Putting Sediment Impacts in to Context
Using New Approaches to Comparative Assessment in Oil and Gas Decommissioning

Potential decommissioning options
A range of decommissioning options have been evaluated in CAs undertaken by Ramboll Environ. Options are defined by specialist O&M engineers and determine the technical feasibility of each option, the safety of vessels, crew and divers during decommissioning, materials needed and disposal considerations.

The options vary depending on the type of infrastructure and may include:
- Leave the drill cuttings pile, structure or pipelines in situ.
- Leave linear features in situ, but cut and tie off ends.
- Leave infrastructure in situ and cover (eg rock dumping).
- Partial removal of infrastructure (eg remove uppermost structure whilst retaining footings and structure extending to 25m above sea bed).
- Partial removal of pipelines where these are >50% exposed above seabed.
- Full removal of infrastructure.

THE APPROACH
Ramboll Environ evaluated a range of offshore installations at sea, requiring full removal of structures and potential sediment contamination associated with drill cuttings and operation.

There is, however, the potential for derogation for complex structures.

The fields are offshore and often at depths of approximately 100m with ecological communities and productive fisheries established over decades.

There is growing evidence that the full removal of subsea infrastructure may not be the best option. For example, decommissioning programmes that exist in other regions include the USA rgs-to-reefs programme where the purposeful sinking of O&M structures form artificial reefs to provide marine habitat and boost regional biodiversity.

Comparative Assessment (CA)
Comparative Assessment (CA) is a process that weighs up the pros and cons of various decommissioning options against key criteria (Table 1). The process is described in Oil & Gas UK Guidelines for CA in Decommissioning Programmes (2011).

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<th>Mass criterion</th>
<th>Sub-criteria (matrices to be considered)</th>
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<tr>
<td>Safety</td>
<td>Risk to personnel</td>
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<td>Risk to other users of the sea</td>
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<td>Risk to those on land</td>
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<td>Environmental</td>
<td>Marine impacts</td>
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<td>Other environmental impacts (including emissions to the atmosphere)</td>
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<td>Other environmental consequences (including corrosive effects)</td>
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<td>Technical</td>
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<td>Social</td>
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<td>Amenities</td>
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<td>Conservation</td>
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<td>Economic</td>
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Table 1: The criteria used in comparative assessment.

Impact pathways
Potential impacts associated with decommissioning are categorized into the following impact pathways, primarily to sediments:
- Oil well cutting piles produced during installation drilling (these may be thousands of cubic meters).
- Gas well cutting pile (considerably smaller and may have been completely dispersed).
- Relict zinc anodes and brackets on pipelines and structures to prevent corrosion.
- Blumen joints between manufactured sections of pipelines used as a seal during installation.
- Potential physical impact pathways associated with sediment dispersion may include:
  - Mass flow erosion techniques for exposing buried pipelines and footings.
  - Rock dumping into excavations.
  - Direct removal of infrastructure.
  - Rock dumping of structures or pipelines.
  - Disturbance of sediments or rock cover.

Valuation of habitat services for CA
Biodiversity and habitats are at the heart of many ecosystem services, such as fisheries, genetic resources and waste detoxification. In these CAs emphasis is placed on the valuation of habitat services. A new innovative method was adopted by Ramboll Environ based on Bas et al. (2016). The approach provides a valuation of the whole of the marine ecosystem in order to put potential sediment impacts into a wider context.

The Bas et al. (2016) method is a two step approach combining a scoring system and habitat equivalency analysis (HEA).

Step 1: Scoring calculates the severity of the impact, as follows:
1. Identify site-specific indicators covering:
   - Physico-chemical, eg sediment quality.
   - Biological structure, eg benthic habitats, key species.
   - Ecological functionality, eg nursery and spawning grounds.
2. Calculate an environmental state index for each indicator which provides a measure of value, such as rarity, potential for recovery and abundance.
3. Rate each indicator at a series of time points, such as baseline, immediately post-decommissioning and following long-term recovery.

Step 2: Habitat equivalency analysis values changes to habitat services in service hectares, as follows:
- Environmental economics tool based on damage assessment methodology (eg VOCA, 1997, Galia, 2008B).
- Accounts for scale (area impacted).
- Duration of environmental recovery (eg 15 years).

Information sources
The assessments rely on a range of information sources including:
- Regulatory, conservation agency and fisheries maps and databases.
- Published scientific literature.
- Client’s documentation, such as environmental impact assessments, monitoring, maintenance, operational reports and remotely operated vehicle footage (Figures 3 and 4).

RESULTS
The value of changes to ecosystem services may be reported quantitatively or qualitatively. The focus is on habitat services and potential impacts associated with each decommissioning option. Results in Figure 5 and Figure 6 show where the pipelaying option has the greatest impact to habitat services, corresponding to the environmental criterion in the CA. This option with the lowest predicted impact on habitat services is to leave the pipeline in situ and cut the ends.

CONCLUSIONS
The use of ecosystem services approaches to value the environment allow for the potential impact or benefit to be measured and compared spatially and to take account of changes (e.g. recovery) over time.

The new method provides a holistic assessment of the ecological functioning of the marine ecosystem as a whole and places potential impacts on marine sediments in it to a wider environmental context, and the ecological, safety and technical feasibility contexts. Key findings from CA undertaken so far include:
- Our methods allow for a greater use of professional judgment, while accounting for a broader set of indicators that can be used when valuing environmental damage (impacts).
- Surface contamination associated with drill cuttings piles has been leached or degraded over time. Residual contamination is buried deep within piles, with low potential for bioaccessibility and availability while undisturbed.
- Decommissioning options vary in their disturbance potential and different effects on marine organisms.
- Variation across the ecosystem can be captured by using a range of relevant indicators to give context. Costs and benefits of decommissioning options vary with infrastructure – it is not a ‘one size fits all’ management decision.

REFERENCES
References are available on a separate sheet.

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