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| Prepared by (Organisation unit / Name): Xodus Group - John Foreman | Date/Signature: |
| X |
| Responsible (Organisation unit/ Name): Xodus Group - Gareth Jones | Date/Signature: |
| X |
| Recommended (Organisation unit/ Name): Equinor – Kristian Kudsk Andreasen | Date/Signature: |
| X |
| Approved by (Organisation unit/ Name): Equinor - Frode Skarstein | Date/Signature: |
| X |
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Terms and Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHP</td>
<td>Analytical Hierarchy Process</td>
</tr>
<tr>
<td>BEIS</td>
<td>Department of Business, Energy and Industrial Strategy</td>
</tr>
<tr>
<td>CA</td>
<td>Comparative Assessment</td>
</tr>
<tr>
<td>CSV</td>
<td>Construction Support Vessel</td>
</tr>
<tr>
<td>DP</td>
<td>Decommissioning Programme</td>
</tr>
<tr>
<td>HSE</td>
<td>Health and Safety Executive</td>
</tr>
<tr>
<td>IP</td>
<td>Institute of Petroleum</td>
</tr>
<tr>
<td>ISBN</td>
<td>International Standard Book Number</td>
</tr>
<tr>
<td>JNCC</td>
<td>Joint Nature Conservation Committee</td>
</tr>
<tr>
<td>MCDA</td>
<td>Multi-Criteria Decision Analysis</td>
</tr>
<tr>
<td>MEI</td>
<td>Major Environmental Incident</td>
</tr>
<tr>
<td>MFE</td>
<td>Mass Flow Excavator</td>
</tr>
<tr>
<td>MS</td>
<td>Much Stronger</td>
</tr>
<tr>
<td>MW</td>
<td>Much Weaker</td>
</tr>
<tr>
<td>NCS</td>
<td>Norwegian Continental Shelf</td>
</tr>
<tr>
<td>NORM</td>
<td>Naturally Occurring Radioactive Material</td>
</tr>
<tr>
<td>OD</td>
<td>Outside Diameter</td>
</tr>
<tr>
<td>ODU</td>
<td>Offshore Decommissioning Unit</td>
</tr>
<tr>
<td>OGUK</td>
<td>Oil &amp; Gas UK</td>
</tr>
<tr>
<td>OPRED</td>
<td>Offshore Petroleum Regulator for Environment &amp; Decommissioning</td>
</tr>
<tr>
<td>PLL</td>
<td>Potential for Loss of Life</td>
</tr>
<tr>
<td>S</td>
<td>Stronger</td>
</tr>
<tr>
<td>SFF</td>
<td>Scottish Fishermen’s Federation</td>
</tr>
<tr>
<td>VC</td>
<td>Video Conference</td>
</tr>
<tr>
<td>VMS</td>
<td>Very Much Stronger</td>
</tr>
<tr>
<td>VMW</td>
<td>Very Much Weaker</td>
</tr>
<tr>
<td>W</td>
<td>Weaker</td>
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</table>
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EXECUTIVE SUMMARY

Equinor Energy AS have conducted a Comparative Assessment (CA) for the decommissioning of the UK section of PL301. The following steps from the Oil and Gas UK CA Guidelines have been completed:

![Flowchart showing the CA process steps: Scoping, Screening, Preparation, Evaluation, Recommendation, and Review.]

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

The CA was conducted on a single group, as described in the table below with the outcome of the CA process making the following recommendation:

<table>
<thead>
<tr>
<th>Group</th>
<th>Title</th>
<th>Decommissioning Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Trenched &amp; Buried Rigid Pipeline</td>
<td>Option 4a – Rock Cover Areas of Spans / Exposure Removal and recovery of short surface laid section out with existing trench. Rock placement or trenching to remediate snag risk from cut end. Rock placement at all areas of spans and exposure.</td>
</tr>
</tbody>
</table>

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

The Heimdal license currently operate the PL301 in its entirety. PL301 is owned by the Heimdal license and is a gas condensate export pipeline running from the Heimdal Platform in the Norwegian Sector of the Northern North Sea (NNS) to the Brae Alpha installation in the UK sector on the NNS. The water depth along the route of PL301 varies from 100 m to 123 m, respectively. The pipeline is trenched and is believed to be 94% buried as per 2017 survey data.

Decommissioning of PL301 means operation in close proximity to the Brae Alpha installation and risk associated with removal activities on a live platform. It is therefore most safe and efficient to decommissioning the PL301 Brae end section at the same time as decommissioning of the Brae Alpha installation under management of one operator.

In addition, the decommissioning of PL301 in the UKCS is to be carried out as part of a greater campaign, decommissioning the whole length of PL301 and the Heimdal field on NCS. Alignment between Norwegian and UK governmental body is required for the decommissioning of PL301.

The decommissioning of PL301 will therefore be split into two Decommissioning Programmes as illustrated in Figure 1 above.

1. The trenched and/or buried length of PL301 running from the Norwegian/UK boundary to cut point KP 116.028 within Brae Alpha safety zone, including cut and removal of the 20-meter section of PL301 (KP 116.008 – KP 116.028)

2. The surface laid length of PL301, entirely within the Brae Alpha safety zone, running from cut point KP 116.028 to the Brae Alpha installation. OPRED will be advised of any agreement made for the decommissioning of this remaining section of PL301.

The section 2 of PL301 from cut point KP 116.028 to Brae Alpha topside will be decommissioned at a later date. Discussions are ongoing and agreement will be made with the Brae Alpha operator. The section of PL301 that is left exposed will not pose any risk to other users of the sea. The justification for leaving this section exposed is that by doing so the decommissioning options for the Brae Alpha facilities will not be influenced or limited by previous work. The removed section of PL301 is to ensure physical split between the two Decommissioning Programmes.

A Norwegian decommissioning plan has been submitted by Equinor to the Norwegian Ministry of Petroleum and Energy (MPE) to allow decommissioning of the Norwegian section of PL301.

The two DPs will be supported by separate Comparative Assessment (CA) and Environmental Appraisal (EA) processes. This CA assesses the project scope for the first DP only, the second DP will be considered at a later date and aligned with future decommissioning of Brae Alpha Platform.
Within the scope of work, KP 78.620 to KP 116.028, PL301 is crossed by a total of seven pipeline assets. For all seven of the crossings PL301 is the pipeline that is crossed over and in six of the seven instances both PL301 and the other pipeline asset crossing over it are covered by protective material e.g. mattresses/gravel, in the other instance both PL301 and the other product are covered in mattresses. Currently the seven crossings will remain intact, consideration of decommissioning will occur at a time when those assets overlaying the PL301 are decommissioned themselves and are the responsibility of their respective operators. The stabilisation features on the four crossings within the Brae Alpha safety zone will be considered with the Brae Alpha facilities. More detailed information regarding PL301 crossings are found in Appendix E of the Decommissioning Programme. PL301 within the Brae Alpha safety zone is covered by gravel or mattresses for a total of 385 m. Mattress coverage accounts for 82 m of this, with the mattresses being associated with two crossing areas and protection/stability in the area immediately adjacent to the Brae Alpha Platform.

Figure 2 The location and boundaries of PL301
1.1 Purpose

The purpose of this document is to present a Comparative Assessment (CA) for the trenched and/or buried length of PL301 running from the Norwegian/UK boundary to cut point KP 116.028 within Brae Alpha safety zone, including cut and removal of the 20-meter section of PL301. It is produced to satisfy the requirement to carry out a CA 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.

1.2 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 CA outcome obtained for Group 1 – Trenched & Buried Rigid Pipeline.
- Appendix A – Evaluation Methodology.
- Appendix B – Stakeholder CA Workshop Minutes.
- Appendix C – Group 1 – Detailed Screening Results.
- Appendix D – Group 1 – Detailed Evaluation Results.
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 Equinor for the decommissioning scope of the PL301.

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 1 introduces each of these steps, along with a status and commentary to demonstrate the current position.

<table>
<thead>
<tr>
<th>Title</th>
<th>Scope</th>
<th>Status</th>
<th>Commentary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scoping</td>
<td>Decide on appropriate CA method, confirm criteria, identify boundaries of CA (physical and phase).</td>
<td>✔️</td>
<td>CA methodology and criteria established for screening to ensure appropriate evaluation phase.</td>
</tr>
<tr>
<td>Screening</td>
<td>Consider alternative uses and deselect unfeasible options.</td>
<td>✔️</td>
<td>Screening workshop held in Q1 2020 with Screening outcomes documented in Section 3.2.</td>
</tr>
<tr>
<td>Preparation</td>
<td>Undertake technical, safety, environmental and other appropriate studies. Undertake stakeholder engagement.</td>
<td>✔️</td>
<td>Studies identified during screening phase undertaken to inform the evaluation of the remaining options detailed in Section 2.4.</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Evaluate the options using the chosen evaluation methodology.</td>
<td>✔️</td>
<td>Internal workshop held Q1 2020 and Stakeholder Workshop on 11\textsuperscript{th} February 2020. Evaluation methodology described in Section 2.5 and outcome detailed in Section 3. Additional detail can be found in Appendix A.</td>
</tr>
<tr>
<td>Recommendation</td>
<td>Document the recommendation in the form of narrative supported by charts explaining key trade-offs.</td>
<td>✔️</td>
<td>The emerging recommendation for decommissioning the pipeline is as identified during the Stakeholder Workshop and as detailed in the CA Report (this document). Recommendation can be found in Section 4.</td>
</tr>
<tr>
<td>Review</td>
<td>Review the recommendation with internal and/or external stakeholders.</td>
<td>✔️</td>
<td>The Stakeholder CA Review Workshop was held on 11\textsuperscript{th} February 2020 with the minutes in Appendix B.</td>
</tr>
<tr>
<td>Submit</td>
<td>Submit to OPRED alongside the Heimdal Decommissioning Programme.</td>
<td>✔️</td>
<td>1\textsuperscript{st} pre-draft submitted Q1 2020 2\textsuperscript{nd} pre-draft submitted Q2 2020.</td>
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</tbody>
</table>

Table 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 PL301 decommissioning scope commencing:
  – The pipeline will be cleaned and flushed
  – The pipeline will be disconnected at the Heimdal end
> The scope of PL301 being considered is from the UK / Norwegian boundary, to cut point KP 116.028 within Brae Alpha safety zone.

2.2.2 Physical Attributes of Equipment

The physical attributes of PL301 are recorded to define the line. Attributes considered include the following:

> 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.
2.2.3 Decommissioning Options

All potential decommissioning options for the UK portion of PL301 are identified. 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. [6].

- 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;
- Leave In-situ – ongoing monitoring.

2.3 Screening Phase

The screening phase of the comparative assessment was carried out during a series of workshops held in Q1 2020. The methodology is briefly summarised below.

- Review proposed decommissioning options for the group.
- Assess decommissioning options and record assessment and outcome in screening worksheets.
- Record actions required to support retained decommissioning options.

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

- Safety;
- Environmental;
- Technical;
- Societal; and
- 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 in Table 2.

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

**Table 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 option are summarised in Table 5.
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:

- **High Level Integrity Review**: Where the integrity associated with performing removal of the line using reverse reeling techniques was considered.
- **Decommissioning Method Statements**: Detailed method statements were developed for options carried forward for evaluation to ascertain the activities and resources required to deliver the option.
- **Decommissioning Cost Estimates**: Cost estimates for each decommissioning option, derived based on the decommissioning method statements.
- **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.

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 table, included in 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 D.

The evaluation phase was performed during an evaluation workshop where the decommissioning project team were represented. This enabled the supporting information for the decommissioning options to be interrogated and increased in maturity and definition as required.

Once the evaluation of the remaining decommissioning 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, the outcome for Group 1 was validated.
The CA Stakeholder Workshop was held at Xodus’ office in Aberdeen on Tuesday 11th February 2020. The attendees were as detailed in Table 3.

<table>
<thead>
<tr>
<th>Name</th>
<th>Company / Organisation</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audrey Banner</td>
<td>BEIS OPRED ODU</td>
<td>Head of Policy</td>
</tr>
<tr>
<td>Helen McArthur</td>
<td></td>
<td>Assistant Decommissioning Manager</td>
</tr>
<tr>
<td>Sam Pattie</td>
<td></td>
<td>Administrative Officer</td>
</tr>
<tr>
<td>Hannah Hood</td>
<td>JNCC</td>
<td>Industry Advisor</td>
</tr>
<tr>
<td>Sarah Canning</td>
<td></td>
<td>Industry Advisor</td>
</tr>
<tr>
<td>Dan Stewart</td>
<td>Marine Scotland</td>
<td>Advisor</td>
</tr>
<tr>
<td>Abdulgani Oseni</td>
<td>HSE</td>
<td>Pipeline Inspector</td>
</tr>
<tr>
<td>Andrew Third</td>
<td>SFF</td>
<td>Industry Advisor</td>
</tr>
<tr>
<td>Steven Alexander</td>
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<td>Offshore Liaison</td>
</tr>
<tr>
<td>Annette Veka</td>
<td>Equinor Energy AS</td>
<td>Subsea Engineer (via VC)</td>
</tr>
<tr>
<td>Jon Harald Johansen</td>
<td></td>
<td>Health, Safety, Environment &amp; Authority Relations</td>
</tr>
<tr>
<td>Kristian Kudsk Andreasen</td>
<td></td>
<td>Heimdal Project Manager</td>
</tr>
<tr>
<td>Gareth Jones</td>
<td>Xodus</td>
<td>Decommissioning Division Manager</td>
</tr>
<tr>
<td>John Foreman</td>
<td></td>
<td>Comparative Assessment Lead</td>
</tr>
<tr>
<td>Nick Moore</td>
<td></td>
<td>Project Manager</td>
</tr>
<tr>
<td>Will Garston</td>
<td></td>
<td>Graduate Decommissioning Engineer</td>
</tr>
</tbody>
</table>

Table 3: Stakeholder Workshop Attendees & Roles
3 CA - GROUP 1 - TRENCHED & BURIED RIGID PIPELINE

3.1 Group 1 Characteristics

There is a single item in Group 1 with the key characteristics are listed in Table 4.

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>OD (inches)</th>
<th>Length (km)</th>
<th>Weight (T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PL301</td>
<td>38 km 8” Condensate Pipeline, Rigid, Concrete Coated, Trenched and Buried</td>
<td>8</td>
<td>37.408</td>
<td>5,778</td>
</tr>
</tbody>
</table>

Table 4: Group 1 Items

3.2 Group 1 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 is detailed fully in Appendix C and summarised in Table 5 herein.

<table>
<thead>
<tr>
<th>Category</th>
<th>Option</th>
<th>Description</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Re-use</td>
<td>1 – Re-use</td>
<td>- Leave rigid pipeline in-situ for use in any potential new developments</td>
<td>Ruled out as a showstopper as there were no potential re-use in-situ options for the pipeline.</td>
</tr>
</tbody>
</table>
| Full removal                    | 2a – Cut and lift with de-burial | - De-burial of rigid pipeline using MFE  
- Recover by cutting into sections (using hydraulic shears) and removal | Retained as the least onerous and most credible Full Removal option.                                                                                                                                   |
|                                 | 2b – Reverse reel without de-burial | - No de-burial prior to removal  
- Recover by reverse reel                                                                 | Ruled out as a technical showstopper on the basis that the concrete coating on the line / the line itself does not have the required integrity for reverse reeling without de-burial. |
|                                 | 2c – Reverse reel with de-burial | - De-burial of rigid pipelines using MFE  
- Recover by reverse reel                                                                 | Ruled out as a technical showstopper on the basis that the concrete coating on the line / the line itself does not have the required integrity for reverse reeling with de-burial. |
| Leave in-situ (major intervention) | 3a – Rock placement over entire line | - Rock placement over full length of rigid pipeline to address areas of spans and exposure  
- No recovery of rigid pipelines                                                                 | Ruled out as an environmental showstopper due to the large quantity of rock required to cover 38 km of line. Additionally, the line is sufficiently trenched / buried along the vast majority of its length so little benefit in introducing large quantity of rock cover. |
| Leave in-situ (major intervention) | 3b – Retrench and bury entire line | - Re-trench and backfill full length of rigid pipeline to remove areas of spans and exposure  
- No recovery of rigid pipelines  
- No introduction of new material                                                                 | Ruled out as a technical showstopper as the as installed evidence shows that there were areas of seabed where trenching was not fully successful originally. It is expected that the required depth of lowering may not be achievable. |
3.3 Group 1 Decommissioning Options for Evaluation

The decommissioning options for Group 1 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 (minor intervention)
  - 4a – Rock placement and over areas of spans / exposures
  - 4c – Remove areas of spans / exposures

Ruled out as a technical showstopper as the as installed evidence shows that there were areas of seabed where trenching was not fully successful originally. It is expected that the required depth of lowering may not be achievable.

Assessed as being attractive (green) against the Technical criteria and acceptable (yellow) against the Safety, Environmental, Societal and Economic criteria.

Ruled out as a safety showstopper due to the existing spans and exposures presenting an unacceptable potential snagging risk.

Ruled out as attractive (green) against the Technical and Economic criteria and acceptable (yellow) against the Safety, Environmental and Societal criteria. Retained as an option for evaluation.

Assessed as being attractive (green) against the Technical and Economic criteria and acceptable (yellow) against the Safety, Environmental and Societal criteria. Retained as an option for evaluation.

Table 5: Group 1 Decommissioning Options & Screening Summary
3.4 Group 1 Evaluation Summary

| Evaluation | Safety | Option 4a is assessed as the most preferred option. | Option 4a is preferred to Option 2a from a risk exposure to Operations Personnel perspective. This is due to the increased risk profile associated with the longer durations associated with the offshore scope to de-bury and cut the entire line into sections and recover in Option 2a versus rock cover of selected sections in Option 4a. Option 4c is also less preferred to Option 4a, again due to the increased risk profile from the longer durations to de-bury, cut and recover the areas of spans and 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 compared to the other options. While the increased safety impact on Other Users is expected to be small, it is sufficient to express a small equal preference for Option 4a and 4c.

Option 4a is preferred from a High Consequence Events perspective as it has much lower potential for dropped objects than either of the other options as they both have lots of lifting of equipment (MFE) into and out of the water and recovery of sections of line through the water column to the vessel. Option 2a, full removal, is preferred to either of the leave in-situ options against the Legacy Risk criterion due to the line being fully removed. The difference in risk profile between the full removal options and the leave in-situ options is assessed as minimal as the remaining line is fully trenched / buried with areas of spans and exposure either removed or rock covered. Overall, Option 4a is preferred over the other options as it is preferred against all safety criteria other than legacy risk.

| Environment | Option 4a is assessed as the most preferred option. | Option 4a and Option 4c are preferred to Option 2a from an Operational Marine Impact perspective as 2a requires extended vessel operations and MFE operations which increases the noise impact and potential for planned and unplanned discharges. Option 4a is preferred from an Emissions and Consumptions perspective as it is the shortest duration of offshore operations. Option 2a is preferred from an Other Consumptions perspective as there is no rock cover in the full removal option. Option 4a is preferred from a short-term seabed impact perspective as there is no MFE used in the option whereas there is use of MFE for line de-burial in both Option 4c and extensively in Option 2a. Option 2a is preferred from a Legacy Marine Impacts perspective as there is no legacy marine impact as line is removed and there are areas of permanent habitat change caused by rock cover in both Option 4a and Option 4c.

Overall, Option 4a is preferred over the other options as it is preferred in three of the five environmental criteria.

| Technical | Option 4a and Option 4c are assessed as being equally preferred options. | All operations across all options i.e. line de-burial, cutting with shears or rock cover are considered routine. There is a preference for Option 4a and Option 4c over Option 2a due to the potential for equipment failures and schedule increase from the length of operations associated with Option 2a, a function of the full removal of a 38 km line. Overall, Option 4a and 4c are equally preferred from a technical perspective.

| Societal | Option 2a is assessed as the most preferred option. | With respect to Societal impact on Fishing, Option 2a is preferred over the leave in-situ options as, while there is potential impact to fishing operations from removing the line, this is the preferred end solution. Option 4a and Option 4c are preferred from a Societal impact on Other Users perspective as, while there is more useful steel being returned than in Option 2a, this is offset by the large quantity of contaminated concrete that would go to land-fill. Overall, the preference from the fishing industry for the line being removed dominates the assessment making Option 2a being the preferred option from a Societal perspective.

| Economic | Option 4a is assessed as the most preferred option. | From a short-term cost perspective, Option 2a is 20 times more than Option 4a and more than 5 time more than Option 4c. Option 4c itself is around 3 times higher cost than Option 2a. For long-term costs, there are none associated with Option 2a as it is full removal but for the leave in-situ options, there are legacy costs associated with monitoring, surveying and managing potential snag hazards associated with the left line. Overall, the short-term costs dominate the assessment with Option 4a being preferred from an economics perspective. |
Summary
Overall, Option 4a is assessed as the preferred option.
Option 4a was preferred against the Safety, Environment and Technical criteria whereas Option 2a was preferred marginally from a Societal perspective.
Once the Economics criterion was considered, this strengthens the preference for Option 4a as it is by far the least expensive option.
Option 4a – Rock placement over areas of spans/exposure will form the emerging recommendation for the decommissioning option for Group 1.

Table 6: Group 1 Evaluation Summary

3.5 Group 1 Evaluation Sensitivities

There were a number of areas during the Stakeholder workshop where sensitivities were identified to check whether the outcome obtained was robust. The sensitivities identified were:

- Sensitivity 1 – Modified assessment in the Safety – Other Users criterion
- Sensitivity 2 – Modified assessment in the Safety – Legacy Risk criterion
- Sensitivity 3 – Modified assessment in the Environmental – Other Consumptions criterion
- Sensitivity 4 – Modified assessment in the Environmental – Seabed Disturbance criterion
- Sensitivity 5 – Modified assessment in the Environmental – Legacy Marine Impacts criterion
- Sensitivity 6 – Modified assessment in the Societal – Other Users criterion

Each of these sensitivities are addressed in the following sub-sections, in summary, none of the sensitivities conducted resulted in a change to the original outcome.

3.5.1 Sensitivity 1

There was a requirement to look at the assessment between Option 2A – Full removal – Cut and lift with de-burial and the two partial removal options. This was requested as the base case assessment was that the impact in terms of safety of other users of the sea between Option 2A and the partial removal options was Weaker. This was based on the increased offshore scope for Option 2A resulting in a much higher number of vessel days and, more significantly from a safety risk to other users, a higher number of transits of vessel to and from shore.

The sensitivity required was to increase the comparative assessment from Option 2A being Weaker than the partial removal options to Much Weaker to reflect a greater safety impact on other users of the sea from the higher number of vessel days and transits.

This adjustment had the effect of increasing the preference for the partial removal options over the full removal option and as such, strengthened the original outcome.
3.5.2 Sensitivity 2

The second sensitivity requested was to look at increasing the legacy risk associated with the partial removal options. The base assessment indicated that the full removal option was Stronger than the partial removal options as removing the line removes the legacy risk. The base assessment was based on the fact that the majority of PL301 is trenched / buried and the commitment to address areas of spanning and exposure, alongside future surveying and monitoring of the line in the partial removal options was less preferable but only marginally so.

The sensitivity required was to increase the comparative assessment from the full removal option being Stronger than the partial removal options to Much Stronger reflecting an increase preference between the full removal of PL301 over the partial removal options.

This adjustment had the effect of increasing the preference for Option 2A but not sufficiently to change the outcome that Option 4A was the overall preferred option.

An additional sensitivity where the base assessment between Option 4A – Rock placement over areas of spans and exposures and Option 4C – Removal of areas of spans and exposure was adjusted from Neutral to Weaker, to reflect the position that rock covered areas of spans and exposure left a higher potential snag risk than removing them, resulted in a minor increase for the preference for Option 4C, but again, did not change the outcome that Option 4A was the overall preferred option.

3.5.3 Sensitivity 3

The third sensitivity related to the impact associated with the Environment – Other Consumptions criterion. The base assessment indicated that the full removal option was Much Stronger than the partial removal options, mainly due to the requirement to use around 5,000 tonnes of rock for both partial removal options versus no rock required for the full removal option.

The sensitivity conducted was to reduce this assessment from Much Stronger to Stronger showing, from an impact from consuming raw materials perspective, the difference between no rock and 5,000 tonnes of rock was less significant.

This adjustment had the effect of reducing the preference for the full removal option and thus strengthened the overall preference for Option 4A.

3.5.4 Sensitivity 4

The fourth sensitivity related to the impact in the Environment – Seabed Disturbance criterion. The base assessment showed that the impact in terms of short-term seabed disturbance for the partial removal options was greater for Option 4C due to the impact associated with the use of MFE for de-burial operations. Option 4A was therefore considered Stronger than Option 4C.

The sensitivity was to make the assessment between the partial removal operations Neutral to reflect the position that, while there are differences in the short-term seabed disturbance between the partial removal options, these differences are insufficient to express a preference.

This adjustment had the effect of reducing the overall preference for Option 4A slightly but was insufficient to alter the overall outcome.
3.5.5 Sensitivity 5

The fifth sensitivity related to the impact in the Environment – Legacy Marine Impacts criterion. The base assessment showed that the legacy impact for the partial removal options was similar, due to the amount of PL301 and associated degradation profile being largely similar and as such, Option 4A was assessed as being Neutral to Option 4C.

The sensitivity was to make Option 4A Weaker than Option 4C to reflect the higher area of permanent habitat change in Option 4A (14,120 m²) than Option 4C (10,100 m²).

This adjustment had the effect of reducing the overall preference for Option 4A slightly but was insufficient to alter the overall outcome.

3.5.6 Sensitivity 6

The sixth and final sensitivity conducted related to the Societal – Other Users criterion. The base assessment considered the full removal option Weaker than the partial removal option as, while more useful material (steel) is returned to shore in the full removal option, more than 60% of the material returned is contaminated concrete and would take up limited landfill capacity.

The sensitivity conducted was to change the assessment of the full removal option versus the partial removal options from Weaker to Neutral to reflect the uncertainty that this would be less preferred from a Societal – Other Users perspective.

This adjustment had the effect of increasing the preference for the full removal option but not sufficiently to change the outcome that Option 4A was the overall preferred option.
4 DECOMMISSIONING RECOMMENDATION

The outcome obtained from performing the comparative assessment of the UK section of PL301 is:

Option 4a – Rock placement over areas of spans / exposure
  − Removal and recovery of short surface laid section out with existing trench
  − Rock placement to remediate snag risk from cut end
  − Rock placement at all areas of spans and exposure

The following sections provide a summary of the evaluation of the remaining Group 1 decommissioning options (Option 2a, Option 4a and Option 4c) against the five criteria and why this recommendation has been made.

4.1.1 Safety

Option 4a has the lowest risk exposure of all options due the shortest offshore durations. It also has the lowest impact on the safety of Other Users as it has the fewest days of offshore operations and the lowest number of transits. The potential for High Consequence Events is also lowest for Option 4a as there is minimal lifting with this option versus the others.

Option 2a carries the lowest legacy risk due to it being fully removed. The risk associated with PL301 being left in-situ with rock cover over areas of spans and exposure is considered acceptable, as the future risk is mitigated by a survey and monitoring programme. Consideration will be given to a survey and monitoring programme which has additional focus on areas of the pipeline that have experienced spanning in the past.

Overall, there is a preference for Option 4a from a Safety perspective.

4.1.2 Environment

Option 4a has the lowest environmental impact in terms of Operational Marine Impacts and Atmospheric Emissions and Consumptions, due to it being the shortest offshore duration. It is also equal lowest in terms of short-term seabed disturbance.

Option 2a has the lowest impact in terms of Other Consumptions as it is the only option that does not use rock. It is also preferred from a legacy environmental impact as it is fully removed and there is no permanent habitat change as there is no rock introduced.

Overall, there is a preference for Option 4a from an Environmental perspective as it is preferred in 3 of the five environmental sub-criteria.

4.1.3 Technical

While all 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 PL301 removal. As such, Option 4a and Option 4c are equally preferred from a Technical perspective.
4.1.4 Societal

Option 4a is preferred from a Societal – Fishing perspective as PL301 is fully removed. This was considered a lower overall impact despite the short-term disruption caused by removing PL301. Option 4a and Option 4c were preferred over Option 2a from a Societal – Other Users perspective as, while there is more useful material being returned with the full PL301 removal, there is a large quantity of contaminated concrete returned with PL301 which would have to consume land-fill capacity which was conserved societally less attractive.

Option 2a is preferred overall from a societal perspective with the stronger preference in the Societal – Fishing criterion influencing the overall outcome.

4.1.5 Economic

The short-term costs associated with executing Option 2a where PL301 is fully removed are much higher (around 20 times higher) than for the much smaller scope associated with executing Option 4a – Rock Cover which is the least expensive option. Option 4a does however, have long-term costs associated with monitoring and surveying required to manage potential snag risks in the future (as does Option 4c), but these are calculated to be <£1m and therefore relatively insignificant in economic terms.

The total costs (short-term + long-term) are significantly less for Option 4a than the other options and therefore this is preferred from an Economic perspective.

5 REFERENCES

1. OGUK Decommissioning CA Guidelines

2. BEIS Guidance Notes
   BEIS, Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines, Nov 2018.

3. Decommissioning Option Methodologies Technical Note

4. Risk Analysis of Decommissioning Activities

5. Analytical Hierarchy Process

6. OGUK North Sea Pipeline Decommissioning Guidelines
   Decommissioning of Pipelines in the North Sea Region – 2013, Issued by Oil & Gas UK

7. IP 2000
APPENDIX A  EVALUATION METHODOLOGY

Appendix A.1  CA Evaluation Methodology

Equinor 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. [5]. 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 – 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 (February 2020); 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 Table 7.
<table>
<thead>
<tr>
<th>Criteria</th>
<th>Sub-Criteria</th>
<th>Description</th>
<th>Approach to Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Safety</td>
<td>1.1 Operations Personnel</td>
<td>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.</td>
<td>Potential for Loss of Life (PLL) metrics were calculated for each option. This allows a quantified direct comparison between options.</td>
</tr>
<tr>
<td></td>
<td>1.2 Other Users</td>
<td>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.</td>
<td>Days of vessel operations and numbers of vessel transits provided to allow assessment of safety risk to other users to be conducted.</td>
</tr>
<tr>
<td></td>
<td>1.3 High Consequence Events</td>
<td>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.</td>
<td>Assessment conducted based on number of lifts expected for each option as, given the option definitions, the potential for dropped object during lifts is the key operation where there is potential for High Consequence Events.</td>
</tr>
<tr>
<td></td>
<td>1.4 Legacy Risk</td>
<td>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.</td>
<td>Narrative assessment of the as left status and the associated legacy safety risk provided based on the defined options. Additionally, the safety risk associated with any legacy surveying and monitoring provided as PLLs.</td>
</tr>
</tbody>
</table>
### Criteria

<table>
<thead>
<tr>
<th>Sub-Criteria</th>
<th>Description</th>
<th>Approach to Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2. Environmental</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 Operational Marine Impact</td>
<td>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.</td>
<td>Planned and unplanned marine impacts are narrative judgement informed by estimates of volumes ($m^3$) / composition of any releases. Impacts from vessels are qualitative in nature. Marine noise impact is calculated based on the vessel durations, subsea cutting operations and other operations that generate marine noise and is a qualitative measure of noise impact with impact on marine mammals is a key focus.</td>
</tr>
<tr>
<td>2.2 Atmospheric Emissions &amp; Fuel Consumption</td>
<td>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.</td>
<td>Fuel use, emissions and energy consumption are calculated from vessel operations using IP 2000 ref. [7] factors for vessel fuel use and emissions. Fuel use, and emissions provided in metric tonnes. Energy provided in joules.</td>
</tr>
<tr>
<td>2.3 Other Consumptions</td>
<td>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.</td>
<td>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$_2$</td>
</tr>
<tr>
<td>Criteria</td>
<td>Sub-Criteria</td>
<td>Description</td>
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<td>--------------</td>
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<td>----------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2. Environmental</td>
<td>2.4 Seabed Disturbance</td>
<td>This sub-criterion addresses the direct and indirect seabed disturbance caused by performing the decommissioning option. Impacts that are both permanent and temporary in nature are considered. The level of impact caused and any specific seabed concerns, such as protected areas or habitat changes may be covered.</td>
</tr>
<tr>
<td></td>
<td>2.5 Legacy Marine Impacts</td>
<td>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.</td>
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<tr>
<td>Criteria</td>
<td>Sub-Criteria</td>
<td>Description</td>
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<td>------------</td>
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</tr>
<tr>
<td>3. Technical</td>
<td>3.1 Technical Risk</td>
<td>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.</td>
</tr>
<tr>
<td>4. Societal</td>
<td>4.1 Fishing</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>4.2 Other Users</td>
<td>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.</td>
</tr>
<tr>
<td>5. Economic</td>
<td>5.1 Short-term Costs</td>
<td>This sub-criterion addresses the cost of delivering the option as described. No long-term cost element is considered here.</td>
</tr>
<tr>
<td>Criteria</td>
<td>Sub-Criteria</td>
<td>Description</td>
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</tr>
<tr>
<td></td>
<td>5.2 Long-term Costs</td>
<td>This sub-criterion addresses the costs associated with any long-term liabilities such as on-going monitoring and any potential future remediation costs.</td>
</tr>
</tbody>
</table>

Table 7: 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 3 shows the pairwise comparison matrix. Equinor decided that equal weightings offer the most transparency and a balanced view from all perspectives.

<table>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Safety</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>20%</td>
</tr>
<tr>
<td>2. Environmental</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>20%</td>
</tr>
<tr>
<td>3. Technical</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>20%</td>
</tr>
<tr>
<td>4. Societal</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>20%</td>
</tr>
<tr>
<td>5. Economic</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>20%</td>
</tr>
</tbody>
</table>

Figure 3: 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 D contains the completed Attributes Table for Group 1.

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, Equinor 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 8). It was agreed that three positions from equal (and their reciprocals) would be sufficient for this CA. These positions were:

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

Table 8: 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 4.
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 output for Group 1 is included in Appendix D. An example of the visual output obtained is shown in Figure 5.

Figure 5: 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

**Subject:**  Heimdal-Brae A Gas Condensate Pipeline PL301 - CA Stakeholder Workshop  
**Location:**  Xodus House, 50 Huntly Street, Aberdeen, AB10 1RS  
**Date:**  11th February 2020  
**Assignment:**  A400300  
**Minutes by:**  Will Garston  
**Issued on:**  14th February 2020  

**Attending:**

- BEIS OPRED ODU: Audrey Banner, Helen McArthur, Sam Pattie  
- JNCC: Hannah Hood, Sarah Canning  
- Marine Scotland: Dan Stewart  
- HSE: Abdulgani Oseni  
- SFF: Andrew Third, Steven Alexander  
- Equinor Energy AS: Annette Veka (via VC), Jon Harald Johansen, Kristian Kudsk Andreasen  
- Xodus: Gareth Jones, John Foreman, Nick Moore, Will Garston  

**Distribution:**  Attendees

Below in the table is a list of the questions, comments and statements made by those attending the CA workshop on the 11th February 2020.

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Comment</th>
<th>Action / Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPRED</td>
<td>What was the target depth of trenching during installation?</td>
<td>At the time of installation, the target depth was 0.9 m</td>
</tr>
<tr>
<td>OPRED</td>
<td>Are there berms present along the edge of the trenches?</td>
<td>Berms are still present, but they are relatively small and pose no hazard to fishing</td>
</tr>
<tr>
<td>SFF</td>
<td>Statement: “The low number of crossings is not purely down to low fishing effort across the pipeline but might also be due to the presence of the pipeline itself deterring fishing in the area”</td>
<td>Statement by SFF.</td>
</tr>
<tr>
<td>OPRED</td>
<td>How is the subsea cutting going to be conducted? Will it utilise divers or diver-less methods?</td>
<td>Cutting will be diver-less using hydraulic shears.</td>
</tr>
<tr>
<td>HSE</td>
<td>Is there any history of span intervention along the pipeline?</td>
<td>No there is not, while a number of spans are over the threshold in length, the overall height of the spans above the trench (in which it sits) is not.</td>
</tr>
<tr>
<td>Organisation</td>
<td>Comment</td>
<td>Action / Response</td>
</tr>
<tr>
<td>--------------</td>
<td>---------</td>
<td>------------------</td>
</tr>
<tr>
<td>OPRED</td>
<td>Have other simultaneous decom operations (Brae A and adjacent fields) been considered as activities by other users of the sea?</td>
<td>This can be looked at in further detail.</td>
</tr>
<tr>
<td>OPRED</td>
<td>How many surveys (post decom) have been allowed for?</td>
<td>Three in total, one non-invasive post decommissioning survey, then two further surveys, one at 5 years and one at 10 years post decom.</td>
</tr>
<tr>
<td>JNCC</td>
<td>In the marine impacts criteria what is included within the number of days?</td>
<td>Only on-site durations, no mob/demob or transit time</td>
</tr>
<tr>
<td>Marine Scotland</td>
<td>Is rock placement included within the operational marine impact section?</td>
<td>No, the rock placement is captured within another section ‘2.4 Seabed Disturbance’.</td>
</tr>
<tr>
<td>OPRED</td>
<td>Do the emissions values capture the emissions generated by future monitoring work?</td>
<td>Yes, the emissions include the outlined 3 post decom surveys.</td>
</tr>
<tr>
<td>OPRED</td>
<td>Is it possible to separate between the execute stage fuel and the residual monitoring fuel use?</td>
<td>Yes, this can be done if required.</td>
</tr>
<tr>
<td>SFF</td>
<td>“If rock dumping is properly carried out then there should not be a residual safety issue, however, in SFF opinion the number of post decom surveys is a bit light especially if interaction between the rock placement and fishing equipment occur over a prolonged period of time after decommissioning has been undertaken. Consideration needs to be taken in planning future survey requirements”.</td>
<td>Better visualisation of where fishing activity occurs and where rock placement will be considered as part of the DP.</td>
</tr>
<tr>
<td>SFF</td>
<td>Does the outcome of the CA (emerging recommendation) match the proposed decommissioning strategy in Norwegian water?</td>
<td>Equinor - Yes it does. Option 4A is preferred option on the NCS.</td>
</tr>
</tbody>
</table>

After an initial run through the of the CA matrix any criteria that were marked for sensitivity checking were revisited, however, the running of sensitivities did not change the emerging recommendation of the CA workshop.

A brief discussion was held over whether to combine all the sensitivities however it was explained that sensitivities are run individually unless there is a good reason for combining them.
**APPENDIX C**  
**GROUP 1 –DETAILED SCREENING RESULTS**

<table>
<thead>
<tr>
<th>Re-use</th>
<th>Full Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Option 1 - Re-use</strong></td>
<td><strong>Option 2A - Cut and lift with Deburial</strong></td>
</tr>
<tr>
<td>- Line is in route for any potential new developments</td>
<td>- Deburial required (done by cutting into sections (assumed by hydraulic shears) and removed)</td>
</tr>
<tr>
<td></td>
<td>- Rigid pipeline, 8” diameter and 38 km in length (UK waters) Line is Bitumen Enamel (6.5mm) and Concrete (40mm) coated and is Trenched and/or Buried along the majority of its length.</td>
</tr>
<tr>
<td><strong>Technical/Challenges</strong></td>
<td>- More offshore operations and vessel operations compared to other full removal options.</td>
</tr>
<tr>
<td></td>
<td>- Deburial required</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td>- Technical showstopper</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Technical/Challenges</strong></td>
<td>- Technical showstopper</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Societal</strong></td>
<td>- Technical showstopper</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td>- Technical showstopper</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Economic</strong></td>
<td>- Technical showstopper</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Summary</strong></td>
<td>- Technical showstopper</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Option 1 has been assessed as being unattractive in all 5 criteria and therefore it is not considered further in the remaining criteria which makes it a technical showstopper. It is therefore removed from the list of potential full removal options and shall be carried forward for further assessment.*

*Although an integrity study is needed to inform and provide risk and prevention options on subsea and onshore cemented coating, the coating is unlikely to be present when installing the pipeline. Therefore this is a showstopper on both technical and safety grounds.*

*Although an integrity study is needed to inform and provide risk and prevention options on subsea and onshore cemented coating, it is unlikely to be present when installing the pipeline. Therefore this is a showstopper on both technical and safety grounds.*
Option 3A - Rock Placement over Entire Line
- Rock placement over full length of line to address areas of spans and exposures
- No recovery of line
- Rigid pipeline, 8" diameter and 38 km in length (UK waters)
- Line is Bitumen Enamel (6.5mm) and Concrete (40mm) coated and is Trenched and/or Buried along the majority of its length.

Option 3B - Re-trench & Bury Entire Line
- Re-trench and backfill full length of line to remove areas of spans and exposures
- Trenching by plough
- No recovery of line
- No introduction of new material
- Rigid pipeline, 8" diameter and 38 km in length (UK waters)
- Line is Bitumen Enamel (6.5mm) and Concrete (40mm) coated and is Trenched and/or Buried along the majority of its length.

Safety
- Although technically feasible, this option is considered an Environmental showstopper due to the large volume of rock that must be placed along the entire length (circa 38km) to an adequate depth of rock cover. The resulting biological impact and permanent changes in sediment type would be considered extensive and therefore will not be taken forward for further assessment as a viable decommissioning option.

Technical
- As installed status / evidence suggest that sections of the pipeline were not trenched initially due to seabed / sediment conditions. Video evidence suggests sections of shell deposits under stiff sediments which may cause problems in getting required depth of lowering.
- Would have to address existing areas of stabilisation material.
- May need areas of spot rock for problem areas.
- Overall, given the challenges associated with achieving depth of lowering over the entire pipeline length, considered a technical showstopper.

Societal
- Although technically feasible this option is considered an Environmental showstopper due to the large volume of rock required to bury the entire length of the pipeline within the MEC (circa 38km), and the resulting permanent biological impact and changes in sediment type which placement would cause.

Economic
- Overall, given the challenges associated with achieving depth of lowering over the entire pipeline length, considered a technical showstopper.
## Heimdal-Brae Alpha Gas Condensate Pipeline (PL301) Decommissioning
### Comparative Assessment

**Doc. No.** A-400300-S00-REPT-005  
**Valid from 31 March 2020**  
**Rev. no. R0**

### Table: Leave in-situ - Ongoing Monitoring

<table>
<thead>
<tr>
<th>Option A</th>
<th>Efficacy Areas of Span / Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spars</td>
<td>Minimal risk of subsea operations and minimal duration to reach operational areas of spans / exposure (shall be limited). No material required to isolate handling. However, risk exists of tower operation. No lift support required.</td>
</tr>
<tr>
<td>Spars</td>
<td>Risk associated with low risk of operational (shall be limited). No material required to isolate handling. However, risk exists of tower operation. No lift support required.</td>
</tr>
</tbody>
</table>

### Table: Leave in-situ - Minor Intervention

<table>
<thead>
<tr>
<th>Option B</th>
<th>Efficacy Areas of Span / Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spars</td>
<td>Minimal risk of subsea operations and minimal duration to reach operational areas of spans / exposure (shall be limited). No material required to isolate handling. However, risk exists of tower operation. No lift support required.</td>
</tr>
<tr>
<td>Spars</td>
<td>Risk associated with low risk of operational (shall be limited). No material required to isolate handling. However, risk exists of tower operation. No lift support required.</td>
</tr>
</tbody>
</table>

### Table: Leave in-situ - Ongoing Monitoring

<table>
<thead>
<tr>
<th>Option C</th>
<th>Efficacy Areas of Span / Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spars</td>
<td>Minimal risk of subsea operations and minimal duration to reach operational areas of spans / exposure (shall be limited). No material required to isolate handling. However, risk exists of tower operation. No lift support required.</td>
</tr>
<tr>
<td>Spars</td>
<td>Risk associated with low risk of operational (shall be limited). No material required to isolate handling. However, risk exists of tower operation. No lift support required.</td>
</tr>
</tbody>
</table>

---

**Classification:** Internal  
**Status:** For Review  
[www.equinor.com]
Appendix D.1 Group 1 Attributes Table

Heimdal to Brae Condensate Pipeline (PL301)

<table>
<thead>
<tr>
<th>Option</th>
<th>Classification</th>
<th>Description</th>
<th>Survey Vessel</th>
<th>CSV</th>
<th>Rockdump Vessel</th>
<th>Survey Days</th>
<th>CSV</th>
<th>Rockdump Days</th>
<th>Total offshore hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>O4A</td>
<td>Leave (Minor)</td>
<td>Rock Placement over Spans / Exposures</td>
<td>Survey Vessel: 11.2</td>
<td>4.6</td>
<td>Rockdump Vessel: 22.3</td>
<td>Total offshore days: 450.1</td>
<td>22.3</td>
<td>38.1</td>
<td>Total offshore hours: 102.4</td>
</tr>
<tr>
<td>O2A</td>
<td>Full Removal - Cut &amp; Lift with Deburial</td>
<td>Line is 8&quot; internal diameter</td>
<td>Survey Vessel: 11.2</td>
<td>4.6</td>
<td>Rockdump Vessel: 22.3</td>
<td>Total offshore days: 450.1</td>
<td>22.3</td>
<td>38.1</td>
<td>Total offshore hours: 102.4</td>
</tr>
<tr>
<td>O4C</td>
<td>Leave (Minor)</td>
<td>Remove Spans / Exposures</td>
<td>Survey Vessel: 11.2</td>
<td>4.6</td>
<td>Rockdump Vessel: 22.3</td>
<td>Total offshore days: 450.1</td>
<td>22.3</td>
<td>38.1</td>
<td>Total offshore hours: 102.4</td>
</tr>
</tbody>
</table>

Summary:
- Option 4A is assessed as being Stronger than Option 4C due to the higher number of lifting operations to recover the sections of pipeline and equipment in Option 4C.
- Option 2A is assessed as being Weaker than Option 4C due to the higher number of lifting operations to recover the sections of pipeline and equipment in Option 4C.
- Option 2A is assessed as being Much Weaker than Option 4A due to the significantly higher number of lifting operations required to recover the sections of pipeline (in baskets) and the deployment and recovery of other equipment in Option 2A.
- Overall, Option 4A is preferred from a risk to Other Users perspective.

Resource Type: Days / Hours / PLL

Total offshore hours: 15,409 hrs

Survey Vessel: 44 / 11.2 / 5,898 / 4.42E-04

Rockdump Vessel: 20 / 22.3 / 5,362 / 4.01E-04

CSV: 4.6 / 22.3 / 4,150 / 3.11E-04

Vessel Type: PoB / Days / Hours / PLL

Option 4A is assessed as being Stronger than Option 4C as the legacy risk presented by these two options is expected to be similar.

Option 2A is assessed as being Stronger than Option 4A and Option 4C as, while the lines remain in-situ in the other options, they are likely buried / covered and any potential snag risk is managed by the survey and monitoring programmes.

Overall, Option 4A is preferred from a risk to Operations Personnel perspective.
### Environmental Summary

The Environmental Summary provides an overview of the environmental impacts associated with each option. The analysis includes operational marine impacts, legacy impacts, and other environmental considerations.

#### Operational Marine Impacts

- **Option 2A**: Much Stronger than Option 4A and Option 4C. The emissions and fuel use are around 20 times higher. Option 2A is assessed as being Much Weaker than Option 4A and Option 4C due to the large area of seabed disturbed using MFE to debury the line and the significant water quality impact from fluidisation and light particle movement of the sediments during the MFE operations.

- **Option 4A**: Preferred from an Operational Marine Impact perspective. Option 4A is assessed as being Neutral to Option 4C as the environmental impact of the releases, noise and vessels is largely similar.

#### Legacy Marine Impacts

- **Option 2A**: Much Stronger than Option 4A and Option 4C as the emissions and fuel use are around four times higher. Option 2A is assessed as being Much Weaker than Option 4A and Option 4C due to the large area of seabed disturbed using MFE to debury the line and the significant water quality impact from fluidisation and light particle movement of the sediments during the MFE operations.

- **Option 4A**: Preferred from a Legacy Marine Impacts perspective. Option 4A is assessed as being Neutral to Option 4C as the legacy marine impact from the slow release of the residual contents of these lines is expected to be low overall. It is noted that there is a limited coating on the line which will remain in situ and there is the potential for degradation products from the material left in situ.

#### Other

- **Option 4A**: Stronger than Option 4C as while there is a larger area of impact from the rock cover resulting in permanent change to the habitat in Option 4A, the increase over Option 4C was considered insufficient to express a preference.

### Comparative Assessment

- **Option 2A**: Preferred from a Legacy Marine Impacts perspective. This is driven by duration of vessel operations and therefore at around 75 days it is the highest of all options. The environmental impact is considered to be negligible.

- **Option 4A**: Preferred from a Legacy Marine Impacts perspective. This option is likely to have the highest volume of discharge to sea during the cut and lift operation. There will be a limited release of residual contents to the sea during the cut and removal of the line end at Brae. These releases will be limited in volume and will be the lowest of all options and will have a minimal environmental impact.

### Atmospheric Emissions & Consumptions

- **Option 2A**: Much Weaker than Option 4A and Option 4C as while the emissions associated with processing recovered material / replacing left in-situ material are largely similar, there is no requirement for rock in Option 2A.

- **Option 4A**: Preferred from an Atmospheric Emissions & Consumptions perspective. Option 4A is assessed as being Stronger than Option 4C as the emissions and fuel use are around 20 times higher. Option 4A is assessed as being Neutral to Option 4C as while there is a larger area of impact from the rock cover resulting in permanent change to the habitat in Option 4A, the increase over Option 4C was considered insufficient to express a preference.

### Operation Discharges

- **Option 2A**: Preferred from a Legally Marine Impacts perspective. This includes Ballast, Grey and Black Water, this is driven by duration of vessel operations and therefore at around 75 days it is the highest of all options. The environmental impact is considered to be negligible.

### Notes and Considerations

- **Overall**: Option 2A is preferred from an Operational Marine Impact perspective. This is driven by duration of vessel operations and therefore at around 75 days it is the highest of all options. The environmental impact is considered to be negligible.

- **Overall**: Option 4A is preferred from a Legacy Marine Impacts perspective. This option is likely to have the highest volume of discharge to sea during the cut and lift operation. There will be a limited release of residual contents to the sea during the cut and removal of the line end at Brae. These releases will be limited in volume and will be the lowest of all options and will have a minimal environmental impact.

### Additional Details

- **Option 2A**: Preferred from a Legacy Marine Impacts perspective. This option includes Ballast, Grey and Black Water, this is driven by duration of vessel operations and therefore at around 75 days it is the highest of all options. The environmental impact is considered to be negligible.

- **Option 4A**: Preferred from a Legacy Marine Impacts perspective. This option includes Ballast, Grey and Black Water, this is driven by duration of vessel operations and therefore at around 75 days it is the highest of all options. The environmental impact is considered to be negligible.
### 3. Technical

#### 3.1 Technical Risk

**Concept Maturity:** The concept is well proven. (Score 3)

**Technical Risks:** Limited technical risks associated with option. (Score 3)

#### Summary

The assessment of the Technical Risk sub-criterion is as follows:
- Option 2A is assessed as being Weaker than Option 4A and Option 4C as while the operations are considered routine, the technical challenges associated with deburial and cutting of the 38 km line into short sections carries with it a higher risk of technical failures than the other options.
- Option 4A is assessed as being Neutral to Option 4C as they are largely routine operations.
- Overall, Option 4A and Option 4C are equally preferred from a Technical Risk perspective.

### 4. Societal

#### 4.1 Fishing

**Short operation, small area of disturbance.** (Score 3)

**Materials Returned:**
- Steel: 68 tonnes (recyclable)
- Concrete: 108 tonnes (landfill)
- Bitumen: 6 tonnes (landfill)

#### Summary

The assessment of the Societal impact on Fishing sub-criterion is as follows:
- Option 2A is assessed as being Much Stronger than Option 4A and Option 4C due to the full removal of the lines being more attractive than the addition of rock berms in the other options.
- Option 4A is assessed as being Neutral to Option 4C as the as left status of the lines from a fishing perspective are similar.
- Overall, Option 2A is preferred from a Societal impact on Fishing perspective.

#### 4.2 Other Users

**Minimal societal benefits / impacts with this option.** (Score 3)

**Materials Returned:**
- Steel: 2 tonnes (recyclable)
- Concrete: 2 tonnes (landfill)
- Bitumen: 1 tonnes (landfill)

#### Summary

The assessment of the Societal impact on Other Users sub-criterion is as follows:
- Option 2A is assessed as being Weaker than Option 4A and Option 4C as, while additional useful material (steel) is returned, a significant quantity of the returned material (concrete / bitumen) would use up limited landfill capacity.
- Option 4A is assessed as being Neutral to Option 4C as, while there is more material returned and routed to landfill in Option 4C, this difference was considered insufficient to express a preference.
- Overall, Option 4A and Option 4C are equally preferred from a Societal impact on Other Users perspective.

### 5. Economic

#### 5.1 Short-term Costs

**£9.774 Million**

#### Summary

The assessment of the Societal impact on Fishing sub-criterion is as follows:
- Option 2A is assessed as being Very Much Weaker than Option 4A as the costs are around 20 times higher (52.5 million more).
- Option 2A is assessed as being Much Weaker than Option 4C as the costs are around 5.5 times higher (45.5 million more).
- Option 4A is assessed as being Stronger than Option 4C as the costs around a less than a third (7 million less).
- Overall, Option 4A is preferred from a Short-term Cost perspective.

#### 5.2 Long-term Costs

**Surveys: £0.337 Million**

**FLTC: N/A**

**Total Legacy Cost: £0.337 Million**

#### Summary

The assessment of the Long-term Costs sub-criterion is as follows:
- Option 2A is assessed as being Very Much Weaker than Option 4A as the costs are around 20 times higher ($2.688 Million more).
- Option 4A is assessed as being Much Weaker than Option 4C as the costs are around 5.5 times higher ($0.744 Million more).
- Option 4A is assessed as being Stronger than Option 4A as the costs around a less than a third (7 million less).
- Overall, Option 4A is preferred from a Long-term Cost perspective.
## Appendix D.2 Group 1 Pairwise Comparison Matrices - Safety

### 1.1 Operations Personnel

<table>
<thead>
<tr>
<th></th>
<th>O2A - Full Removal - Cut and Lift with Deburial</th>
<th>O4A - Leave (Minor) - Rock Placement over Spans / Exposures</th>
<th>O4C - Leave (Minor) - Remove Spans / Exposures</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>O2A - Full Removal - Cut and Lift with Deburial</td>
<td>N</td>
<td>VMW</td>
<td>W</td>
<td>11.0%</td>
</tr>
<tr>
<td>O4A - Leave (Minor) - Rock Placement over Spans / Exposures</td>
<td>VMS</td>
<td>N</td>
<td>S</td>
<td>62.6%</td>
</tr>
<tr>
<td>O4C - Leave (Minor) - Remove Spans / Exposures</td>
<td>S</td>
<td>W</td>
<td>N</td>
<td>26.3%</td>
</tr>
</tbody>
</table>

### 1.2 Other Users

<table>
<thead>
<tr>
<th></th>
<th>O2A - Full Removal - Cut and Lift with Deburial</th>
<th>O4A - Leave (Minor) - Rock Placement over Spans / Exposures</th>
<th>O4C - Leave (Minor) - Remove Spans / Exposures</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>O2A - Full Removal - Cut and Lift with Deburial</td>
<td>N</td>
<td>W</td>
<td>W</td>
<td>25.0%</td>
</tr>
<tr>
<td>O4A - Leave (Minor) - Rock Placement over Spans / Exposures</td>
<td>S</td>
<td>N</td>
<td>N</td>
<td>37.5%</td>
</tr>
<tr>
<td>O4C - Leave (Minor) - Remove Spans / Exposures</td>
<td>S</td>
<td>N</td>
<td>N</td>
<td>37.5%</td>
</tr>
</tbody>
</table>

### 1.3 High Consequence Events

<table>
<thead>
<tr>
<th></th>
<th>O2A - Full Removal - Cut and Lift with Deburial</th>
<th>O4A - Leave (Minor) - Rock Placement over Spans / Exposures</th>
<th>O4C - Leave (Minor) - Remove Spans / Exposures</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>O2A - Full Removal - Cut and Lift with Deburial</td>
<td>N</td>
<td>MW</td>
<td>W</td>
<td>18.6%</td>
</tr>
<tr>
<td>O4A - Leave (Minor) - Rock Placement over Spans / Exposures</td>
<td>MS</td>
<td>N</td>
<td>S</td>
<td>50.7%</td>
</tr>
<tr>
<td>O4C - Leave (Minor) - Remove Spans / Exposures</td>
<td>S</td>
<td>W</td>
<td>N</td>
<td>30.7%</td>
</tr>
</tbody>
</table>

### 1.4 Legacy Risk

<table>
<thead>
<tr>
<th></th>
<th>O2A - Full Removal - Cut and Lift with Deburial</th>
<th>O4A - Leave (Minor) - Rock Placement over Spans / Exposures</th>
<th>O4C - Leave (Minor) - Remove Spans / Exposures</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>O2A - Full Removal - Cut and Lift with Deburial</td>
<td>N</td>
<td>S</td>
<td>S</td>
<td>42.9%</td>
</tr>
<tr>
<td>O4A - Leave (Minor) - Rock Placement over Spans / Exposures</td>
<td>W</td>
<td>N</td>
<td>N</td>
<td>28.6%</td>
</tr>
<tr>
<td>O4C - Leave (Minor) - Remove Spans / Exposures</td>
<td>W</td>
<td>N</td>
<td>N</td>
<td>28.6%</td>
</tr>
</tbody>
</table>
### Appendix D.3  Group 1 Pairwise Comparison Matrices - Environment

#### 2.1 Operational Marine Impact

<table>
<thead>
<tr>
<th></th>
<th>O2A - Full Removal - Cut and Lift with Deburial</th>
<th>O2A - Leave (Minor) - Rock Placement over Spans / Exposures</th>
<th>O4C - Leave (Minor) - Remove Spans / Exposures</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>MS</td>
<td>MS</td>
<td>14.3%</td>
</tr>
<tr>
<td>O2A - Full Removal</td>
<td></td>
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</tr>
<tr>
<td>Cut and Lift with</td>
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<tr>
<td>Deburial</td>
<td></td>
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<td>Spans / Exposures</td>
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<td>O4C - Leave (Minor)</td>
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#### 2.2 Atmospheric Emissions & Fuel Consumption

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<th>O4C - Leave (Minor) - Remove Spans / Exposures</th>
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#### 2.3 Other Consumptions

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#### 2.4 Seabed Disturbance

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<th>O2A - Leave (Minor) - Rock Placement over Spans / Exposures</th>
<th>O4C - Leave (Minor) - Remove Spans / Exposures</th>
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<td>Spans / Exposures</td>
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</tr>
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#### 2.5 Legacy Marine Impacts

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<th>O2A - Leave (Minor) - Rock Placement over Spans / Exposures</th>
<th>O4C - Leave (Minor) - Remove Spans / Exposures</th>
<th>Weighting</th>
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<td>Cut and Lift with</td>
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<td>MW</td>
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<td>N</td>
<td>20.0%</td>
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<tr>
<td>Rock Placement over</td>
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<tr>
<td>Spans / Exposures</td>
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</tr>
<tr>
<td>O4C - Leave (Minor)</td>
<td>MW</td>
<td>N</td>
<td>N</td>
<td>20.0%</td>
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<tr>
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### Appendix D.4 Group 1 Pairwise Comparison Matrices – Technical

#### 3.1 Technical Risk

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<th>O4C - Leave (Minor) - Remove Spans / Exposures</th>
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</thead>
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<td>S N N</td>
<td>S N N</td>
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<tr>
<td>Weight</td>
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<td>37.5%</td>
<td>37.5%</td>
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### Appendix D.5 Group 1 Pairwise Comparison Matrices – Societal

#### 4.1 Fishing

<table>
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<tr>
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<th>O4A - Leave (Minor) - Rock Placement over Spans / Exposures</th>
<th>O4C - Leave (Minor) - Remove Spans / Exposures</th>
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<tbody>
<tr>
<td>Weighting</td>
<td>N MS MS</td>
<td>MW N</td>
<td>MW N</td>
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<td>20.0%</td>
<td>20.0%</td>
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#### 4.2 Other Users

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<th>O4A - Leave (Minor) - Rock Placement over Spans / Exposures</th>
<th>O4C - Leave (Minor) - Remove Spans / Exposures</th>
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</thead>
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<tr>
<td>Weighting</td>
<td>N W W</td>
<td>S N N</td>
<td>S N N</td>
</tr>
<tr>
<td>Weight</td>
<td>25.0%</td>
<td>37.5%</td>
<td>37.5%</td>
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### Appendix D.6 Group 1 Pairwise Comparison Matrices - Economic

#### 5.1 Short-term Costs

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<tr>
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<th>O4A - Leave (Minor) - Rock Placement over Spans / Exposures</th>
<th>O4C - Leave (Minor) - Remove Spans / Exposures</th>
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</thead>
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<tr>
<td>Weighting</td>
<td>N VMW MW</td>
<td>VMS</td>
<td>MS W</td>
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<tr>
<td>Weight</td>
<td>8.4%</td>
<td>59.9%</td>
<td>31.7%</td>
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</table>

#### 5.2 Long-term Costs

<table>
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<tr>
<th></th>
<th>O2A - Full Removal - Cut and Lift with Deburial</th>
<th>O4A - Leave (Minor) - Rock Placement over Spans / Exposures</th>
<th>O4C - Leave (Minor) - Remove Spans / Exposures</th>
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</thead>
<tbody>
<tr>
<td>Weighting</td>
<td>N S S</td>
<td>W N</td>
<td>W N N</td>
</tr>
<tr>
<td>Weight</td>
<td>42.9%</td>
<td>28.6%</td>
<td>28.6%</td>
</tr>
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</table>
Appendix D.7  Group 1 Results Charts

Heimdal to Brae Condensate Pipeline (PL301)

- 30.2% 38.4% 31.5%
- 6.0% 7.5% 7.5%
- 2.9% 2.0% 2.0%
- 0.8% 0.8% 2.9%
- 2.5% 7.5% 7.5%
- 3.3% 9.4% 9.4%
- 4.3% 8.3% 9.4%
- 2.1% 1.9% 1.9%
- 0.7% 3.1% 3.1%
- 0.2% 2.4% 2.4%
- 2.1% 1.4% 1.4%
- 0.2% 1.2% 1.2%
- 0.5% 1.7% 1.7%
- 4.3% 2.9% 2.9%
- 2.3% 0.8% 0.8%
- 4.3% 0.8% 0.8%
- 6.0% 5.8% 5.8%
- 7.5% 7.5% 7.5%
- 6.0% 6.0% 6.0%
- 6.2% 6.2% 6.2%

O2A - Full Removal - Cut and Lift with Deburial
O4A - Leave (Minor) - Rock Placement over Spans / Exposures
O4C - Leave (Minor) - Remove Spans / Exposures

Heimdal to Brae Condensate Pipeline (PL301)


30.2% 38.4% 31.5%
5.1% 5.8% 6.0%
8.5% 7.5% 5.8%
5.0% 7.3% 7.5%
6.7% 9.0% 6.0%
4.9% 6.2% 6.2%

O2A - Full Removal - Cut and Lift with Deburial
O4A - Leave (Minor) - Rock Placement over Spans / Exposures
O4C - Leave (Minor) - Remove Spans / Exposures

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## APPENDIX E  PL301 EXPOSURES

### Appendix E.1 Summary of past pipeline survey data, between 2009 and 2017, along PL301

<table>
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<th>Item</th>
<th>2009</th>
<th>2013</th>
<th>2017</th>
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</thead>
<tbody>
<tr>
<td>Length of buried pipe (within EA scope) (m)</td>
<td>36322</td>
<td>35305</td>
<td>35807</td>
</tr>
<tr>
<td>% Coverage</td>
<td>95%</td>
<td>92%</td>
<td>94%</td>
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<tr>
<td>Number of freespans (within EA scope)*</td>
<td>1</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Length of freespans (m) (within EA scope)*</td>
<td>6</td>
<td>34</td>
<td>28</td>
</tr>
<tr>
<td>Average Depth of Cover (m) (within EA scope)</td>
<td>-</td>
<td>0.21</td>
<td>0.19</td>
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</table>

*All spans within the scope of this DP are less than 0.8m in height or 10m in length and as such are non-reportable.
### Appendix E.2 Summary of exposures and freespans along PL301 (Deepocean, 2017)

<table>
<thead>
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<th>Exposure/Freespan</th>
<th>Number</th>
<th>Total Length (m)</th>
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<tr>
<td>Exposures &lt; 5 m</td>
<td>67</td>
<td>175</td>
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<tr>
<td>Exposures 5-20 m</td>
<td>54</td>
<td>492</td>
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<tr>
<td>Exposures &gt;20 m</td>
<td>13</td>
<td>678</td>
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<tr>
<td>Freespans</td>
<td>3</td>
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### Appendix E.3 Location, length and depth of exposures along PL301 (Deepocean, 2017)

<table>
<thead>
<tr>
<th>KP Point Start</th>
<th>KP Point End</th>
<th>Distance (km)</th>
<th>Depth to Top of Pipe (ToP) (m)</th>
<th>Depth of Adjacent Mean Seabed (m)</th>
<th>Depth of Trench (m)</th>
<th>Depth of Cover (DoC) (m)</th>
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<tbody>
<tr>
<td>78.148</td>
<td>78.153</td>
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<td>121.42</td>
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Classification: Internal
Status: For Review
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