COMPARATIVE ASSESSMENT SERVICES

CONTRACTOR DOCUMENT COVER SHEET

Total # of Pages (incl. Doc Cover Sheet)	62

Company Document No	**AB-JO-XGL-LL-SU-RP-0001**	**Revision No**	**B02**
Document Title	Comparative Assessment Report – Johnston		
Contract No	POUK/C2420		
Tag No	N/A		

Notes	**Contractor Name, Address and Logo**
	Xodus Group Limited, Xodus House, 50 Huntly Street, Aberdeen, AB10 1RS

Contractor Document No	A-302470-S00-REPT-008	Contractor Rev No	A02

Rev	Issue Date	Status	Amendment Details	Originated By	Checked By	Approved By
R01	08/04/20	IFR	ISSUED FOR REVIEW	J. Foreman	N. Duncan	N. Duncan
A01	25/05/20	IFU	ISSUED FOR USE	J. Foreman	N. Duncan	N. Duncan
A02	29/06/21	IFU	ISSUED FOR USE	N. Duncan Nic Duncan Digitally signed by Nic Duncan Date: 2021.06.29 03:40:53 +01'00'	J. Foreman John Foreman Digitally signed by John Foreman Date: 2021.07.02 08:25:49 +01'00'	N. Duncan Nic Duncan Digitally signed by Nic Duncan Date: 2021.06.29 03:41:09 +01'00'

CONTRACTOR DOCUMENT STATUS

Code	Comment	Action Required	Manufacture
01	Approved	Do not re-submit unless data is modified	May Proceed
02	Accepted with Comment	Approved subject to comments being incorporated	May Proceed
03	Rejected	Not Accepted, work may not proceed, revise and resubmit	May not Proceed
04	Information Only	Do not resubmit	May Proceed

Return Code		**Premier Oil Signature (Electronic)**	
Date		**Premier Oil - Approver Name**	

Review of contractor data does not relieve the contractor of responsibility for correctness under term of the contract.

CA and EA Services

Johnston Field Comparative Assessment Report

Premier Oil E&P UK EU Limited

Assignment Number: A302470-S00
Document Number: A-302470-S00-REPT-008

Xodus Group
Xodus House, 50 Huntly Street
Aberdeen, UK, AB10 1RS

T +44 (0)1224 628300
E info@xodusgroup.com
www.xodusgroup.com

Johnston Field Comparative Assessment Report

A302470-S00

Client: Premier Oil E&P UK EU Limited
Document Type: Report
Document Number: A-302470-S00-REPT-008

			Nic Duncan Digitally signed by Nic Duncan Date: 2021.06.29 03:41:28 +01'00'	John Foreman Digitally signed by John Foreman Date: 2021.07.02 08:26:22 +01'00'	Nic Duncan Digitally signed by Nic Duncan Date: 2021.06.29 03:41:42 +01'00'	
A02	29/06/2021	Issued for Use	Nic Duncan	John Foreman	Nic Duncan	
A01	25/05/2020	Issued for Use	John Foreman	Nic Duncan	Nic Duncan	
R01	08/04/2020	Issued for Review	John Foreman	Nic Duncan	Nic Duncan	
Rev	**Date**	**Description**	**Issued By**	**Checked By**	**Approved By**	**Client Approval**

CONTENTS

EXECUTIVE SUMMARY

Premier Oil have conducted a Comparative Assessment (CA) for the decommissioning of the Huntington, Caledonia, Hunter, Rita and Johnston fields collectively. The following steps from the Oil and Gas UK CA Guidelines have been completed:

On the 31st March 2021, Premier Oil plc and Chrysaor Holdings Limited merged to form Harbour Energy plc. At this point in time, the Premier Oil plc and Chrysaor Holdings Limited companies, including Premier Oil UK EU Limited as Johnston Operator and partial equity holder, are not affected by the completion of the merger, and there are no changes to the company registration details.

This CA report for the Johnston field presents the methodology, decisions taken, the preparation works carried out, and the outcomes (recommendations) from the internal and external (with stakeholders) workshops.

The CA for the Johnston field subsea infrastructure has focussed on two decommissioning groups - groups 2 and 4, as described in the table below.

All other decommissioning groups of the Johnston Subsea Infrastructure were confirmed at the CA Scoping and Screening stage to be fully removed from the field. The outcome of the CA process has made the following recommendations:

Grp	Title	Decommissioning Approach
2	Trenched & Buried Rigid Pipelines (SNS)	Option 5 – Remove ends and remediate snag risk Pipelines will be disconnected Removal and recovery of surface laid sections out with existing trench Rock placement to remediate snag risk from cut ends
4	Trenched & Buried Flexible Pipelines & Umbilicals (SNS)	Option 2b – Reverse reel without de-burial Lines will be disconnected No de-burial prior to removal Recover by reverse reel
6	Spools & Jumpers	Full Removal
7	Structures	Full Removal
8	Protection / Stabilisation	Full Removal
11	Rigid Risers	Full Removal

The decisions were reached on completion of an appropriate amount of preparatory study work, with clear decision outcomes.

The buried sections of the trenched and buried rigid pipelines (PL989 12” Production Pipeline with piggybacked PL990 2” Methanol Pipeline) will be decommissioned *in situ*.

The CA outcome for the trenched and buried flexible pipelines & umbilicals (PL2105 8” Production Flowline, PL991 Static Umbilical and PLU2106 Static Umbilical) is full removal by reverse reeling.

The rigid risers associated with Johnston will be addressed as part of the Ravenspurn North installation decommissioning which is beyond the scope of this document.

All other infrastructure shall be fully removed.

1 INTRODUCTION

1.1 Background

The Johnston Field in the Southern North Sea consists of six gas wells tied back to Ravenspurn North via a seabed template structure. Two of these wells are step outs, J5 well is daisy chained via J4 well.

On the 31st March 2021, Premier Oil plc and Chrysaor Holdings Limited merged to form Harbour Energy plc. At this point in time, the Premier Oil plc and Chrysaor Holdings Limited companies, including Premier Oil UK EU Limited as Johnston Operator and partial equity holder, are not affected by the completion of the merger, and there are no changes to the company registration details.

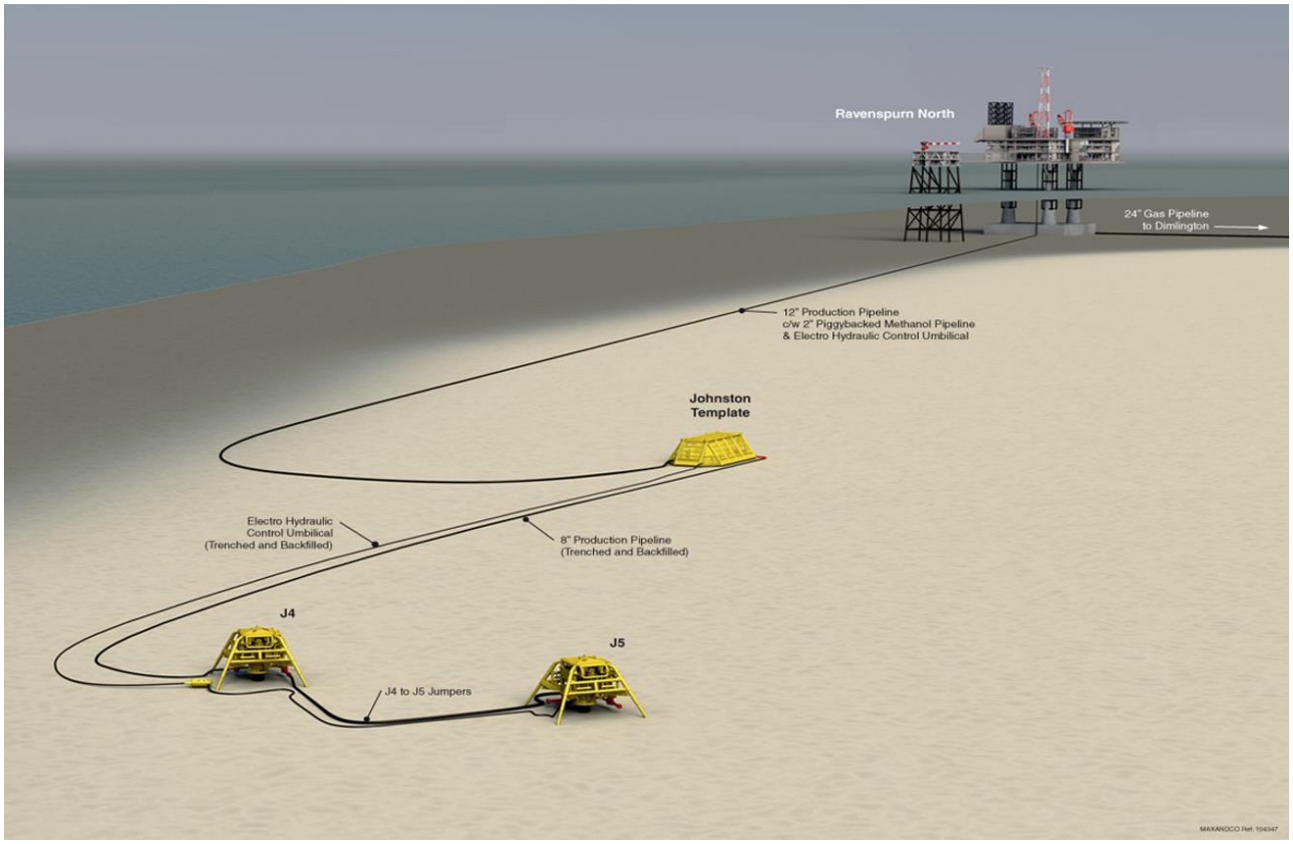


Figure 1.1: Johnston Field Schematic

Wells J4 and J5 are an extension of the original Johnston Field which was initially developed via wells drilled from the Johnston Template.

1.2 Purpose

The purpose of this document is to present a Comparative Assessment (CA) for the Subsea Infrastructure of the Johnston Field in support of the Decommissioning Programme (DP). It is produced in satisfaction of the requirement to perform a CA for any potential derogation application for subsea equipment as detailed in the OGUK Decommissioning CA Guidelines ref. [1].

It describes the field infrastructure addressed, the decommissioning options considered, the CA methodology and the recommendations made during the CA process.

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 methodology and definition of the scoping and boundaries of the CA.
- Section 3 – The decommissioning groups identified and the initial decommissioning approach.
- Section 4 – The CA outcome obtained for Group 2 – Trenched & Buried Rigid Pipelines (SNS).
- Section 5 – The CA outcome obtained for Group 4 – Trenched & Buried Flexible Pipelines & Umbilicals (SNS).
- Appendix A – Evaluation Methodology.
- Appendix B – Stakeholder CA Workshop Minutes.
- Appendix C – Group 2 – Detailed Evaluation Results.
- Appendix D – Group 4 – Detailed Evaluation Results.

1.4 Terms, Abbreviations and Acronyms

AHP	Analytical Hierarchy Process
BEIS	Department for Business, Energy & Industrial Strategy
CA	Comparative Assessment
CNS	Central North Sea
CoP	Cessation of Production
CP	Cathodic Protection
CSV	Construction Support Vessel
DoB	Depth of Burial
DSV	Diver Support Vessel
EMT	Environmental Management Team
HAZID	Hazard Identification
HSE	Health and Safety Executive
JNCC	Joint Nature Conservation Committee
MCDA	Multi-Criteria Decision Analysis
MEI	Major Environmental Incident
MFE	Mass Flow Excavator
MS	Much Stronger
MW	Much Weaker
NFFO	National Federation of Fishermen's Organisations
NORM	Naturally Occurring Radioactive Material
OD	Outside Diameter
ODU	Offshore Decommissioning Unit

OGA	Oil & Gas Authority
OGUK	Oil & Gas UK
OPRED	Offshore Petroleum Regulator for Environment & Decommissioning
PLL	Potential for Loss of Life
POB	Personnel on Board
S	Stronger
SFF	Scottish Fishermen's Federation
SNS	Southern North Sea
ToP	Top of Pipe
ToU	Top of Umbilical
VMS	Very Much Stronger
VMW	Very Much Weaker
W	Weaker

1.5 References

1.	OGUK Decommissioning CA Guidelines	OGUK – Guidelines for Comparative Assessment in Decommissioning Programmes, Dated: October 2015, ISBN: 1 903 004 55 1, Issue: 1.
2.	BEIS Guidance Notes	BEIS, Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines, Nov 2018.
3.	CA Scoping Report	Xodus, CA Scoping Report, AB-UK-XGL-LL-SU-RP-0001 B01, Apr 2019
4.	CA Screening Report	Xodus, CA Screening Report, AB-UK-XGL-LL-SU-RP-0002 B01, Sep 2019
5.	Decommissioning Option Methodologies Report	Xodus, Decommissioning Option Methodologies, AB-UK-XGL-LL-SU-RP-0003 B01, Sep 2019
6.	Subsea HAZID Report	Xodus, HAZID Report, AB-UK-XGL-LL-SU-RP-0004 B01, July 2019
7.	Risk Analysis of Decommissioning Activities	Safetec, Joint Industry Project Report "Risk Analysis of Decommissioning Activities (http://www.hse.gov.uk/research/misc/safetec.pdf), 2005
8.	Analytical Hierarchy Process	T.L. Saaty, The Analytical Hierarchy Process, 1980
9.	OGUK North Sea Pipeline Decommissioning Guidelines	Decommissioning of Pipelines in the North Sea Region – 2013, Issued by Oil & Gas UK
10.	IP 2000	Institute of Petroleum, Guidelines for the Calculation of Estimates of Energy Use and Gaseous Emissions in the Decommissioning of Offshore Structures, ISBN: 9780852932551, Dated: February 2000

2 COMPARATIVE ASSESSMENT METHODOLOGY

2.1 Overview

Comparative Assessment is a process by which decisions are made on the most appropriate approach to decommissioning. As such it is a core part of the overall decommissioning planning process being undertaken by Premier Oil for the Johnston Field Decommissioning Project (Subsea Infrastructure).

The OGUK Decommissioning CA Guidelines ref. [1] were prepared in 2015 by Oil and Gas UK, where seven steps to the CA process were recommended. Table 2.1 introduces each of these steps, along with a status and commentary to demonstrate the current position.

Title	Scope	Status	Commentary
Scoping	Decide on appropriate CA method, confirm criteria, identify boundaries of CA (physical and phase).	✓	CA methodology and criteria established for screening to ensure appropriate evaluation phase. CA Scoping Report [3]
Screening	Consider alternative uses and deselect unfeasible options.	✓	Screening workshops were held in Q2 2019 the screening workshops were attended by members of the Premier Oil project team. Screening outcomes are documented in CA 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. Detailed in Section 2.4.
Evaluation	Evaluate the options using the chosen evaluation methodology.	✓	Internal workshops held Q4 2019 and Stakeholder Workshop on 8th October 2019 Evaluation methodology described in Section 2.5 and outcomes detailed in Section 4 and 5. More detail can be found in Appendix A.
Recommendation	Document the recommendation in the form of narrative supported by charts explaining key trade-offs.	✓	The emerging recommendations for the decommissioning options selected are as identified during the Stakeholder Workshop and as detailed in the CA Report (this document). Recommendations can be found in Section 6.
Review	Review the recommendation with internal and/or external stakeholders.	✓	The Stakeholder CA Review Workshop was held on 8th October 2019 and the minutes can be found in Appendix B.
Submit	Submit to OPRED as part of / alongside the Johnston Decommissioning Programme.	✓	Planned Q3 2021

Table 2.1: CA Process Overview and Status

2.2 Scoping

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

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

These are addressed in the following sub-sections.

2.2.1 CA Boundaries

The applicable boundaries for the CA are as follows:

- The following will be complete prior to the Johnston subsea infrastructure decommissioning scope commencing:
  - Lines will be flushed and cleaned to an acceptable level to permit breaking containment.
- The rigid production riser, from the production ESDV flange at the Ravenspurn North platform to the tie-in spool at the subsea end of the rigid production riser will be removed as part of the Ravenspurn North installation removal, and is not considered within the scope of this CA.
- The rigid methanol riser, from the topside methanol pipework to the tie-in spool at the subsea end of the rigid methanol riser will be removed as part of the Ravenspurn North installation removal, and is not considered within the scope of this CA.
- Johnston Field subsea infrastructure is as follows:
  - All structures including their foundations;
  - All rigid subsea pipelines;
  - All flexible subsea pipelines;
  - All umbilicals;
  - All control and chemical jumpers;
  - All spools;
  - All mattresses and deposits.

2.2.2 Physical Attributes of Equipment

All equipment within the scope of the Johnston Field Decommissioning Project (subsea infrastructure) is listed along with the physical attributes that define the equipment. Attributes considered include the following:

- Structures:
  - Type;
  - Weight / size / shape;
  - General arrangement;
  - Installation method / foundation type;
  - Integrity issues.
- Pipelines / Flowlines / Spools:
  - Pipeline number;
  - Type (rigid / flexible);
  - Service (gas / oil / water);
  - Material / diameter / wall thickness / coatings / length;
  - Seabed configuration (trenched / buried / surface laid);
  - Details of crossings / mattresses;
  - As-left cleanliness / ability to clean lines;
  - Integrity issues.
- Umbilicals / Cables / Jumpers:
  - Material / diameter / wall thickness / coatings / length;
  - Seabed configuration (trenched / buried / surface laid);
  - Details of crossings / mattresses;
  - As-left cleanliness / ability to clean lines / chemicals used;
  - Integrity issues.

All equipment associated with the Johnston Field Decommissioning Project (subsea infrastructure) along with their physical attributes are listed in full in the CA Scoping Report ref. [3] with a summary of the equipment included in Table 3.1 herein.

2.2.3 Decommissioning Groups

Once the equipment to be decommissioned and their attributes are captured, it is desirable to group similar equipment together. This has the benefit that many items can be considered as a single group and can reduce the number of items for consideration from potentially hundreds, down to a few, thus streamlining the process. For the Johnston Decommissioning Project (Subsea Infrastructure) the decommissioning groups, along with a list of each individual item that makes up the population of those groups, is detailed in full within the CA Scoping Report ref. [3]. A brief summary of the decommissioning groups identified is included in Table 3.1 herein.

2.2.4 Decommissioning Options

With the decommissioning groups established, all potential decommissioning options for each of the groups are identified. The base case for all groups is full removal as per the BEIS Guidance Notes ref. [2] and it is only those decommissioning groups where default full removal is not considered to be the clear recommended solution, that alternative decommissioning options are considered.

Alongside full removal options, the following partial removal scenarios should be considered as specified in the BEIS Guidance Notes ref. [2] and OGUK North Sea Pipeline Decommissioning Guidelines ref. [9].

- Re-Use.
- Full Removal:
  - Cut and Lift – Cut pipe into small sections and recover;
  - Reverse Installation without de-burial – Recover pipe using reverse s-lay or reverse reeling;
  - Reverse Installation with de-burial – Recover pipe using reverse s-lay or reverse reeling.
- Leave *In situ* with Major Intervention:
  - Rock cover entire length including surface laid sections out with trench / cover;
  - Re-Trench and bury entire length including surface laid sections out with trench / cover.
- Leave *In situ* with Minor Intervention:
  - Rock cover areas of spans, exposure and shallow burial. Remove surface laid sections out with trench / cover;
  - Trench and bury areas of spans, exposure and shallow burial. Remove surface laid sections out with trench / cover;
  - Cut and Lift areas of spans, exposure and shallow burial. Remove surface laid sections out with trench / cover;
  - Accelerated Decomposition of lines using reverse cathodic protection / chemicals / etc.
- Leave *In situ* and Minimal Intervention:
  - Cut and Lift surface laid sections out with trench / cover only.
- Leave *In situ* and Do Nothing.

Table 3.1 lists the decommissioning groups and identifies those which were judged to be appropriate for decommissioning by full removal and those where full removal was not considered the clear recommended solution. Of those groups where full removal was not considered the clear recommended solution, the proposed decommissioning options for each of those groups are detailed as follows:

- Section 4.2 for Group 2 – Trenched and Buried Rigid Pipelines (SNS);
- Section 5.2 for Group 4 – Trenched and Buried Flexible Pipelines & Umbilicals (SNS).

2.3 Screening Phase

The screening phase of the comparative assessment was carried out during a series of workshops held in Q2 2019. The methodology adopted, workshop attendance and outcomes obtained are detailed fully in the CA Screening Report ref. [4]. The methodology is briefly summarised below.

- Identify decommissioning groups for full removal;
- Review proposed decommissioning options for each remaining group;
- Assess decommissioning options and record assessment and outcome in screening worksheets;
- Record actions required to support retained decommissioning options;
- Compile Screening Report.

The decommissioning options for the remaining groups were assessed against the primary assessment criteria suggested in the OGUK Decommissioning CA Guidelines ref. [1]. These are:

- Safety;
- Environmental;
- Technical;
- Societal;
- Economic.

The assessment was performed using a coarse Red / Amber / Green method, as recommended in the OGUK Decommissioning CA Guidelines ref. [1]. An additional category of 'showstopper', coloured dark grey, was used. These categories are described Table 2.2.

Category	Description
Attractive	The option is considered attractive i.e. it has positive attributes in terms of the criterion being assessed.
Acceptable	The option is considered acceptable i.e. its attributes are not positive or negative in terms of the criterion being assessed.
Unattractive	The option is considered unattractive i.e. it has negative attributes in terms of the criterion being assessed.
Showstopper	The option is considered unacceptable. Should an option be assessed as unacceptable against any of the criteria, no further assessment is required.

Table 2.2: Screening Assessment Categories

The cumulative assessment for each decommissioning option was then captured based on some basic ground rules. These are:

- Three or more criteria assessed as red resulted in the option being screened out (red).
- For similar full removal options, the likely least onerous option was retained (green) with any more onerous option considered as a sub-set of the less onerous option (light grey).
- For similar leave *in situ* options, the most onerous option was retained (green) with any less onerous options considered as a sub-set of the more onerous option (light grey).
- This approach was considered appropriate to ensure that the worst-case full removal options were compared to the less onerous leave *in situ* options. This ensures, during the evaluation phase, that the assessment is not skewed such that leave *in situ* options are selected over full removal options.

The outcomes for each group are summarised in Table 4.2 and Table 5.2.

2.4 Preparation Phase

During the preparation phase, detailed studies / analyses are conducted to provide information to support the Evaluation phase of the Comparative Assessment. The detailed studies / analyses that may be required are often identified early in the CA process. These studies / analyses are then supplemented by additional studies / analyses identified during the screening phase of the CA.

The studies / analyses conducted during the preparation phase of the CA process are as follows:

- Integrity Assessment — A high-level assessment of the residual integrity of the Group 4 lines in order to screen the reverse reel options for this group in or out.
- Accelerated Decomposition Review — A review of the latest status within industry of options for performing accelerated decomposition of rigid pipelines.
- Method Statements — Detailed method statements were developed for options carried forward for evaluation to ascertain the activities and resources required to deliver the option.
- Emissions Assessment — Fuel consumption and atmospheric emissions assessment performed for options carried forward based upon activities and resources identified in method statements.
- Environmental Impact Review — Environmental impact reviews were conducted for options carried forward in areas of planned discharges, unplanned discharges and seabed disturbance based on activities and resources identified in method statements. Underwater noise impact was based on a qualitative assessment of the vessels and activities employed as detailed in the method statements.

Each of the above studies is detailed in the Decommissioning Option Methodologies Report ref. [5].

The findings of the studies / analyses are gathered in preparation for the evaluation phase of the CA. The key information obtained from these studies / analyses, used during the evaluation phase are provided in the attributes tables, included in Appendix C and Appendix D.

2.5 Evaluation Phase

The evaluation phase of the comparative assessment is where the remaining decommissioning options for each group are evaluated against each other. This evaluation process is conducted according to the OGUK Decommissioning CA Guidelines ref. [1] and employs the data obtained during the preparation phase as summarised in the attributes tables, included in Appendix C and Appendix D.

The evaluation phase was performed during several evaluation workshops where the decommissioning project team and field partners were represented. This enabled the supporting information for each of the decommissioning groups and associated decommissioning options to be interrogated and increased in maturity and definition.

Once the evaluation of the remaining decommissioning groups and options was ready, a CA Workshop was convened with external stakeholders; the CA process to date was described and the evaluation of the remaining options was reviewed. This CA Stakeholder Workshop enabled the invited stakeholders to gain familiarity with the evaluation methodology and the information generated through the supporting studies and analyses. It also allowed the evaluation to be challenged in key areas and, at the culmination of the workshop, outcomes for each of the decommissioning groups were validated.

The CA Stakeholder Workshop was held at Premier Oil's offices in Kingswells, Aberdeen on Tuesday October 8th, 2019. The attendees were as detailed in Table 2.3.

Name	Company / Organisation	Role
Robert Willison	BEIS OPRED ODU	Decommissioning Manager
Drew Bond		Assistant Decommissioning Manager
Debbie Taylor		Senior Decommissioning Manager
Nicola Abrams	BEIS OPRED EMT	Environment Manager
Doug Stewart	JNCC	Offshore Industries Advisors Manager
Thomas Fey		Offshore Industries Advisors
Ian Rowe	NFFO	Offshore Liaison
Steven Alexander	SFF	Offshore Liaison
Andrew Third		Industry Advisor
Hywel Williams	HSE	Pipelines Specialist HM Inspector
Pieter voor de Poorte	Premier Oil	Subsea Decommissioning Lead
Paul Newby		Subsea Engineer (Decommissioning)
Lilla Onodi		Decommissioning Engineer
Margaret Christie		Environmental Advisor
Martyn Akers		Technical Safety Lead
Kate Arman		Asset Manager
Phil McIntyre		Asset Manager
David Hunt	Neptune Energy	Decommissioning Manager
Nic Duncan	Xodus	Project Manager
John Foreman		Comparative Assessment Lead
Jenny Smith		Environmental Consultant

Table 2.3: Stakeholder Workshop Attendees & Roles

3 JOHNSTON DECOMMISSIONING GROUPS

Table 3.1 lists all decommissioning groups identified for the Johnston Subsea Infrastructure. Early CA scoping and screening activities, detailed in full in the CA Scoping Report ref. [3] and the CA Screening Report ref. [4], identified the decommissioning groups where full removal is the recommended decommissioning approach (highlighted in grey).

The remaining groups are subjected to the remainder of the CA process to identify the recommended decommissioning option. These outcomes are also captured in Table 3.1. Note that the group numbers align with those in Table 2.2 of the CA Screening Report ref. [4].

Grp	Title	Description	Decommissioning Approach
2	Trenched & Buried Rigid Pipelines (SNS)	All trenched and buried, rigid pipelines, located in the Southern North Sea (SNS).	Subject to full Comparative Assessment
4	Trenched & Buried Flexible Pipelines & Umbilicals (SNS)	All trenched and buried, flexible pipelines and umbilicals located in SNS. Inclusion of flexible pipelines and umbilicals in the same group is deemed appropriate as they share similar design and manufacture characteristics, consisting of multiple layers of metals and polymers	Subject to full Comparative Assessment
6	Spools & Jumpers	All rigid tie-in spools and elector-hydraulic and chemical jumpers across all fields	Full Removal
7	Structures	All subsea structures across all fields	Full Removal
8	Protection / Stabilisation	All protection, support and stabilisation materials such as mattresses and grout bags across all fields.	Full Removal
11	Rigid Risers	All rigid risers across all fields.	Full Removal

Table 3.1: Decommissioning Groups and Initial Decommissioning Recommendation

Note that groups 1 and 3 are not included in this table as they are applicable to Central North Sea (CNS) fields only, Johnston is Southern North Sea (SNS) and therefore does not have any equipment belonging to these groups. Group 5 is not included in this table as it only applies to items in the Hunter field.

3.1 Decommissioning Groups for Full CA

In summary, the decommissioning groups for the Johnston subsea infrastructure where full removal was not considered to be the clear recommended solution and that are to be subjected to the full CA process are:

- Group 2 – Trenched & Buried Rigid Pipelines (SNS)
- Group 4 – Trenched & Buried Flexible Pipelines & Umbilicals (SNS)

4 CA - GROUP 2 - TRENCHED & BURIED RIGID PIPELINES

4.1 Group 2 Characteristics

The items that make up Group 2 for the Johnston Field and their key characteristics are listed in Table 4.1. This information was taken from the CA Scoping Report ref. [3].

ID	Description	OD (inches)	Length (km)	Weight (T)
PL989	9.28 km 12" Production Pipeline, trenched and buried	12"	9.28	1,533
PL990	9.28 km 2" Methanol Pipeline (piggybacked to PL989)	2"	9.28	125

Table 4.1: Group 2 Items

4.2 Group 2 Decommissioning Options & Screening Outcome

During the Screening Phase, all potential decommissioning options were assessed against the Safety, Environmental, Technical, Societal and Economic criteria using a coarse, red / amber / green methodology. The assessment performed and the outcomes are detailed fully in the CA Screening Report ref. [4] and summarised in Table 4.2 herein.

Group 2 – Trenched & Buried Rigid Pipelines (SNS)			
Category	**Option**	**Description**	**Discussion**
Re-use	1 – Re-use	- Leave rigid pipelines *in situ* for use in any potential new developments	Ruled out as a showstopper as there were no potential re-use *in situ* options for the Johnston production or methanol pipelines.
Full removal	2a – Cut and lift with de-burial	- Rigid pipelines will be disconnected - De-burial of rigid pipelines using MFE - Recover by cutting into sections and removal	Retained as the least onerous and credible Full Removal option.
	2b – Reverse reel without de-burial	- Rigid pipelines will be disconnected - No de-burial prior to removal - Recover by reverse reel - Lines vary up to 12" diameter	Ruled out on the basis that the lines do not have the required integrity for reverse reeling without de-burial.
	2c – Reverse reel with de-burial	- Rigid pipelines will be disconnected - De-burial of rigid pipelines using MFE - Recover by reverse reel - Lines vary up to 12" diameter	Ruled out on the basis that the lines do not have the required integrity for reverse reeling with de-burial.
	2d – Lift and cut without de-burial	- Rigid pipelines will be disconnected - No de-burial prior to removal - Recover to vessel with cut on vessel	Ruled out on the basis that the lines do not have the required integrity for recovery to vessel for cutting.
	2e – Lift and cut with de-burial	- Rigid pipelines will be disconnected - De-burial of rigid pipelines using MFE - Recover to vessel with cut on vessel.	Ruled out on the basis that the lines do not have the required integrity for recovery to vessel for cutting.
Leave *in situ* (major intervention)	3a – Rock placement over entire line	- Rigid pipelines will be disconnected - Rock placement over full length of rigid pipelines to address areas of spans, exposure & shallow burial (potentially less than 0.4m ToP / ToU) - No recovery of rigid pipelines	Ruled out as a technical showstopper as there are no areas of spans, exposure or shallow burial. There is no benefit in fully rock covering lines already fully buried.

Group 2 – Trenched & Buried Rigid Pipelines (SNS)			
Category	**Option**	**Description**	**Discussion**
Leave *in situ* (major intervention)	3b – Retrench and bury entire line	- Rigid pipelines will be disconnected - Re-trench and backfill full length of rigid pipelines to remove areas of spans, exposure & shallow burial depth (potentially less than 0.4m Top of Pipe (ToP) / Top of Umbilical (ToU)) - No recovery of rigid pipelines - No introduction of new material	Ruled out as a technical showstopper as there are no areas of spans, exposure or shallow burial. There is no benefit in trenching lines already fully buried.
Leave *in situ* (minor intervention)	4a – Rock placement over exposures	- Rigid pipelines will be disconnected - Removal and recovery of surface laid sections out with existing trench - Rock placement to remediate snag risk from cuts ends - Rock placement at all areas of spans, exposure and shallow burial depth (potentially less than 0.4m ToP / ToU)	Ruled out as a technical showstopper as there are no areas of spans, exposure or shallow burial. As there are no areas to address, this option becomes the same as Option 5.
	4B – Trench & bury exposures	- Rigid pipelines will be disconnected - Removal and recovery of surface laid sections out with existing trench - Rock placement to remediate snag risk from cut ends - Trench / bury areas of spans, exposure and shallow burial depth (potentially less than 0.4m ToP / ToU) - Minimal introduction of new material	Ruled out as a technical showstopper as there are no areas of spans, exposure or shallow burial. As there are no areas to address, this option becomes the same as Option 5.
	4C – Remove exposures	- Rigid pipelines will be disconnected - Removal and recovery of surface laid sections out with existing trench - Rock placement to remediate snag risk from cut ends - Removal of areas of spans, exposure and shallow burial depth (potentially less than 0.4m ToP / ToU) using cut and lift techniques, including de-burial where required)	Ruled out as a technical showstopper as there are no areas of spans, exposure or shallow burial. As there are no areas to address, this option becomes the same as Option 5.
	4D – Accelerated decomposition	- Rigid pipelines will be disconnected - Removal and recovery of surface laid sections out with existing trench - Rock placement to remediate snag risk from cut ends - Introduce material / techniques to accelerate the decomposition process - Potential options include reverse polarity CP, Sulphate Reducing Bacteria (SRBs), chemicals, etc.	Ruled out due to the novelty associated with delivering accelerated decomposition solutions. Whilst research is being conducted, no solutions are near market / commercially viable at this time.
Leave *in situ* (minimal intervention)	5 – Remove ends and remediate snag risk	- Rigid pipelines will be disconnected - Removal and recovery of surface laid sections out with existing trench - Rock placement to remediate snag risk from cut ends	Retained as a viable leave *in situ* option as there are no areas of spans, exposure or shallow burial. Removing the ends of the line out with the trench presents a leave *in situ* option that should be evaluated.
Leave *in situ* (do nothing)	6 – Leave as-is	- There will be no planned subsea intervention - Appropriate legislative considerations shall be addressed and any advisory zones implemented for remaining subsea infrastructure	Ruled out as a safety showstopper due to the sections of line out with the trench leaving an unacceptable potential snagging risk.

Table 4.2: Group 2 Decommissioning Options & Screening Summary

4.3 Group 2 Decommissioning Options for Evaluation

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

- Full Removal
  - 2a – Cut and lift with de-burial
- Leave *in situ* (minimal intervention)
  - 5 – Remove ends & remediate snag risk

4.4 Group 2 Evaluation Summary

Group 2 – Trenched & Buried Rigid Pipelines (SNS)		
Note: for full attributes tables and assessment see Appendix C		
Evaluation	Safety	**Option 5 is assessed as the preferred option.** Option 5 is preferred to Option 2a from a risk exposure to Operations Personnel perspective. This is due to the longer durations associated with the offshore scope to cut the line into sections and recover in Option 2a versus removing the line ends only in Option 5. This also returns more material to shore for handling which also increases the risk exposure. With respect to Other Users, Option 2a has a much higher number of vessel days and a higher number of vessel transits to and from site. While the increased safety impact on Other Users is expected to be small, it is sufficient to express a small preference for Option 5. Option 5 is preferred from a High-Consequence Events perspective as it has much lower potential for dropped objects than 2a due to the high number of lifts associated with Option 2a. Option 2a is preferred to Option 5 in the Legacy Risk criterion due to the line being fully removed. The difference in risk profile between Option 2a and Option 5 is assessed as minimal as the remaining line is fully trenched and buried in Option 5. Overall, Option 5 is preferred over Option 2a as it is lower risk in all safety categories other than residual risk.
	Environment	**Option 5 is assessed as the preferred option.** Option 5 is preferred to Option 2a from an Operational Marine Impact perspective as 2a requires extended vessel operations, cutting and MFE operations which slightly increases the noise impact and potential for planned and unplanned discharges. All impacts are relatively minor, but the cumulative impact results in a preference for Option 5. Both options are considered equally preferred from an Atmospheric Emissions perspective as the fuel use and atmospheric emissions are largely similar. They are also equally preferred from an Other Consumptions perspective as, while the impact from processing all returned material in the full removal option is lower, this was insufficient to express a preference. Option 5 is preferred with respect to Seabed Disturbance as Option 2a disturbs a much greater area of seabed during de-burial of lines by MFE although the seabed will recover quickly in this highly mobile seabed location in the SNS. Option 2a is preferred from a Legacy Marine Impacts perspective as there is no legacy marine impact as line is removed. There is also a small area of permanent habitat change caused by rock cover in Option 5.
	Technical	**Option 5 is assessed as the preferred option.** Both options use largely proven technology and routine operations. The extensive cut & lift and de-burial operations in Option 2a do, however, carry more risk of a technical failure. As such Option 5 is preferred.
	Societal	**Option 2a is assessed as the preferred option.** With respect to Societal impact on Fishing, there is no preference between the two options. While Option 2a may appear to be preferable as it involves full removal of the line, it also causes disruption to fishing operations from the de-burial and removal of the line, which may impact nephrops fishing activities prevalent in this area. Option 2a is preferred from a Societal impact on Other Users perspective as there is a significantly higher quantity of useful material being returned than in Option 5.
	Economic	**Option 5 is assessed as the preferred option.** From a short-term cost perspective, Option 2a is around 17 times more expensive than Option 5. For long-term costs, there are none associated with Option 2a as it is full removal but for Option 5 there are legacy costs associated with monitoring, surveying and managing potential snag hazards. The total short-term plus long-term costs are still significantly less for Option 5, as such this is the preferred option.
	Summary	**Overall, Option 5 is assessed as the preferred option.** Option 5 was clearly preferred against the Safety, Environment and Technical criteria whereas Option 2a was preferred from a Societal perspective. Once the Economics criterion was considered, this strengthens the preference for Option 5. Option 5 – Remove ends and remediate snags will form the emerging recommendation for the decommissioning option for Group 2.

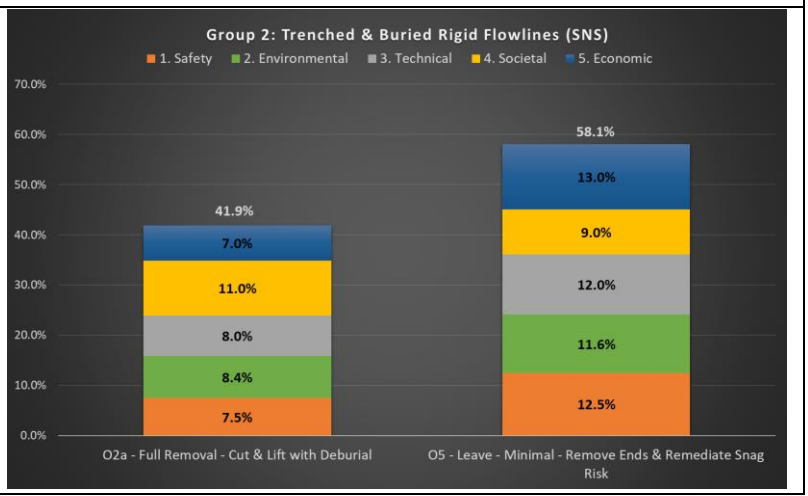


Table 4.3: Group 2 Evaluation Summary

5 CA - GROUP 4 - TRENCHED & BURIED FLEXIBLE PIPELINES & UMBILICALS

5.1 Group 4 Characteristics

The items that make up Group 4 and their key characteristics are listed in Table 5.1. This information was taken from the CA Scoping Report ref. [3].

ID	Description	OD (inches)	Length (km)	Weight (T)
PL991	9.52 km Static Umbilical, trenched and buried	4	9.52	177
PL2105	6.89 km 8" Production Flowline, trenched and buried	8	6.89	547
PLU2106	6.88 km Static Umbilical, trenched and buried	4	6.88	100

Table 5.1: Group 4 Items

5.2 Group 4 Decommissioning Options & Screening Outcome

During the Screening Phase, all potential decommissioning options were assessed against the Safety, Environmental, Technical, Societal and Economic criteria using a coarse, red / amber / green methodology. The assessment performed and the outcomes are detailed fully in the CA Screening Report ref. [4] and summarised in Table 5.2.

Group 4 – Trenched & Buried Flexible Pipelines & Umbilicals (SNS)			
Category	**Option**	**Description**	**Discussion**
Re-use	1 – Re-use	- Leave flexibles and umbilicals *in situ* for use in any potential new developments	Ruled out as a showstopper as there were no potential re-use *in situ* options for the flowline or umbilicals.
Full removal	2a – Cut and lift with de-burial	- Lines will be disconnected - De-burial of lines using MFE - Recover by cutting into sections and removal	Ruled out as a more onerous full removal option than Option 2b.
	2b – Reverse reel without de-burial	- Lines will be disconnected - No de-burial prior to removal - Recover by reverse reel - Lines are between 4" and 8" diameter	Retained as the least onerous and credible Full Removal option.
	2c – Reverse reel with de-burial	- Lines will be disconnected - De-burial of lines using MFE - Recover by reverse reel - Lines are between 4" and 8" diameter	Ruled out as a more onerous full removal option than Option 2b.
	2d – Lift and cut without de-burial	- Lines will be disconnected - No de-burial prior to removal - Recover to vessel with cut on vessel	Ruled out as a more onerous full removal option than Option 2b.
	2e – Lift and cut with de-burial	- Lines will be disconnected - De-burial of lines using MFE - Recover to vessel with cut on vessel.	Ruled out as a more onerous full removal option than Option 2b.
Leave *in situ* (major intervention))	3a – Rock placement over entire line	- Lines will be disconnected - Rock placement over full length of lines to address areas of spans, exposure & shallow burial (potentially less than 0.4m ToP / ToU) - No recovery of lines	Ruled out as a technical showstopper as there are no areas of spans, exposure or shallow burial. There is no benefit in fully rock covering lines already fully buried.

Group 4 – Trenched & Buried Flexible Pipelines & Umbilicals (SNS)			
Category	**Option**	**Description**	**Discussion**
	3b – Retrench and bury entire line	- Lines will be disconnected - Re-trench and backfill full length of lines to remove areas of spans, exposure & shallow burial depth (potentially less than 0.4m Top of Pipe (ToP) / Top of Umbilical (ToU)) - No recovery of lines - No introduction of new material	Ruled out as a technical showstopper as there are no areas of spans, exposure or shallow burial. There is no benefit in trenching lines already fully buried.
Leave *in situ* (minor intervention)	4a – Rock placement over exposures	- Lines will be disconnected - Removal and recovery of surface laid sections out with existing trench - Rock placement to remediate snag risk from cut ends - Rock placement at all areas of spans, exposure and shallow burial depth (potentially less than 0.4m ToP / ToU)	Ruled out as a technical showstopper as there are no areas of spans, exposure or shallow burial. As there are no areas to address, this option becomes the same as Option 5.
	4B – Trench & bury exposures	- Lines will be disconnected - Removal and recovery of surface laid sections out with existing trench - Rock placement to remediate snag risk from cut ends - Trench / bury areas of spans, exposure and shallow burial depth (potentially less than 0.4m ToP / ToU) - Minimal introduction of new material	Ruled out as a technical showstopper as there are no areas of spans, exposure or shallow burial. As there are no areas to address, this option becomes the same as Option 5.
	4C – Remove exposures	- Lines will be disconnected - Removal and recovery of surface laid sections out with existing trench - Rock placement to remediate snag risk from cut ends - Removal of areas of spans, exposure and shallow burial depth (potentially less than 0.4m ToP / ToU) using cut and lift techniques, including de-burial where required)	Ruled out as a technical showstopper as there are no areas of spans, exposure or shallow burial. As there are no areas to address, this option becomes the same as Option 5.
	4D – Accelerated decomposition	- Lines will be disconnected - Removal and recovery of surface laid sections out with existing trench - Rock placement to remediate snag risk from cut ends - Introduce material / techniques to accelerate the decomposition process - Potential options include reverse polarity CP, Sulphate Reducing Bacteria (SRBs), chemicals, etc.	Ruled out as a technical showstopper as accelerated decomposition not a viable solution for flexibles or umbilicals due to their construction.
Leave *in situ* (minimal intervention)	5 – Remove ends and remediate snag risk	- Lines will be disconnected - Removal and recovery of surface laid sections out with existing trench - Rock placement to remediate snag risk from cut ends	Retained as a viable leave *in situ* option as there are no areas of spans, exposure or shallow burial. Removing the ends of the line out with the trench presents a leave *in situ* option that should be evaluated.
Leave *in situ* (do nothing)	6 – Leave as-is	- There will be no planned subsea intervention - Appropriate legislative considerations shall be addressed and any advisory zones implemented for remaining subsea infrastructure	Ruled out as a safety showstopper due to the sections of line out with the trench leaving an unacceptable potential snagging risk.

Table 5.2: Group 4 Decommissioning Options and Screening Summary

5.3 Group 4 Decommissioning Options for Evaluation

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

- Full Removal
  - 2b – Reverse reel without de-burial
- Leave *in situ* (minimal intervention)
  - 5 – Remove ends & remediate snag risk

5.4 Group 4 Evaluation Summary

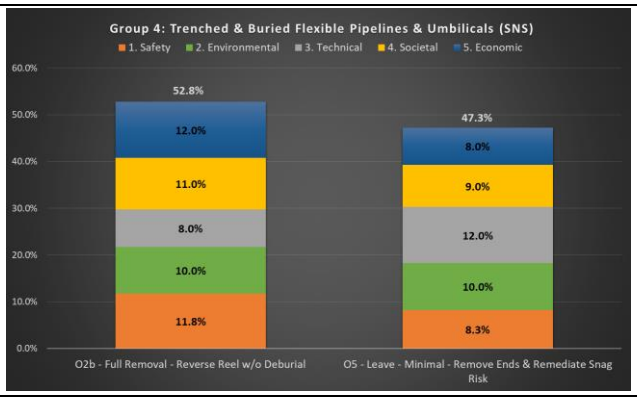
Group 4 – Trenched & Buried Flexible Pipelines and Umbilicals (SNS)		
Note: for full attributes tables and assessment see Appendix D		
	Safety	**Option 2b is assessed as the preferred option.** Option 2b is preferred to Option 5 from a risk exposure to Operations Personnel perspective. This is due to the longer durations associated with the offshore scope to cut the line end sections into short sections and their recovery in Option 5 versus efficient reverse reeling of the lines in Option 2b. The increased risk exposure from the increased quantity of material returned to shore for handling was insufficient to offset the increased offshore risk exposure. With respect to Safety risk to Other Users, Option 2b and Option 5 are both equally preferred due to a largely similar numbers of vessel days and transits. They are also equally preferred from a High-Consequence Events perspective as the potential for dropped objects is similar due to the similar number of lifts. The HAZID indicated that the potential for High Consequence Events from an integrity failure of the line during reverse reeling would be negligible due to no personnel being exposed on the high-tension side of the tensioner. Option 2b is preferred to Option 5 in the Legacy Risk criterion due to it being a full removal option. The difference in risk profile between Option 2b and Option 5 is assessed as minimal as the remaining line is fully trenched and buried in Option 5. Option 2b is therefore preferred over Option 5 as it is preferred in two Safety categories with the others equal.
	Environment	**Option 2b and Option 5 are assessed as equally preferred.** Option 2b and Option 5 are equally preferred from an Operational Marine Impact perspective as the noise impacts and potential for unplanned discharges is similar for both options. Although there would be higher operational discharges from reverse reeling the lines (2b), as all contents would be released in a single discharge, the impact of this is expected to be low due to the small inventory remaining after these lines have already been cleaned and flushed and therefore insufficient to express a preference. Both options are considered equally preferred from an Atmospheric Emissions perspective as, while there is more fuel use and atmospheric emissions for Option 5, this differential was considered insufficient to express a preference. They are also equally preferred from an Other Consumptions perspective as, while the impact from processing all returned material in the full removal option is lower, this was insufficient to express a preference. Option 5 is preferred with respect to Seabed Disturbance as Option 2b disturbs a greater area of seabed during reverse reeling the lines through cover. Option 2b is preferred from a Legacy Marine Impacts perspective as there is no legacy marine impact as the lines are removed. There is also a small area of permanent habitat change caused by rock cover in Option 5. Note: the environmental impact of all decommissioning options is low and the differences between the options are minor.
	Technical	**Option 5 is assessed as the preferred option.** Both options use largely proven technology and routine operations. However, there is potential for the reverse reeling option to fail, requiring the decommissioning solution to be revisited. As such Option 5 is preferred.
	Societal	**Option 2b is assessed as the preferred option.** With respect to Societal impact on Fishing, there is a preference for Option 2b as, while the removal of this line by reverse reeling causes disruption to fishing operations during the removal, this is relatively short duration disturbance and impact to nephrops fishing activities prevalent in this area. Option 5 would result in similar duration disruption (although disruption focussed at line ends) along with periodic survey activities that would cause similar disruption but over a longer timeframe. Option 2b and Option 5 are equally preferred from a Societal impact on Other Users perspective as while there is more useful material returned in Option 2b, there is also more material destined for landfill which cancels this out.
	Economic	**Option 2b is assessed as the preferred option.** From a short-term cost perspective, Option 2b is around half the cost of Option 5. For long-term costs, there are none associated with Option 2b as it is full removal but for Option 5 there are legacy costs associated with, surveying and managing potential snag hazards. The total short-term plus long-term costs are significantly lower for Option 2b, as such this is the preferred option.
	Summary	**Overall, option 2b is assessed as the preferred option.** Option 2b was preferred against the Safety and Societal criteria and equally preferred against the Environmental criterion. Option 5 was preferred from a Technical perspective. Overall, without including economics, there is a small preference for Option 2b. Once the Economics criterion was considered, this strengthens the preference for Option 2b. Option 2b – Reverse reeling without de-burial will form the emerging recommendation for the decommissioning option for Group 4.
		

Table 5.3: Group 4 Evaluation Summary

6 RECOMMENDATIONS

The outcomes obtained from performing the comparative assessment of the decommissioning groups and decommissioning options for the Johnston area subsea infrastructure are summarised here.

There were several groups where full removal was the recommended decommissioning approach without any further comparative assessment. These are:

- Group 6 – Spools & Jumpers
- Group 7 – Structures
- Group 8 – Protection / Stabilisation
- Group 11 – Rigid Risers

The full comparative assessment process was applied to the remaining decommissioning groups (2 and 4). The recommended decommissioning options for these groups follow below.

6.1 Group 2 Recommendations

The recommended decommissioning option for Group 2 – Trenched & Buried Rigid Pipelines (SNS) is:

- Option 5 – Remove ends and remediate snag risk
  - Pipelines will be disconnected
  - Removal and recovery of transition and surface laid sections out with existing trench
  - Rock placement to remediate snag risk from cut ends

The following sections provide a summary of the evaluation of the two most viable Group 2 decommissioning options (Option 2a and Option 5) against the five criteria and why this recommendation has been made.

6.1.1 Safety

Option 2a has four times the risk exposure of Option 5 due to the extended durations required for cutting the entire line into sections and recovering them rather than just the line ends out with the trench. In addition, Option 2a poses a slightly higher risk to Other Users from the larger number of vessel days and vessel transits and has higher potential for High Consequence Events from dropped objects as there are a much higher number of lifts through the splash zone. Option 2a is considered preferable to Option 5 from a Legacy Risk perspective as the line is fully removed. This preference is small however, as the line left *in situ* in Option 5 is fully trenched and buried and is therefore expected to present a negligible potential for snagging.

Overall, there is a preference for Option 5 from a Safety perspective.

6.1.2 Environment

Option 2a has higher Operational Marine Impact due to more vessel noise, more subsea cutting noise and greater potential for unplanned discharges from the extended vessel and cutting operations associated with cutting the full pipeline versus just the end sections. There will also be more seabed disturbance with Option 2a from the MFE de-burial of the line required to cut it into small sections.

Both options perform similarly from an Emissions and Consumptions perspective and Option 2a is preferred from a Legacy Marine Impact as the line is fully removed.

Overall, there is a preference for Option 5 from an Environmental perspective.

6.1.3 Technical

While both options use largely routine activities and methods, Option 2a carries a higher risk of technical failure due to the longer duration cut and lift operations associated with the full pipeline removal rather than just the end section removal in Option 5. As such, Option 5 is preferred from a Technical perspective.

6.1.4 Societal

Both Options 2a and 5 have a similar impact on fishing as, although the lines will be fully removed in Option 2a, there will be disturbance caused to fishing activities from the de-burial and cutting operations. This is particularly disruptive to the nephrop fishing activities prevalent in this area. Option 5 will cause less disruption, but the pipeline will be left *in situ*, albeit fully trenched and buried.

Option 2a is preferred to Option 5 with respect to the amount of useful material being returned from the cut and lift operations. Overall there is a slight preference for Option 2a from a Societal perspective.

6.1.5 Economic

The short-term costs associated with executing Option 2a where the line is fully removed are much higher (around 17 times higher) than for the much smaller scope associated with executing Option 5. Option 5 does however, have long-term costs associated with monitoring and surveying required to manage potential snag risks in the future, but these are relatively insignificant in economic terms. The total costs (short-term + long-term) are significantly less for Option 5 and therefore this is preferred from an Economic perspective.

6.1.6 Group 2 Evaluation Scope

It should be noted that the evaluation session conducted for Group 2 – Trenched & Buried Rigid Pipelines (SNS) included lines for both the Johnston field (as described in Section 4.1) and the Hunter / Rita lines. This approach was deemed appropriate for the evaluation workshops as these fields are being decommissioned by Premier Oil in a similar time frame. It also reduced the burden on stakeholder attendance by combining elements in similar geographic areas, environmental conditions and characteristics.

As the reporting of the recommendation for Group 2 is by field (this Johnston CA Report) but the evaluation was conducted collectively (Johnston & Hunter / Rita), the outcome for Group 2 was tested for validity by the project team by reducing the scope to just Johnston lines or Hunter / Rita lines and confirming that the judgements made between the options remained valid.

Given that the decommissioning programme may be conducted as a collective campaign, this approach is considered appropriate and acceptable.

6.2 Group 4 Recommendations

The recommended decommissioning option for Group 4 - Trenched & Buried Flexible Pipelines & Umbilicals (SNS) is:

- Option 2b – Reverse reel without de-burial
  - Lines will be disconnected
  - No de-burial prior to removal
  - Recover by reverse reel
  - The lines are between 4” and 8” diameter

The following sections provide a summary of the evaluation of the two most viable Group 4 decommissioning options (Option 2b and Option 5) against the five criteria and why this recommendation has been made.

6.2.1 Safety

Option 2b lower risk exposure than Option 5 due to the efficiency of reverse reeling the lines versus the duration required for cutting and removing the line ends. Both options are similar with respect to vessel days and transits and therefore the safety risk to Other Users is considered equal. The options are also considered to have similar risk for high consequence events as there is a similar number of lifting operations. Option 2b is preferred from a Legacy Risk perspective due to the lines being fully removed. This preference is small however, as the lines left *in situ* in Option 5 are fully trenched and buried and are therefore expected to present a small potential for snagging.

Overall, there is a preference for Option 2b from a Safety perspective.

6.2.2 Environment

Both options have similar Environmental performance. Option 2b has a higher Operational Marine Impact due to discharge of the line contents from reverse reeling. The impact of this discharge is expected to be low as the lines will be flushed and cleaned prior to removal. Option 5 has Higher Operational Marine Impact from the longer durations with vessels on site. These minor differentiators cancel each other out and as such, both options are equally preferred from an Operational Marine Impact perspective. There is higher fuel use and atmospheric emissions associated with Option 5, but the difference is not significant enough to warrant a preference. This is also the case with Other Consumptions. Option 5 is preferred from a seabed disturbance as there is less impact than the reverse reeling operations where the lines are pulled through existing cover. Option 2b is preferred from a Legacy Marine Impact perspective as the lines are fully removed.

Overall, both options are equally preferred from an Environmental perspective.

6.2.3 Technical

Both options do employ largely routine operations although Option 2b carries a higher risk of technical failure due to uncertainty around the integrity of the line for reverse reeling operations. As such, Option 5 is preferred from a Technical perspective.

6.2.4 Societal

Option 2b is preferred over Option 5 from an impact on fishing perspective as, although there is disruption associated with the line being reverse reeled in Option 2b, these are shorter durations of impact and it is removed. Option 5 has longer durations of disruption albeit in a smaller area as it is concentrated on the line ends, however there will be additional disruption from the ongoing survey and monitoring activities for this leave *in situ* option. These operations are particularly disruptive to the nephrop fishing activities prevalent in this area.

Option 2b returns more useful material for recycling than Option 5, but also returns more material that is likely to end up in landfill which is a negative societal impact. Overall, there is a small preference for Option 2b from a societal perspective.

6.2.5 Economic

The short-term costs associated with executing Option 2b where the line is fully removed by reverse reeling is around half that for the partial removal in Option 5. This reflects the efficient nature of reverse reeling operations. There are no legacy costs associated with the full removal option versus the costs associated with surveying and monitoring required for the partial removal in Option 5. As such, Option 2b is preferred from an Economic perspective.

6.2.6 Group 4 Evaluation Scope

It should be noted that the evaluation session conducted for Group 4 – Trenched & Buried Flexible Pipelines & Umbilicals (SNS) included lines for both the Johnston field (as described in Section 5.1) and the Hunter / Rita lines. This approach was deemed appropriate for the evaluation workshops as these fields are being decommissioned by Premier Oil in a similar time frame. It also reduced the burden on stakeholder attendance by combining elements in similar geographic areas, environmental conditions and characteristics.

As the reporting of the recommendation for Group 4 is by field (this Johnston CA Report) but the evaluation was conducted collectively (Johnston & Hunter / Rita), the outcome for Group 4 was tested for validity by the project team by reducing the scope to just Johnston lines or Hunter / Rita lines and confirming that the judgements made between the options remained valid.

Given that the decommissioning programme may be conducted as a collective campaign, this approach is considered appropriate and acceptable.

APPENDIX A EVALUATION METHODOLOGY

Appendix A.1 CA Evaluation Methodology

Premier Oil has selected a Multi Criteria Decision Analysis (MCDA) methodology for the evaluation phase of the CA. This methodology uses a pairwise comparison system based on the methodologies of the Analytical Hierarchy Process (AHP) by T.L. Saaty, described in various publications, such as Analytical Hierarchy Process ref. [8]. 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 Q2 2019 and listed in Appendix A.2
- 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 internal CA workshop;
- Discuss attributes of each option against each differentiating criteria – the discussion was recorded 'live' during the workshop in order that informed opinion and experience was factored into the decision-making process;
- Perform scoring (see Section Appendix A.5);
- Perform sensitivity analyses to test the decision outcomes;
- Export worksheets as a formal record of the workshop attendees' combined opinion on the current preferred options, the 'Emerging Recommendations';
- Evaluate whether the CA needs to 'recycle' to the Preparation phase to obtain any further information to help inform decision making;
- Discuss Emerging Recommendations with stakeholders (October 2019); and
- Recycle process as required prior to decision on the selected options which will be presented in the Decommissioning Programme and assessed in the Environmental Impact Assessment.

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

Appendix A.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 considered for this CA were taken from the BEIS Guidelines for Decommissioning of Offshore Oil and Gas Installations and Pipelines which are as follows:

- Safety
- Environmental
- Economic
- Technical
- Societal

These differentiating criteria were found to be appropriate for the decommissioning options tabled and were taken forward as the primary differentiating criteria for the CA. Additional sub-criteria and definitions were added for clarity and are shown in

Criteria	Sub-Criteria	Description	Approach to Assessment
1. Safety	1.1 Operations Personnel	This sub-criterion considers elements that impact risk to operations 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. Any requirement for handling HazMat / NORM shall also be addressed here.	Potential for Loss of Life (PLL) metrics were calculated for each option. This allows a quantified direct comparison between options.
	1.2 Other Users	This sub-criterion covers the impact associated with the risk to other users. Considers elements such as collision impact whilst performing activities. Users such as fishing vessels, commercial transport vessels and military vessels are considered.	
	1.3 High Consequence Events	This sub-criterion relates to any inherent potential for high consequence events i.e. major accident hazard. It applies to all onshore and offshore personnel involved in the project. Considerations such as dropped object concerns, support vessel risks, are considered.	A coarse HAZID was conducted to identify elements associated with the options that had potential for High Consequence Events. The coarse HAZID also addressed the legacy risk component associated with the options.
	1.4 Legacy Risk	This sub-criterion addresses residual safety risk to other sea users i.e. fishermen, military vessel crews, commercial vessel crews and passengers, other sea users, that is provided by the option. Issues such as residual snag risk, collision risk, etc. may be considered.	

Criteria	Sub-Criteria	Description	Approach to Assessment
2. Environmental	2.1 Operational Marine Impact	This sub-criterion addresses the marine environmental impact caused by performing the decommissioning option. Covers 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)). Impacts may be from Project Vessels, Supply Boats, Survey vessels, etc. Examples include; Noise generated by vessels, cutting operations, any explosives, etc., discharges from vessels and from removing infrastructure such as residual pipeline contents.	Planned and unplanned marine impacts are narrative judgement informed by estimates of volumes / composition of any releases. Impacts from vessels are qualitative in nature. Marine noise impact is a qualitative judgement informed by the vessel durations, subsea cutting operations and other operations that generate marine noise.
	2.2 Atmospheric Emissions & Fuel Consumption	This sub-criterion addresses the atmospheric emissions, fuel consumption and energy consumption from performing the decommissioning option. This may be from Project Vessels, Survey vessels, etc. Impacts may be greenhouse gas emissions such as CO_2, NO_x, SO_2, etc. Fuel and energy consumption is included and is tightly correlated to atmospheric emissions. Not considered: Energy / emissions / resource consumption required to replace materials not recovered for re-use or recycling which is covered in 2.3 Other Consumptions.	Fuel use, emissions and energy consumption are calculated from vessel operations using IP 2000 ref. [10] factors for vessel fuel use and emissions. Fuel use, and emissions provided in metric tonnes. Energy provided in joules.
	2.3 Other Consumptions	This sub-criterion addresses the environmental impact caused by the amount of resource consumption associated with the option. It covers elements such as environmental impact from processing returned materials, the use of quarried rock or other new material and any production of replacement materials for equipment left *in situ*.	Consumptions such as rock / steel / other fabrications are quoted in metric tonnes. Impact of recycling / processing returned material and replacing leave-*in situ* material is quoted in metric tonnes of CO_2. The CO_2 figures allow a direct, quantitative comparison between options.

Criteria	Sub-Criteria	Description	Approach to Assessment
2. Environmental	2.4 Seabed Disturbance	This sub-criterion addresses the direct and indirect seabed disturbance caused by performing the decommissioning option. The level of impact caused and any specific seabed concerns, such as protected areas or habitat changes may be covered.	Assessment based on quantifying the area of disturbance and by type of disturbance (dredging, rock dump, trenching, backfilling, mass flow excavation) in combination with an understanding of the baseline environment in the area as shown by the outputs from the environmental surveys.
	2.5 Legacy Marine Impacts	This sub-criterion addresses the marine environmental impact caused after the decommissioning option has been performed. Covers the long-term impact of any infrastructure left *in situ* such as release of materials into the marine environment, environmental impact from legacy monitoring and remediation i.e. planned and unplanned releases from vessels, vessel noise, etc. Also addresses permanent habitat loss / change as part of the decommissioning option i.e. introduction of rock cover.	Planned and unplanned marine impacts are narrative judgement informed by estimates of volumes / composition of any releases and the duration these may occur over. Impacts from vessels are qualitative in nature. Marine noise impact is a qualitative judgement informed by the vessel durations, subsea cutting operations and other operations that generate marine noise.

Criteria	Sub-Criteria	Description	Approach to Assessment
3. Technical	3.1 Technical Risk	This sub-criterion relates to the various technical risks that could result in a major project failure i.e. failure to deliver the decommissioning option broadly within the timescale / budget / endorsed decommissioning programme. Consideration is given to: Technical Novelty / Track Record, where the novelty of the technical solution is considered. Technical Challenges / Consequence of Failure to deliver the such as amendment to decommissioning approach 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.	Scored 1 – 3 with 1 being least technically feasible and 3 most technically feasible.
4. Societal	4.1 Fishing	This sub-criterion addresses the impact of the option on commercial fishing operations. It includes consideration of impacts from both the decommissioning activities any residual impacts post decommissioning such as reinstatement of access to area.	Scored 1 – 3 with 1 being a proportionally large area lost for fishing and 3 being a minimal area
	4.2 Other Users	This sub-criterion addresses any positive or negative socio-economic impacts on other users, where the impact may be from dismantling, transporting, treating, recycling and land filling activities relating to the decommissioning option. Additionally, 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 decommissioning option which has a negative impact on communities, increased traffic disruption due to extra-large transport loads, etc.	Scored 1 -3 with 1 being significant long-term impact to communities and 3 being minimal.
5. Economic	5.1 Short-term Costs	This sub-criterion addresses the cost of delivering the option as described. No long-term cost element is considered here.	Cost data (£ k)
	5.2 Long-term Costs	This sub-criterion addresses the costs associated with any long-term liabilities such as on-going monitoring and any potential future remediation costs.	Cost data (£ k)

Table 6.1: Sub-criteria Definition

Appendix A.3 Differentiator Weighting

The 5 differentiating criteria all carry a 20% weighting. That is, all criteria are neutral to each other. Figure 6.1 shows the pairwise comparison matrix. Premier Oil 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 6.1: Example Pairwise Comparison Matrix (N = Neutral)

Appendix A.4 Option Attributes

The next step in the CA process was to describe and discuss the attributes of each option with respect to each of the differentiating criteria. In preparation, all relevant data and information developed during the preparation phase were pre-populated into the attributes table for each option. Appendix C and Appendix D contain the completed Attributes Tables for Groups 1 and 3 respectively.

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

Appendix A.5 Option Pair-Wise Comparison

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

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

To manage this, Premier Oil 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 6.2). 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 6.2: 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 dumping from a safety perspective? Are these Neutral to each other? Are they stronger? If so, how much stronger? If you had to prioritise one over the other, which would it be?' This promoted a collaborative dynamic in the workshop and enabled the collective mind-set of the attendees to be captured. Where there was quantitative data to provide back-up and evidence to support the collective assertions, so much the better.

A summary example of the completed pair-wise comparisons for differentiating criteria versus options are shown in Figure 6.2.

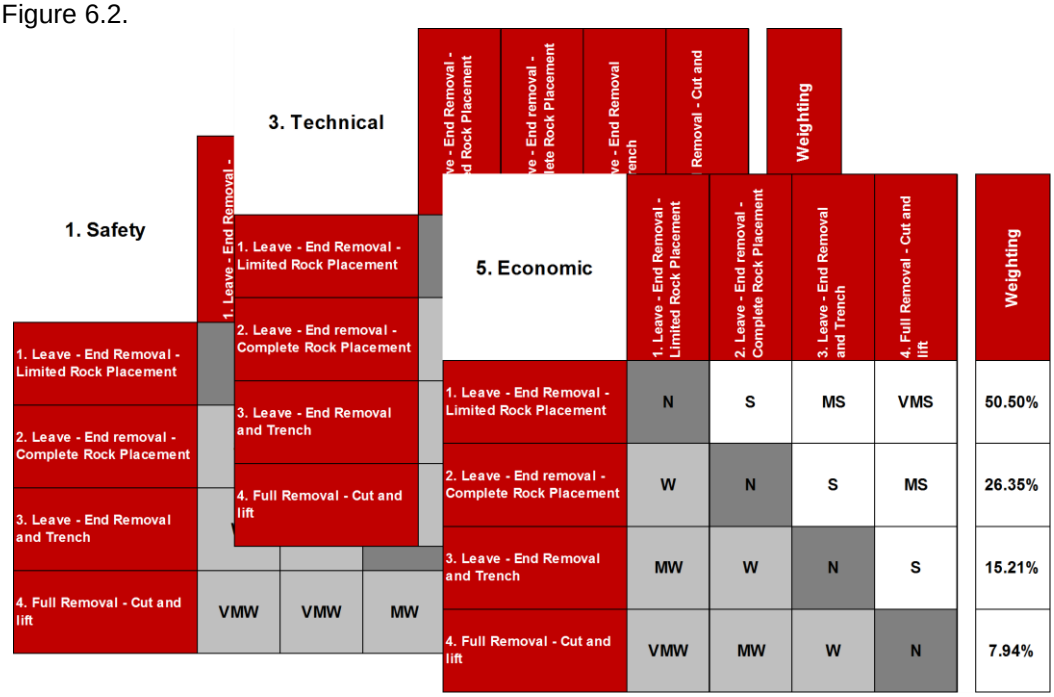


Figure 6.2: Example Option Pair-Wise Comparison

Appendix A.6 Visual Output and Sensitivities

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, opportunity was provided to fine tune the judgements provided, to ensure that all attendees were happy to endorse the outcome. The visual outputs from each decision point are included in Appendix C and Appendix D. An example of the visual output obtained is shown in Figure 6.3.

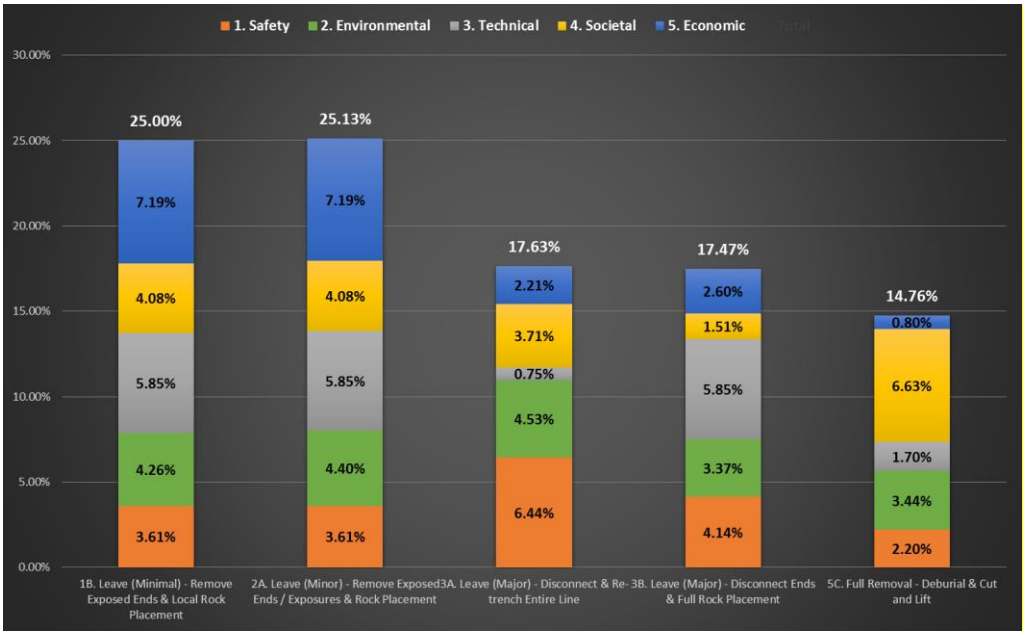


Figure 6.3: CA Visual Output Example

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

Minutes of Meeting

Subject: Huntington, Caledonia, Hunter, Rita and Johnston Comparative Assessment Stakeholder Review

Location: Premier Oil, Prime Four Business Park, Aberdeen

Date: 8th October 2019

Issued on: 11th November 2019

Attending:

Name	Company
Robert Willison	BEIS OPRED ODU
Drew Bond	
Debbie Taylor	
Nicola Abrams	BEIS OPRED EMT
Doug Stewart	JNCC
Thomas Fey	
Ian Rowe	NFFO
Steven Alexander	SFF
Andrew Third	
Hywel Williams	HSE
Pieter voor de Poorte	Premier Oil
Paul Newby	
Lilla Onodi	
Margaret Christie	
Martyn Akers	
Kate Arman	
Phil McIntyre	
David Hunt	Neptune Energy
Nic Duncan	Xodus
John Foreman	
Jenny Smith	

Distribution: **Attendees +**

Item	Issue	Action
1.0	**Introduction and Background**	
1.1	The workshop was introduced by Premier Oil followed by a brief overview of the fields and relevant infrastructure under consideration. > Huntington, cessation of production (CoP) scheduled for 2020. > Caledonia, last production 2010, seabed facilities are currently disconnected at the wellhead and at the Britannia riser. > Hunter and Rita, CoP reached 2018. > Johnston, CoP scheduled for 2022.	Info
2.0	**Environmental Baseline**	
2.1	The environmental baseline and relevant impacts for each field were described by Xodus Group.	Info
2.2	It was noted that the Hornsea Windfarm is in the early planning stages. Should it go ahead, construction would commence in 2025 at the earliest.	Info
3.0	**Comparative Assessment Review**	
3.1	The background to the comparative assessment (CA) process conducted to date was provided by Xodus Group, as well as details of the evaluation methodology that would be re-visited during this review workshop.	Info
3.2	Handouts provided for the workshop included: A set of presentation slides (appended to these minutes) A set of the criteria and sub-criteria definitions used A set of the attributes developed for each option used for the evaluation and to be re-appraised for this review workshop.	Info
3.3	Note that the sequence of review was defined to accommodate the availability of specific workshop attendees, focusing on the Southern North Sea (SNS) fields first and the Central North Sea (CNS) fields second.	Info
3.4	**Group 4 – Trenched and Buried Flexibles/Umbilical – SNS**	
3.4.1	An introduction and summary of the infrastructure included within this group was provided. > Rita - 14.33km Static Umbilical - No Exposures (PLU2529) > Johnston - 9.52km Static Umbilical - No Exposure (PL991) | 6.88km Static Umbilical - No Exposure (PLU2106) > Johnston - 6.89km 8” Production Flexible - No Exposure (PL2105)	
3.4.2	Clarification was requested (OPRED) regarding the depth of burial (DoB) for the lines. This was provided by Premier Oil. All of these lines are buried deeper than the recommended 0.6m with no areas of exposure or shallow burial outside of the trench transitions.	
3.4.3	Two options were evaluated for this group: > Option 2b – full removal using reverse reel without de-burial.	

Item	Issue	Action
	> Option 5 – leave *in situ*, minimal intervention, remove ends and remediate snag risk.	
3.4.4	**1.0 Safety**	
3.4.4.1	1.1 Operational Personnel – no change to evaluated scores.	
3.4.4.2	1.2 Other Users – no change to evaluated scores. SIMOPS relating to the windfarm installation and operation was noted as having the same impact on both options.	
3.4.4.3	1.3 High Consequence Events – no change to evaluated scores. Clarification was requested (HSE) whether this referred to a specific Reel Vessel or whether this referred to temporary deck mounted reels. Deck mounted reels have been assumed.	
3.4.4.4	1.4 Legacy Risk – no change to evaluated scores. A stronger preference for full removal was suggested (JNCC). It was decided to treat this as a sensitivity.	
3.4.5	**2.0 Environmental**	
3.4.5.1	2.1 Operational Marine Impacts – no change to evaluated scores. Options scored as neutral, however, some discussion was held regarding the differences in figures but it was agreed that this was not sufficient to drive a difference. It was requested to note that this includes for accidental discharges.	
3.4.5.2	2.2 Atmospheric Emissions & Fuel Consumption – no change to evaluated scores.	
3.4.5.3	2.3 Other Consumptions – evaluated score favouring Option 2b full removal as Stronger (S) changed to Neutral (N) as although there is a relatively large difference the overall quantities are small and not significant enough to drive a difference.	
3.4.5.4	2.4 Seabed Disturbance – evaluated score showing Much Weaker (MW) for the larger area of disturbance changed to Weaker (W) as the actual area is limited.	
3.4.5.5	2.5 Legacy Marine Impacts – no change to evaluated scores. A note is to be added to the report that the potential for line exposure over time is not considered a risk.	
3.4.6	**3.0 Technical**	
3.4.6.1	3.1 Technical Risk – no change to evaluated scores.	
3.4.7	**4.0 Societal**	
3.4.7.1	4.1 Fishing – evaluated score changed from Weaker (W) for full removal to Stronger (S) for full removal. It was noted (NFFO) that significant change is being experienced within the fishing industry due to the implementation of Marine Conservation Zones (MCZ) and the expansion of the renewables sector. As such it is difficult to forecast what type of fishing (static or mobile gear) will predominate in the SNS. It was also highlighted that future disruption from monitoring of infrastructure left *in situ* is not preferred.	
3.4.7.2	4.2 Other Users – evaluated score was changed to Neutral (N) from a Strong (S) preference for full removal as it was considered that the differences were not sufficient to express a preference.	
3.4.8	**5.0 Economic**	
3.4.8.1	5.1 Short-Term Costs – no change to evaluated scores.	
3.4.8.1	5.2 Long-Term Costs – no change to evaluated scores.	
3.4.9	**Results**	

Item	Issue	Action
3.4.9.1	Slight preference for full removal. The result is strengthened by economics.	
3.5	**Group 5 – Trenched and Buried Flexible (failed) /Umbilical – SNS**	
3.5.1	An introduction and summary of the infrastructure included within this group was provided. > Hunter 8.14km Static Umbilical (PLU2138) > Hunter 8.2km 8" Production Flexible (PL2137) – 18 off exposures	
3.5.2	DoB for the lines was provided by Premier Oil. The trenched and buried flexible PL2137 suffered from upheaval buckling (UHB) becoming exposed at 18 locations. During testing it failed and was replaced by a rigid flowline, PL3005. The exposed sections were protected by concrete structures which shall be fully removed. PL2137 shares a trench with an umbilical, PLU2138 with which it is partially entangled.	
3.5.3	Four options were evaluated for this group. > Option 2c – Full removal with de-burial (advised by supply chain that prior de-burial is required due to partial entanglement) > Option 4a – Leave *in situ*, minor, rock placement over exposures > Option 4b – Leave *in situ*, minor, trench and bury exposures > Option 4c – Leave *in situ*, minor, remove exposures	
3.5.4	**1.0 Safety**	
	1.1 Operational Personnel – no change to evaluated scores.	
	1.2 Other Users – no change to evaluated scores.	
	1.3 High Consequence Events – no change to evaluated scores.	
	1.4 Legacy Risk – no change to evaluated scores.	
3.5.5	**2.0 Environmental**	
	2.1 Operation Marine Impacts – no change to evaluated scores. It was agreed that the contents of the failed flexible flowline was likely already fully released.	
	2.2 Atmospheric Emissions & Fuel Consumption – no change to evaluated scores. A sensitivity is to be run on a potential preference for Option 2c over all other options. Some discussion was held regards comparison of these options and wider North Sea activities, which concluded that none of these options are significant. Some text should be added to the report to put these figures in context of the wider North Sea emissions.	
	2.3 Other Consumptions – no change to evaluated scores.	
	2.4 Seabed Disturbance – no change to evaluated scores. A sensitivity is to be run to change Option 2c from MW against all other options to W.	
	2.5 Legacy Marine Impacts – evaluated scores changed to reflect the sensitivity of placing any rock at this location. Option 2c against 4a from S to MS, option 2c against 4c from S to MS and Option 4b against 4c from N to S.	
3.5.6	**3.0 Technical**	

Item	Issue	Action
	3.1 Technical Risk – evaluated scores changed for Option 2c against 4a from N to W, Option 2c against 4c from N to MW and Option 4b against 4c from W to MW. Changes based on experience provided by Neptune Energy on difficulties of reverse reeling, cut and remove exposed sections was considered to be far preferable. It was also agreed that re-trenching would be very challenging.	
3.5.7	**4.0 Societal**	
	4.1 Fishing – no change to evaluated scores. Whilst full removal is the preferred base case, the type of fishing in the area is changing considerably. A sensitivity is to be run to reflect predominantly static gear fishing in the area in the future which would favour rock dump over full removal.	
	4.2 Other Users – evaluated scores for Option 2c against all other options changed from S to N.	
3.5.8	**5.0 Economic**	
	5.1 Short-Term Costs – evaluated scores for Option 2c against Option 4a changed from MW to W for consistency.	
	5.2 Long-Term Costs – no change to evaluated scores.	
3.5.9	**Results**	
	Preference for Option 4c, leave *in situ*, remove exposures.	
3.6	**Group 2 – Trenched and Buried Rigid Flowlines – SNS**	
3.6.1	An introduction and summary of the infrastructure included within this group was provided. > Rita 14.07km 8” Production Pipeline – No exposures (PL2528) > Hunter 8.03km 8” Production Pipeline – No exposures (PL3005) > Johnston 9.28km 12” Production Pipeline – No exposures (PL989) | 9.28km 2” Methanol Pipeline (piggybacked onPL989) – No exposures (PL990)	
3.6.2	DoB for the lines was provided by Premier Oil.	
3.6.3	Two options were evaluated for this group: > Option 2a – full removal using cut and lift with de-burial. > Option 5 – leave *in situ*, minimal intervention, remove ends and remediate snag risk.	
3.6.4	**1.0 Safety**	
	1.1 Operational Personnel – no change to evaluated scores.	
	1.2 Other Users – no change to evaluated scores.	
	1.3 High Consequence Events – no change to evaluated scores. Clarification was requested on details of the operation. A potential sensitivity was identified whereby Option 2a was scored as MW to Option 5 may be VMW.	
	1.4 Legacy Risk – no change to evaluated scores.	

Item	Issue	Action
3.6.5	**2.0 Environmental**	
	2.1 Operation Marine Impacts – no change to evaluated scores. A note is to be added to the report to highlight the high level of seabirds in the area and the associated increased level of consequence in the event of a marine diesel release coupled with the longer duration operation.	
	2.2 Atmospheric Emissions & Fuel Consumption – no change to evaluated scores.	
	2.3 Other Consumptions – evaluated score for Option 2a against Option 5 changed from S to N for consistency.	
	2.4 Seabed Disturbance – evaluated score for option 2a against Option 5 changed from VMW to MW, with VMW as a sensitivity. Some discussion held regarding the recovery period for Dogger Bank. The extended recovery period may justify the 90:10 preference associated with the VMW score.	
	2.5 Legacy Marine Impacts – evaluated score for Option 2a against Option 5 changed from W to S due to rock placement considered worse than short term disturbance.	
3.6.6	**3.0 Technical**	
	3.1 Technical Risk – no change to evaluated scores.	
3.6.7	**4.0 Societal**	
	4.1 Fishing- evaluated score for Option 2a against Option 5 changed from W to N due to local disturbance. In this case, as the line is deeply buried, the preference would be to leave *in situ* (SFF).	
	4.2 Other Users – no change to evaluated scores.	
3.6.8	**5.0 Economic**	
	5.1 Short-Term Costs – no change to evaluated scores.	
	5.2 Long-Term Costs – no change to evaluated scores.	
3.6.9	**Results**	
	A preference for Option 5, leave *in situ*, was concluded. A sensitivity was run on 4.1 Fishing to determine the effect of changing N to S in favour of full removal. The result was unchanged.	
3.7	**Group 1 – Trenched & Buried Rigid Flowlines (CNS)**	
3.7.1	An introduction and summary of the infrastructure included within this group was provided. > Huntington - 11.8km 8” Gas Export Pipeline - No Exposure (PL2805) > Caledonia - 5.88km 8" / 12" Production Pipe-in-pipe - No Exposure (PL1919) > Caledonia - 5.88km 4" Gas Lift Pipeline (Piggybacked to PL1919) - No Exposure (PL1920)	
3.7.2	DoB for the lines was provided by Premier Oil.	
3.7.3	Two options were evaluated for this group: > Option 2a – full removal using cut and lift with de-burial.	

Item	Issue	Action
	> Option 5 – leave *in situ*, minimal intervention, remove ends and remediate snag risk.	
3.7.4	**1.0 Safety**	
	1.1 Operational Personnel – evaluated score for option 2a against Option 5 was changed from MW to W for consistency.	
	1.2 Other Users – no change to evaluated scores.	
	1.3 High Consequence Events – no change to evaluated scores.	
	1.4 Legacy Risk – no change to evaluated scores.	
3.7.5	**2.0 Environmental**	
	2.1 Operation Marine Impacts – the evaluated score for Option 2a against Option 5 was changed from W to MW for consistency.	
	2.2 Atmospheric Emissions & Fuel Consumption – no change to evaluated scores.	
	2.3 Other Consumptions – evaluated score for Option 2a against Option 5 changed from S to N.	
	2.4 Seabed Disturbance – evaluated score for Option 2a against Option 5 changed from MW to W. Sensitivity to be run with MW due to the recovery duration for the site.	
	2.5 Legacy Marine Impacts – no change to evaluated scores.	
3.7.6	**3.0 Technical**	
	3.1 Technical Risk – no change to evaluated scores.	
3.7.7	**4.0 Societal**	
	4.1 Fishing – no change to evaluated scores.	
	4.2 Other Users – no change to evaluated scores.	
3.7.8	**5.0 Economic**	
	5.1 Short-Term Costs – no change to evaluated scores.	
	5.2 Long-Term Costs – no change to evaluated scores.	
3.7.9	**Results**	
	A preference for Option 5, leave *in situ* was concluded.	
3.8	**Group 3 – Trenched & Buried Flexible Flowlines / Umbilicals (CNS)**	
3.8.1	An introduction and summary of the infrastructure included within this group was provided. > Huntington - 1.86km 10” Production Flowline - No Exposure (PL2806) | 1.87km 4” Gas Lift Flowline - No Exposure (PL2807) > Huntington - 1.83km 8" Water Injection Flowline - No Exposure (PL2808) | 1.8km Static Umbilical - No Exposure (PLU2809)	

Item	Issue	Action
	> Caledonia - 6.05km Static Umbilical - No Exposure (PLU1921) > Note: 10" Production and 4" Gas Lift lines at Huntington are in the same trench. 10" has midline connection (mattressed and buried)	
3.8.2	DoB for the lines was provided by Premier Oil.	
3.8.3	Two options were evaluated for this group: > Option 2b – full removal using reverse reel without de-burial. > Option 5 – leave *in situ*, minimal intervention, remove ends and remediate snag risk.	
3.8.4	**1.0 Safety**	
	1.1 Operational Personnel – evaluated score for Option 2b against Option 5 was changed from MS to S for consistency.	
	1.2 Other Users – no change to evaluated scores.	
	1.3 High Consequence Events – no change to evaluated scores.	
	1.4 Legacy Risk – no change to evaluated scores. A sensitivity will be run for MS instead of S.	
3.8.5	**2.0 Environmental**	
	2.1 Operation Marine Impacts – no change to evaluated scores.	
	2.2 Atmospheric Emissions & Fuel Consumption – no change to evaluated scores.	
	2.3 Other Consumptions – evaluated score for Option 2b against Option 5 was changed from S to N for consistency.	
	2.4 Seabed Disturbance – no change to evaluated scores.	
	2.5 Legacy Marine Impacts – no change to evaluated scores.	
3.8.6	**3.0 Technical**	
	3.1 Technical Risk – no change to evaluated scores.	
3.8.7	**4.0 Societal**	
	4.1 Fishing – no change to evaluated scores.	
	4.2 Other Users – evaluated scores for Option 2b against Option 5 changed from S to N for consistency.	
3.8.8	**5.0 Economic**	
	5.1 Short-Term Costs – no change to evaluated scores.	
	5.2 Long-Term Costs – no change to evaluated scores.	
3.8.9	**Results**	
	A preference for Option 2b, full removal was concluded. The result was driven by the shorter length lines in Group 3 and the differences in fishing type in this area in comparison to the SNS.	
4.0	**Additional Points**	

Item	Issue	Action
4.1	A query was tabled (JNCC) regards lines left *in situ* and the potential for future lines crossing over or trenching through lines left *in situ*, such as inter-connectors. It was agreed in the room that future infrastructure installation was beyond the scope of this workshop and should not be a factor in decision making.	
4.2	Where results produced are particularly close Premier Oil should firm up on supporting data and re-appraise as required.	

APPENDIX C GROUP 2 – DETAILED EVALUATION RESULTS

Appendix C.1 Group 2 Attributes Table

		O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk
		- Flowlines will be disconnected - Deburial of flowline using MFE - Recover by cutting into sections and removal	- Flowlines will be disconnected - Removal and recovery of surface laid sections out with existing trench - Rock placement to remediate snag risk from cut ends
1. Safety	1.1 Operations Personnel	Vessel Type: PoB / Days / Hours / PLL Trawler: 5 / 8.0 / 480 / 3.60E-05 Survey Vessel: 44 / 10.6 / 5,607 / 4.21E-04 CSV: 76 / 405.7 / 369,971 / 2.77E-02 Total offshore hours: 376,058 hrs Total offshore PLL: 2.82E-02 Resource Type: Days / Hours / PLL Engineering & Management: 4,977.9 / 39,824 / 1.59E-04 Project Management: 5,708.0 / 45,664 / 1.83E-04 Onshore Operations (includes Cleaning & Disposal): 123.0 / 984 / 1.21E-04 Total onshore hours: 86,472 hrs Total onshore PLL: 4.63E-04 Total operational hours: 462,530 hrs Total operational PLL: 2.87E-02	Vessel Type: PoB / Days / Hours / PLL DSV: 110 / 11.9 / 15,642 / 1.17E-03 Divers: 18 / 11.9 / 5,119 / 4.97E-03 Trawler: 5 / 8.0 / 480 / 3.60E-05 Survey Vessel: 44 / 10.6 / 5,607 / 4.21E-04 Total offshore hours: 26,849 hrs Total offshore PLL: 6.60E-03 Resource Type: Days / Hours / PLL Engineering & Management: 330.9 / 2,647 / 1.06E-05 Project Management: 309.0 / 2,472 / 9.89E-06 Onshore Operations (includes Cleaning & Disposal): 2.0 / 16 / 1.97E-06 Total onshore hours: 5,135 hrs Total onshore PLL: 2.24E-05 Total operational hours: 31,984 hrs Total operational PLL: 6.62E-03
		MW	
	Summary	The assessment of the Operations Personnel sub-criterion is as follows: Option 2a is assessed as being Much Weaker than Option 5 as the risk exposure is more than 4 times higher due to the extended durations required to cut the lines into short sections for recovery versus removing the line ends only. **Overall, Option 5 is the preferred option from a risk to Operations Personnel perspective.**	
1. Safety	1.2 Other Users	Vessel Days: Trawler: 8.0 Survey Vessel: 10.6 CSV: 405.7 Total vessel days: 424.3 days Transits: 52	Vessel Days: DSV: 11.9 Divers: 11.9 Trawler: 8.0 Survey Vessel: 10.6 Total vessel days: 30.5 days Transits: 9
		W	
	Summary	The assessment of the Other Users sub-criterion is as follows: Option 2a is assessed as being Weaker than Option 5 as there is a much higher number of vessel days, the majority of which will be out with any existing exclusion zones. In addition, there is a higher number of vessel transits to and from the site. Together, these are likely to present a small increase in safety impact on other users. **Overall, Option 5 is the preferred option from a risk to Other Users perspective.**	
1. Safety	1.3 High Consequence Events	Routine operations however this involves a high volume of lifting operations (263 lifts).	Routine operations with minimal lifting (21 lifts).
		MW	
	Summary	The assessment of the High Consequence Events sub-criterion is as follows: Option 2a is assessed as being Much Weaker than Option 5 as there is a higher potential for dropped object from the higher number of lifts associated with Option 2a. **Overall, Option 5 is the preferred option from a High Consequence Events perspective.**	

		O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk
1. Safety	1.4 Legacy Risk	No legacy risk from this full removal option.	The lines would remain in-situ with this option with their full lengths fully buried. The survey & monitoring programme is committed to ensuring that the potential snag hazard from left in-situ infrastructure continues to be managed & mitigated as appropriate.
		S	
	Summary	The assessment of the Legacy Risk sub-criterion is as follows: Option 2a is assessed as being Stronger than Option 5 as there is no legacy risk from the full removal option versus a small potential for a snag hazard from the fully buried lines with rock placement at the cut ends although this risk is mitigated by the survey and monitoring campaign. **Overall, Option 2a is the preferred option from a Legacy Risk perspective.**	
2. Environmental	2.1 Operational Marine Impact	Vessel Noise (days on-site): Survey Vessel: 2.7 days CSV: 396.7 days Trawler: 5.0 days Total: 404.4 days Tooling Noise: MFE: 26.2 days Hydraulic Shears: 290.6 days Operation Discharges: Line cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) and other chemical levels in lines post flush and discharges to the marine environment during flushing activities. Cutting of line ends and midline cuts would lead to an elevated discharge of fluids from within the lines. However, given the prior cleaning of the lines, the concentration and quantity of discharge should still be low overall. Therefore, the related impact is also anticipated to be low. Vessel Discharges: This includes Ballast, Grey and Black Water, this is driven by duration of vessel operations and therefore at 405 days will be the highest of the options being evaluated.	Vessel Noise (days on-site): Survey Vessel: 2.7 days DSV: 7.4 days Trawler: 5.0 days Total: 15.1 days Tooling Noise: Dredger: 1.5 days Hydraulic Shears: 3.4 days Operation Discharges: Line cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) and other chemical levels in lines post flush and discharges to the marine environment during flushing activities. Cutting of line ends would lead to an elevated discharge of fluids from within the lines. However, given the prior cleaning of the lines, the concentration and quantity of discharge should still be low overall. Therefore, the related impact is also anticipated to be low. Vessel Discharges: This includes Ballast, Grey and Black Water, this is driven by duration of vessel operations and therefore at 15 days will be the lowest of the options being evaluated.
		MW	
	Summary	The assessment of the Operational Marine Impact sub-criterion is as follows: Option 2a is assessed as being Much Weaker than Option 5 as there is more marine noise from the extended vessel operations, diamond wire cutting and MFE operations. There would also be more discharges associated with the higher number of vessel days and increased operational discharges from cutting the pipeline into small sections. There is also more potential for accidiental release from having the hydraulic shears in the water for long durations and for diesel spill from vessels during longer duration of operations in Option 2A. It is noted that all these impacts are relatively minor with the cumulative impact being sufficient to express a small preference for Option 5. Note: any marine environmental impacts are likely to be greater for Johnston lines due to prximity to shore and seabord habitats and thier sensitivity to oiling. **Overall, Option 5 is the preferred option from an Operational Marine Impact perspective.**	
2. Environmental	2.2 Atmospheric Emissions & Fuel Consumption	Vessel Emissions (in tonnes): Fuel: 2,323 CO2: 7,363 NOx: 137.98 SO2: 9.29 Vessel Energy Use: 99,881 GJ	Vessel Emissions (in tonnes): Fuel: 1,498 CO2: 4,748 NOx: 88.97 SO2: 5.99 Vessel Energy Use: 64,407 GJ
		N	
	Summary	The assessment of the Atmospheric Emissions & Consumptions sub-criterion is as follows: Option 2a is assessed as being Neutral to Option 5 as, whilst there is a difference in the fuel use and atmospheric emissions, these differences are insufficient to express a preference. **Overall, both options are equally preferred from an Atmospheric Emissions & Consumptions perspective.**	

		O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk
2. Environmental	2.3 Other Consumptions	Material Emissions (CO2 in tonnes): Recovered Material: 3,711 Remaining Material: Total: 3,711 Rock: N/A tonnes	Material Emissions (CO2 in tonnes): Recovered Material: 49 Remaining Material: 6,873 Total: 6,922 Rock: 200 tonnes
		N	
	Summary	The assessment of the Other Consumptions sub-criterion is as follows: Option 2a is assessed as being Stronger than Option 5 as the impact from processing all returned material in the full removal option is around half the impact from producing replacement material for the lines left in-situ. **Overall, both options are equally preferred from an Other Consumptions perspective.**	
2. Environmental	2.4 Seabed Disturbance	Short Term Disturbance (MFE): Hunter / Rita: 110,500 m^2 (70%) Johnston: 46,400 m^2 (30%)	Short Term Disturbance (Rock Cover): 60 m^2
		MW	
	Summary	The assessment of the Seabed Disturbance sub-criterion is as follows: Option 2a is assessed as being Much Weaker than Option 5 due to the much greater area of seabed disturbed during the deburial of the lines by MFE in Option 2a. It is recognised that the seabed in these areas wil recover quickly due to high mobility. **Overall, Option 5 is the preferred option from a Seabed Disturbance perspective.**	
2. Environmental	2.5 Legacy Marine Impacts	There is significant legacy marine impact caused by the deburial operations, particularly on the Hunter and Rita lines which are in the Dogger Bank SAC. The deburial impact in this area will take a long time to recover. Habitat Loss (Rockdump): N/A	Line cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) and other chemical levels in lines post flush. The legacy marine impact from the slow release of these low concentration / quantity discharges is therefore expected to be low overall. Habitat Loss (Rockdump): 60 m^2
		S	
	Summary	The assessment of the Legacy Marine Impacts sub-criterion is as follows: Option 2a is assessed as being Stronger than Option 5 as there is no legacy marine impact from Option 2a versus a small legacy impact from the lines being left in-situ. There is also a small area of permanent habitat change due to the small area of rock cover. **Overall, Option 5 is the preferred option from a Legacy Marine Impacts perspective.**	
3. Technical	3.1 Technical Risk	**Concept Maturity:** The concept is well proven. (Score 3) Current tooling is not proven in use but uses shears & subsea grabbers which are with the score of 3 reflecting that confidence is high that concept is ok. Basis of development of tool will be to have redundancy built in and spare tool available. **Technical Risks:** The length of pipe and depth of burial may present some technical challenges. (Score 2)	**Concept Maturity:** Minimal operations, well proven techniques. (Score 3) **Technical Risks:** Limited technical risks associated with option (Score 3)
		W	
	Summary	The assessment of the Technical Risk sub-criterion is as follows: Option 2a is assessed as being Weaker than Option 5 as whilst both options use largely proven technology and routine operations, the extensive cut and lift and deburial operations in Option 2a carry more risk of technical failure. **Overall, Option 5 is the preferred option from a Technical Risk perspective.**	

		O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk
4. Societal	4.1 Fishing	Vessels will be working in the area for a significant number of days causing disruption to any local fishing activities, particularly nethrop fishing. (Score 2)	Minimal disturbance to fishing operations. (Score 3)
		N	
Summary		The assessment of the Societal impact on Fishing sub-criterion is as follows: Option 2a is assessed as being Neutral to Option 5 as whilst it is preferred that lines be fully removed, the disruption caused by the deburial and removal of the lines in Option 2a may have impact on nethrops fishing activities which are prevalent in this area. **Overall, both options are equally preferred from a Societal impact on Fishing perspective.**	
4. Societal	4.2 Other Users	A reasonable amount of steel can be recovered with this option with minimal material requiring to go to landfill. (Score 3) Materials Returned: Steel: 3,687 tonnes (recyclable)	Minimal societal benefits / impacts with this option. (Score 3) Materials Returned: Steel: 48 tonnes (recyclable)
		S	
Summary		The assessment of the Societal impact on Other Users sub-criterion is as follows: Option 2a is assessed as being Stronger than Option 5 as there is a significantly higher quantity of useful material being returned in Option 2a. **Overall, Option 2a is the preferred option from a Societal impact on Other Users perspective.**	
5. Economic	5.1 Short-term Costs	£55.849 Million	£3.208 Million
		VMW	
Summary		The assessment of the Short-term Costs sub-criterion is as follows: Option 2a is assessed as being Very Much Weaker than Option 5 as the costs are around 17 times higher. **Overall, Option 5 is the preferred option from a Short-term Cost perspective.**	
5. Economic	5.2 Long-term Costs	Surveys: N/A FLTC: N/A Total Legacy Cost: £0 Million	Surveys: £1.05 Million FLTC: N/A Total Legacy Cost: £1.05 Million
		S	
Summary		The assessment of the Long-term Costs sub-criterion is as follows: Option 2a is assessed as being Stronger than Option 5 as there are no long-term costs associated with the full removal option. **Overall, Option 2a is the preferred option from a Long-term Cost perspective.**	

Appendix C.2 Group 2 Pairwise Comparison Matrices - Safety

1.1 Operations Personnel	O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2a - Full Removal - Cut & Lift with Deburial	N	MW	25.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	MS	N	75.0%

1.2 Other Users	O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2a - Full Removal - Cut & Lift with Deburial	N	W	40.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	S	N	60.0%

1.3 High Consequence Events	O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2a - Full Removal - Cut & Lift with Deburial	N	MW	25.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	MS	N	75.0%

1.4 Legacy Risk	O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2a - Full Removal - Cut & Lift with Deburial	N	S	60.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	W	N	40.0%

Appendix C.3 Group 2 Pairwise Comparison Matrices - Environment

2.1 Operational Marine Impact	O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2a - Full Removal - Cut & Lift with Deburial	N	MW	25.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	MS	N	75.0%

2.2 Atmospheric Emissions & Fuel Consumption	O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2a - Full Removal - Cut & Lift with Deburial	N	N	50.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	N	N	50.0%

2.3 Other Consumptions	O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2a - Full Removal - Cut & Lift with Deburial	N	N	50.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	N	N	50.0%

2.4 Seabed Disturbance	O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2a - Full Removal - Cut & Lift with Deburial	N	MW	25.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	MS	N	75.0%

2.5 Legacy Marine Impacts	O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2a - Full Removal - Cut & Lift with Deburial	N	S	60.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	W	N	40.0%

Appendix C.4 Group 2 Pairwise Comparison Matrices – Technical

3.1 Technical Risk	O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2a - Full Removal - Cut & Lift with Deburial	N	W	40.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	S	N	60.0%

Appendix C.5 Group 2 Pairwise Comparison Matrices – Societal

4.1 Fishing	O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2a - Full Removal - Cut & Lift with Deburial	N	N	50.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	N	N	50.0%

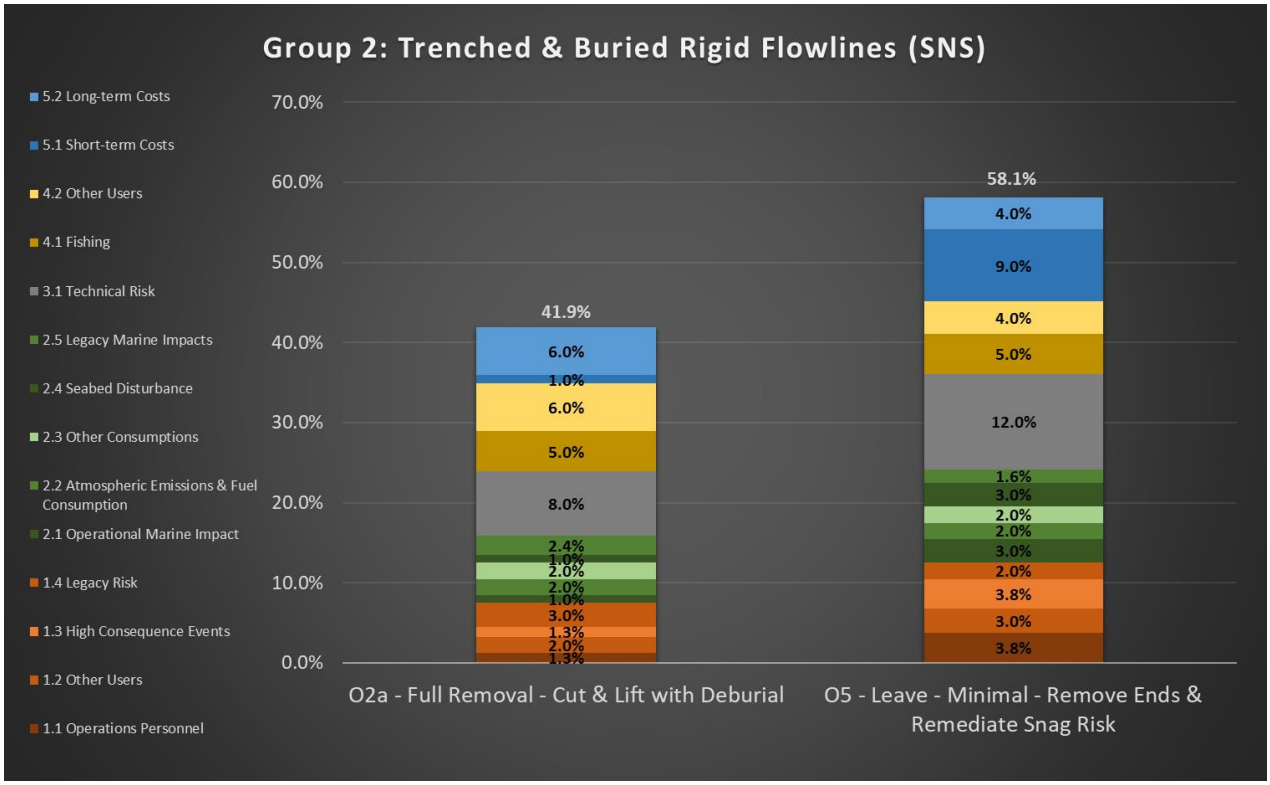
4.2 Other Users	O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2a - Full Removal - Cut & Lift with Deburial	N	S	60.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	W	N	40.0%

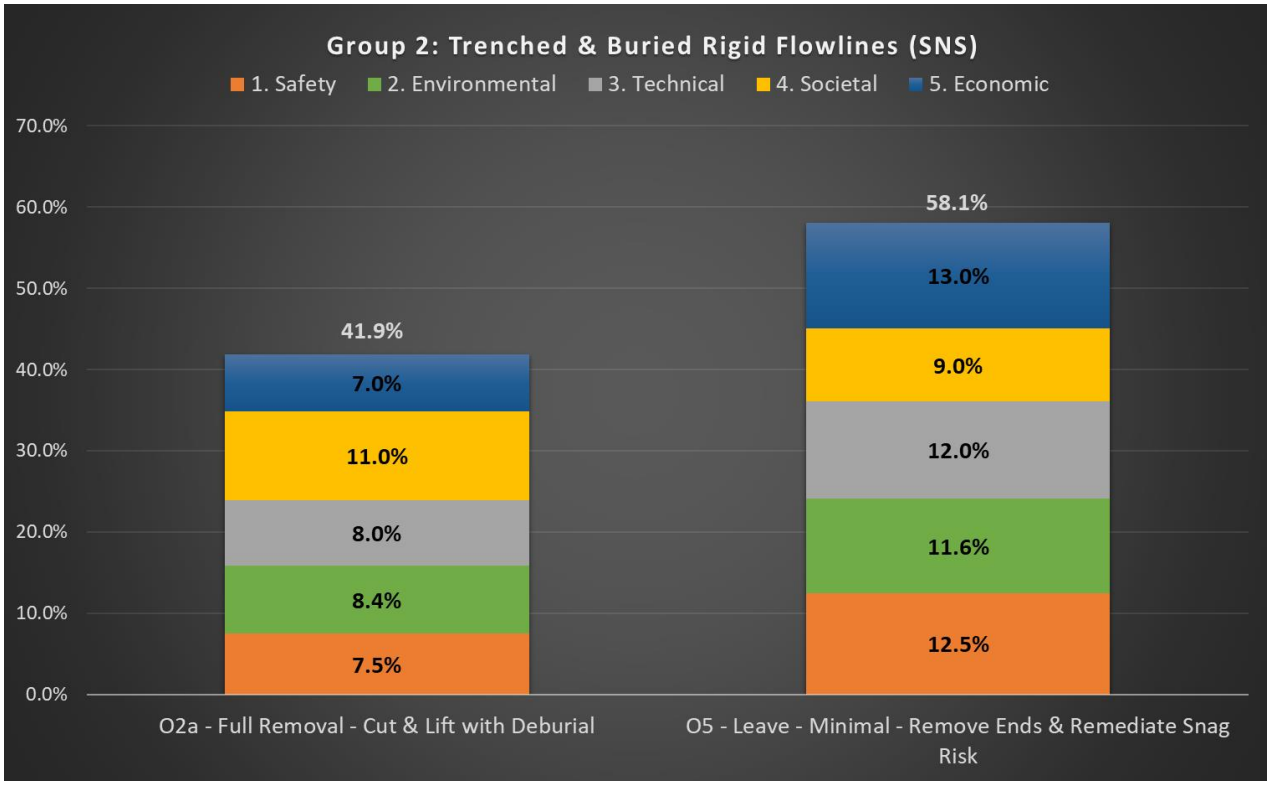
Appendix C.6 Group 2 Pairwise Comparison Matrices - Economic

5.1 Short-term Costs	O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2a - Full Removal - Cut & Lift with Deburial	N	VMW	10.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	VMS	N	90.0%

5.2 Long-term Costs	O2a - Full Removal - Cut & Lift with Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2a - Full Removal - Cut & Lift with Deburial	N	S	60.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	W	N	40.0%

Appendix C.7 Group 2 Results Charts





APPENDIX D GROUP 4 – DETAILED EVALUATION RESULTS

Appendix D.1 Group 4 Attributes Table

		O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk
		- Flowlines / umbilicals will be disconnected - No deburial prior to removal - Recover by reverse reel - Lines vary up to 8" internal diameter / 10.2" outer diameter	- Flowlines / umbilicals will be disconnected - Removal and recovery of surface laid sections out with existing trench - Rock placement to remediate snag risk from cut ends
1. Safety	1.1 Operations Personnel	Vessel Type: PoB / Days / Hours / PLL DSV: 110 / 6.2 / 8,144 / 6.11E-04 Divers: 18 / 6.2 / 2,665 / 2.59E-03 Trawler: 5 / 8.0 / 480 / 3.60E-05 Survey Vessel: 44 / 11.1 / 5,882 / 4.41E-04 CSV: 76 / 11.0 / 10,014 / 7.51E-04 Total offshore hours: 27,186 hrs Total offshore PLL: 4.42E-03 Resource Type: Days / Hours / PLL Engineering & Management: 329.4 / 2,635 / 1.05E-05 Project Management: 298.0 / 2,384 / 9.54E-06 Onshore Operations (includes Cleaning & Disposal): 18.0 / 144 / 1.77E-05 Total onshore hours: 5,163 hrs Total onshore PLL: 3.78E-05 Total operational hours: 32,349 hrs Total operational PLL: 4.46E-03	Vessel Type: PoB / Days / Hours / PLL DSV: 110 / 20.9 / 27,641 / 2.07E-03 Divers: 18 / 20.9 / 9,046 / 8.77E-03 Trawler: 5 / 8.0 / 480 / 3.60E-05 Survey Vessel: 44 / 11.1 / 5,882 / 4.41E-04 Total offshore hours: 43,049 hrs Total offshore PLL: 1.13E-02 Resource Type: Days / Hours / PLL Engineering & Management: 561.8 / 4,494 / 1.80E-05 Project Management: 516.0 / 4,128 / 1.65E-05 Onshore Operations (includes Cleaning & Disposal): 1.0 / 8 / 9.84E-07 Total onshore hours: 8,630 hrs Total onshore PLL: 3.55E-05 Total operational hours: 110,297 hrs Total operational PLL: 2.04E-02
		MS	
	Summary	The assessment of the Operations Personnel sub-criterion is as follows: Option 2b is assessed as being Much Stronger than Option 5 as the risk exposure is around a quarter due to the extended durations required to cut the line ends into short sections for recovery versus the efficient reverse reeling operations. **Overall, Option 2b is the preferred option from a risk to Operations Personnel perspective.**	
1. Safety	1.2 Other Users	Vessel Days: DSV: 6.2 Divers: 6.2 Trawler: 8.0 Survey Vessel: 11.1 CSV: 11.0 Total vessel days: 36.3 days Transits: 12	Vessel Days: DSV: 20.9 Divers: 20.9 Trawler: 8.0 Survey Vessel: 11.1 Total vessel days: 40.1 days Transits: 9
		N	
	Summary	The assessment of the Other Users sub-criterion is as follows: Option 2b is assessed as being Neutral to Option 5 as the number of vessel days and transits are largely similar and as such, the safety impact on other users is likely to be similar. **Overall, both options are equally preferred from a risk to Other Users perspective.**	
1. Safety	1.3 High Consequence Events	Integrity assumed by engineering only and as such reverse reeling has the potential for integrity failure. There are 4 lines and therefore there will be a minimum of 4 lifts from vessel to shore.	Routine operations - Minimal lifting (c. 10 lifts offshore and onshore).
		N	
	Summary	The assessment of the High Consequence Events sub-criterion is as follows: Option 2b is assessed as being Neutral to Option 5 as the potential for dropped object is similar as the number of lifts are similar. The HAZID indicated that the potential for High Consequence Events from an integrity failure of the line during reverse reeling would be negligible due to no personnel being exposed on high tension side of the tensioner. **Overall, both options are equally preferred from a High Consequence Events perspective.**	

		O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk
1. Safety	1.4 Legacy Risk	No legacy risk from this full removal option.	The lines would remain in-situ with this option although the majority of their length would be fully buried. There will be remaining areas of exposure or shallow burial will may present a potential snag hazard. The survey & monitoring programme is committed to ensuring that the potential snag hazard from left in-situ infrastructure continues to be managed & mitigated as appropriate.
		S	
	Summary	The assessment of the Legacy Risk sub-criterion is as follows: Option 2b is assessed as being Stronger than Option 5 as there is no legacy risk from the full removal option versus a small potential for a snag hazard from the fully buried lines with rock placement at the cut ends although this risk is mitigated by the survey and monitoring campaign. **Overall, Option 2b is the preferred option from a Legacy Risk perspective.**	
2. Environmental	2.1 Operational Marine Impact	Vessel Noise (days on-site): Survey Vessel: 3.2 days CSV: 6.5 days DSV: 1.7 days Trawler: 5.0 days Total: 16.4 days Operation Discharges: Line cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) and other chemical levels in lines post flush and discharges to the marine environment during flushing activities. Cutting of line ends and reverse reeling would lead to an elevated discharge of fluids from within the lines. However, given the prior cleaning of the lines, the concentration and quantity of discharge should still be low overall. Therefore, the related impact is also anticipated to be low. Vessel Discharges: This includes Ballast, Grey and Black Water, this is driven by duration of vessel operations and therefore at 17 days will be similar to option 5.	Vessel Noise (days on-site): Survey Vessel: 3.2 days DSV: 16.5 days Trawler: 5.0 days Rockdump Vessel: 2.0 days Total: 26.7 days Tooling Noise: Dredger: 3.4 days Hydrualic Shears: 8.0 days Operation Discharges: Line cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) and other chemical levels in lines post flush and discharges to the marine environment during flushing activities. Cutting of line ends would lead to an elevated discharge of fluids from within the lines. However, given the prior cleaning of the lines, the concentration and quantity of discharge should still be low overall. Therefore, the related impact is also anticipated to be low. Vessel Discharges: This includes Ballast, Grey and Black Water, this is driven by duration of vessel operations and therefore at 27 days will be similar to option 2b.
		N	
	Summary	The assessment of the Operational Marine Impact sub-criterion is as follows: Option 2b is assessed as being Neutral to Option 5 as the marine noise impact and discharges from vessels is largely similar for both options. There would be higher operational discharges from reverse reeling the lines as all contents would be released in a single discharge, however the impact of this is expected to be low and insufficient to express a preference as the inventory would be very small as these lines will already have been cleaned and flushed. Note: there are no significant differences between options from an accidental discharge perspective. **Overall, both options are equally preferred from an Operational Marine Impact perspective.**	
2. Environmental	2.2 Atmospheric Emissions & Fuel Consumption	Vessel Emissions (in tonnes): Fuel: 435 CO2e: 1,426 NOx: 25.84 SO2: 1.74 Vessel Energy Use: 18,708 GJ	Vessel Emissions (in tonnes): Fuel: 1,743 CO2e: 5,714 NOx: 103.54 SO2: 6.97 Vessel Energy Use: 74,953 GJ
		N	
	Summary	The assessment of the Atmospheric Emissions & Consumptions sub-criterion is as follows: Option 2b is assessed as being Neutral to Option 5 as, whilst there 4 times the fuel use and emissions for Option 5, this difference is insufficient to express a preference from an environmental impact perspective. **Overall, both options are equally preferred from an Atmospheric Emissions & Consumptions perspective.**	

		O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk
2. Environmental	2.3 Other Consumptions	Material Emissions (CO2 in tonnes): Recovered Material: 550 Remaining Material: Total: 550 Rock: N/A tonnes	Material Emissions (CO2 in tonnes): Recovered Material: 15 Remaining Material: 1,123 Total: 1,138 Rock: 200 tonnes
		N	
Summary		The assessment of the Other Consumptions sub-criterion is as follows: Option 2b is assessed as being Neutral to Option 5 as, whilst there are differences between the impact from processing all returned material in the full removal option and the impact from producing replacement material for the lines left in-situ, these differences were insufficient to express a preference. **Overall, both options are equally preferred from an Other Consumptions perspective.**	
2. Environmental	2.4 Seabed Disturbance	Short Term Disturbance (Reverse Reel): Rita: 28,660 m^2 (39%) Johnston: 44,668 m^2 (61%)	Short Term Disturbance (Rock Cover): 100 m^2
		W	
Summary		The assessment of the Seabed Disturbance sub-criterion is as follows: Option 2b is assessed as being Weaker than Option 5 due to the greater area of seabed disturbed by reverse reeling the lines through cover in Option 2b. This is a small area in terms of the overall Dogger Bank SAC and the impact is expected to be limited due to seabed mobility. **Overall, Option 5 is the preferred option from a Seabed Disturbance perspective.**	
2. Environmental	2.5 Legacy Marine Impacts	No legacy marine impact from this full removal option. Habitat Loss (Rockdump): N/A	Line cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) and other chemical levels in lines post flush. The legacy marine impact from the slow release of these low concentration / quantity discharges is therefore expected to be low overall. Habitat Loss (Rockdump): 100 m^2
		S	
Summary		The assessment of the Legacy Marine Impacts sub-criterion is as follows: Option 2b is assessed as being Stronger than Option 5 as there is no legacy marine impact from Option 2a versus a small legacy impact from the lines being left in-situ. There is also a small area of permanent habitat change due to the small area of rock cover. There may also be a need for additional rock in Option 2b if additional remediation is required in the future. **Overall, Option 2b is the preferred option from a Legacy Marine Impacts perspective.**	
3. Technical	3.1 Technical Risk	**Concept Maturity:** Proven technique, however integrity of line pulled through soils needs to be confirmed. (Score 2) **Technical Risks:** The potential for technical failure and the requirement to re-assess option remains. (Score 2)	**Concept Maturity:** Minimal operations, well proven techniques. (Score 3) **Technical Risks:** Limited technical risks associated with option (Score 3)
		W	
Summary		The assessment of the Technical Risk sub-criterion is as follows: Option 2b is assessed as being Weaker than Option 5 as whilst both options use proven technology and routine operations, there is potential for the reverse reeling option to fail, requiring the decommissioning solution to be revisited. This was sufficient to express a small preference for Option 5. **Overall, Option 5 is the preferred option from a Technical Risk perspective.**	

		O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk
4. Societal	4.1 Fishing	Short duration operation, small short-term area of disturbance, Fishing operations are conducted in vicinity of the pipeline and back-filling to remove berms may be required. (Score 2)	Minimal disturbance to fishing operations. (Score 3)
		S	
Summary		The assessment of the Societal impact on Fishing sub-criterion is as follows: Option 2b is assessed as being Stronger than Option 5 as it is preferred that lines be fully removed. It is recognised that there is disruption caused by reverse reeling the lines in Option 2b may have impact on nethrops fishing activities which are prevalent in this area. However, survey operations for the left in-situ lines will also cause future disruption which is consdered worse than the one time dirsuption associated with removing the line in Option 5. This would impact static fishing operations key and increasing in these areas i.e. the economic impact from moving fishing / creel pots / etc. and the restrictions of movement. This is exacerbated in the Johnston area as closer to shore. **Overall, Option 2b is preferred from a Societal impact on Fishing perspective.**	
4. Societal	4.2 Other Users	A significant amount of material will require to go to land-fill. (Score 2) Materials Returned: Steel: 103 tonnes (recyclable) Copper: 26 tonnes (recyclable) Polymer: 384 tonnes (landfill)	Minimal societal benefits / impacts with this option. (Score 3) Materials Returned: Steel: 3 tonnes (recyclable) Copper: 1 tonnes (recyclable) Polymer: 10 tonnes (landfill)
		N	
Summary		The assessment of the Societal impact on Other Users sub-criterion is as follows: Option 2b is assessed as being Neutral to Option 5 as, whilst there is more useful material returned in Option 2b, there is also more material destined for landfill which cancels this out. **Overall, both options are equally preferred from a Societal impact on Other Users perspective.**	
5. Economic	5.1 Short-term Costs	£3.097 Million	£5.225 Million
		S	
Summary		The assessment of the Short-term Costs sub-criterion is as follows: Option 2b is assessed as being Stronger than Option 5 as the costs are just under half that of Option 5. **Overall, Option 2b is the preferred option from a Short-term Cost perspective.**	
5. Economic	5.2 Long-term Costs	Surveys: N/A FLTC: N/A Total Legacy Cost: £0 Million	Surveys: £1.092 Million FLTC: £0 Million Total Legacy Cost: £1.093 Million
		S	
Summary		The assessment of the Long-term Costs sub-criterion is as follows: Option 2b is assessed as being Stronger than Option 5 as there are no long-term costs associated with the full removal option. **Overall, Option 2b is the preferred option from a Long-term Cost perspective.**	

Appendix D.2 Group 4 Pairwise Comparison Matrices - Safety

1.1 Operations Personnel	O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2b - Full Removal - Reverse Reel w/o Deburial	N	MS	75.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	MW	N	25.0%

1.2 Other Users	O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2b - Full Removal - Reverse Reel w/o Deburial	N	N	50.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	N	N	50.0%

1.3 High Consequence Events	O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2b - Full Removal - Reverse Reel w/o Deburial	N	N	50.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	N	N	50.0%

1.4 Legacy Risk	O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2b - Full Removal - Reverse Reel w/o Deburial	N	S	60.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	W	N	40.0%

Appendix D.3 Group 4 Pairwise Comparison Matrices - Environment

2.1 Operational Marine Impact	O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2b - Full Removal - Reverse Reel w/o Deburial	N	N	50.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	N	N	50.0%

2.2 Atmospheric Emissions & Fuel Consumption	O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2b - Full Removal - Reverse Reel w/o Deburial	N	N	50.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	N	N	50.0%

2.3 Other Consumptions	O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2b - Full Removal - Reverse Reel w/o Deburial	N	N	50.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	N	N	50.0%

2.4 Seabed Disturbance	O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2b - Full Removal - Reverse Reel w/o Deburial	N	W	40.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	S	N	60.0%

2.5 Legacy Marine Impacts	O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2b - Full Removal - Reverse Reel w/o Deburial	N	S	60.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	W	N	40.0%

Appendix D.4 Group 4 Pairwise Comparison Matrices – Technical

3.1 Technical Risk	O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2b - Full Removal - Reverse Reel w/o Deburial	N	W	40.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	S	N	60.0%

Appendix D.5 Group 4 Pairwise Comparison Matrices - Societal

4.1 Fishing	O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2b - Full Removal - Reverse Reel w/o Deburial	N	S	60.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	W	N	40.0%

4.2 Other Users	O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2b - Full Removal - Reverse Reel w/o Deburial	N	N	50.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	N	N	50.0%

Appendix D.6 Group 4 Pairwise Comparison Matrices - Economic

5.1 Short-term Costs	O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2b - Full Removal - Reverse Reel w/o Deburial	N	S	60.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	W	N	40.0%

5.2 Long-term Costs	O2b - Full Removal - Reverse Reel w/o Deburial	O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	Weighting
O2b - Full Removal - Reverse Reel w/o Deburial	N	S	60.0%
O5 - Leave - Minimal - Remove Ends & Remediate Snag Risk	W	N	40.0%

Appendix D.7 Group 4 Results Charts