 1 was marginally preferred to Option 2 due to the increased risk exposure from performing the removals marginally outweighing the legacy risk associated with leaving these items *in situ*.

### 8.3.2 Environment

From an environmental perspective the assessment showed that there was little to separate the leave *in situ* and full removal options for this group. A minor preference for option 1 was indicated from an operational marine impacts perspective, mainly due to the negative environmental impact associated with the seabed

disturbance caused by deburial and recovery the mattresses and grout bags and replacing them with rock under Option 2.

No preference was indicated from an emissions and consumptions perspective as the impacts are largely similar with the additional rock required for Option 2 considered insufficient to express a preference.

Again, no preference was indicated from a legacy marine impact perspective. The impact from the polypropylene ropes and bags remaining *in situ* under Option 1 was judged to be negated by the negative environmental impact associated with the permanent habitat change from the rock cover introduced to replace these items. This is particularly true given that these items are currently fully buried. Overall, a minor preference for Option 1 over Option 2 was indicated.

### 8.3.3 Technical

Against the technical criterion, as with Group 2, there was a minor preference indicated for Option 1 over Option 2 reflecting the potential difficulties in retrieving the mattresses and grout bags resulting in the need to perform an alternative decommissioning method (such as rock cover) should they prove unrecoverable.

### 8.3.4 Societal

Given the currently buried nature of the deposits, there was no preference indicated from a commercial fishing perspective. No preference was indicated in the area of other groups as the quantities concerned are minimal.

### 8.3.5 Economic

There was a preference of Option 1 over Option 2 as the costs associated with deburial and recovery of these items is significantly higher than the leave *in situ* option.

### 8.3.6 Summary

| Option | Description |
|---|---|
| Option 1 | Leave *in situ* – No Intervention |
| Option 2 | Full Removal |

Given the buried status of the deposits, the CA showed that the leave *in situ* option was preferred against the Safety, Environmental and Technical criteria. It was equally preferred against the Societal criterion. The inclusion of the Economic criterion strengthened the preference for Option 1. During the workshop, no sensitivities were identified and therefore Option 1 has been recommended.

## 8.4 Group 4 – Deposits (Pipeline Support)

The outcome from the CA showed that Option 1 – Leave *in situ* – Minimal Intervention was the preferred option for Group 4 – Deposits (Pipeline Support). A discussion of the relative merits of the options against each of the primary and sub-criteria are provided in the following sub-sections.

| Option | Description |
|---|---|
| Option 1 | Leave *in situ* – Minimal Intervention (Spot rock cover over snag hazards) |
| Option 2 | Full Removal |

### 8.4.1 Safety

As with the other deposits groups, Option 1 was preferred over Option 2 from an operational personnel perspective as the work scope and thus operations personnel risk exposure was much lower for Option 1.

The similarities continued from an impact to other users perspective with both options being equally preferred, again, due to the differential between the options being insufficient to indicate a preference from a safety impact to other users.

The legacy risk associated with leaving these pipeline support materials (grout bags) *in situ* was judged to be higher and thus less preferable than removing them.

Overall, Option 2 (full removal) was marginally preferred to Option 1 (leave *in situ*) due to the legacy risk exposure outweighing the risk exposure associated with removal.

### 8.4.2 Environment

From an environmental perspective the assessment showed that there was little to separate the leave *in situ* and full removal options for this group. A minor preference for Option 1 was indicated from an operational marine impacts perspective, mainly due to the negative environmental impact associated with the seabed disturbance caused by recovering the grout bags and replacing them with rock.

No preference was indicated from an emissions and consumptions perspective as the impacts are largely similar with the increased quantity of rock required for Option 2 considered insufficient to express a preference.

No preference was indicated from a legacy marine impact perspective. The impact from the polypropylene bags remaining *in situ* associated with the grout bags under Option 1 was judged to be negated out by the negative environmental impact associated with the permanent habitat change from the rock cover introduced to replace these items. Overall, a minor preference for Option 1 over Option 2 was indicated.

### 8.4.3 Technical

Against the technical criterion, as with the other deposits groups, there was a minor preference indicated for Option 1 over Option 2 reflecting the potential difficulties in accessing and retrieving the grout bags. This may result in the need to perform an alternative decommissioning method (such as rock cover) should they prove unrecoverable.

### 8.4.4 Societal

Given the nature of these pipeline support materials being largely located under the pipeline in the existing trench, and in some cases, buried from natural backfill, there was no preference indicated from a commercial fishing perspective. No preference was indicated in the area of other groups as the quantities concerned are minimal.

### 8.4.5 Economic

As with Group 2 and 3, there was a preference of Option 1 (leave *in situ*) over Option 2 (full removal) as the costs associated with accessing, deburying and recovering these items is significantly higher than the leave *in situ* option.

### 8.4.6 Summary

| Option | Description |
|---|---|
| Option 1 | Leave *in situ* – Minimal Intervention (Spot rock cover over snag hazards) |
| Option 2 | Full Removal |

Given the function of the deposits, the CA showed that the leave *in situ* option was preferred against the Environmental and Technical criteria. It was equally preferred against the Societal criterion. It was not the preferred option against the Safety criterion but this was insufficient to offset the other preferences. The inclusion of the Economic criterion strengthened the preference for Option 1. During the workshop, no sensitivities were identified.

# 9 CONCLUSION

The CA process and outputs presented in this report have been undertaken by industry and statutory stakeholders in support of the Decommissioning Programme to be submitted for the decommissioning of the Dunlin Alpha to Cormorant Alpha Export Pipeline (PL5) infrastructure.

The proposed decommissioning options for the Dunlin Alpha to Cormorant Alpha Export Pipeline (PL5) infrastructure have been comparatively assessed resulting in the following selected options when a balanced view of all assessment criteria was taken into account.

Key assessment elements and the findings of the fully evaluated groups are summarised as follows:

- Group 8 – Trenched Pipeline PL5 – Option 1 – Leave *in situ* – Minimal Intervention:

  PL5 is over 34km long and recent survey results have shown that the majority of the pipeline (approximately 93% of its length) lies within a trench with the Top of Pipe being below the Mean Seabed Level (MSBL).

  The assessment recognised that there are areas where the pipeline is spanning and that these may present a snag hazard now or in the future. It should be noted that no existing pipeline spans exceed FishSAFE limits (spans greater than 10m in length and 0.8m in height). Option 1 – Leave in situ – Minimal Intervention makes provision for rock placement in these areas to mitigate the snag hazard. The aim for these areas of rock placement is to make them level with the surrounding seabed where this provides the necessary snag hazard mitigation. It was recognised that there are areas where the rock cover will need to be proud of the MSBL to provide the necessary snag hazard mitigation. These areas of rock cover above MSBL are to be minimised except where essential. The assessment has shown that this provision for rock cover presents the best balance of snag hazard mitigation, seabed environmental impact and impact to commercial fishing operations.

  Commitment to the periodic monitoring of the pipeline and rock cover is included in the selected option to ensure that the rock cover, introduced to mitigate the legacy snag hazard, continues to perform as required in the future.

- Group 2 – Deposits (Partially Exposed) – Option 2 – Full Removal:

  There are eight partially exposed deposits (concrete mattresses). Two of these are located at the surface laid portion of PL5 at the Dunlin Alpha end, five are located at the surface laid portion of PL5 at the Cormorant Alpha end. These surface laid parts of PL5 are to be removed as part of the pipeline decommissioning option and, as such, the associated mattresses shall be removed as part of those operations;

  The final concrete mattress in this group is located along the pipeline at approximately 20km from Dunlin Alpha. Whilst the outcome of the CA showed a preference for the leave in situ option, it would be Fairfield's intention to propose their removal in the Decommissioning Programme due to the operational requirement to recover the other mattresses, as detailed above.

- Group 3 – Deposits (Buried) – Option 1 – Leave *in situ* – No Intervention:

  Nine buried concrete mattresses and 1,840 grout bags are associated with PL5 at various locations along its length. These pipeline deposits have been used to provide pipeline stability and support during its operational life.

  Given that these deposits are currently sufficiently buried, and that the emerging recommendation for PL5 (Group 8) will see the pipeline remain in situ, access to these deposits would be technically challenging.

  In addition, should these deposits be removed, additional rock cover would be needed to provide the pipeline support currently provided, resulting in further seabed environmental impact.

  The CA showed that, when a balanced view is taken of the assessment criteria, the preferred outcome for these deposits is to leave them in situ;

  As with PL5, a commitment is made to monitor the burial status of these deposits (as part of the PL5 monitoring) to ensure that any emerging snag hazards presented by these deposits are managed into the future.

- Group 4 – Deposits (Pipeline Support) – Option 1 – Leave in situ – Minimal Intervention:

  Approximately 2,500 grout bags (buried and partially buried) have been used at various locations along the length of PL5. These grout bags have provided pipeline support during its operational life.

  Given the function of these deposits is to provide pipeline support, they are largely located under the pipeline in the existing trench. As such, there are potential technical difficulties in accessing and retrieving the grout bags due to the selection of the leave in situ option for PL5;

  As with Group 3 – Buried Deposits, should these pipeline support materials be removed, additional rock cover would be required to replace the support currently given to the pipeline by these deposits.

  The Comparative Assessment showed that, when a balanced view is taken of the assessment criteria, the preferred outcome for these deposits is to leave them in situ with any areas where a snag hazard is present to be mitigated by localised, spot rock cover.

  As with PL5, a commitment is made to monitor these pipeline support materials (as part of the PL5 monitoring) to ensure that any emerging snag hazards are managed into the future.

These selected decommissioning options along with those identified as full removal shall form the basis of the decommissioning programme and environmental to be submitted to BEIS, supported by this CA Report.

# 10 REFERENCES


1 Guidance Notes - Decommissioning of Offshore Oil and Gas Installations and Pipelines, Dated: May 2018, Produced by: Offshore Decommissioning Unit, Offshore Petroleum Regulator for Environment and Decommissioning and Department for Business, Energy & Industrial Strategy, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/704675/Offshore_Oil_and_Gas_Decommissioning_Guidance_Notes_May_2018.pdf

2 OGUK – Guidelines for Comparative Assessment in Decommissioning Programmes, Dated: October 2015, ISBN: 1 903 004 55 1, Issue: 1 https://oilandgasuk.co.uk/product/en038/

3 Fairfield Betula Limited – Dunlin Alpha to Cormorant Alpha Export Pipeline (PL5) Decommissioning Inventory, Pipeline, Controls and Structures, FBL-DUN-SSP-PL5-RPT-00001, Revision A3, Dated 23/06/17

4 Fairfield Betula Limited – Decommissioning Screening – Dunlin Alpha to Cormorant Alpha Export Pipeline (PL5), Pipeline, Control and Structures, FBL-DUN-SSP-PL5-RPT-00005, Revision R2, Dated 06/12/17.

5 Decommissioning of Pipelines in the North Sea Region – 2013, Issued by Oil & Gas UK.

6 Xodus Group - Common Scope Preparation Report, A-301649-S17-REPT-001, Rev A02

7 Xodus Group - Specific Scope Technical Note, A-301649-S17-TECH-001, Rev A01

8 Xodus Group – Option Selection Methodology, A-301649-S17-TECH-002, Rev A01

9 Xodus Group – Fisheries QRA, A-301649-S17-REPT-006, Rev A01

10 Xodus Group – Commercial Fisheries Baseline, A-301649-S17-REPT-007, Rev A01

11 Fairfield Betula Limited – Decommissioning Scoping – Dunlin Alpha to Cormorant Alpha Export Pipeline (PL5), Pipeline, Control and Structures, FBL-DUN-SSP-PL5-RPT-00002, Revision A2, Dated 08/09/17

12 The Analytical Hierarchy Process by T.L. Saaty, McGraw Hill, 1980

13 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]

# APPENDIX A EVALUATION METHODOLOGY

## Appendix A.1 CA Evaluation Methodology

A Multi-Criteria Decision Analysis (MCDA) methodology was employed by Fairfield for undertaking the evaluation phase of the CA. This methodology uses a pairwise comparison system based on the methodologies of the Analytical Hierarchy Process (AHP) [12] by T.L. Saaty, described in various publications. 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 October 2017 and listed in Table A-1;
- Define Options – completed as part of CA Screening;
- 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 CA workshops (internal and external) – this was completed during Q3 2018;
- 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.2) – scoring was completed as part of the CA workshops;
- Perform sensitivity analyses to test the decision outcomes – sensitivities were discussed and, where applicable, were completed during the CA workshops;
- Export worksheets as a formal record of the workshop attendees' combined opinion on the current preferred options, the 'Emerging Recommendations' – completed after each CA workshop and distributed to workshop attendees;
- Evaluate whether the CA needs to 'recycle' study work (Preparation Phase) to obtain any further information to help inform decision making – sufficient study work has been completed to inform CA decisions and no further studies are considered required;
- Discuss Emerging Recommendations with Stakeholders – completed in Q3 2018;
- Recycle process as required prior to decision on the selected options which will be presented in the Decommissioning Programme and assessed in the Environmental Appraisal;

The sections below describe how the MCDA methodology has been applied.

## Appendix A.2 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 used for this CA were taken from the DECC (now BEIS) Guidance Notes for Decommissioning of Offshore Oil and Gas Installations and Pipelines [1] 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 taken forward as the main differentiating criteria for the CA. Additional sub-criteria and definitions were added for clarity and are shown in Table A-1 alongside the approach used for assessment under each criteria or sub-criteria.

| Criteria | Sub-Criteria | Description | Approach to Assessment | Units |
|---|---|---|---|---|
| 1. Safety (20%) | 1.1 Operations Personnel (6.66%) | 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.<br>This sub-criterion also 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.<br>**Not considered:-**<br>- Rest (off-shift) risk exposure for all worker groups | Quantitative data is used to compare the options against this criterion. Potential for Loss of Life (PLL) metrics are calculated based on the Fatal Accident Rate (FAR) x Hours of Exposure for each of the worker groups and is considered a suitable metric for Comparative Assessment purposes.<br>The FAR is taken from the summary report of the Joint Industry Project investigating the Risk Analysis into Decommissioning Activities issued by Safetec [13]<br>The Hours of Exposure is taken from the various studies / method statements developed to define the options. | PLL |
| | 1.2 Other Users (6.66%) | 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 and commercial transport vessel are considered.<br>**Not considered:-**<br>- 3rd party interactions / collisions and military vessels | A quantitative assessment is made based on the number of vessel days associated with each of the decommissioning options. This is considered acceptable as the safety impact on other users is a function of the operational vessel numbers / durations / movements. | Days |
| | 1.3 Legacy Risk (6.66%) | This sub-criterion addresses the legacy risk to other sea users i.e. fishermen, military vessel crews, commercial vessel crews and passengers, other sea users, that is associated with the decommissioning option being assessed. Issues such as snag risk for fishing operations and collision risk (where appropriate) for all users is considered.<br>Any personnel risk exposure associated with long-term monitoring is also encompassed by this criterion.<br>**Not considered:-**<br>- Operational phase risk | A qualitative assessment of the legacy risk to other users, informed by the PLL metrics from the Anatec Fishing Risk Study. The legacy risk associated with any required monitoring is calculated in a similar manner to 1.1 above. | PLL |

| Criteria | Sub-Criteria | Description | Approach to Assessment | Units |
|---|---|---|---|---|
| 2. Environmental (20%) | 2.1 Operational Marine Impacts (6.66%) | Encompasses any marine environmental impacts from the operational phase of the decommissioning option being assessed.<br>Considers short-term environmental impact from seabed disturbance caused by the decommissioning operations.<br>Should also address both planned impacts (inherent to the option being assessed) and potential unplanned impacts (accidental releases, both large and small in scale and encompassing Major Environmental Incidents (MEIs)).<br>Also encompasses marine noise generated by vessels, cutting operations and explosives where used. | Seabed disturbance is based on area of impact and type of disturbance i.e. trenching considered higher short-term impact than cut and lift.<br>Planned and unplanned marine impacts are narrative judgements informed by estimates of volumes ($m^3$) / composition of any releases.<br>Marine noise is calculated based on the vessel durations, subsea cutting operations and is a quantitative measure of cumulative sound energy level in $TPa^2S$. | $m^2$<br>$m^3$<br>$TPa^2S$ |
| | 2.2 Atmospheric Emissions / Consumptions (6.66%) | Encompasses environmental impact of atmospheric emissions from both the operational phase and any associated legacy phase of the decommissioning option being assessed.<br>It also encompasses the resource consumption (such as Fuel / Energy Use) associated with the decommissioning option being assessed. This includes the environmental impact of processing any returned materials and production of any replacement materials (for those left *in situ)*. Note that quarried rock is assumed to be received at the quayside and therefore emissions associated with quarrying and transportation to quayside are not included in the assessment.<br>**Not considered:-**<br>NOx and SOx due to their minimal impact in an offshore environment and their proportionality to the $CO_2$ impact. | Emissions are quantified by $CO_2$ in metric tonnes. Fuel consumption is quantified in metric tonnes. Other consumptions such as steel / other fabrications are also quoted in metric tonnes.<br>Impact of recycling / processing returned material and replacing leave *in situ* material is quoted in $CO_2$ in metric tonnes. | GJ (Energy)<br>Tonnes ($CO_2$) |

| Criteria | Sub-Criteria | Description | Approach to Assessment | Units |
|---|---|---|---|---|
| | 2.3 Legacy Marine Impacts (6.66%) | Encompasses any marine environmental impacts associated with the legacy phase of the decommissioning option being assessed.<br>Considers long-term environmental impact in terms of altered or lost habitats from the as left decommissioned infrastructure.<br>Should also address both planned impacts (inherent to the option being assessed) and potential unplanned impacts (accidental releases, both large and small in scale and encompassing Major Environmental Incidents (MEIs)). | Altered / lost habitats based on area and permanency of impact.<br>Planned and unplanned marine impacts are narrative judgement informed by estimates of volumes ($m^3$) / composition of any releases.<br>Expected duration of releases is also provided. | $m^2$<br>$m^3$ |
| 3. Technical (20%) | 3.1 Project Technical Risk (20%) | This sub-criterion relates to the various technical risks that could result in a major project failure (those that may require a DP re-submission). 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. | Supported by narrative discussion of technical risk provided from the various technical studies conducted and summarised in datasheets. | N/A |
| 4. Societal (20%) | 4.1 Fishing Industry (10%) | This sub-criterion addresses the impact of the option on commercial fishing operations. It includes consideration of impacts from both the decommissioning activities and any residual impacts post decommissioning such as reinstatement of access to area.<br>**Not considered:-**<br>Safety impacts - addressed in 1.3 above. | Assessed using narrative of the impact of the decommissioning option on fishing operations. | N/A |

| Criteria | Sub-Criteria | Description | Approach to Assessment | Units |
|---|---|---|---|---|
| | 4.2 Other Groups (10%) | This sub-criterion addresses any positive or negative 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.<br>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 Fairfield Guiding Principle of 'Minimal business interruption to others'. | Assessed using narrative of the positive and negative impact of the decommissioning option on all groups of society (excluding fishing industry as this is covered in sub-criterion 4.1). Supported by quantification of the quantities of material being transported (metric tonnes) and amount of job creation (man-hours). | N/A |
| 5. Economic (20%) | 5.1 Operational & Legacy Costs (20%) | This sub-criterion addresses the cost of delivering the option as described. Cost certainty (a function of activity maturity) is also recorded.<br>Also covers any long-term cost element (such as monitoring) associated with the decommissioning option, stated explicitly rather than included in overall figure. | Both operational and legacy costs are quantified in GBP. Cost certainty is generally in line with a class 4 estimate as defined by American Association of Cost Engineers (AACE) and thus covers an estimated range of -15% to +50% however a narrative around cost estimate associated with each option is provided. | £ |

Table A-1: Sub-criteria Definition

The 5 differentiating criteria all carry a 20% weighting. That is, all criteria are neutral to each other. Figure A.1 shows the pairwise comparison matrix. Fairfield decided that equal weightings offer the most transparency and a balanced view from all perspectives.

| 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 A.1: Example Pairwise Comparison Matrix (N = Neutral)

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 C to 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.

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 Table A-2). It was agreed that three positions from equal (and their reciprocals) would be sufficient for this CA. These positions were:

| Title | Scope | Relative Preference Ratio |
|---|---|---|
| Neutral | Equal Importance, equivalent to 1 in the AHP importance scale. | 50 / 50 |
| Stronger (S) / Weaker (W) | Moderate importance of one criteria / option over the other, equivalent to 1.5 in the AHP importance scale. | 60 / 40 |
| Much Stronger (MS) / Much Weaker (MW) | Essential / strong importance of one criteria / option over the other equivalent to 5 or 6 in the AHP importance scale. | 75 / 25 |
| Very Much Stronger (VMS) / Very Much Weaker (VMW) | Extreme importance of one criteria / option over the other equivalent to 8 or 9 in the AHP importance scale. | 90 / 10 |

Table A-2: 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 cover from a safety perspective? Are these Neutral to each other? Is it 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.

A summary example of the completed pair-wise comparisons for differentiating criteria versus options are shown in Figure A.2.

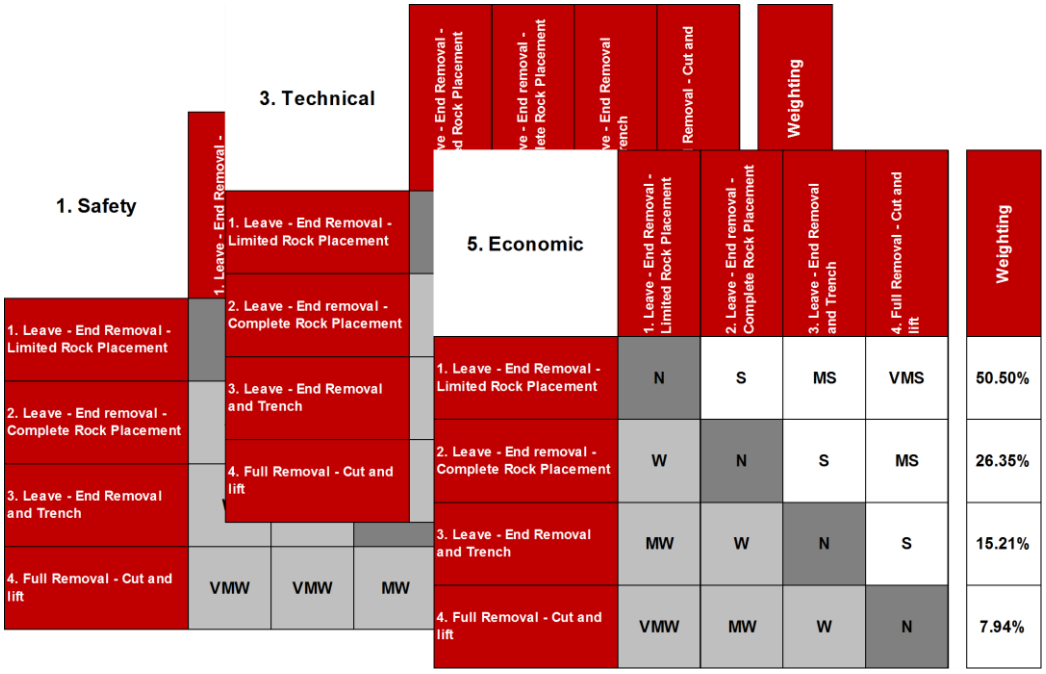



Figure A.2: Example Option Pair-Wise Comparison

The decision-making tool used the above pairwise comparisons 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, an opportunity was provided to test the judgements provided, to ensure that all attendees were happy to endorse the outcome. The visual test outputs from each decision point are included in Appendices, C.3, D.3, E.3 and F.3.

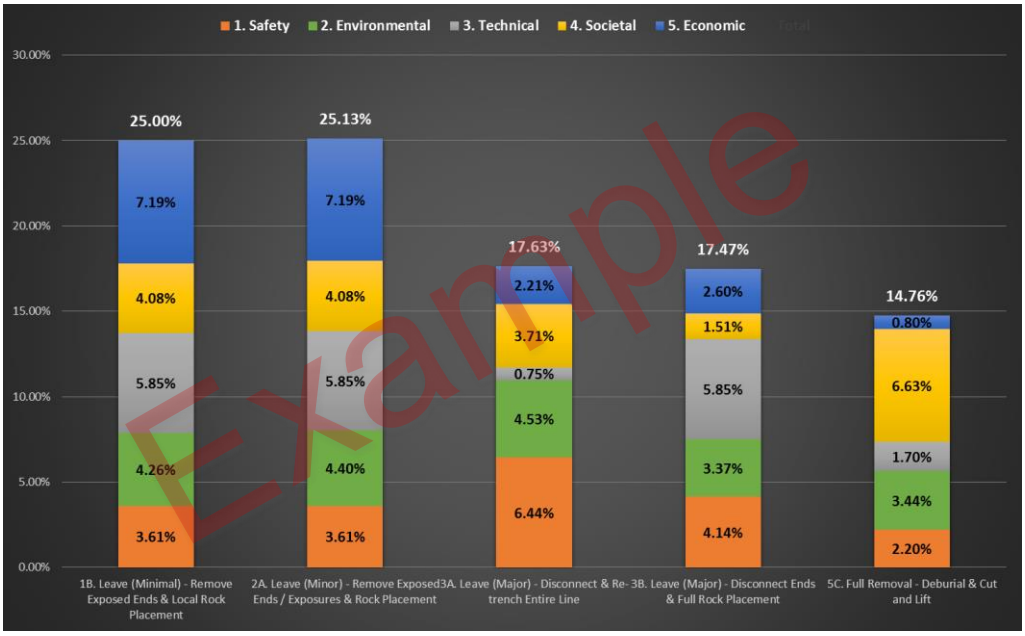



Figure A.3: A Visual Output Example

The CA output can then easily be stress tested by the workshop attendees by undertaking a sensitivity analysis:

- By applying a modification to the weighting of the criteria – bearing in mind that the base case for this assessment is to have all criteria equally weighted, and / or
- Modifying the pair-wise comparison of the options against each other within the criteria where appropriate

These sensitivities will help inform workshop attendees as to whether a particular aspect is driving a preferred option, or indeed if the preferred option remains the same when the sensitivities are applied.

# APPENDIX B STAKEHOLDER CA WORKSHOP MINUTES

**Subject:** Dunlin Alpha to Cormorant Alpha Pipeline CA – External Stakeholders CA Session

**Location:** Fairfield Energy offices

**Date & Time:** 28th of September 2018 (9:00hrs to 14:00hrs)

**Assignment:** A301649-S17

**Reference:** A301649-S17-MIN-003

**Minuted by:** J. MacDonald

**Issued on:** 28th of September 2018

**Attending:** *Fairfield Energy Limited:*

Peter Lee (PL), Satya Maganti (SM), Jonathan Bird (JPB), Carol Barbone (CB), Jeff Burns (JB)

*Xodus Group:* John Foreman (JF), Jamie MacDonald (JM), Gareth Jones (GJ), Rob Duncan (RD)

*Partners:* Don Orr – BP (DO); Ceri Wheaton – CNRI (CW), Magnus Lethaby – CNRI (ML), Fumio Ichishima – Mitsubishi (FI),

*External Stakeholders* – Jillian Whyte – JNCC (JW), Becky Hitchin – JNCC (BH), Abdulgani Oseni – HSE (AO), Drew Bond – BEIS (DW), Audrey Banner – BEIS (AB), Debbie Taylor – BEIS (DT), Brenda Muirhead – BEIS(BM), Colin Megginson – Marine Scotland (CM), Raymond Hall – SFF (RH), Steven Alexander – SFF (SA),

**Distribution:** *Fairfield Energy Limited:* Peter Lee (PL), Satya Maganti (SM), Russell Hogg (RH), Jonathan Bird (JPB), Jeff Burns (JB), Carol Barbone (CB)

*Xodus Group:* John Foreman (JF), Jamie MacDonald (JM), Gareth Jones (GJ), Rob Duncan (RD)

| Item | Issue | Action |
|---|---|---|
| **1.** | **General** | |
| 1.1 | The comparative assessment workshop for the Dunlin Alpha to Cormorant Alpha Pipeline PL5 was held on 28 September 2018. The following high-level objectives were set for the workshop:<br>> To ensure that all participants have a good working knowledge of the comparative assessment process.<br>> To ensure that all participants understand the boundaries of the comparative assessment process and groups.<br>> To run through the comparative assessment process for the PL5 pipeline and associated deposits and obtain emerging recommendations for the decommissioning option for each group being examined.<br>A briefing document (A-301649-S17-REPT-002 A01) outlining the CA evaluation workshop was sent to external stakeholders (~4 weeks in advance).<br>The CA workshop examined the following subsea infrastructure groups:<br>> Group 8: Trenched Pipeline<br>> Based on the emerging recommendation of Group 8 a discussion was held around the requirement to run through the full CA for the following groups (see Item 9.1).<br>> Group 2: Deposits (Partially Buried) | Info |

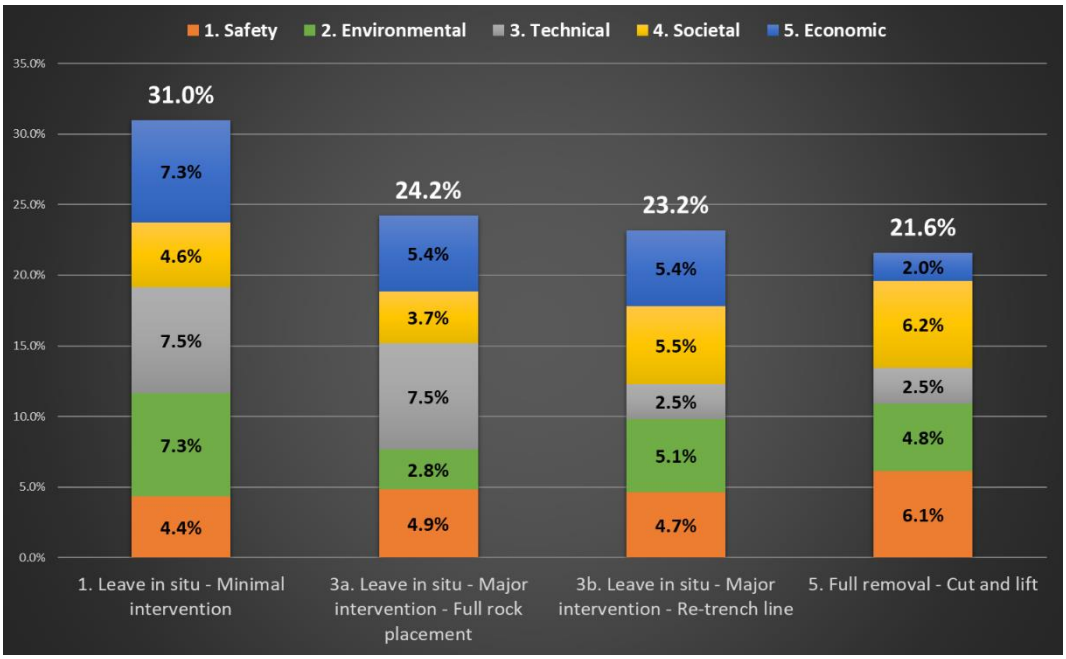
| Item | Issue | Action |
|---|---|---|
| | > Group 3: Deposits (Buried)<br>> Group 4: Deposits (Pipeline Support)<br>> The outcome in the form of a results chart for Group 8 only is attached in Appendix B.1. | |
| **2.** | **Comparative Assessment Session - General** | |
| 2.1 | Introductory presentation by JF on Multi-criteria Decision Analysis process (MCDA). 'Scene Setting' presentation detailing groups and pipeline status provided by JM. | Info |
| 2.2 | Question from SFF relating to the number of spans developing over a recent time-period i.e. is this an area of highly mobile seabed? Advised that pipeline is stable and major spans are not developing. Advised that although multiple spans have been identified in the 2016 survey none exceed the FISHSAFE limits and are predominantly located in the trench below mean seabed level (MSBL). | Info |
| 2.3 | SFF asked for further clarity and details regarding the future monitoring programme.<br>Advised that a definitive final program had not been established and FAIRFIELD would be looking to consult with regulator and its advisors regarding this. For the purpose of this CA process it was advised that a 50-year time period was assumed to align with previous CAs performed by FAIRFIELD. Whilst not worst-case, the monitoring regime assumed for the purpose of the CA is more onerous rather than less onerous than what may be required in the future. e.g. the potential to move to risk based approach depending on survey results over time. It was also acknowledged that future monitoring programmes may be adapted to account for development in technology in this area i.e. autonomous inspection | Info |
| **3.** | **Group 8 - Pipeline Comparative Assessment - Safety** | |
| 3.1 | SFF stated that, from a historical perspective, general offshore Oil and Gas vessel operations have shown to be safer in comparison to the historical loss of life due to fishing gear snagging on subsea infrastructure. JF advised that legacy risk (sub-criteria 1.3) aims to account for the potential of future snagging on subsea infrastructure whereas sub-criteria 1.1 focuses on the safety risk from performing the offshore decommissioning works. | Info |
| 3.2 | Concerns were expressed that risk to fisherman may not be immediate but 'sometime' in the future as the integrity of the pipeline degrades and 'breaks-up'. | Info |
| 3.3 | Comment was made that fishing intensity; future fishing patterns and fishing methods may change in the future and as such would impact the calculated PLLs. This was acknowledged and FAIRFIELD advised that a statement to that effect has been included in the Common Scope Report (A-301649-S17-REPT-001). | Info |
| 3.4 | SFF commented regarding general lack of engagement with the fishing community in the generation of study report and codes and standards. Offer from FAIRFIELD to engage further with SFF regarding Fisheries QRA produced by Anatec to report back to the latter on the concerns about input. | FAIRFIELD |
| 3.5 | It was acknowledged that if the calculated PLL values around the legacy fishing risk (criterion 1.3) were increased, as all options have been scored as very much weaker | Info |

| Item | Issue | Action |
|---|---|---|
| | than Option 5 (Full removal), there would be no material change to the assessment as all options are already the least preferred against option 5. | |
| 3.6 | SFF confirmed in line with its published policy that trench and buried solutions would be preferred over full rock placement solutions in cases where full removal was impractical.<br>A sensitivity analysis was performed against criterion 1.3 Safety – Legacy Risk to make Option 3a (Rock Cover) weaker (from neutral) to Option 3b (Trench and bury); no material change to emerging recommendation was noted. | Xodus |
| 3.7 | CB requested clarity from BEIS regarding 0.6m of cover. BEIS advised that 0.6m is an 'aim' and where this was not achievable without compromise to other users of the sea or the environment, consideration would be given to a reduced depth of cover e.g. soil/sediment mobility would have an input into the optimum depth of burial and whether or not the infrastructure was below MSBL. | Info |
| **4.** | **Pipeline Comparative Assessment - Environmental** | |
| 4.1 | JNCC commented that generally the lowest amount of additional rock will drive their preferred option. | Info |
| 4.2 | JNCC advised that guidance from PIMS website should be sought regarding difference between operational and legacy impact. | Info |
| 4.3 | JNCC indicated that importance of legacy environmental impact should be the key environmental driver and as such the sub-criteria weightings should be altered to reflect this. Sensitivity performed against the Environmental sub-criteria as follows:<br>> 2.1 Operational Marine Impact changed from 6.67% to 5%<br>> 2.2 Atmospheric Emission and Consumptions changed from 6.67% to 5%<br>> 2.3 – Legacy Marine Impacts changed from 6.67% to 10%<br>> Sensitivity performed accordingly and no material change to emerging recommendation was noted. | Xodus |
| 4.4 | Sensitivity testing performed against criterion 2.1 Environmental – Operational Marine Impact to make Option 3a (Rock Cover) Neutral (from Stronger) to Options 3b (Trench and bury) & 5 (Full removal). No material change accordingly and no material change to emerging recommendation was noted. | Xodus |
| 4.5 | FAIRFIELD provided clarity provided that all legacy monitoring equipment would be non-invasive and therefore would have no material environmental impact. | Info |
| **5.** | **Pipeline Comparative Assessment - Technical** | |
| 5.1 | There was general agreement on technical feasibility assessment. | Info |
| 5.2 | Sensitivity testing identified against criterion 3.1 Technical to make Option 3b (Trench and bury) weaker (from neutral) when compared to Option 5 (Full removal). Sensitivity performed accordingly and no material change to emerging recommendation was noted. | Xodus |
| **6.** | **Pipeline Comparative Assessment – Societal** | |
| 6.1 | SFF indicated that creating a rock berm 'proud' of the trench (Option 3b) across the entire line length is less preferable in comparison to Option 1. | Info |

| Item | Issue | Action |
|---|---|---|
| 6.2 | SFF advised their preference would be to rock cover to the top of the trenched pipeline to bring cover level with the surrounding seabed and avoid over spilling except where essential. | Info |
| 6.3 | SFF advised that they agree with scoring given the particular characteristics of PL5 but reaffirmed that this did not set a precedent for other pipelines and burial depths. Acknowledged that, generally, fishing vessel types operating in this area will likely be able to accommodate rock berms. The area is also lightly fished. | Info |
| 6.4 | FAIRFIELD was asked whether SEPA has been contacted regarding proposed waste to landfill. Advised no engagement with SEPA on PL5. Acknowledged that SEPA may have concerns about the amount of contaminated waste coming back to shore as the onshore capacity for some waste streams is very limited (in particular contaminated concrete/mattresses). As such, SEPA may support decommissioning '*in situ*' where it is acceptable (i.e. done responsibly). | Info |
| 6.5 | Sensitivity identified against criterion 4.2 Societal – Other Group. Option 5 (Full removal) to be assessed as weaker (from neutral) to all other options. This is to reflect the greater volume of materials going to landfill due to the concrete coating that cannot be recycled . Sensitivity performed accordingly and no material change to emerging recommendation was noted. | Xodus |
| **7.** | **Pipeline Comparative Assessment - Economic** | |
| 7.1 | Clarification was requested of the operational cost for Option 3a (Rock Cover - higher cost) vs Option 3b (Trench and bury - lower cost) as this was Fairfieldt to be counter-intuitive. FAIRFIELD advised that differential is due to additional transits required for rock cover operations. | Info |
| 7.2 | There was some discussion around the principle of liability in perpetuity. Clarified that to allow a comparison to be made for comparative assessment purposes a baseline period of 50 years was used, which is in alignment with previous FAIRFIELD scopes (see also Item 2.3). | Info |
| 7.3 | Xodus clarified that as part of the CA process the economics will be removed to ensure that the project cost is not unduly influencing the emerging recommendation. | Info |
| **8.** | **Group 8 – Emerging Recommendation Discussion** | |
| 8.1 | SFF advised that safety of fishermen is their main priority and as such their preference would be for the safety criteria weighting to be increased. Acknowledged and noted however there was no desire in the room for sensitivity to be performed. | Info |
| 8.2 | Consensus over emerging recommendation. | Info |
| **9.** | **Group 2, 3 and 4** | |
| **9.1** | Following the emerging recommendation of Group 8 (Option 1 – Leave *in situ* – Minimal Intervention) a discussion was held to understand the relationship between the deposits (Group 2, 3 and 4) and the pipeline and requirements for running through the CA process on the remaining groups.<br>The following was agreed:<br>> After presentation of the results charts from the partner CA workshop for Group 2,3 & 4 and achieved consensus from the room was that there was sufficient | Info/Xodus |

| Item | Issue | Action |
|---|---|---|
| | confidence in the process of obtaining these results that a full review of the attributes was not needed;<br>> Group 2 – Partially buried mattresses (8 off). Mattresses are to be removed as part of the pipeline end removal. 6 mattresses are close to the pipeline ends at Dunlin Alpha and Cormorant Alpha and removal will be attempted as part of pipeline end removal works. 2 mattresses at ~KP20 will also be removed as a base-case. FAIRFIELD acknowledged that this was in contradiction to the CA result outcome however it is the belief of FAIRFIELD that removal is the correct thing to be doing. There was agreement in the room regarding this approach.<br>> Group 3/4 – Buried Deposits – As the emerging recommendation will see the pipeline remain *in situ*, access to these deposits (typically grout bags and mattresses) will be technically challenging and require additional rock cover to provide the support currently provided to the pipeline by these deposits should they be removed. It was therefore agreed the base-case approach will be to leave deposits associated with Groups 3 & 4 *in situ* on the basis that any snag hazards created by leaving these deposits *in situ* will be mitigated by rock cover to align with the approach taken for Group 8. This is supported by the outcome obtained by the CA process. There was agreement in the room regarding this approach. | |
| **9.2** | HSE asked about the integrity of the mattresses and feasibility of removal. FAIRFIELD advised that exposed mattress removal operation from Osprey have been very positive with approx. 200 mattresses recovered to date. Mattresses on PL5 are of a similar construction to those on Osprey and Merlin. | Info |
| **10.** | **Any Other Business** | |
| 10.1 | All stakeholders in agreement with the CA process and outcomes. | Info |
| 10.2 | Advised that CA report to be issued to partners for review on 11th November 2018 | Info |
| 10.3 | All parties agreed that the event was well presented and clear. | Info |

## Appendix B.1 Group 8 - CA Session Decision Chart

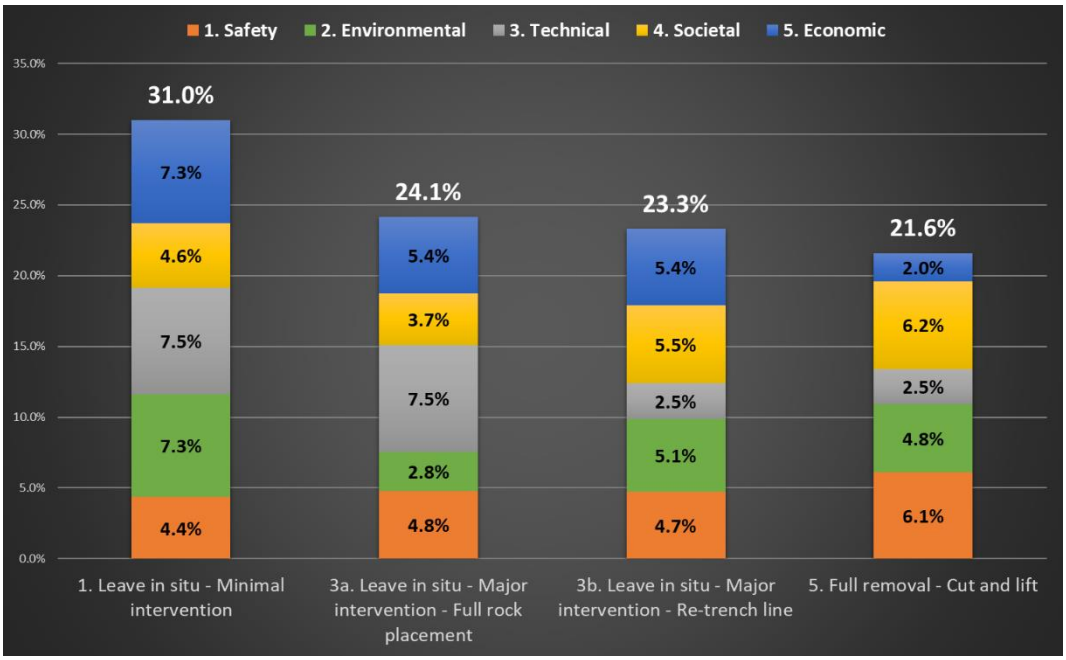


## Appendix B.2 Sensitivities

**Sensitivity number corresponds to item numbers in attached meeting minutes.**

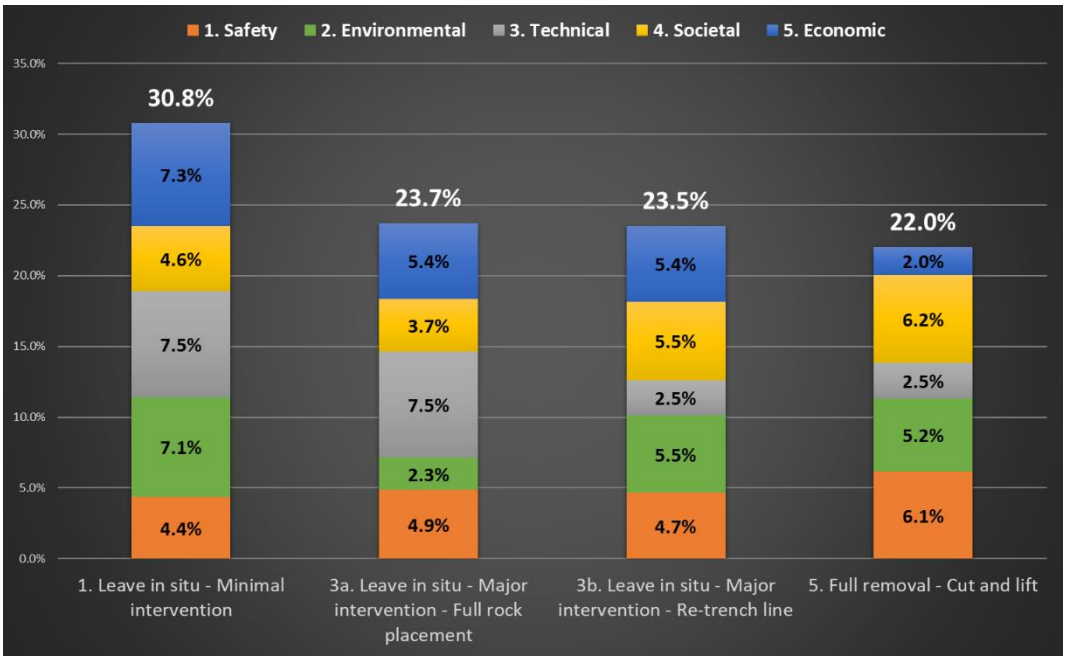
Sensitivity 1 – Adjusted Legacy Risk (Item 3.6 above)

Option 3a reduces slightly overall, Option 3b increases slightly overall.



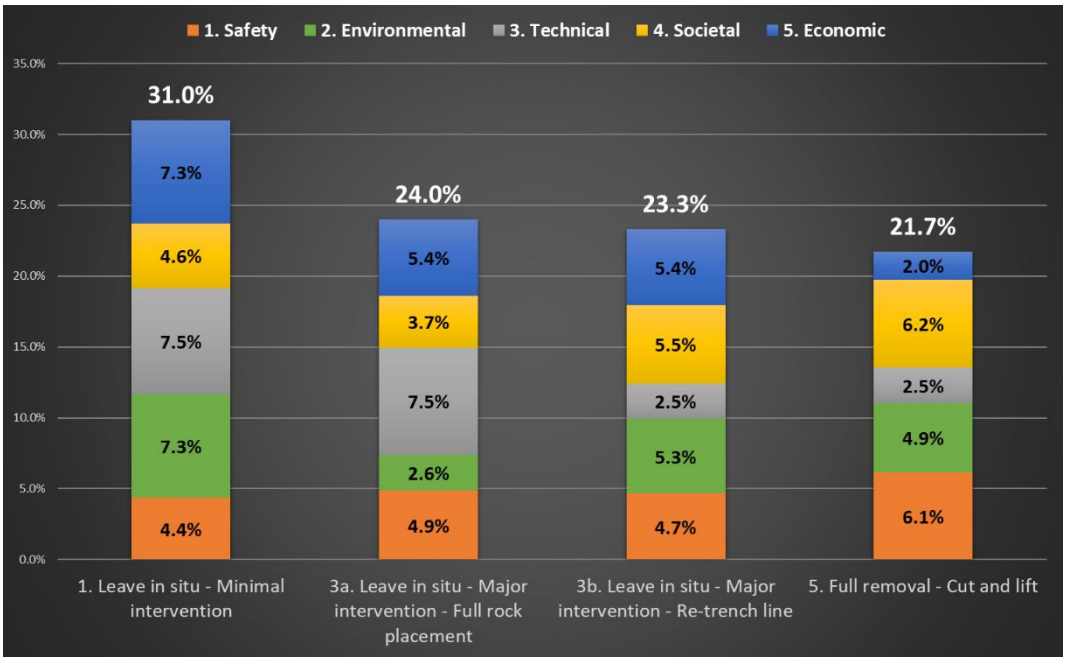

Sensitivity 2 – Adjusted Environmental sub-criteria weighting (Item 4.3 above)

Option 1 and 3a reduce slightly with Options 3a and 5 increasing.



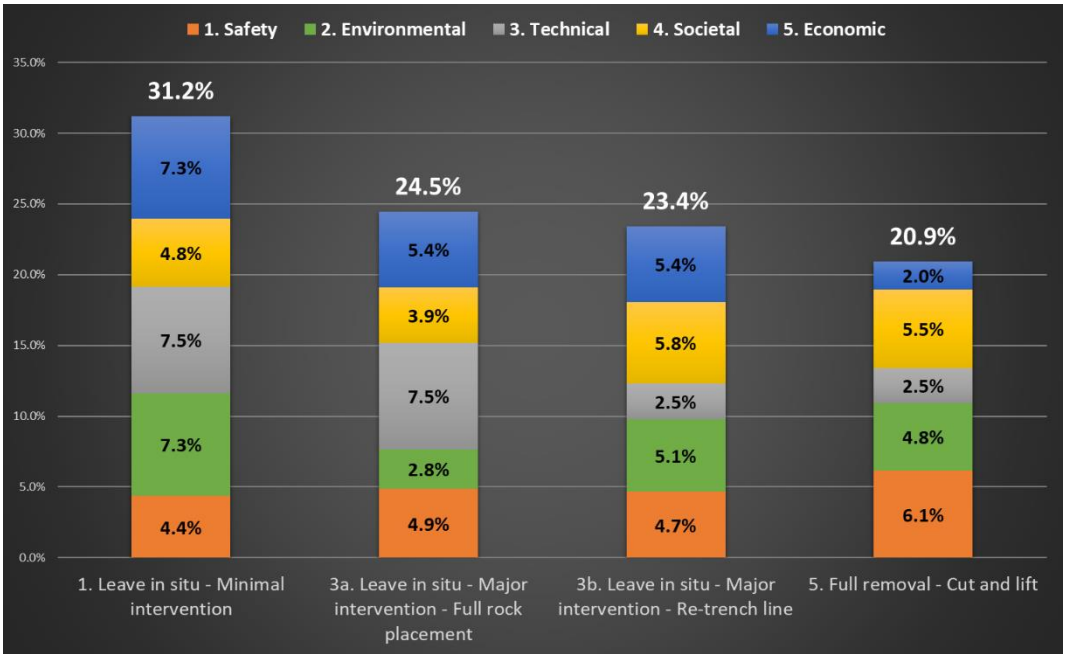
Sensitivity 3 – Adjusted Operational Marine Impact (Item 4.4 above)

Option 3a reduces slightly with Options 3a and 5 increasing.



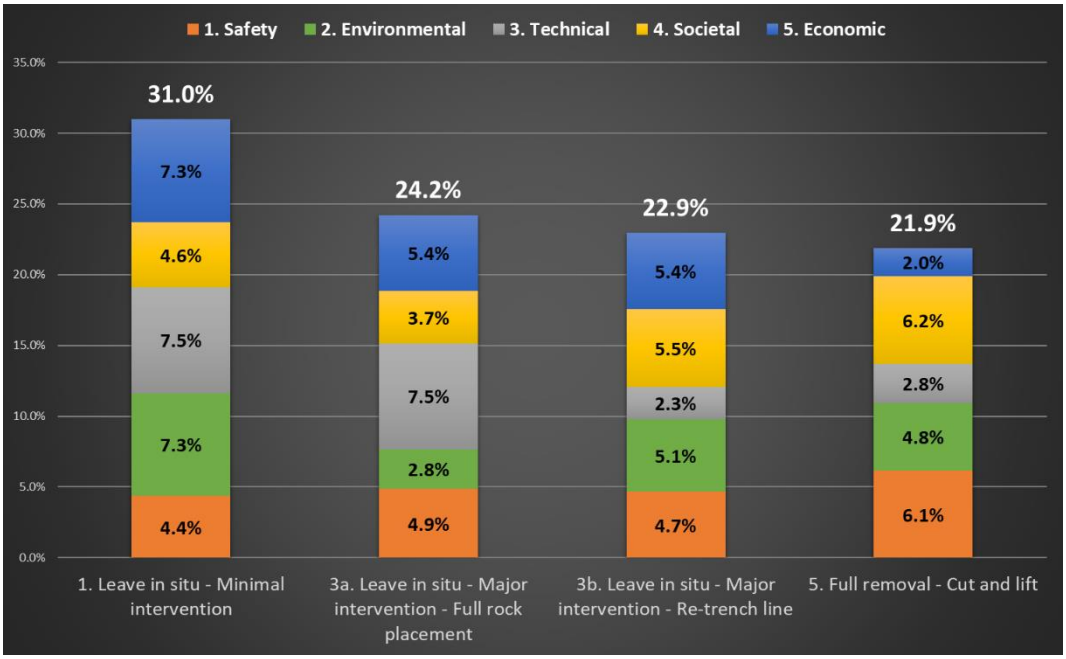

Sensitivity 4 – Adjusted Societal – Other users (Item 6.5 above)

All options increase exept Option 5 which reduces.



Sensitivity 5 – Technical adjusted (Item 5.2 above)

Option 3b reduces, option 5 increases.



# APPENDIX C GROUP 8 – DETAILED EVALUATION RESULTS

## Appendix C.1 Group 8 – Attributes Table

| | | 1. Leave in situ - Minimal intervention | | | 3a. Leave in situ - Major intervention - Full rock placement | | 3b. Leave in situ - Major intervention - Re-trench line | 5. Full removal - Cut and lift |
|---|---|---|---|---|---|---|---|---|
| | | Cut, recover and transfer to shore pipeline end sections (300m at Dunlin A & 650m at Cormorant A).<br>Place rock over cut ends and snag hazards. | | | Cut, recover and transfer to shore pipeline end sections (300m at Dunlin A & 650m at Cormorant A).<br>Place rock over remaining pipeline. | | Cut, recover and transfer to shore pipeline end sections (300m at Dunlin A & 650m at Cormorant A).<br>Re-trench remaining pipeline, transitioning at each crossing.<br>Backfill spoil heaps into trench and place rock at crossings. | Debury buried pipeline sections (excluding crossings)<br>Cut pipeline into 25m sections / recover cut sections and transfer to shore.<br>Backfill trench and place rock at crossings. |
| 1. Safety | 1.1 Operations Personnel | Offshore: 24,178 hrs / 2.93E-03 PLL<br>Onshore: 6,153 hrs / 4.08E-05 PLL<br><br>**Total option hours: 30,331**<br>**Total option PLL: 2.97E-03** | | | Offshore: 31,858 hrs / 3.50E-03 PLL<br>Onshore: 14,485 hrs / 7.41E-05 PLL<br><br>**Total option hours: 46,343**<br>**Total option PLL: 3.58E-03** | | Offshore: 38,324 hrs / 3.99E-03 PLL<br>Onshore: 13,808 hrs / 7.14E-05 PLL<br><br>**Total option hours: 52,132**<br>**Total option PLL: 4.06E-03** | Offshore: 290,430 hrs / 3.59E-02 PLL<br>Onshore: 115,388 hrs / 6.84E-03 PLL<br><br>**Total option hours: 405,842**<br>**Total option PLL: 4.27E-02** |
| | **Comparison** | **N** | **S** | **VMS** | **N** | **VMS** | **VMS** | |
| | **Summary** | The summary Potential for Loss of Life (PLL) metrics for the options are 2.97E-03, 3.58E-03, 4.06E-03 and 4.27E-02, respectively. The assessment of the risk exposure for the various worker groups is as follows:<br><br>Option 1 is assessed as being Neutral to Option 3a as the PLL values and thus the risk exposures are very close. Option 1 is assessed as being Stronger than Option 3b as the risk exposure is around 30% lower. Option 1 is assessed as being Very Much Stronger than Option 5 as the risk exposure is around 14 times lower.<br>Option 3a is assessed as being Neutral to Option 3b as the risk exposure is similar. Option 3a is assessed as being Very Much Stronger than Option 5 as the risk exposure is around 12 times lower.<br>Option 3b is assessed as being Very Much Stronger than Option 5 as the risk exposure is around 11 times lower.<br><br>Overall, Option 1 would be the preferred option from a risk to operations personnel perspective. | | | | | | | |
| 1. Safety | 1.2 Other Users | Survey Vessel: 11.6 days<br>Rockdump Vessel: 11.6 days<br>DSV: 8.9 days<br>Barge / Pipehaul Vessel: 7.2 days<br>Trawler: 8.0 days<br><br>**Total vessel days: 47.3 days**<br>**Number of transits: 12** | | | Survey Vessel: 11.6 days<br>Rockdump Vessel: 43.6 days<br>DSV: 8.9 days<br>Barge / Pipehaul Vessel: 7.2 days<br>Trawler: 8.0 days<br><br>**Total vessel days: 79.3 days**<br>**Number of transits: 26** | | Survey Vessel: 11.6 days<br>Trenching vessel: 23.8<br>Rockdump Vessel: 5.0 days<br>DSV: 8.9 days<br>Barge / Pipehaul Vessel: 7.2 days<br>Trawler: 8.0 days<br><br>**Total vessel days: 64.5 days**<br>**Number of transits: 16** | Survey Vessel: 11.6 days<br>Rockdump Vessel: 5.0 days<br>DSV: 114.5 days<br>CSV: 91.2 days<br>Barge / Pipehaul Vessel: 132.4 days<br>Trawler: 8.0 days<br><br>**Total vessel days: 362.7 days**<br>**Number of transits: 28** |
| | **Comparison** | **N** | **N** | **S** | **N** | **S** | **S** | |
| | **Summary** | The assessment of the impact of each of the options on Other Users is largely driven by the number of transits to and from the field and the total duration that vessels are located in the area during the decommissioning works. The assessment is as follows:<br><br>Option 1 is assessed as being Neutral to Options 3a and 3b as the risk to other users is considered relatively similar. Option 1 is assessed as being Stronger than Option 5 as total duration is around 8 times lower.<br>Option 3a is assessed as being Neutral to Option 3b as the safety risk to other users is considered relatively similar. Option 3a is assessed as being Stronger than Option 5 as the total duration is around 5 times lower.<br>Option 3b is assessed as being Stronger than Option 5 as the total duration is around 6 times lower.<br><br>Overall Options 1, 3a and 3b are assessed as equally preferred options from a risk to other users perspective. | | | | | | | |
| 1. Safety | 1.3 Legacy Risk | Operations:-<br>Monitoring: 31,660 hrs / 2.37E-03 PLL<br><br>Other users:<br>Fishing Vessel Snagging: 1.35E-02 PLL<br><br>**Total Legacy PLL: 1.59E-02** | | | Operations:-<br>Monitoring: 16,433 hrs / 1.23E-03 PLL<br><br>Other users:<br>Fishing Vessel Snagging: 1.50E-04 PLL<br><br>**Total Legacy PLL: 1.38E-03** | | Operations:-<br>Monitoring: 16,433 hrs / 1.23E-03 PLL<br><br>Other users:<br>Fishing Vessel Snagging: 1.50E-04 PLL<br><br>**Total Legacy PLL: 1.38E-03** | Operations:-<br>N/A<br><br>Other users:<br>Fishing Vessel Snagging: 4.15E-06 PLL<br><br>**Total Legacy PLL: 4.15E-06** |
| | **Comparison** | **VMW** | **VMW** | **VMW** | **N** | **VMW** | **VMW** | |
| | **Summary** | The summary Potential for Loss of Life (PLL) metrics associated with the legacy risk for the options are 1.59E-02, 1.38E-03, 1.38E-03 and 4.15E-06 respectively. The assessment of the risk exposure is as follows:<br><br>Option 1 is assessed as being Very Much Weaker than all other options as the risk exposure is at least 11 times higher.<br>Option 3a is assessed as being Neutral to Option 3b as the risk exposure is the same. Option 3a is assessed as being Very Much Weaker than Option 5 as the risk exposure is more than 300 times higher.<br>Option 3b is assessed as being Very Much Weaker than Option 5 for similar reasons.<br><br>Overall Option 5 would be the preferred option from a legacy risk perspective. | | | | | | | |

| | | 1. Leave in situ - Minimal intervention | | | 3a. Leave in situ - Major intervention - Full rock placement | | 3b. Leave in situ - Major intervention - Re-trench line | 5. Full removal - Cut and lift |
|---|---|---|---|---|---|---|---|---|
| | | Cut, recover and transfer to shore pipeline end sections (300m at Dunlin A & 650m at Cormorant A).<br>Place rock over cut ends and snag hazards. | | | Cut, recover and transfer to shore pipeline end sections (300m at Dunlin A & 650m at Cormorant A).<br>Place rock over remaining pipeline. | | Cut, recover and transfer to shore pipeline end sections (300m at Dunlin A & 650m at Cormorant A).<br>Re-trench remaining pipeline, transitioning at each crossing.<br>Backfill spoil heaps into trench and place rock at crossings. | Debury buried pipeline sections (excluding crossings)<br>Cut pipeline into 25m sections / recover cut sections and transfer to shore.<br>Backfill trench and place rock at crossings. |
| 2. Environmental | 2.1 Operational Marine Impacts | Operational marine impact from short-term seabed disturbance associated with rock placement (material change to environment).<br>Moderate area (16,900 $m^2$) of impact over a wide area.<br><br>Operational impact from noise exposure low. From vessels and cutting operations.<br>Cumulative Sound Exposure:<br>Vessels: 249 dB re 1mP / 7.58 $TPa^2s$<br>Cutting: 246 dB re 1mP / 3.58 $TPa^2s$ | | | Operational marine impact from short-term seabed disturbance associated with rock placement. Significant area (321,370 $m^2$) of impact over a wide area.<br><br>Operational impact from noise exposure low. From vessels and cutting operations.<br>Overall Cumulative Sound Exposure:<br>Vessels: 254 dB re 1mP / 26.20 $TPa^2s$<br>Cutting: 246 dB re 1mP / 3.58 $TPa^2s$ | | Operational marine impact from short-term seabed disturbance associated with trenching and rock placement. Significant area (Rock placement: 10,000 $m^2$, Trenching: 479,310 $m^2$) of impact over a wide area.<br><br>Operational impact from noise exposure low. From vessel and cutting operations.<br>Overall Cumulative Sound Exposure:<br>Vessels: 253 dB re 1mP / 17.65 $TPa^2s$<br>Cutting: 246 dB re 1mP / 4.40 $TPa^2s$ | Operational marine impact from short-term seabed disturbance associated with deburial and rock placement. Significant area of (Rock placement: 10,000 $m^2$, Deburial: 318,540 $m^2$) of impact over a wide area. In addition, the use of MFE impacts the area around the pipeline and the water column from the fluidisation of the seabed.<br><br>It is noted that a small release of flushed pipeline contents will occur with every cut, however pipeline will be cleaned to regulatory requirements and therefore environmental impact will be small.<br><br>Operational impact from noise exposure moderate. From vessels, cutting and deburial operations.<br>Overall Cumulative Sound Exposure:<br>Vessels: 255 dB re 1mP / 29.82 $TPa^2s$<br>Cutting: 261.8 dB re 1mP / 149.83 $TPa^2s$<br>MFE: 226 dB re 1mP / 0.004 $TPa^2s$<br><br>Whilst it is accepted that this option will require more vessels and for longer durations, the unplanned marine impacts are considered to be similar to the other options. |
| | Comparison | MS | MS | MS | S | S | N | |
| | Summary | The assessment for operational marine impact is to consider short term seabed disturbance as the primary factor. Although cumulative noise values have been calculated for each of the options, overall the noise levels are not considered excessive and would therefore score neutral across the board. Additionally, unplanned operational marine impacts are considered limited and not differentiator.<br>The assessment of the impact of each of the options in terms of Operational Marine Impacts is as follows:<br><br>Option 1 is assessed as being Much Stronger than all other options as the short-term seabed impact is across a much smaller area versus the impact from rock dumping / trenching and then backfilling and the use of MFE for deburying the pipeline as this not only excavates the seabed but also disperses sediment in to the water column and across a large area.<br>Option 3a is assessed as being Stronger than Options 3b and 5 as seabed disturbance is across a smaller area and does not involve excavation of the seabed.<br>Option 3b is assessed as being Neutral to Option 5 as the operational marine impact is considered comparatively similar - the larger area of seabed trenched offset by MFE dispersing seabed material in to the water column.<br><br>Overall Option 1 would be the preferred option from an Operational Marine Impact perspective. | | | | | | |
| 2. Environmental | 2.2 Atmospheric Emissions / Consumptions | Operational / Legacy emissions:<br>$CO_2$: 8,202 tonnes<br>Fuel: 2,585 tonnes<br>Rock: 16,900 tonnes<br>Note: emissions include 10 off legacy surveys.<br><br>Recycling emissions:<br>$CO_2$: 467<br><br>Replacement material emissions:<br>$CO_2$: 21,842 tonnes<br><br>Total $CO_2$: 30,591 tonnes | | | Operational / Legacy emissions:<br>$CO_2$: 7,003 tonnes<br>Fuel: 2,207 tonnes<br>Rock: 181,000 tonnes<br>Note: emissions include 5 off legacy surveys.<br><br>Recycling emissions:<br>$CO_2$: 467 tonnes<br><br>Replacement material emissions:<br>$CO_2$: 21,842 tonnes<br><br>Total $CO_2$: 29,312 tonnes | | Operational / Legacy emissions:<br>$CO_2$: 6,081 tonnes<br>Fuel: 1,916 tonnes<br>Rock: 6,000 tonnes<br>Note: emissions include 5 off legacy surveys.<br><br>Recycling emissions:<br>$CO_2$: 467 tonnes<br><br>Replacement material emissions:<br>$CO_2$: 21,842 tonnes<br><br>Total $CO_2$: 28,390 tonnes | Operational / Legacy emissions:<br>$CO_2$: 29,368 tonnes<br>Fuel: 9,257 tonnes<br>Rock: 6,000 tonnes<br>Note: emissions include no legacy surveys.<br><br>Recycling emissions:<br>$CO_2$: 16,154 tonnes<br><br>Replacement material emissions:<br>$CO_2$: 791 tonnes<br><br>Total $CO_2$: 46,313 tonnes |
| | Comparison | S | N | N | W | W | S | |
| | Summary | The assessment of the impact of each of the options in terms of Emissions and Consumption is as follows:<br><br>Option 1 is assessed as being Stronger than Option 3a due to the significant amount of rock consumed in Option 3a. Option 1 is assessed as being Neutral to Option 3b as the fuel and emissions consumption is relatively close. Option 1 is assessed as being Neutral to Option 5 as, whilst the fuel and emission consumption is lower for Option 1, this is offset by the increased quantity of rock consumed.<br>Option 3a is assessed as being Weaker than Option 3b and Option 5 due to the amount of rock consumed.<br>Option 3b is assessed as being Stronger to Option 5 as, whilst there is sufficient difference in fuel use and emissions to express a preference.<br><br>Overall Option 3b would be the preferred option from an Emissions and Consumption perspective. | | | | | | |

| | | 1. Leave in situ - Minimal intervention | | | 3a. Leave in situ - Major intervention - Full rock placement | | 3b. Leave in situ - Major intervention - Re-trench line | 5. Full removal - Cut and lift |
|---|---|---|---|---|---|---|---|---|
| | | Cut, recover and transfer to shore pipeline end sections (300m at Dunlin A & 650m at Cormorant A).<br>Place rock over cut ends and snag hazards. | | | Cut, recover and transfer to shore pipeline end sections (300m at Dunlin A & 650m at Cormorant A).<br>Place rock over remaining pipeline. | | Cut, recover and transfer to shore pipeline end sections (300m at Dunlin A & 650m at Cormorant A).<br>Re-trench remaining pipeline, transitioning at each crossing.<br>Backfill spoil heaps into trench and place rock at crossings. | Debury buried pipeline sections (excluding crossings)<br>Cut pipeline into 25m sections / recover cut sections and transfer to shore.<br>Backfill trench and place rock at crossings. |
| 2. Environmental | 2.3 Legacy Marine Impacts | Legacy marine impact from permanent altered seabed associated with rock placement. Moderate area (16,900 $m^2$) of impact over a wide area.<br><br>Legacy impact from noise exposure low. From vessels only.<br>Cumulative Sound Exposure:<br>250 dB re 1mP / 8.85 $TPa^2s$<br><br>Legacy marine impacts considered negligible. | | | Legacy marine impact from permanent altered seabed associated with rock placement. Significant area (321,370 $m^2$) of impact over a wide area. Rockdump to stretch approximately 33km and permanently change seabed, although profiled to be over-trawlable.<br><br>Legacy impact from noise exposure low. From vessels only.<br>Cumulative Sound Exposure:<br>248 dB re 1mP / 5.88 $TPa^2s$<br><br>Legacy marine impacts considered negligible. | | Legacy marine impact from permanent altered seabed associated with rock placement. Moderate area (10,000 $m^2$) of impact over a wide area.<br><br>Legacy impact from noise exposure low. From vessels only.<br>Cumulative Sound Exposure:<br>252 dB re 1mP / 15.07 $TPa^2s$<br><br>Legacy marine impacts considered negligible. | Legacy marine impact from permanent altered seabed associated with rock placement. Moderate area (10,000 $m^2$) of impact over a wide area.<br><br>Small benefit associated with removing asphalt / bitumen and residual contents from the seabed. This removes the eventual degradation of material and release of contents to environment. Insufficient to use as a differentiator. |
| Comparison | | VMS | N | N | VMW | VMW | N | |
| Summary | | The assessment for legacy marine impact is to consider long-term seabed disturbance as the primary factor as cumulative noise levels from legacy works is considered negligible. The assessment of the Legacy Marine Impact of each of the options is as follows:<br><br>Option 1 is assessed as being Very Much Stronger than Option 3a due to the long term impact to a significant area of seabed due to rock placement associated with Option 3a. Option 1 is assessed as being Neutral to Option 3b and Option 5 as the long term impact associated with decommissioning works is considered similar in terms of seabed disturbed.<br>Option 3a is assessed as being Very Much Weaker than Options 3b and 5 due to the large area of rock placement associated with Option 3a.<br>Option 3b is assessed as being Neutral to Option 5 as the area of long-term seabed disturbance associated with rock placement is the same.<br><br>Overall Options 1, 3b and 5 are assessed as equally preferred options from a Legacy Marine Impact perspective. | | | | | | |
| 3. Technical | 3.1 Project Technical Risk | **Concept Maturity:** Medium.<br>**Availability of Technology:** High – All vessels and equipment generally available.<br>**Track Record:** High - Rock placement considered a routine operation. Track record lower for cut & lift of concrete coated, large diameter pipelines - limited distance (c. 1km). Note: cut & lift of untrenched pipeline ends common scope for all options.<br>**Technical Risks:** Medium – Several tools / vessels required. Will require diver support. Note: Common across all options.<br>**Consequence of Failure:** Medium – Risk of cost / schedule over run. Alternative decommissioning method may be required e.g. rock dump. No material change to DP. | | | **Concept Maturity:** Medium.<br>**Availability of Technology:** High – All vessels and equipment generally available.<br>**Track Record:** High - Rock placement considered routine operation. Track record lower for cut & lift of concrete coated, large diameter pipelines - limited distance (c. 1km). Note: cut & lift of untrenched pipeline ends common scope for all options.<br>**Technical Risks:** Medium – Several tools / vessels required. Will require diver support. Note: Common across all options.<br>**Consequence of Failure:** Medium – Risk of cost / schedule over run. Additional rock dump may be required. No material change to DP. | | **Concept Maturity:** Medium - The burial / lowering needed (status) of the pipeline poses a challenge for re-trenching works as there is a variable degree of existing lowering and cover. Also significant number of spans and previous span correction works adds to complexity of operation.<br>**Availability of Technology:** Medium - Vessels and equipment generally available. May need to modify plough to ride within a pre-cut trench. Identified only 1 plough capable of doing this for PL5 size and conditions.<br>**Track Record:** Low – Limited track record of post-lay trenching of large OD pipelines in similar conditions. Note: NW Hutton trenched & buried 20" concrete coated pipeline with mixed results.<br>**Technical Risks:** High - Considered challenging to accomplish either DoL and/or to achieve 0.6m DoC. Third party crossings, free spans and uncertainty of seabed conditions adds to complexity.<br>**Consequence of Failure:** Additional rock required where failure to meet DoL / DoC requirements. Will result in schedule and cost impacts. No material change to DP. | **Concept Maturity:** Medium.<br>**Availability of Technology:** Medium - Generally available but may require bespoke tooling for extended operations. Suitable diverless technology limited.<br>**Track Record:** Low - Routine operation but track record low for cut & lift over extended distance. Low track record of deburial over extended distance.<br>**Technical Risks:** High - Considered challenging over large distance. Will require diver support. Extended subsea works & simultaneous on-deck and onshore operations.<br>**Consequence of Failure:** High - Significant risk of schedule / cost overrun. Alternative decommissioning methods may be required if failure occurs. Resubmission of DP. |
| Comparison | | N | MS | MS | MS | MS | N | |
| Summary | | The assessment of the Technical Risk associated with each of the options is as follows:<br><br>Option 1 is assessed as being Neutral to Option 3a as the operations are considered routine. Option 1 is assessed as being Much Stronger than Option 3b as there is considerable uncertainty surrounding the achievability of trenching a 24" concrete coated pipeline uniformly to Depth of Lowering (DoL) / Depth of Cover (DoC) regulatory requirements. Option 1 is assessed as being Much Stronger than Option 5 as, although the process of cut and lift is the same, it is significantly longer, involves deburial of the line and failure to successfully recover would likely result in resubmission of the DP.<br>Option 3a is assessed as being Much Stronger than Options 3b and 5 for the same reasons as noted above for Option 1.<br>Option 3b is assessed as being Neutral to Option 5 as technically they are both considered to carry significant uncertainty and risk.<br><br>Overall Options 1 and 3a would be the preferred options from a Technical Risk perspective. | | | | | | |

| | | 1. Leave in situ - Minimal intervention | | | 3a. Leave in situ - Major intervention - Full rock placement | | 3b. Leave in situ - Major intervention - Re-trench line | 5. Full removal - Cut and lift |
|---|---|---|---|---|---|---|---|---|
| | | Cut, recover and transfer to shore pipeline end sections (300m at Dunlin A & 650m at Cormorant A).<br>Place rock over cut ends and snag hazards. | | | Cut, recover and transfer to shore pipeline end sections (300m at Dunlin A & 650m at Cormorant A).<br>Place rock over remaining pipeline. | | Cut, recover and transfer to shore pipeline end sections (300m at Dunlin A & 650m at Cormorant A).<br>Re-trench remaining pipeline, transitioning at each crossing.<br>Backfill spoil heaps into trench and place rock at crossings. | Debury buried pipeline sections (excluding crossings)<br>Cut pipeline into 25m sections / recover cut sections and transfer to shore.<br>Backfill trench and place rock at crossings. |
| 4. Societal | 4.1 Fishing Industry | Medium – Moderate area permanently lost to demersal fishing operations (16,900 $m^2$) due to rock placement on cut ends and snag hazards. Profiled to be over-trawlable.<br><br>The status of the pipeline left in-situ will be in an open trench with variable natural backfill and pipeline exposures in places. | | | High – Significant area of seabed permanently lost demersal fishing operations (321,370 $m^2$) due to rock placement. Profiled to be over-trawlable. | | Medium - Significant area of short term disturbance from trenching (479,310 $m^2$), moderate area permanently lost (10,000 $m^2$) due to rock placement. Profiled to be over-trawlable. | Medium - Significant area (318,540 $m^2$) temporarily disturbed due to deburial, moderate area permanently lost (10,000 $m^2$) due to rock placement. Profiled to be over-trawlable. |
| **Comparison** | | **S** | **W** | **W** | **MW** | **MW** | **W** | |
| **Summary** | | The assessment of each of the options in terms of the Societal impact on the Fishing Industry is as follows:<br><br>Option 1 is assessed as being Stronger than Option 3a as the status of the naturally backfilled trench is considered relatively similar to a profiled rockberm in terms of impact to fishing. Option 1 is assessed as being Weaker than Options 3b and 5 as the pipeline end status would be sitting within an open trench as opposed to a clear seabed for the other options, excluding crossing locations.<br>Option 3a is assessed as being Much Weaker than Options 3b and 5 as the rock berm extends a significant distance, as opposed to clear seabed for the other options.<br>Option 3b is assessed as being Neutral to Option 5 as, whilst the end status of the pipeline will be similar, there is a preference for the line to be removed.<br><br>Overall Option 5 would be the preferred option from a Societal - Fishing Industry perspective. | | | | | | |
| 4. Societal | 4.2 Other Groups | Low – Approx. 1.2 km (pipeline ends) of low value material returned to shore.<br>Steel: 221 tonnes (recyclable)<br>Aluminium Alloy: 1.5 tonnes (recyclable)<br>Concrete: 230 tonnes (landfill)<br>Polymer: 26 tonnes (landfill)<br><br>Volume to landfill: Approx. 114 $m^3$<br><br>The societal impact of these relatively minor quantities of material, given them being a combination of recyclable and material to landfill is considered limited. | | | Low - rock material procurement, negative transportation impact.<br>Steel: 221 tonnes (recyclable)<br>Aluminium Alloy: 1.5 tonnes (recyclable)<br>Concrete: 230 tonnes (landfill)<br>Polymer: 26 tonnes (landfill)<br><br>Volume to landfill: Approx. 114 $m^3$<br><br>The societal impact of these relatively minor quantities of material, given them being a combination of recyclable and material to landfill is considered limited.<br><br>Consumes 181k tonnes rock but from licensed source so there is limited societal impact. | | Low - No perceived benefit.<br>Steel: 221 tonnes (recyclable)<br>Aluminium Alloy: 1.5 tonnes (recyclable)<br>Concrete: 230 tonnes (landfill)<br>Polymer: 26 tonnes (landfill)<br><br>Volume to landfill: Approx. 114 $m^3$<br><br>The societal impact of these relatively minor quantities of material, given them being a combination of recyclable and material to landfill is considered limited. | Medium - Significant volume of material returned to shore.<br>Steel: 7,667 tonnes (recyclable)<br>Aluminium Alloy: 52 tonnes (recyclable)<br>Concrete: 7,963 tonnes (landfill)<br>Polymer: 888 tonnes (landfill)<br><br>Volume to landfill: Approx. 3962 $m^3$<br><br>The societal impact of these more significant quantities of material, given them being a combination of recyclable and material to landfill is considered limited and balanced with any negative impacts being offset against the job creation / retention offered by 400,000 hours of operations. |
| **Comparison** | | **N** | **N** | **N** | **N** | **N** | **N** | |
| **Summary** | | The assessment of each of the options in terms of the Societal impact on the Other Users is as follows:<br><br>All options have been scored neutral to one another as all options are perceived to balance socio-economic benefit and detriment.<br><br>There is no preferred option from a Societal - Other Users perspective. | | | | | | |
| 5. Economic | 5.1 Operational & Legacy Costs | Total Operational Cost: £5.6 million<br>Total Legacy Cost: £3.8 million<br>Cost Risk: Medium - Track record of cut & lift of large diameter concrete coated pipelines. Long term legacy commitments / responsibilities.<br>**Total Cost: £9.4 million** | | | Total Operational Cost: £12.2 million<br>Total Legacy Cost: £2.0 million<br>Cost Risk: Medium - High degree of achievability associated with rockdumping. Track record of cut & lift on large diameter concrete coated pipelines. Potential requirement for additional rock dependent on trawl activity. Responsible for maintenance of significant length of rock berm. Long term legacy commitments / responsibilities.<br>**Total Cost: £14.2 million** | | Total Operational Cost: £10.9 million<br>Total Legacy Cost: £2.0 million<br>Cost Risk: High - Considered technically challenging. Geotechnical study required. Trenching works uncertain. May require unplanned additional rock placement. Legacy management required.<br>**Total Cost: £12.9 million** | Total Operational Cost: £45.1 million<br>Total Legacy Cost: N/A<br>Cost Risk: High - Considered achievable but concept maturity low at this stage. Increased technical and safety risk associated with extended subsea operations. No legacy management requirement. Crossing remnant sections are considered to be the responsibility of the third-party pipeline operator.<br>**Total Cost: £45.1 million** |
| **Comparison** | | **S** | **S** | **MS** | **N** | **MS** | **MS** | |
| **Summary** | | The assessment of each of the options in terms of the Economic impact is as follows:<br><br>Option 1 is assessed as being Stronger than both Options 3a and 3b as the costs are around £5 million and £3.5 million lower respectively. Option 1 is assessed as Much Stronger than Option 5 as it has a cost around 5 times lower.<br>Option 3a is assessed as being Neutral to Option 3b as the costs are relatively similar. Option 3a is assessed as being Much Stronger than Option 5 as the costs are around three times lower.<br>Option 3b is assessed as being Much Stronger than Option 5 as the costs are around 3.5 times lower.<br><br>Overall Option 1 would be the preferred option from an Economic perspective. | | | | | | |

## Appendix C.2 Group 8 – Pairwise Comparison Matrices

| 1.1 Operations Personnel | 1. Leave in situ - Minimal intervention | 3a. Leave in situ - Major intervention - Full rock placement | 3b. Leave in situ - Major intervention - Re-trench line | 5. Full removal - Cut and lift | Weighting |
|---|---|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | N | S | VMS | 35% |
| 3a. Leave in situ - Major intervention - Full rock placement | N | N | N | VMS | 32% |
| 3b. Leave in situ - Major intervention - Re-trench line | W | N | N | VMS | 29% |
| 5. Full removal - Cut and lift | VMW | VMW | VMW | N | 4% |

| 1.2 Other Users | 1. Leave in situ - Minimal intervention | 3a. Leave in situ - Major intervention - Full rock placement | 3b. Leave in situ - Major intervention - Re-trench line | 5. Full removal - Cut and lift | Weighting |
|---|---|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | N | N | S | 27% |
| 3a. Leave in situ - Major intervention - Full rock placement | N | N | N | S | 27% |
| 3b. Leave in situ - Major intervention - Re-trench line | N | N | N | S | 27% |
| 5. Full removal - Cut and lift | W | W | W | N | 18% |

| 1.3 Legacy Risk | 1. Leave in situ - Minimal intervention | 3a. Leave in situ - Major intervention - Full rock placement | 3b. Leave in situ - Major intervention - Re-trench line | 5. Full removal - Cut and lift | Weighting |
|---|---|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | VMW | VMW | VMW | 3% |
| 3a. Leave in situ - Major intervention - Full rock placement | VMS | N | N | VMW | 14% |
| 3b. Leave in situ - Major intervention - Re-trench line | VMS | N | N | VMW | 14% |
| 5. Full removal - Cut and lift | VMS | VMS | VMS | N | 70% |

| 2.1 Operational Marine Impacts | 1. Leave in situ - Minimal intervention | 3a. Leave in situ - Major intervention - Full rock placement | 3b. Leave in situ - Major intervention - Re-trench line | 5. Full removal - Cut and lift | Weighting |
|---|---|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | MS | MS | MS | 50% |
| 3a. Leave in situ - Major intervention - Full rock placement | MW | N | S | S | 20% |
| 3b. Leave in situ - Major intervention - Re-trench line | MW | W | N | N | 15% |
| 5. Full removal - Cut and lift | MW | W | N | N | 15% |

| 2.2 Atmospheric Emissions / Consumptions | 1. Leave in situ - Minimal intervention | 3a. Leave in situ - Major intervention - Full rock placement | 3b. Leave in situ - Major intervention - Re-trench line | 5. Full removal - Cut and lift | Weighting |
|---|---|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | S | N | N | 27% |
| 3a. Leave in situ - Major intervention - Full rock placement | W | N | W | W | 18% |
| 3b. Leave in situ - Major intervention - Re-trench line | N | S | N | S | 30% |
| 5. Full removal - Cut and lift | N | S | W | N | 25% |

| 2.3 Legacy Marine Impacts | 1. Leave in situ - Minimal intervention | 3a. Leave in situ - Major intervention - Full rock placement | 3b. Leave in situ - Major intervention - Re-trench line | 5. Full removal - Cut and lift | Weighting |
|---|---|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | VMS | N | N | 32% |
| 3a. Leave in situ - Major intervention - Full rock placement | VMW | N | VMW | VMW | 4% |
| 3b. Leave in situ - Major intervention - Re-trench line | N | VMS | N | N | 32% |
| 5. Full removal - Cut and lift | N | VMS | N | N | 32% |

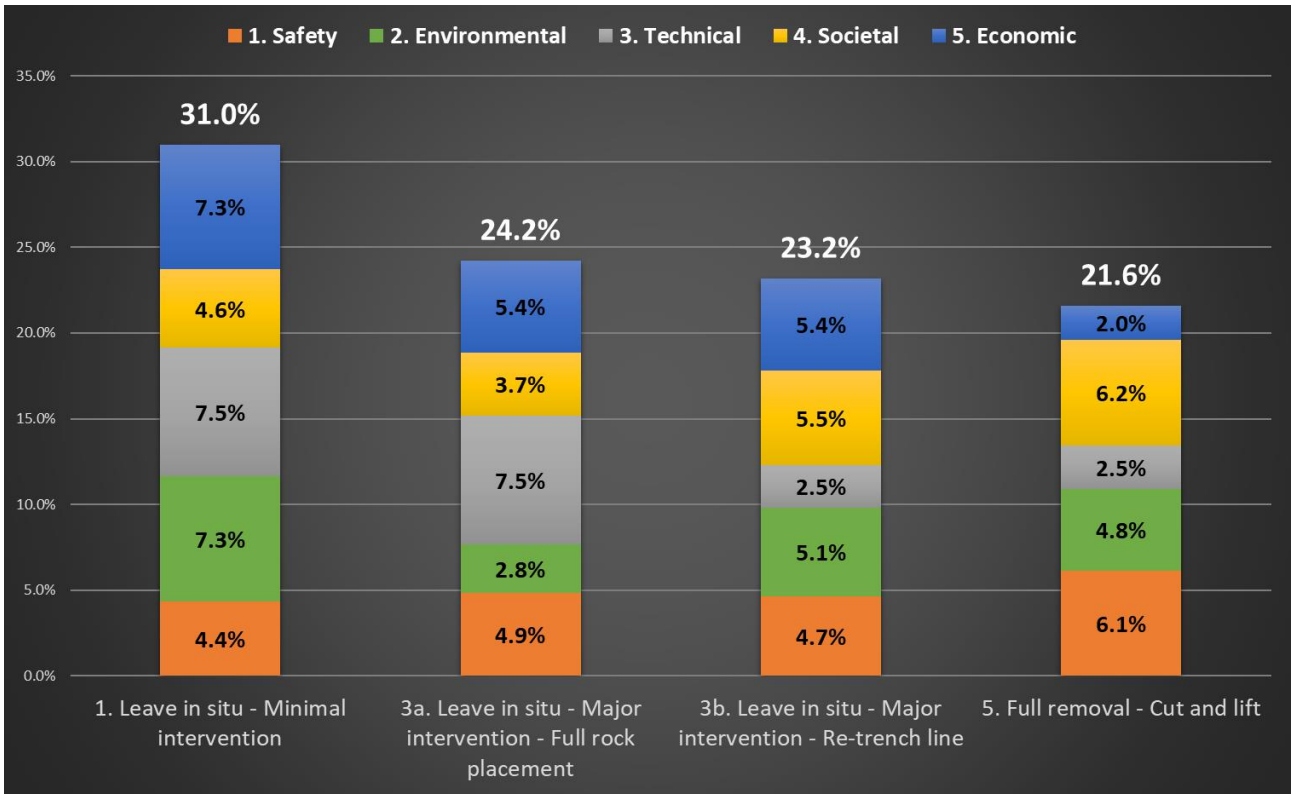
| 3. Technical | 1. Leave in situ - Minimal intervention | 3a. Leave in situ - Major intervention - Full rock placement | 3b. Leave in situ - Major intervention - Re-trench line | 5. Full removal - Cut and lift | Weighting |
|---|---|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | N | MS | MS | 38% |
| 3a. Leave in situ - Major intervention - Full rock placement | N | N | MS | MS | 38% |
| 3b. Leave in situ - Major intervention - Re-trench line | MW | MW | N | N | 13% |
| 5. Full removal - Cut and lift | MW | MW | N | N | 13% |

| 4.1 Fishing Industry | 1. Leave in situ - Minimal intervention | 3a. Leave in situ - Major intervention - Full rock placement | 3b. Leave in situ - Major intervention - Re-trench line | 5. Full removal - Cut and lift | Weighting |
|---|---|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | S | W | W | 21% |
| 3a. Leave in situ - Major intervention - Full rock placement | W | N | MW | MW | 12% |
| 3b. Leave in situ - Major intervention - Re-trench line | S | MS | N | W | 30% |
| 5. Full removal - Cut and lift | S | MS | S | N | 37% |

| 4.2 Other Groups | 1. Leave in situ - Minimal intervention | 3a. Leave in situ - Major intervention - Full rock placement | 3b. Leave in situ - Major intervention - Re-trench line | 5. Full removal - Cut and lift | Weighting |
|---|---|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | N | N | N | 25% |
| 3a. Leave in situ - Major intervention - Full rock placement | N | N | N | N | 25% |
| 3b. Leave in situ - Major intervention - Re-trench line | N | N | N | N | 25% |
| 5. Full removal - Cut and lift | N | N | N | N | 25% |

| 5. Economics | 1. Leave in situ - Minimal intervention | 3a. Leave in situ - Major intervention - Full rock placement | 3b. Leave in situ - Major intervention - Re-trench line | 5. Full removal - Cut and lift | Weighting |
|---|---|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | S | S | MS | 36% |
| 3a. Leave in situ - Major intervention - Full rock placement | W | N | N | MS | 27% |
| 3b. Leave in situ - Major intervention - Re-trench line | W | N | N | MS | 27% |
| 5. Full removal - Cut and lift | MW | MW | MW | N | 10% |

## Appendix C.3 Group 8 Results Chart



# APPENDIX D GROUP 2 – DETAILED EVALUATION RESULTS

## Appendix D.1 Group 2 – Attributes Table

| | | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover |
|---|---|---|---|
| | | No planned intervention, leave partialy buried deposits as-is. | Uncover items (8 mattresses) with CSV / DSV.<br>Lift and recover items.<br>Place rock over areas items removed to provide over trawlable berm. |
| 1. Safety | 1.1 Operations Personnel | Offshore: 182 hrs / 1.37E-05 PLL<br>Onshore: 48 hrs / 1.90E-07 PLL<br><br>**Total option hours: 230**<br>**Total option PLL: 1.39E-05** | Offshore: 3,350 hrs / 4.72E-04 PLL<br>Onshore: 784 hrs / 1.02E-05 PLL<br><br>**Total option hours: 4,134**<br>**Total option PLL: 4.82E-04** |
| **Comparison** | | **MS** | |
| **Summary** | | The summary Potential for Loss of Life (PLL) metrics for the options are 1.39E-05 and 4.82E-04 respectively. The assessment of the risk exposure for the various worker groups is as follows:<br><br>Option 1 is assessed as being Much Stronger than Option 2 as the risk exposure is significantly lower.<br><br>Overall, Option 1 would be the preferred option from a risk to operations personnel perspective. | |
| 1. Safety | 1.2 Other Users | Survey Vessel: 0.3 Days<br>Trawler: 0.4 Days<br><br>**Total vessel days: 0.7 days**<br>**Number of transits: 4** | Survey Vessel: 0.6 days<br>Rockdump Vessel: 2.1 days<br>DSV: 1.7 days<br>Trawler: 0.4 days<br><br>**Total vessel days: 4.8 days**<br>**Number of transits: 10** |
| **Comparison** | | **N** | |
| **Summary** | | The assessment of the impact of each of the options on Other Users is largely driven by the number of transits to and from the field and the total durations that vessels are located in the area during the decommissioning works. The assessment is as follows:<br><br>Option 1 is assessed as being Neutral to Option 2 as, although there is a small difference between options, the risk to other users will be largely similar for both options.<br><br>Overall, there is no preference from a risk to other users perspective. | |
| 1. Safety | 1.3 Legacy Risk | Operations:<br>Monitoring: 1,596 hrs / 1.20E-04 PLL<br><br>Other users:<br>Fishing Vessel Snagging: 8.00E-04 PLL<br><br>**Total Legacy PLL: 9.20E-04** | Operations:<br>None<br><br>Other users:<br>Fishing Vessel Snagging: Not calculated but lower than leave in situ option. |
| **Comparison** | | **W** | |
| **Summary** | | The summary Potential for Loss of Life (PLL) metrics associated with the legacy risk for the options are 9.20E-04 and less than 8.00E-04 respectively. The assessment of the risk exposure is as follows:<br><br>Option 1 is assessed as being Weaker than Option 2 as the legacy risk exposure is around double.<br><br>Overall Option 2 would be the preferred option from a legacy risk perspective. | |
| 2. Environmental | 2.1 Operational Marine Impacts | Operational marine impacts from seabed disturbance considered negligable.<br><br>Operational impact from noise exposure very low. From vessels only.<br>Cumulative Sound Exposure:<br>221 dB re 1mP / 0.01 $TPa^2s$ | Operational marine impact from short-term seabed disturbance associated with rock placement. Small area (800 $m^2$) of impact over a wide area. Further low impact disturbance associated with dredging to expose 8 off mattresses.<br><br>Operational impact from noise exposure low. From vessels only.<br>Overall Cumulative Sound Exposure:<br>245 dB re 1mP / 3.33 $TPa^2s$ |
| **Comparison** | | **S** | |
| **Summary** | | The assessment for operational marine impact is to consider short term seabed disturbance as the primary factor. Although cumulative noise values have been calculated, the impact is considered negligible. The assessment of the impact of each of the options in terms of Operational Marine Impacts is as follows:<br><br>Option 1 is assessed as being Stronger than Option 2 as there is a small area of short-term disturbance associated with deburial of the mattresses for the full removal option.<br><br>Overall Option 1 would be the preferred option from a Marine Impact perspective. | |

| | | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover |
|---|---|---|---|
| | | No planned intervention, leave partialy buried deposits as-is. | Uncover items (8 mattresses) with CSV / DSV.<br>Lift and recover items.<br>Place rock over areas items removed to provide over trawlable berm. |
| 2. Environmental | 2.2 Atmospheric Emissions / Consumptions | Operational / Legacy emissions:<br>$CO_2$: 311 tonnes<br>Fuel: 98 tonnes<br><br>Recycling emissions:<br>N/A<br><br>Replacement material emissions:<br>$CO_2$: 47 tonnes<br><br>Total $CO_2$: 358 tonnes | Operational / Legacy emissions:<br>$CO_2$: 262 tonnes<br>Fuel: 82 tonnes<br>Rock: 800 tonnes<br><br>Recycling emissions:<br>$CO_2$: 57 tonnes<br><br>Replacement material emissions:<br>N/A<br><br>Total $CO_2$: 319 tonnes |
| Comparison | | N | |
| Summary | | The assessment of the impact of each of the options in terms of Emissions and Consumption is as follows:<br><br>Option 1 is assessed as being Neutral to Option 2 as the emissions are largely similar. There is a small amount of rock associated with Option 2, however not significant enough to indicate a preference.<br><br>Overall there is no preference from an Emissions and Consumption perspective. | |
| 2. Environmental | 2.3 Legacy Marine Impacts | Legacy impact from noise exposure very low. From vessels only.<br>Cumulative Sound Exposure:<br>237 dB re 1mP / 0.54 $TPa^2s$<br><br>Legacy marine impacts considered negligable. There may be an environmental impact associated with leaving foreign material subsea indefinitely, such as polypropylene ropes, particularly as it degrades and breaks up over time. | Legacy marine impact from permanent altered seabed associated with rock placement. Small area (800 $m^2$) of impact over a wide area. |
| Comparison | | N | |
| Summary | | The assessment for legacy marine impact is to consider long-term seabed disturbance as the primary factor as cumulative noise levels from legacy works is considered negligible. The assessment of the Legacy Marine Impact of each of the options is as follows:<br><br>Option 1 is assessed as being Neutral to Option 2 as the impact of leaving a small amount of foreign material subsea to degrade over time is largely balanced by the impact of introducing a small amount of rock material subsea.<br><br>Overall, there is no preference from a Legacy Marine Impact perspective. | |
| 3. Technical | 3.1 Project Technical Risk | **Concept Maturity:** High.<br>**Availability of Technology:** High - off the shelf.<br>**Track Record:** High.<br>**Technical Risks:** Medium – Uncertainty surrounding long term snagging risk.<br>**Consequence of Failure:** Medium – Retrospective campaign to remove snagging hazard. | **Concept Maturity:** Medium.<br>**Availability of Technology:** High - off the shelf.<br>**Track Record:** Medium - Mattress removal has been performed many times, however partially buried mattresses less so.<br>**Technical Risks:** Medium - Deburial operations could possibly damage mattresses and compromise ability to recover.<br>**Consequence of Failure:** New decommissioning technique (such as remedial rock) required. |
| Comparison | | S | |
| Summary | | The assessment of the Technical Risk associated with each of the options is as follows:<br><br>Option 1 is assessed as being Stronger than Option 2 as there is uncertainty surrounding the integrity of the mattresses which may compromise the ability to recover them.<br><br>Overall Option 1 would be the preferred option from a Technical Risk perspective. | |
| 4. Societal | 4.1 Fishing Industry | Low – No seabed disturbance. No additional rock placement. There is a snag hazard associated with leaving the partially buried mattresses in situ, however this is considered minimal. | Low – Small area of disturbance associated with 800 tonnes of rock placement to fill void caused by removing mattresses. |
| Comparison | | W | |
| Summary | | The assessment of each of the options in terms of the Societal impact on the Fishing Industry is as follows:<br><br>Option 1 is assessed as being Weaker than Option 2 on the basis that the mattresses present a snag risk if left in-situ.<br><br>Overall Option 1 would be the preferred option from a Societal - Fishing Industry perspective. | |

| | | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover |
|---|---|---|---|
| | | No planned intervention, leave partialy buried deposits as-is. | Uncover items (8 mattresses) with CSV / DSV.<br>Lift and recover items.<br>Place rock over areas items removed to provide over trawlable berm. |
| 4. Societal | 4.2 Other Groups | Low – No identified societal impact.<br><br>Material returned:<br>N/A | Low – Small amount of material returned to shore.<br><br>Material returned:<br>Mattresses and Grout Bags: 54 tonnes / 22 m³ (landfill) |
| Comparison | | N | |
| Summary | | The assessment of each of the options in terms of the Societal impact on the Other Users is as follows:<br><br>Option 1 is assessed as being Neutral to Option 2 as the socio-economic impact for both options is considered low.<br><br>Overall, there is no preference from a Societal - Other Users perspective. | |
| 5. Economic | 5.1 Operational & Legacy | Total Operational Cost: £81 k<br>Total Legacy Cost: £190 k<br>**Total Cost: £271 k** | Total Operational Cost: £554 k<br>Total Legacy Cost: N/A<br>**Total Cost: £554 k** |
| Comparison | | N | |
| Summary | | The assessment of each of the options in terms of the Economic impact is as follows:<br><br>Option 1 is assessed as being Neutral to Option 2 as, although around double the cost, as a proportion of the expected total project costs they are considered relatively minor and as such no preference is indicated.<br><br>Overall, there is no preference from an Economic perspective. | |

## Appendix D.2 Group 2 – Pairwise Comparison Matrices

| 1.1 Operations Personnel | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | MS | 75% |
| 2. Full removal - Lift & recover | MW | N | 25% |

| 1.2 Other Users | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | N | 50% |
| 2. Full removal - Lift & recover | N | N | 50% |

| 1.3 Legacy Risk | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | W | 40% |
| 2. Full removal - Lift & recover | S | N | 60% |

| 2.1 Operational Marine Impacts | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | S | 60% |
| 2. Full removal - Lift & recover | W | N | 40% |

| 2.2 Atmospheric Emissions / Consumptions | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | N | 50% |
| 2. Full removal - Lift & recover | N | N | 50% |

| 2.3 Legacy Marine Impacts | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | N | 50% |
| 2. Full removal - Lift & recover | N | N | 50% |

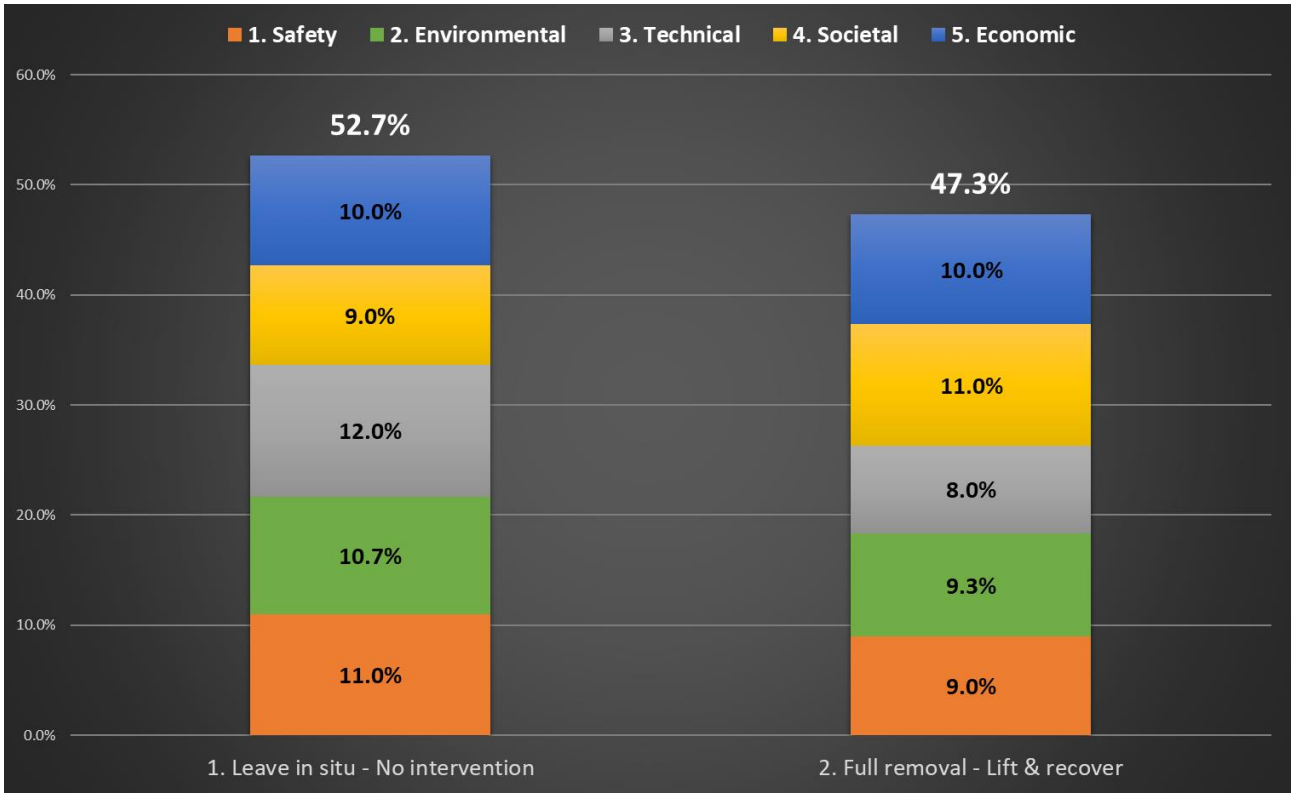
| 3. Technical | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | S | 60% |
| 2. Full removal - Lift & recover | W | N | 40% |

| 4.1 Fishing Industry | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | W | 40% |
| 2. Full removal - Lift & recover | S | N | 60% |

| 4.2 Other Groups | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | N | 50% |
| 2. Full removal - Lift & recover | N | N | 50% |

| 5. Economics | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | N | 50% |
| 2. Full removal - Lift & recover | N | N | 50% |

## Appendix D.3 Group 2 Results Chart



# APPENDIX E GROUP 3 – DETAILED EVALUATION RESULTS

## Appendix E.1 Group 2 – Attributes Table

| | | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover |
|---|---|---|---|
| | | No planned intervention, leave buried deposits as-is. | Uncover items (9 mattresses & 1840 grout bags) with CSV / DSV.<br>Lift and recover items.<br>Place rock over areas items removed to provide over trawlable berm. |
| 1. Safety | 1.1 Operations Personnel | Offshore: 360 hrs / 2.70E-05 PLL<br>Onshore: 95 hrs / 3.82E-07 PLL<br><br>**Total option hours: 455**<br>**Total option PLL: 2.74E-05** | Offshore: 15,992 hrs / 2.45E-03 PLL<br>Onshore: 3,830 hrs / 3.95E-05 PLL<br><br>**Total option hours: 19,822**<br>**Total option PLL: 2.49E-03** |
| **Comparison** | | **MS** | |
| **Summary** | | The summary Potential for Loss of Life (PLL) metrics for the options are 2.74E-05 and 2.49E-03 respectively. The assessment of the risk exposure for the various worker groups is as follows:<br><br>Option 1 is assessed as being Much Stronger than Option 2 as the risk exposure is around 100 times lower.<br><br>Overall, Option 1 would be the preferred option from a risk to operations personnel perspective. | |
| 1. Safety | 1.2 Other Users | Survey Vessel: 0.6 Days<br>Trawler: 0.8 Days<br><br>**Total vessel days: 1.4 days**<br>**Number of transits: 4** | Survey Vessel: 1.2 days<br>Rockdump Vessel: 4.6 days<br>DSV: 9.7 days<br>Trawler: 0.8 days<br><br>**Total vessel days: 16.3 days**<br>**Number of transits: 10** |
| **Comparison** | | **N** | |
| **Summary** | | The assessment of the impact of each of the options on Other Users is largely driven by the number of transits to and from the field and the total durations that vessels are located in the area during the decommissioning works. The assessment is as follows:<br><br>Option 1 is assessed as being Neutral to Option 2 as, although there is a small difference between options, the risk to other users will be largely similar for both options.<br><br>Overall, there is no preference from a risk to other users perspective. | |
| 1. Safety | 1.3 Legacy Risk | Operations:-<br>Monitoring: 3,193 hrs / 2.39E-04 PLL<br><br>Other users:<br>Fishing Vessel Snagging: 3.55E-04 PLL<br><br>**Total Legacy PLL: 5.94E-04** | Operations:<br>None<br><br>Other users:<br>Fishing Vessel Snagging: 3.55E-04<br><br>**Total Legacy PLL: 3.55E-04** |
| **Comparison** | | **W** | |
| **Summary** | | The summary Potential for Loss of Life (PLL) metrics associated with the legacy risk for the options are 5.94E-04 and 3.55E-04 respectively. The assessment of the risk exposure is as follows:<br><br>Option 1 is assessed as being Weaker than Option 2 as the legacy risk exposure is around double.<br><br>Overall Option 2 would be the preferred option from a legacy risk perspective. | |

| | | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover |
|---|---|---|---|
| | | No planned intervention, leave buried deposits as-is. | Uncover items (9 mattresses & 1840 grout bags) with CSV / DSV.<br>Lift and recover items.<br>Place rock over areas items removed to provide over trawlable berm. |
| 2. Environmental | 2.1 Operational Marine Impacts | Operational marine impacts from seabed disturbance considered negligable.<br><br>Operational impact from noise exposure very low. From vessels only.<br>Cumulative Sound Exposure:<br>224 dB re 1mP / 0.03 $TPa^2s$ | Operational marine impact from short-term seabed disturbance associated with deburial (MFE) and subsequent rock placement. Small area (2,000 $m^2$) of impact over a wide area.<br><br>Use of MFE can potentially damage the grout bags through abrasion of the outer bag (plastic) with rock and sediment. There is a risk that this disperses plastic material into the water.<br><br>Operational impact from noise exposure very low.<br>Overall Cumulative Sound Exposure:<br>Vessels: 246 dB re 1mP / 3.95 $TPa^2s$<br>Dredging: 210 dB re 1mP / 0.001 $TPa^2s$<br>MFE: 215 dB re 1mP / 0.003 $TPa^2s$ |
| Comparison | | S | |
| Summary | | The assessment for operational marine impact is to consider short term seabed disturbance as the primary factor. Although cumulative noise values have been calculated, they are considered negligible. The assessment of the impact of each of the options in terms of Operational Marine Impacts is as follows:<br><br>Option 1 is assessed as being Stronger than Option 2 as there is a small area of short-term disturbance associated with the deburial of the mattresses / grout bags for the full removal option.<br><br>Overall, Option 1 would be the preferred option from a Marine Impact perspective. | |
| 2. Environmental | 2.2 Atmospheric Emissions / Consumptions | Operational / Legacy emissions:<br>$CO_2$: 621 tonnes<br>Fuel: 196 tonnes<br><br>Recycling emissions:<br>N/A<br><br>Replacement material emissions:<br>$CO_2$: 94 tonnes<br><br>Total $CO_2$: 715 tonnes | Operational / Legacy emissions:<br>$CO_2$: 933 tonnes<br>Fuel: 294 tonnes<br>Rock: 2,000 tonnes<br><br>Recycling emissions:<br>$CO_2$: 112 tonnes<br><br>Replacement material emissions:<br>N/A<br><br>Total $CO_2$: 1,045 tonnes |
| Comparison | | N | |
| Summary | | The assessment of the impact of each of the options in terms of Emissions and Consumption is as follows:<br><br>Option 1 is assessed as being Neutral to Option 2 as the emissions and consumptions are largely similar. There is a small amount of rock associated with Option 2, however not significant enough to indicate a preference.<br><br>Overall there is no preference from an Emissions and Consumption perspective. | |
| 2. Environmental | 2.3 Legacy Marine Impacts | Legacy impact from noise exposure very low. From vessels only.<br>Cumulative Sound Exposure:<br>240 dB re 1mP / 1.09 $TPa^2s$<br><br>Legacy marine impacts considered negligable as the impact of leaving foreign material subsea indefinitely, such as polypropylene ropes and plastic grout bag material is lower as they are buried. | Legacy marine impact from permanent altered seabed associated with rock placement over areas of mattress / grout bag retrieval. Small area (2,000 $m^2$) of impact over a wide area.<br><br>The environmental impact of rockdump considered somewhat lessened because the areas already contain existing rock placement. |
| Comparison | | N | |
| Summary | | The assessment for legacy marine impact is to consider long-term seabed disturbance as the primary factor as cumulative noise levels from legacy works is considered negligible. The assessment of the Legacy Marine Impact of each of the options is as follows:<br><br>Option 1 is assessed as being Neutral to Option 2 as the impact of leaving foreign material subsea (but buried) to degrade over time largely balanced by the impact of introducing rock material subsea.<br><br>Overall, there is no preference from a Legacy Marine Impact perspective. | |

| | | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover |
|---|---|---|---|
| | | No planned intervention, leave buried deposits as-is. | Uncover items (9 mattresses & 1840 grout bags) with CSV / DSV.<br>Lift and recover items.<br>Place rock over areas items removed to provide over trawlable berm. |
| 3. Technical | 3.1 Project Technical Risk | **Concept Maturity:** High.<br>**Availability of Technology:** High - off the shelf.<br>**Track Record:** High.<br>**Technical Risks:** Medium – Uncertainty surrounding long term snagging risk.<br>**Consequence of Failure:** Medium – Retrospective campaign to remove snagging hazard. | **Concept Maturity:** Medium.<br>**Availability of Technology:** High - off the shelf.<br>**Track Record:** Medium - Mattress removal has been performed many times, however partially buried mattresses less so.<br>**Technical Risks:** Medium - Deburial operations could possibly damage mattresses and compromise ability to recover.<br>**Consequence of Failure:** New decommissioning technique (such as remedial rock) required. |
| **Comparison** | | **S** | |
| **Summary** | | The assessment of the Technical Risk associated with each of the options is as follows:<br><br>Option 1 is assessed as being Stronger than Option 2 as there is uncertainty surrounding the integrity of the mattresses and grout bags which may compromise the ability to recover them.<br><br>Overall Option 1 would be the preferred option from a Technical Risk perspective. | |
| 4. Societal | 4.1 Fishing Industry | Low – No seabed disturbance. No additional rock placement. Snag hazard is managed as already buried. | Low – Small area of disturbance with 2,000 tonnes of rock placement to fill void caused by removing mattresses and grout bags. |
| **Comparison** | | **N** | |
| **Summary** | | The assessment of each of the options in terms of the Societal impact on the Fishing Industry is as follows:<br><br>Option 1 is assessed as being Neutral to Option 2 as the end status of both options will be the same i.e. rock berm profiled for over-trawlability.<br><br>Overall, there is no preference from a Societal - Fishing Industry perspective. | |
| 4. Societal | 4.2 Other Groups | Low – No identified societal impact<br><br>Material returned:<br>N/A | Low – Small amount of material returned to shore.<br><br>Material returned:<br>Mattresses & Grout Bags: 107 tonnes / 45 m³ (landfill) |
| **Comparison** | | **N** | |
| **Summary** | | The assessment of each of the options in terms of the Societal impact on the Other Users is as follows:<br><br>Option 1 is assessed as being Neutral to Option 2 as both options are considered to be no or very low impact to communities.<br><br>Overall, there is no preference from a Societal - Other Users perspective. | |
| 5. Economic | 5.1 Operational & Legacy | Total Operational Cost: £151 k<br>Total Legacy Cost: £379 k<br>Cost Risk: Low - Low upfront cost. There is associated long term liability. Risk that further remedial works is required.<br>**Total Cost: £530 k** | Total Operational Cost: £2.7 million<br>Total Legacy Cost: N/A<br>Cost Risk: Medium - Achievability uncertain. Alternative decommissioning method required upon failure. No long term liability.<br>**Total Cost: £2.7 million** |
| **Comparison** | | **MS** | |
| **Summary** | | The assessment of each of the options in terms of the Economic impact is as follows:<br><br>Option 1 is assessed as being Much Stronger than Option 2 as the costs are around £2 million lower.<br><br>Overall Option 1 would be the preferred option from an Economic perspective. | |

## Appendix E.2 Group 3 – Pairwise Comparison Matrices

| 1.1 Operations Personnel | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | MS | 75% |
| 2. Full removal - Lift & recover | MW | N | 25% |

| 1.2 Other Users | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | N | 50% |
| 2. Full removal - Lift & recover | N | N | 50% |

| 1.3 Legacy Risk | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | W | 40% |
| 2. Full removal - Lift & recover | S | N | 60% |

| 2.1 Operational Marine Impacts | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | S | 60% |
| 2. Full removal - Lift & recover | W | N | 40% |

| 2.2 Atmospheric Emissions / Consumptions | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | N | 50% |
| 2. Full removal - Lift & recover | N | N | 50% |

| 2.3 Legacy Marine Impacts | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | N | 50% |
| 2. Full removal - Lift & recover | N | N | 50% |

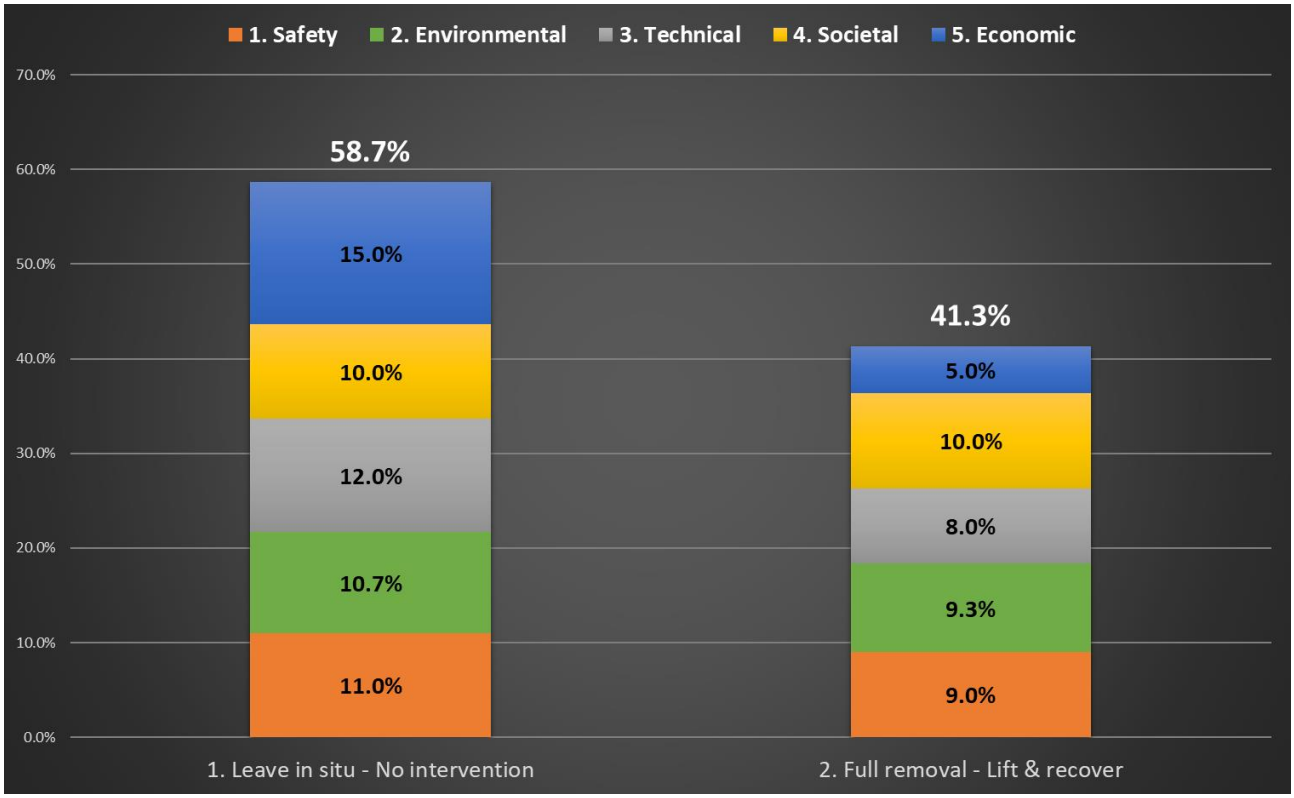
| 3. Technical | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | S | 60% |
| 2. Full removal - Lift & recover | W | N | 40% |

| 4.1 Fishing Industry | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | N | 50% |
| 2. Full removal - Lift & recover | N | N | 50% |

| 4.2 Other Groups | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | N | 50% |
| 2. Full removal - Lift & recover | N | N | 50% |

| 5. Economics | 1. Leave in situ - No intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - No intervention | N | MS | 75% |
| 2. Full removal - Lift & recover | MW | N | 25% |

## Appendix E.3 Group 3 Results Chart



# APPENDIX F GROUP 4 – DETAILED EVALUATION RESULTS

## Appendix F.1 Group 4 – Attributes Table

| | | 1. Leave in situ - Minimal intervention | 2. Full removal - Lift & recover |
|---|---|---|---|
| | | Place rock over grout bag supports. | Recover grout bags (estmated 2,500 bags) for onshore disposal / recycling.<br>Place rock to cover any snag hazards. |
| 1. Safety | 1.1 Operations Personnel | Offshore: 2,317 hrs / 1.74E-04 PLL<br>Onshore: 341 hrs / 1.36E-06 PLL<br><br>**Total option hours: 2,658**<br>**Total option PLL: 1.75E-04** | Offshore: 16,049 hrs / 2.41E-03 PLL<br>Onshore: 3,571 hrs / 2.00E-05 PLL<br><br>**Total option hours: 19,620**<br>**Total option PLL: 2.43E-03** |
| | Comparison | **S** | |
| | Ratio | **1:13.9 or 0.1:1** | |
| | Summary | The summary Potential for Loss of Life (PLL) metrics for the options are 1.75E-04 and 2.43E-03 respectively. The assessment of the risk exposure for the various worker groups is as follows:<br><br>Option 1 is assessed as being Stronger than Option 2 as the risk exposure is around 14 times lower, although remains a relatively small number.<br><br>Overall, Option 1 would be the preferred option from a risk to operations personnel perspective. | |
| 1. Safety | 1.2 Other Users | Survey Vessel: 1.2 Days<br>Rockdump Vessel: 6.9<br>Trawler: 0.8 Days<br><br>**Total vessel days: 8.9 days**<br>**Number of transits: 8** | Survey Vessel: 1.2 days<br>Rockdump Vessel: 6.9 days<br>DSV: 9.4 days<br>Trawler: 0.8 days<br><br>**Total vessel days: 18.2 days**<br>**Number of transits: 10** |
| | Comparison | **N** | |
| | Ratio | **1:2 or 0.5:1** | |
| | Summary | The assessment of the impact of each of the options on Other Users is largely driven by the number of transits to and from the field and the total durations that vessels are located in the area during the decommissioning works. The assessment is as follows:<br><br>Option 1 is assessed as being Neutral to Option 2 as, although there is a small difference between options, the risk to other users will be largely similar for both options.<br><br>Overall, there is no preference from a risk to other users perspective. | |
| 1. Safety | 1.3 Legacy Risk | Operations:-<br>Monitoring: 3,193 hrs / 2.39E-04 PLL<br><br>Other users:<br>Fishing Vessel Snagging: 2.95E-05 PLL<br><br>**Total Legacy PLL: 2.69E-04** | Operations:<br>None<br><br>Other users:<br>Fishing Vessel Snagging: 2.95E-05 PLL<br><br>**Total Legacy PLL: 2.95E-05 PLL** |
| | Comparison | **MW** | |
| | Ratio | **1:0.1 or 9.1:1** | |
| 2. Environmental | 2.1 Operational Marine Impacts | Operational marine impact from short-term seabed disturbance associated with rock placement. Small area (1,900 $m^2$) of impact over a wide area.<br><br>Operational impact from noise exposure very low. From vessels only.<br>Cumulative Sound Exposure:<br>249 dB re 1mP / 4.05 $TPa^2s$ | Operational marine impact from short-term seabed disturbance associated with rock placement. Small area (3,800 $m^2$) of impact over a wide area.<br><br>Operational impact from noise exposure very low.<br>Overall Cumulative Sound Exposure:<br>Vessels: 247 dB re 1mP / 4.59 $TPa^2s$ |
| | Comparison | **S** | |
| | Ratio | **1:1.13 or 0.88:1** | |
| | Summary | The assessment for operational marine impact is to consider short term seabed disturbance as the primary factor. Although cumulative noise values have been calculated, they are considered negligible. The assessment of the impact of each of the options in terms of Operational Marine Impacts is as follows:<br><br>Option 1 is assessed as being Stronger than Option 2 as the seabed disturbance is around half the area associated with the full removal option.<br><br>Overall Option 1 would be the preferred option from a Marine Impact perspective. | |

| | | 1. Leave in situ - Minimal intervention | 2. Full removal - Lift & recover |
|---|---|---|---|
| | | Place rock over grout bag supports. | Recover grout bags (estmated 2,500 bags) for onshore disposal / recycling.<br>Place rock to cover any snag hazards. |
| 2. Environmental | 2.2 Atmospheric Emissions / Consumptions | Operational / Legacy emissions:<br>$CO_2$: 1,046 tonnes<br>Fuel: 330 tonnes<br>Rock: 1,900 tonnes<br><br>Recycling emissions:<br>N/A<br><br>Replacement material emissions:<br>$CO_2$: 55 tonnes<br><br>Total $CO_2$: 1,101 tonnes | Operational / Legacy emissions:<br>$CO_2$: 1,036 tonnes<br>Fuel: 326 tonnes<br>Rock: 3,800 tonnes<br><br>Recycling emissions:<br>$CO_2$: 66 tonnes<br><br>Replacement material emissions:<br>N/A<br><br>Total $CO_2$: 1,102 tonnes |
| **Comparison** | | **N** | |
| **Summary** | | The assessment of the impact of each of the options in terms of Emissions and Consumption is as follows:<br><br>Option 1 is assessed as being Neutral to Option 2 as the emissions and consumptions are largely similar. There is more rock associated with Option 2, however not significant enough to indicate a preference.<br><br>Overall there is no preference from an Emissions and Consumption perspective. | |
| 2. Environmental | 2.3 Legacy Marine Impacts | Operational marine impact from long-term altered seabed associated with rock placement. Small area (1,900 $m^2$) of impact over a wide area.<br><br>Legacy impact from noise exposure very low. From vessels only.<br>Cumulative Sound Exposure:<br>240 dB re 1mP / 1.09 $TPa^2s$<br><br>There may be a small environmental impact associated with leaving foreign material subsea indefinitely, such as the plastic grout bags material, particularly as it degrades and breaks up over time, however this is limited due to them being buried. | Operational marine impact from long-term altered seabed associated with rock placement. Small area (3,800 $m^2$) of impact over a wide area. |
| **Comparison** | | **N** | |
| **Summary** | | The assessment for legacy marine impact is to consider long-term seabed disturbance as the primary factor as cumulative noise levels from legacy works is considered negligible. The assessment of the Legacy Marine Impact of each of the options is as follows:<br><br>Option 1 is assessed as being Neutral to Option 2 as the impact of leaving foreign material subsea (but buried) to degrade over time is largely balanced by the impact of introducing more rock material subsea.<br><br>Overall there is no preference from a Legacy Marine Impact perspective. | |
| 3. Technical | 3.1 Project Technical Risk | **Concept Maturity:** High.<br>**Availability of Technology:** High - off the shelf.<br>**Track Record:** High.<br>**Technical Risks:** Medium – Uncertainty surrounding long term snagging risk.<br>**Consequence of Failure:** Medium – Retrospective campaign to remove snagging hazard. | **Concept Maturity:** Medium.<br>**Availability of Technology:** High - off the shelf.<br>**Track Record:** Medium - Grout bag removal has been performed previously but not so commonly in pipe support removal.<br>**Technical Risks:** Medium - Majority of bags likely to be removed successfully but some may have become embedded underneath the pipe.<br>**Consequence of Failure:** Additional remedial rock cover will be required. |
| **Comparison** | | **S** | |
| **Summary** | | The assessment of the Technical Risk associated with each of the options is as follows:<br><br>Option 1 is assessed as being Stronger than Option 2 as there is uncertainty surrounding the integrity and status of the grout bags which may compromise the ability to recover them.<br><br>Overall Option 1 would be the preferred option from a Technical Risk perspective. | |

| | | 1. Leave in situ - Minimal intervention | 2. Full removal - Lift & recover |
|---|---|---|---|
| | | Place rock over grout bag supports. | Recover grout bags (estmated 2,500 bags) for onshore disposal / recycling.<br>Place rock to cover any snag hazards. |
| 4. Societal | 4.1 Fishing Industry | Low – Small area of seabed impacted from additional rock (1,900 $m^2$, 1,900 tonnes), profiled to be over-trawlable. | Low – Small area of seabed impacted from additional rock (3,800 $m^2$, 3,800 tonnes), profiled to be over-trawlable. |
| Comparison | | N | |
| Summary | | The assessment of each of the options in terms of the Societal impact on the Fishing Industry is as follows:<br><br>Option 1 is assessed as being Neutral to Option 2 as the end status of both options is the same and the areas impacted are insufficient to indicate a preference.<br><br>Overall there is no preference from a Societal - Fishing Industry perspective. | |
| 4. Societal | 4.2 Other Groups | Low – No identified societal benefit / detriment.<br><br>Material returned:<br>N/A | Low – Small amount of material returned to shore.<br><br>Material returned:<br>Mattresses / Grout Bags: 63 tonnes / 28 $m^3$ (landfill) |
| Comparison | | N | |
| Summary | | The assessment of each of the options in terms of the Societal impact on the Other Users is as follows:<br><br>Option 1 is assessed as Neutral to Option 2 as both options are considered to be no or very low impact to communities.<br><br>Overall, there is no preference from a Societal - Other Users perspective. | |
| 5. Economic | 5.1 Operational & Legacy Costs | Total Operational Cost: £334 k<br>Total Legacy Cost: £379 k<br>Cost Risk: Low - Low upfront cost. There is associated long term liability. Risk that further remedial works is required.<br>**Total Cost: £713 k** | Total Operational Cost: £2.6 million<br>Total Legacy Cost: N/A<br>Cost Risk: Medium - Achievability uncertain. Alternative decommissioning method required upon failure. No long term liability.<br>**Total Cost: £2.6 million** |
| Comparison | | MS | |
| Summary | | The assessment of each of the options in terms of the Economic impact is as follows:<br><br>Option 1 is assessed as Much Stronger than Option 2 as the costs are around £2 million lower.<br><br>Overall Option 1 would be the preferred option from an Economic perspective. | |

## Appendix F.2 Group 4 – Pairwise Comparison Matrices

| 1.1 Operations Personnel | 1. Leave in situ - Minimal intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | S | 60% |
| 2. Full removal - Lift & recover | W | N | 40% |

| 1.2 Other Users | 1. Leave in situ - Minimal intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | N | 50% |
| 2. Full removal - Lift & recover | N | N | 50% |

| 1.3 Legacy Risk | 1. Leave in situ - Minimal intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | MW | 25% |
| 2. Full removal - Lift & recover | MS | N | 75% |

| 2.1 Operational Marine Impacts | 1. Leave in situ - Minimal intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | S | 60% |
| 2. Full removal - Lift & recover | W | N | 40% |

| 2.2 Atmospheric Emissions / Consumptions | 1. Leave in situ - Minimal intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | N | 50% |
| 2. Full removal - Lift & recover | N | N | 50% |

| 2.3 Legacy Marine Impacts | 1. Leave in situ - Minimal intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | N | 50% |
| 2. Full removal - Lift & recover | N | N | 50% |

| 3. Technical | 1. Leave in situ - Minimal intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | S | 60% |
| 2. Full removal - Lift & recover | W | N | 40% |

| 4.1 Fishing Industry | 1. Leave in situ - Minimal intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | N | 50% |
| 2. Full removal - Lift & recover | N | N | 50% |

| 4.2 Other Groups | 1. Leave in situ - Minimal intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | N | 50% |
| 2. Full removal - Lift & recover | N | N | 50% |

| 5. Economics | 1. Leave in situ - Minimal intervention | 2. Full removal - Lift & recover | Weighting |
|---|---|---|---|
| 1. Leave in situ - Minimal intervention | N | MS | 75% |
| 2. Full removal - Lift & recover | MW | N | 25% |

## Appendix F.3 Group 4 Results Chart