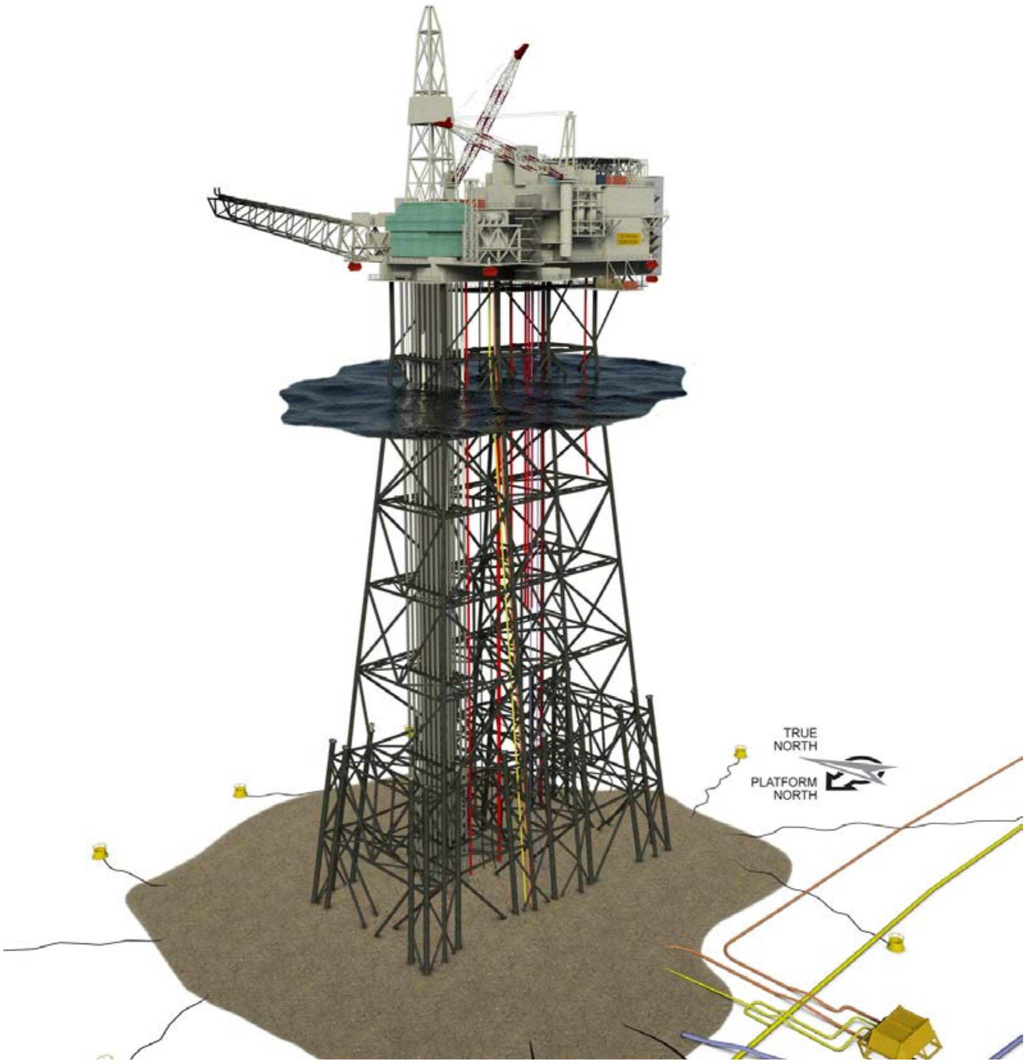
CNR International




# NINIAN NORTHERN PLATFORM DECOMMISSIONING

## Report – Jacket & Drill Cuttings Pile Comparative Assessment & Appendices

**P0005-BMT-PM-REP-00001-Stakeholder Version**

**February 2017**

| Date | Issue Description | Rev | By | Chk | App |
|---|---|---|---|---|---|
| 08-11-16 | Preliminary draft | A1 | | | |
| 29-11-16 | Issued as pre-read for stakeholder review | B1 | | | |
| 28-02-17 | Issued for public consultation | B2 | | | |
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## ABBREVIATIONS, ACRONYMS AND UNITS

| Abbreviation/Glossary | Meaning |
|---|---|
| BEIS | Department for Business, Energy and Industry Strategy |
| BTA | Buoyancy Tank Assemblies |
| CA | Comparative Assessment |
| CAPEX | Capital Expenditure |
| CCS | Carbon Capture and Storage |
| CNRI | CNR International (U.K.) Limited |
| $CO_2$ | Carbon Dioxide |
| COP | Cessation of Production |
| CRI | Cuttings Re-Injection |
| CSV | Construction Support Vessel |
| DECC | Department of Energy and Climate Change |
| DP | Decommissioning Programme |
| EIA | Environmental Impact Assessment |
| ERRV | Emergency Response and Rescue Vessel |
| GJ | Gigajoules |
| HAZID | Hazard Identification |
| HLV | Heavy Lift Vessel |
| IoP | Institute of Petroleum |
| IRC | Independent Review Consultant |
| JNCC | Joint Nature Conservation Committee |
| km | kilometre |
| KIS-ORCA | Kingfisher Information Service – Offshore Renewable and Cable Awareness |
| m | metres |
| NCMPA | Nature Conservation Marine protected Area |
| NNP | Ninian Northern Platform |
| NPV | Net Present Value |
| OIM | Offshore Installation Manager |
| OSPAR | Oslo/ Paris Convention (for the Protection of the Marine Environment of the North-East Atlantic) |
| pSAC | Possible Special Area of Conservation |
| PLL | Potential Loss of Life |
| QRAs | Quantitative Risk Assessments |
| ROV | Remotely Operated Vehicle |
| SAC | Special Area of Conservation |
| SCI | Site of Community Importance |
| SFF | Scottish Fisherman's Federation |
| SHE | Safety, Health and Environment |
| SPA | Special Protected Areas |

| Abbreviation/Glossary | |
|---|---|
| Te | tonnes |
| UKDMAP | United Kingdom Digital Marine Atlas |
| VMS | Vessel Monitoring System |

## Non-Technical Summary

CNR International (U.K.) Ltd. (CNRI) undertook a Comparative Assessment of the decommissioning options for the Ninian Northern Platform (NNP) and associated drill cuttings pile. The facilities covered by this Comparative Assessment include:

- The Ninian Northern Platform (including the jacket and footings only); and
- The Ninian Northern drill cuttings pile.

The assessment identified no conservation areas within 50 km of the NNP. The closest site is the Pobie Bank Reef which is a Site of Community Importance which is located 73 km southwest of the platform.

As part of the Comparative Assessment process, CNRI undertook a two-day workshop to assess the technical feasibility of potential jacket and drill cuttings pile decommissioning options and evaluate the environmental and societal impacts from the activities/ operations of the options considered.

The Comparative Assessment provided a framework for assessing the proposed decommissioning options and assigning scores to five main criteria, further divided into the following ten sub-criteria:

1. Safety
    - Quantitative assessment of safety impacts for jacket decommissioning options
    - Qualitative assessment of safety impacts for drill cuttings pile decommissioning options
2. Environmental
    - Qualitative assessment of environmental risk
    - Quantitative assessment of energy use
    - Quantitative assessment of emissions
3. Technical Feasibility
    - Qualitative assessment of Technical Feasibility
    - Qualitative assessment of Ease of Recovery from Excursion
    - Qualitative assessment of Use of Proven Technology and Equipment
4. Societal Impact
    - Qualitative and Quantitative assessments of Commercial and socio-economic impacts
5. Economic
    - Quantitative assessment of CAPEX, ongoing monitoring and liability

All options were assessed from a post-mitigation position, where suitable mitigation measures have been implemented where possible.

The assessment scores were then weighted to allow direct comparisons between the criteria for each decommissioning option. This enabled a balanced and transparent comparison in order to

identify a recommended method for decommissioning the Ninian Northern platform jacket and the associated drill cuttings pile.

The decommissioning options selected were developed from technical studies undertaken specifically for NNP. Two options for jacket decommissioning and five options for the drill cuttings removal were selected for further assessment through the Comparative Assessment process, these included:

Jacket Decommissioning

- Full removal with multiple lifts
- Partial removal with multiple lifts

Drill Cuttings Pile Decommissioning

- Option 1 – recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore
- Option 2 – recover to surface, slurry to shore
- Option 3 – recover to surface, offshore re-injection
- Option 4 – redistribution of drill cuttings on the seabed
- Option 5 - leave in situ

The Comparative Assessment recommends that the jacket decommissioning is undertaken using **Partial Removal with Multiple Lifts**. This option would result in reduced risk to project personnel offshore, reduced commercial and socioeconomic impacts and a lesser economic impact in comparison to the full removal of the jacket in multiple lifts.

The recommended option for decommissioning the cuttings pile was the **Leave in situ** approach. The drivers for this recommendation are based on the technical challenges associated with the other management options for the cuttings pile. This includes the issues with fluidisation and mobilisation of drill cutting material and the lack of proven technology to recover the material.

Combined, these two options provide the recommended approach when considering the overall interaction between the activities related with the decommissioning of the jacket and cuttings piles. The remaining footings will provide an element of protection to the core of the cuttings pile until this can degrade naturally over time. The decommissioning activities involved in partially removing the jacket will have the least direct impact on the cuttings pile and minimise disturbance of this material.

# 1.0 INTRODUCTION

This report describes the Comparative Assessment (CA) of decommissioning options for the Ninian Northern Platform (NNP) jacket and drill cuttings pile, which CNRI intend to decommission. The topsides and pipelines are excluded from this assessment, on the basis that the topsides will be fully removed and the pipelines will be assessed as part of the wider Ninian Field Decommissioning Programme. Figure 1.1 illustrates the location of the Ninian field and Ninian Northern Platform.

The CA has been undertaken in line with Department of Energy and Climate Change (DECC) (now known as the Department for Business, Energy and Industrial Strategy (BEIS)) 'Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998' (DECC, 2011). For the purposes of the assessment all impacts have been assessed post-mitigation.

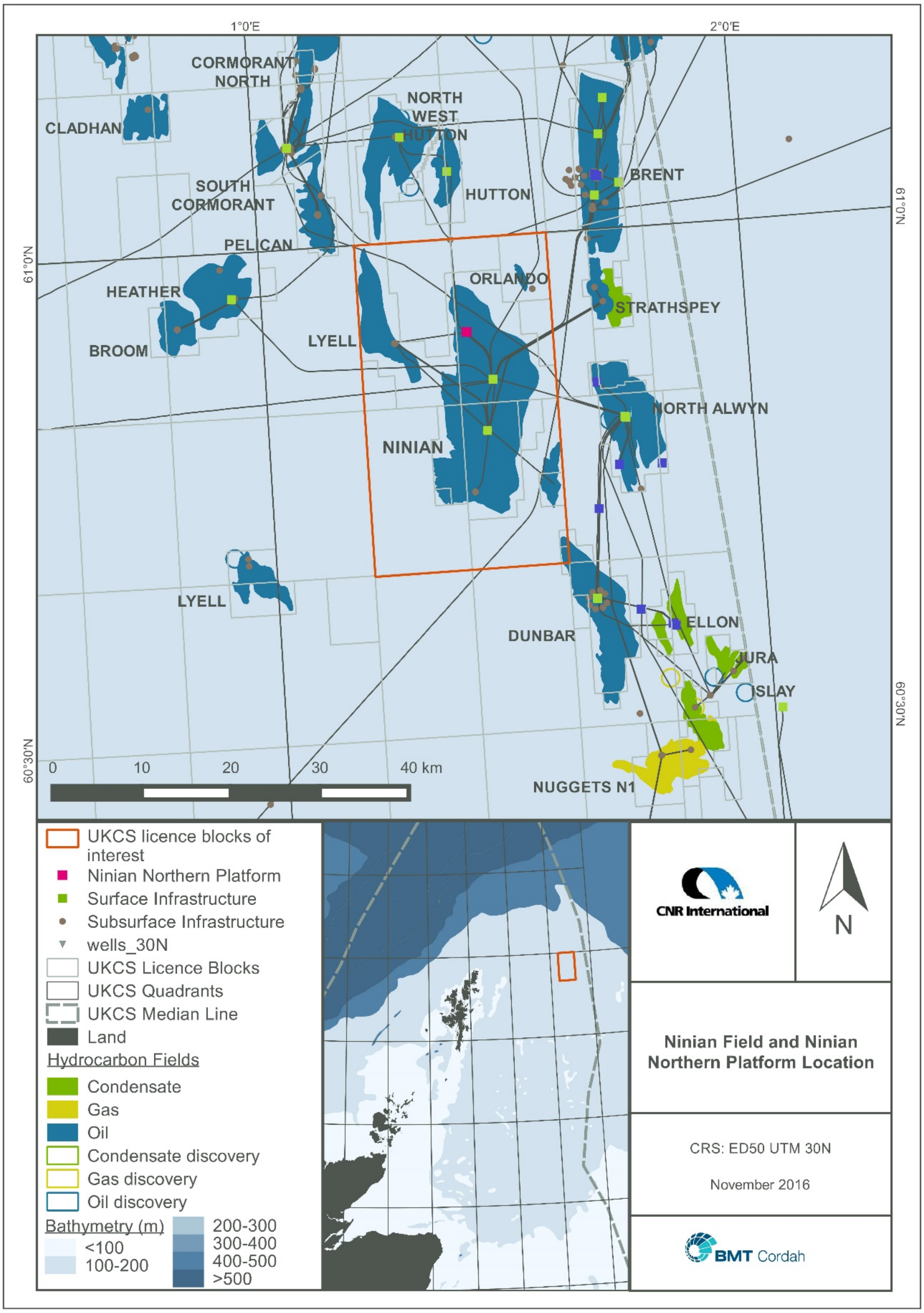
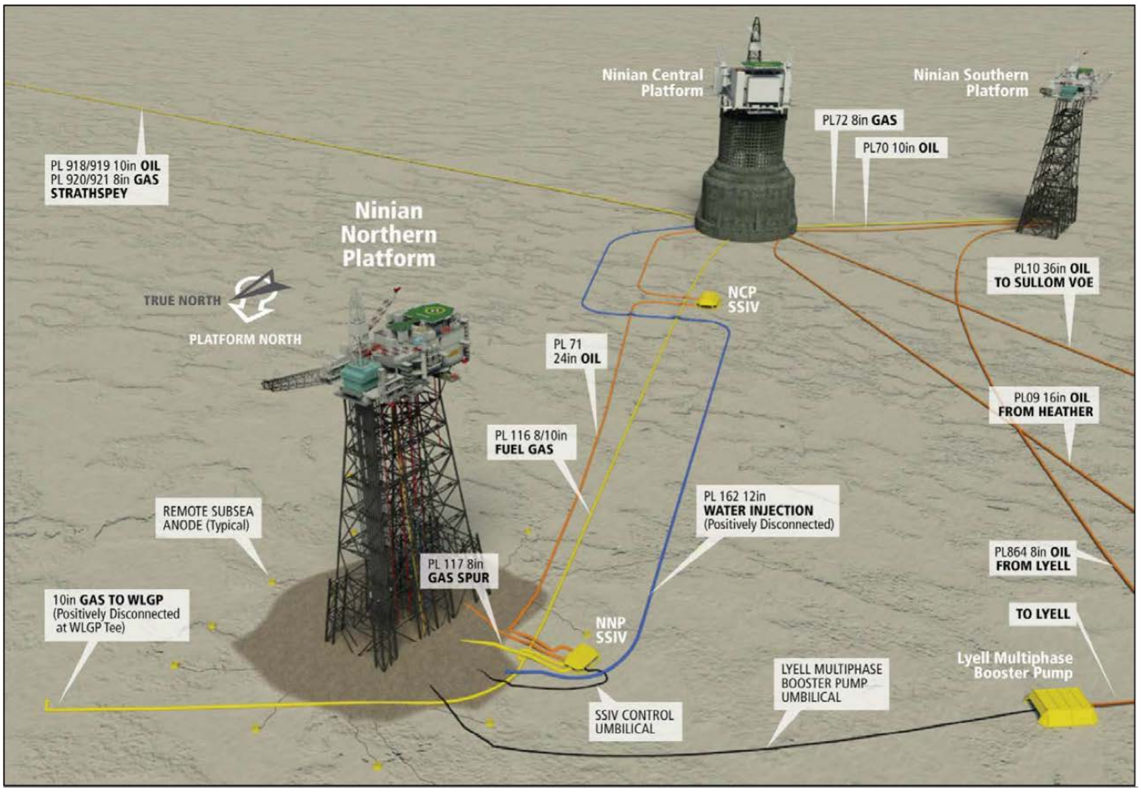



**Figure 1.1: Location of the Ninian field and Ninian Northern Platform.**

## 1.1 Background

NNP is one of three fixed platforms in the Ninian Field (Figure 1.2). BP/ Ranger Oil UK Ltd began exploration of the Ninian Field in March 1974, with the drilling of the 3/8A-1 discovery well. The Field was subsequently developed by Chevron. CNRI acquired the Ninian Field from Kerr McGee in 2002. CNRI are the operator of the field with an equity share of 87.06%, in partnership with JX Nippon (12.94%). The platform was installed in 1978 with first oil produced in 1980 (CNRI, 2016a).




Source: CNRI (2016a)

**Figure 1.2: Schematic of Ninian Field facilities**

## 1.2 Infrastructure within the Scope of this CA

The CA covers the technically feasible decommissioning options for the NNP jacket steel structure and drill cuttings pile (Table 1.1.). The CA only assesses infrastructure which may be decommissioned in situ, the NNP topsides will be completely removed and recovered to shore for reuse and/or recycling, therefore are not considered further in the CA process. The pipelines associated with NNP will be assessed at the point of decommissioning the wider Ninian Field.

**Table 1.1: Facilities included within the scope of the NNP decommissioning project**

| Facility | Components of the facility to be decommissioned |
|---|---|
| Topsides | 10 modules and associated topsides equipment captruss |
| Jacket and footings | 147 m high steel jacket structure<br>Weight – 15,561 te (unflooded)<br>24 conductors<br>26 steel piles<br>12 seabed anodes |
| Drill cuttings pile | Volume 33,144 $m^3$,<br>Height 11.93 m above seabed<br>Surface area – 23,620 $m^2$<br>The predicted cumulative persistence of oil within the pile from 2006 is calculated to be 1.7 $km^2y$ this is well below the OSPAR criterion of 500 $km^2y$. |

Decommissioning options for the associated pipelines and subsea structures will be subject to a separate Decommissioning Plan (DP) when considering the wider Ninian Field.

Screening of the NNP drill cuttings pile indicates that it falls well below the OSPAR thresholds for oil release rate (10 tonnes/ yr.) and area persistence (500 $km^2$ years) and as such would not be subject to a formal Stage 2 assessment (CNRI, 2012b). However, as the drill cuttings pile would need to be disturbed or removed in order to access the jacket footings, CNRI conducted a CA to determine the best option for the drill cuttings pile.

A number of supporting studies were undertaken prior to the commencement of the CA, Table 1.2 lists these along with their relevant CNRI document reference numbers. All participants in the CA were provided these as pre-read material before the CA workshop and these provided supporting information during the assessment process.

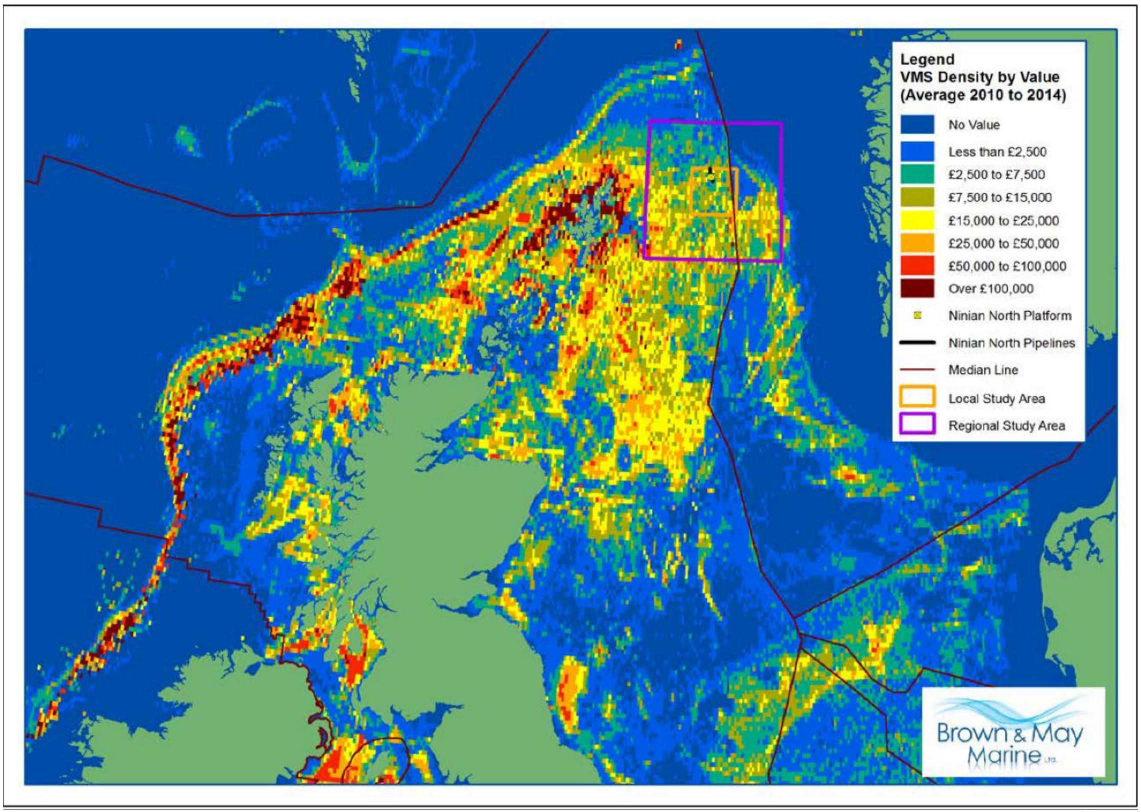
**Table 1.2: Supporting studies for the decommissioning of Ninian Northern jacket and drill cuttings CA process**

| Report Title | CNRI document reference number |
|---|---|
| Ninian Northern Platform EIA Scoping Report | P0005-BMT-EN-REP-00001 |
| Environmental Assessment of Options for the Management of the Ninian Northern Drill Cuttings Pile | P0005-BMT-EN-STU-00001 |
| Ninian Northern Platform – Report - Project Description | P0005-CNR-PM-REP-00003 |
| Commercial Fisheries – Socioeconomic Impact Study for the Decommissioning of Ninian North | P0005-SFF-EN-STU-00001 |
| NNP - Evaluation of Removal Options for Ninian Northern Jacket | P0005-NDE-PM-REP-00001 |
| Ninian North – Method Statement – Comparative Assessment | P0005-CNR-PM-MES-00001 |
| Ninian Northern – Method Statement - Topsides & Jacket Removal Study | P0005-HMC-ST-PRO-00001 |
| Ninian Northern – Method Statement - Jacket Removal Procedure | P0005-ALS-ST-PRO-00001 |
| CNRI Technical Note on Ninian Northern Drill Cuttings Pile Removal Methods | P0005-CNR-PM-TFN-00001 |

## 1.3 Environmental and Societal Setting

The environmental and societal characteristics and sensitivities in the surrounding area of the NNP are summarised in Table 1.3. The references used to compile Table 1.3 are provided in Section 7.0.

The satellite Vessel Monitoring System (VMS) data for the area from 2010 to 2014 are presented in Figure 1.3. This provides an indication of where the fishing effort is concentrated in the surrounding area. The figure indicates that there is moderate to low fishing activity within the vicinity of the platform.




Source: CNRI (2016b)

**Figure 1.3: VMS density within UK and surrounding territorial waters for vessels over 15 m by landings value (average 2010-2014)**

There are no conservation areas in the vicinity of the NNP. The closest, Pobie Bank Reef Site of Community Importance (SCI), is located 73 km southeast of the NNP (Figure 1.4).

Harbour porpoise is the only Annex II species that has been reported within the NNP area. This species has been observed in very high numbers in February and July, in medium numbers in August and in low numbers in January, April, May, June, September and December (UKDMAP, 1998).

Five potential Special Areas of Conservation (pSACs) have been proposed for the management of harbour porpoise populations in UK Waters (JNCC, 2016). These pSAC sites have been identified within the North, Irish and Celtic Seas, encompassing areas that represent the physical and biological factors essential to harbour porpoise. To date, only one site has been put forward by the Scottish Government for harbour porpoise in Scottish waters (JNCC, 2016), this is located on the West Coast of Scotland.

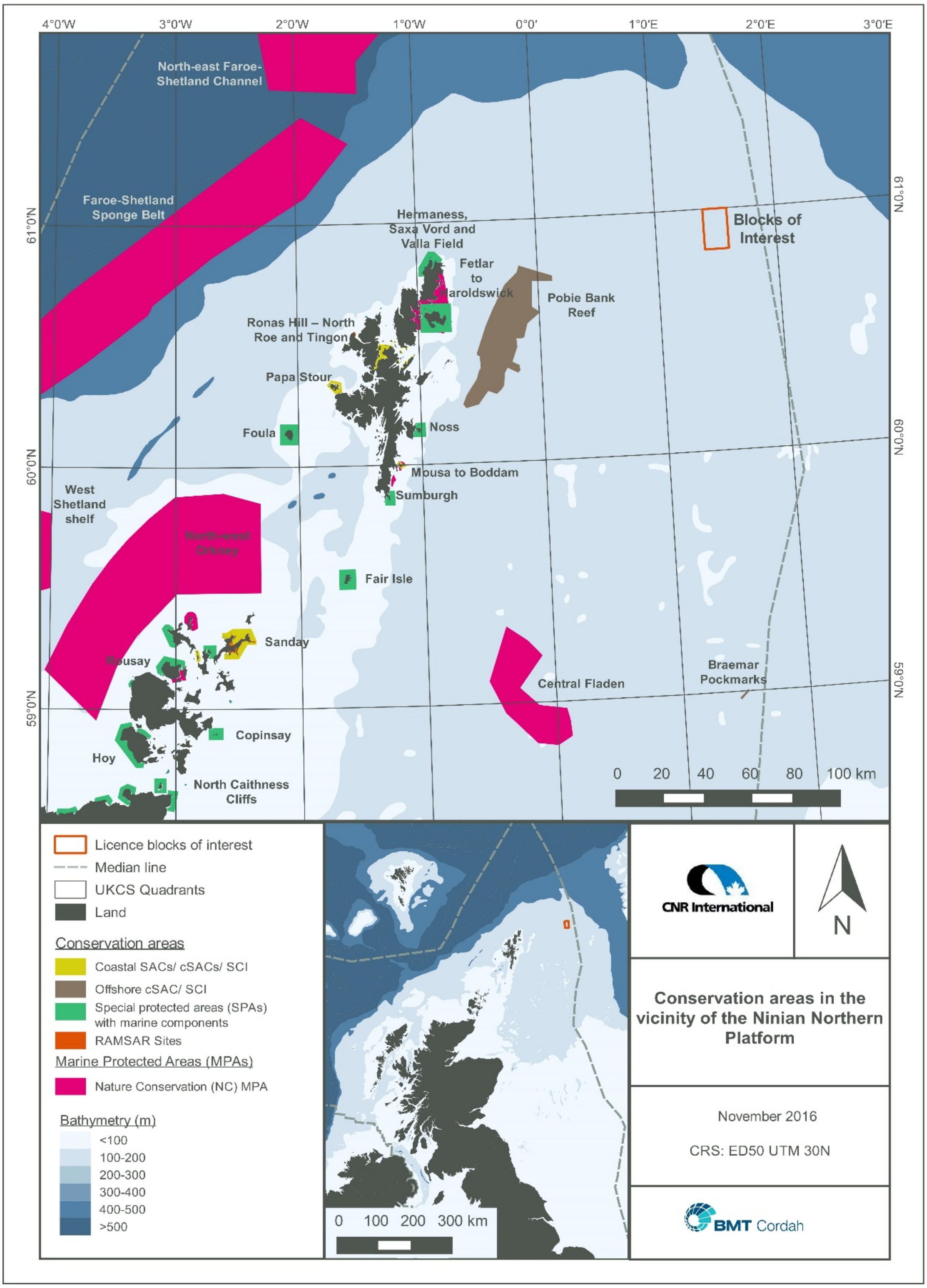



**Figure 1.4: Conservation areas in the vicinity of the Ninian Northern Platform**

**Table 1.3: Summary of key environmental characteristics and sensitivities in the decommissioning area**

| Aspect | Detail |
|---|---|
| ***Offshore conservation interests*** | |
| Annex I habitats | There are no known Annex I habitats in the NNP area. Although *Lophelia pertusa* has colonised the NNP, it would not have occurred without the presence of the platform and therefore does not constitute an Annex I habitat (Fugro ERT, 2011; BMT Cordah, 2016). The closest Annex I habitat, the Pobie Bank Reef SCI, is located 73 km to the SE (Scottish Government, 2016a). |
| Annex II species | Of the Annex II species, only the harbour porpoise has been sighted in the Ninian Northern area, with very high abundance in February and July, medium numbers in August and low numbers in December, January and throughout the summer months (April, May, June and September) (UKDMAP, 1998). |
| ***Environmental characteristics and sensitivities*** | |
| Plankton | The plankton in the NNP area is typical of the northern North Sea. Peak productivity occurs in spring and summer. |
| Benthic fauna | Benthic communities in the NNP area are similar to those found throughout a large surrounding area of the northern North Sea. No rare species are known to occur in this area (Fugro ERT, 2011). |
| Fish spawning areas | The NNP is located in spawning grounds for cod (Jan to Apr), haddock (Feb to May), Norway pout (Jan to Apr), saithe (Jan to Apr) and sandeels (Nov to Feb) (Coull et al., 1998; Ellis et al., 2010) . |
| Fish nursery areas | The NNP is located in nursery grounds for herring, ling, mackerel, spurdog, haddock, Norway pout, blue whiting, sandeels, whiting, anglerfish and European hake (throughout the year) (Coull et al., 1998; Ellis et al., 2010). |
| Marine mammals | Marine mammals sighted in and around the Ninian Northern area include minke whales, long-finned pilot whales, killer whales, white-beaked dolphins and harbour porpoises. Peak sightings predominantly occur in the summer months (Reid et al., 2003; UKDMAP, 1998). |
| Seabirds | Seabird vulnerability to oil pollution in the NNP area is “high” in January, March, July, October and November and “moderate” to “low” for the rest of the year. The overall vulnerability in the NNP area is “low” (JNCC, 1999). |
| ***Societal characteristics and sensitivities*** | |
| Fisheries | The fishing effort in 2015 in the NNP area was dominated by pelagic fisheries. Demersal species dominated the landings, with their relative value being “moderate” in 2015 (Scottish Government, 2016b). |
| Shipping | Shipping traffic in the vicinity of NNP is of moderate density (BEIS, 2016). |
| Oil and gas industries | Within 30 km radius of NNP there are Ninian Central (Block 3/3), Ninian Southern (Block 3/8), Alwyn North NAA and NAB (Block 3/9), Brent A, B, C and D (Block 211/29), NW Hutton A (decommissioned, footings in place; Block 211/27), Cormorant A (Block 211/26) and Heather A (Block 2/5), (UK Oil and Gas Data, 2016). |
| Other users of the sea | In the vicinity of the NNP there are no recorded military activities, offshore renewables, dredging and aggregate activities, wrecks and telecommunication or power cables (SeaZone, 2013; KIS-ORCA, 2016; Crown Estate, 2015; Baxter et al., 2011). |

## 2.0 ALTERNATIVE USES CONSIDERED POST CESSATION OF PRODUCTION

CNRI has considered the following potential alternatives for use of NNP after Cessation of Production (COP) either in situ or at alternative locations (CNRI, 2011):

- Offshore renewable energy generation (wind, wave or tidal);
- Offshore sub-station/ hub;
- Marine research station;
- Training centre;
- Carbon capture and Storage (CCS);
- Re-use of platform facilities at an alternative location;
- Proposed methods for identifying further potential uses.

A summary of the assessment undertaken on both the technical and economic viability of these options is provided below:

- The use of the platform for wind, wave and tidal energy generation was assumed to be technically feasible, however, all three forms of energy generation were found to be economically unviable. The capital outlays combined with annual operational and maintenance costs were found to far outweigh the revenue from energy generation.
- After analysis of other platform uses, no viable in situ platform uses have been identified.
- Relocation of platform to other site for re-use was rendered impractical by the condition, size and age of the NNP. However, it was recommended to identify individual deck elements and operational equipment with re-use potential (CNRI, 2011).
- Potential value of the platform subsea elements use as an artificial reef has been identified (CNRI, 2011). However, this is not recognised as valid re-use application in the North Sea due to current legislation requirements of the Oslo-Paris Commission (OSPAR), Decision 98/3.
- It is anticipated that the costs associated with modification of NNP for CCS, and associated maintenance following these modifications, would preclude their re-use for this purpose. The infrastructure required, based upon a study preformed on Fairfield Dunlin (Fairfield Energy Ltd, 2010) would cost in the order of £50 million, delivering around 3 million tonnes of $CO_2$ per year. Additional operating and maintenance costs for a large, and relatively old-age Northern North Sea platform would make it an unattractive option compared with a subsea alternative solution, or use of new hub with subsea tiebacks (CNRI, 2011). Additionally, CCS would require the provision of a high pressure pipeline system for transport of the $CO_2$ to the field, however these would cost up to 20 or 30 times the platform costs, and could only be feasibly supported though the development of several parallel $CO_2$ injection sites (CNRI, 2011)

For further information regarding the detailed assessment of each option, including both the technical and economic viability of each option, the reader is referred to CNRI, 2011.

# 3.0 DECOMMISSIONING OPTIONS ASSESSED IN THE CA

The jacket decommissioning options which were previously considered included:

- Full removal single lift.
- Full removal by multiple lifts
- Partial removal by single lift
- Partial removal by multiple lifts
- Buoyancy Tank Assemblies (BTA)

Following the assessment of technical feasibility, two jacket decommissioning options were carried forward to the CA, full removal by multiple lifts and partial removal by multiple lifts (Table 3.1.). The single lift options were not taken forward for further assessment due to unproven technological factors, absence of vessels which could remove the jacket to the derogation depth of 88.5 m at the date of assessment, and timeframe issues which were found to be unfavourable.

The BTA option was not taken forward due to the requirement to gain consent to traverse live infrastructure between the Ninian Field and onshore for dismantlement. The potential risks of grounding of the structure while transporting also led to the decision not to take this option forward for further assessment.

The drill cuttings removal options which were previously considered included:

- Leave in situ.
- Dispersal, redistribution of drill cuttings on seabed
- Recover to surface, solids disposed onshore, liquids disposed offshore
- Recover to surface, solids disposed onshore, liquids disposed offshore, Solids and liquids slurry taken for disposal onshore.
- Re-injection of solids/ liquids slurry to disposal well offshore.

All five drill cuttings removal options were considered in the technical feasibility assessment and all options were taken forward for further assessment (Table 3.2.). All options were taken forward on the grounds that none of the options attained a score of 6 in the CNRI consequence matrix which would indicate a high risk or impact to the assessed criterion (Appendix A). A number of studies were undertaken to support the CA of the drill cuttings removal options. These included studies, modelling the effects of human disturbance of the drill cuttings pile using the removal options outlined, and assessments of the drill cuttings long term characteristics and environmental impacts to the surrounding area have been utilised to assess the risk of each option (CNRI, 2016c, CNRI, 2013a, CNRI, 2013b).

The decommissioning options that CNRI have taken forward for assessment within the CA are presented in Tables 3.1 and 3.2.

**Table 3.1: Jacket decommissioning options considered in CA**

| Decommissioning option | Method |
|---|---|
| **Jacket full removal**<br>(multiple lifts) | The jacket top section members would be cut into sections and lifted by Heavy Lift Vessel (HLV). Drill cuttings pile would be removed to allow access to jacket footing. The jacket top section members would be cut into sections and lifted by HLV. The piles in the seabed would be cut 3 m below the seabed. |
| **Jacket partial removal**<br>(multiple lifts) | Jacket top sections will be cut into smaller sections down to the top of the footings and removed in multiple lifts. Jacket footings will be left in situ for this option. |

**Table 3.2: Drill cuttings decommissioning options considered in CA**

| Decommissioning option | Method |
|---|---|
| **Drill cuttings removal Option 1**<br>(recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore) | Recover drill cuttings to the surface (either to platform or a vessel) using the Remotely Operated Vehicle (ROV) dredge system; separate solids from fluids offshore, discharge the treated oily fluids under permit to the offshore environment and transporting the solids for onshore treatment and landfill disposal. |
| **Drill cuttings removal Option 2**<br>(recover to surface, slurry to shore) | Recover drill cuttings to the surface using the ROV dredge system to a vessel for direct transport to shore for separation and treatment; oily water to be discharged under permit in a coastal environment and the dry cuttings disposed of to landfill. |
| **Drill cuttings removal Option 3**<br>(recover to surface, offshore re-injection) | Recover drill cuttings to the surface using the ROV dredge system to the platform for slurrification and disposal through a Cuttings Re-Injection (CRI) system to an existing well, which would be converted to a disposal well. |
| **Drill cuttings Option 4**<br>(redistribution of drill cuttings on the seabed) | An ROV dredge system collects the cuttings and an exhaust pipe distributes them from a number of discharge locations 70 m from the current position. |
| **Drill cuttings Option 5**<br>(leave in situ) | No removal. |

## 3.1 General Assumptions

For comparative purposes, assumptions and limitations have been made in regard to scope, materials, transportation, vessel usage, etc. These general assumptions and considerations are listed below. Additional assumptions for each of the criteria evaluated in this CA are included in the description of the methodologies in the relevant Appendices.

- A round trip by helicopter to Ninian Northern takes two hours and the helicopter uses approximately 1,008 litres of aviation fuel per hour (CNRI, 2016d)
- Estimates of vessel and equipment use, duration of operations, quantities of temporary steel work required (e.g. work platforms, clamps and removal aids) and helicopter use were taken from contractor values that were collated and normalised by CNRI (CNRI, 2012a; CNRI, 2016d)
- Recovered steel and anode material is recycled; recovered concrete and wood are taken to landfill.
- Marine growth is not recycled and there is no requirement to include a theoretical replacement cost.
- No new components or materials are required to be manufactured for the decommissioning of the drill cuttings pile.
- The drill cuttings material is not recyclable and any material recovered will be processed and disposed of in appropriate landfill. If treated offshore, the recovered water will be disposed of to sea.
- Recovered cuttings material will be landed at either Tyneside or Invergordon (CNRI, 2012b). The onshore cuttings material processing unit is located in Peterhead and, therefore, the worst case assumption in terms of amount of road transport required is Tyneside

# 4.0 CA METHODOLOGY

The following section details the CA process by which the most appropriate options for decommissioning of the jacket and drill cuttings pile were assessed.

In preparation for the CA, CNRI identified and described the decommissioning options, decided upon the assessment criteria (and sub-criteria) to be used in the CA (Section 4.2) and established the weighting to be applied to scores for the individual assessment criteria. The options and weightings reflect the balance of CNRI's decision-making priorities, corporate values and stakeholder views (Section 4.3).

Stakeholder comments received from Scottish Fisherman's Federation (SFF), Joint Nature Conservation Committee (JNCC), Marine Scotland and BEIS as part of the early stakeholder engagement and relevant information raised from the Murchison Decommissioning Project (CNRI, 2013c) were reviewed and assessed, and where possible, incorporated within this CA process.

## 4.1 CA Workshop

As part of the CA, two workshops were undertaken to assess the environmental and societal risks. These were independently facilitated and chaired by BMT Cordah Limited (BMT Cordah) on the 4th and 7th of October 2016. Participants at the workshops included various disciplines and specialists from CNRI, BMT Cordah, the Scottish Fisherman's Federation (SFF) and Energised Environments including:

4th October 2016 Participants – Jacket Decommissioning Workshop

| Name | Role | Company |
|---|---|---|
| Ceri Wheaton | SHE Advisor/ CA Process Lead | CNRI |
| Murdo MacRitchie | Decommissioning Project Lead | CNRI |
| Gabriel Neves | Project Controller | CNRI |
| Mark Raistrick | Senior Project Engineer | CNRI |
| Alan Minty | Operations - OIM | CNRI |
| Roy Aspden | Decommissioning Manager | CNRI |
| Jonathan Hoare | Senior Pipelines Engineer | CNRI |
| Peter Ronnie | Operational SHE Team Leader | CNRI |
| Chris Cook | Operations – OIM | CNRI |
| Caroline Lawford | Senior Structural and Marine Engineer | CNRI |
| Mike Corcoran | Decommissioning Strategy Consultant | CNRI |
| Paul Johnson | Technical Safety Engineer | CNRI |
| Peter West | Industry Advisor | SFF |
| Stuart McGowan | IRC | Energised Environments |
| Claire Hinton | Principal Environmental Consultant/ Workshop Facilitator | BMT Cordah |
| Gareth Jones | Principal Environmental Consultant/ Workshop Facilitator | BMT Cordah |
| Faron McLellan | Environmental Consultant/ Scribe | BMT Cordah |
| Dorota Bastrikin | Senior Environmental Consultant/ Observer | BMT Cordah |

7th October 2016 Participants – Drill Cuttings Pile Decommissioning

| Name | Role | Company |
|---|---|---|
| Ceri Wheaton | SHE Advisor/ CA Process Lead | CNRI |
| Murdo Macritchie | Decommissioning Project Lead | CNRI |
| Mark Raistrick | Project Engineer | CNRI |
| Alan Minty | Operations – OIM | CNRI |
| Paul Johnson | Technical Safety Engineer | CNRI |
| Roy Aspden | Decommissioning Manager | CNRI |
| Olivia Robertson | SHE Advisor | CNRI |
| Jonas Beaugas | IRC | Energised Environments |
| Gareth Jones | Principal Environmental Consultant/ Workshop Facilitator | BMT Cordah |
| Claire Hinton | Principal Environmental Consultant/ Workshop Facilitator | BMT Cordah |
| Faron McLellan | Environmental Consultant /Scribe | BMT Cordah |

25th October 2016 Participants – Workshop and Presentation

| Name | Role | Company |
|---|---|---|
| Ceri Wheaton | SHE Advisor/ CA Process Lead | CNRI |
| Murdo MacRitchie | Decommissioning Project Lead | CNRI |
| Gabriel Neves | Project Controller | CNRI |
| Alan Minty | Operations – OIM | CNRI |
| Roy Aspden) | Decommissioning Manager | CNRI |
| Jonathan Hoare | Pipeline Engineer | CNRI |
| Mike Corcoran | Decommissioning Strategy Consultant | CNRI |
| Paul Johnson | Technical Safety Engineer | CNRI |
| Andrew Lowrie | Partner | JX Nippon |
| Peter West | Industry Advisor | SFF |
| Steven Alexander | Industry Advisor | SFF |
| Stuart McGowan | Independent Review Consultant (IRC) | Energised Environments |
| Claire Hinton | Principal Environmental Consultant | BMT Cordah |
| Joe Ferris | Technical Associate | BMT Cordah |

## 4.2 Assessment Criteria

The individual decommissioning options were assessed against the five main assessment criteria and associated sub-criteria, details of which are provided in Table 4.1. These were based on:

- The "matters to be considered" listed in the OSPAR framework and DECC's Guidance Notes (DECC, 2011);
- The range of safety, technical, environmental, societal and economic assessments and studies that CNRI decommissioning projects have undertaken or shall undertake;
- CNRI's SHE Policy, CNRI vision and mission statements.

**Table 4.1: Assessment criteria/ sub-criteria and a brief description of method used to assess each option**

| Main criteria | Sub-criteria | Description of sub-criteria | Assessment of sub-criteria |
|---|---|---|---|
| Safety* | Risk to project personnel offshore | Safety risk to project personnel working offshore. | Quantitative estimate of total Potential Loss of Life (PLL) for project personnel. |
| | Residual risk to other users of the sea | The combined safety risk to the crews of commercial fishing vessels, the crews of military vessels and the crew and passengers of commercial shipping vessels. | Independent quantitative assessment of PLL to fishermen from the snagging risk posed by residual infrastructure, and a quantitative assessment of consequent risk to life and limb, as a result of the option's end-points for other users of the sea |
| Environment | Impacts of operations and end-points | The impacts of offshore and nearshore operations on any aspect of the marine environment. The impacts of onshore operations (e.g. dismantling, transporting, treating, recycling) on any ecological aspect of the terrestrial environment. The impacts of offshore and nearshore end-points on any aspect of the marine environment. The impacts of onshore end-points (e.g. landfilling, secondary use) on any ecological aspect of the terrestrial environment. | Qualitative assessment where impacts are assessed and the significance categorised according to a pre-defined Risk Assessment Matrix. |
| | Total energy consumption | Total energy consumption (GJ). | The estimated total energy consumption (GJ) and $CO_2$ emissions (tonnes) that would arise as a result of the successful completion of the option, including theoretical energy use and gaseous emissions that would arise if otherwise recyclable materials were left in the sea. Scores of both measures are averaged to provide an overall score for energy and emissions. |
| | $CO_2$ emissions | $CO_2$ emissions (tonnes). | |
| Technical | Technical feasibility | Assessment of the technical feasibility of each option. | Expert judgement based on the range of engineering and technical studies carried out by the CNRI decommissioning team and their independent consultants. |
| | Ease of recovery from excursion | Assessment of the ability to recover from unplanned excursions and complete the planned decommissioning option. | |
| | Use of proven technology and equipment | Assessment of the extent to which the option requires the use of proven technology. | |

| Main criteria | Sub-criteria | Description of sub-criteria | Assessment of sub-criteria |
|---|---|---|---|
| Societal | Commercial and Socio-economics | **Commercial Impact on Fisheries**<br>Impacts of both the operations and the end-points on the present commercial fisheries in and around the field. (NB Safety risks were considered under "safety" above). | Qualitative assessment based on information in the Commercial Fisheries Study on the level of fishing activity in the area, the type of gear used, the value of the fishery, and the value of the ground that may or may not be available for fishing on completion of the options. |
| | | **Socio-economic impacts to amenities**<br>The risks from any near-shore and onshore operations and end-points (dismantling, transporting, treating, recycling, land filling) on any aspect of the amenity or infrastructure of the environment. | Qualitative assessment based on the results of the Environmental Impact Assessment (EIA) process, where impacts are assessed and the significance categorised according to a pre-defined Risk Assessment Matrix. Also informed by feedback from stakeholder dialogue. |
| | | **Socio-economic impacts on communities**<br>The risks from any near-shore and onshore operations and end-points (dismantling, transporting, treating, recycling, land filling) on the health, well-being, standard of living, structure or coherence of communities. | Qualitative assessment based on the results of the EIA process, where impacts are assessed and the significance categorised according to a pre-defined Risk Assessment Matrix. Also informed by feedback from stakeholder dialogue. |
| Economic | CAPEX and ongoing calls | Total project cost. The estimated total Capital Expenditure (CAPEX) cost plus a Net Present Value (NPV) estimate of the cost of any ongoing liability. | Quantitative estimate by CNRI based on the programmes and schedules being prepared for the "Select" phase of the project. |

*A qualitative assessment was undertaken for the drill cutting removal options, which only incorporated the risk to personnel, there were deemed to be negligible safety risks to commercial fishers directly.

## 4.3 Assessment Scoring

Initially, the scores from each of the assessments were expressed in their respective quantitative and qualitative units. Justification for the scores assigned during the assessments, as well as assumptions and limitations were noted and a detailed breakdown is provided in Sections 5.1 to 5.5, as well as in the relevant appendices (Appendices A to D).

To enable a comparison to be made of the decommissioning options, the results were then collated and compared using a normalised/ weighted scoring system. The results of each of the assessments were expressed in common units and ranked in order of performance from best to worst, based on the weightings assigned by CNRI (Table 4.2). BEISs Guidance Notes (DECC, 2011) make provision for weightings to be assigned to the scoring for the individual assessments to transparently reflect the proportionality/ or balancing of the options from the viewpoint of the operator or its stakeholders.

Weightings for each of the criteria and sub-criteria have been assigned by the CNRI Decommissioning Project Team and reflect CNRI's corporate vision and mission statements.

**Table 4.2: Weightings of main criteria**

| Criteria/ sub-criteria | Weighting (percentage) |
| --- | --- |
| Safety – risk to offshore personnel* | 20 |
| Safety – Risk to other users of the sea* | 10 |
| Environmental - Environmental Risk | 13.3 |
| Environmental - Energy Use | 3.35 |
| Environmental – Emissions | 3.35 |
| Technical Feasibility** | 20 |
| Societal | 10 |
| Economic | 20 |
| **Total** | **100** |

*For the purpose of the drill cuttings assessment these were combined as a qualitative assessment criterion, with a combined weighting of 30%

**Technical feasibility here is displayed as a combination of the three sub-criteria under technical feasibility, each contributing ~6.67% to attain the combined weighting (percentage) of 20%

The maximum weighting was assigned to the best scoring decommissioning method for each individual criterion. For example, a maximum weighted score of 20 was assigned to the best performing method under technical feasibility. All subsequent decommissioning options were assigned a normalised weighted value in proportion to the best performing method. The output was a matrix presenting normalised/ weighted values for the criteria/ sub-criteria for every method of decommissioning.

An overall value was established by totalling the normalised/ weighted values for the assessments and comparing and ranking these totals. A ranked value of 1 suggests this option has the least risk or lowest impact, and therefore is the most highly recommended. CNRI used the output from the CA to select the recommended decommissioning option, with the CA report documenting the justification for their choice.

In any instance in which an option is weighted with a value of zero, for the purposes of mathematical calculations it was assumed that zero has a nominal value of 1 x $10^{-X}$ where X = -1 magnitude of the lowest raked/ lowest performing option (see Tables 5.4., 5.9., 5.17. and 5.18.).

The normalised weighting system allows criteria which are measured in different units to be directly compared with each other.

Appendices A and B detail the methodology implemented for the CA.

## 5.0 COMPARATIVE ASSESSMENT RESULTS

The following section presents the results of the CA for the two jacket decommissioning options and five drill cuttings pile options. Tables 5.1 and 5.2 provide the scored results for each assessment and the total comparative assessment score (out of a maximum of 100 points) for each of the options.

**Table 5.1: Summary table of the comparative assessment weighted scores/ results for jacket decommissioning options**

| Decommissioning option | Comparative Assessment Scores | | | | | | | | Total Comparative Assessment Score | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|
| | Safety – Risk to project personnel (quantitative) | Safety – Risk to other users of the sea (quantitative) | Environmental risk (qualitative) | Energy use (quantitative) | Emissions (quantitative) | Technical feasibility (qualitative)* | Societal (qualitative) | Economic (quantitative) | | |
| **Jacket full removal** (multiple lifts) | 7.80 | 10.00 | 8.61 | 3.35 | 3.35 | 8.89 | 9.42 | 10.71 | 62.13 | 2 |
| **Jacket partial removal** (multiple lifts) | 20.00 | 0.43 | 13.30 | 1.88 | 2.62 | 20.00 | 10.00 | 20.00 | 88.23 | 1 |

*Technical feasibility is presented as the sum of the weightings assigned to the sub-criteria (technical feasibility, ease of recovery and use of proven technology and equipment).

**Table 5.2: Summary table of the comparative assessment weighted scores/ results for drill cuttings pile decommissioning options**

| Decommissioning option | Comparative Assessment Scores | | | | | | | Total Comparative Assessment Score | Ranking |
|---|---|---|---|---|---|---|---|---|---|
| | Safety (qualitative) | Environmental risk (qualitative) | Energy use (quantitative) | Emissions (quantitative) | Technical feasibility (qualitative)* | Societal (qualitative) | Economic (quantitative) | | |
| **Drill cuttings removal Option 1** (recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore) | 2.50 | 7.80 | $2.77 \times 10^{-6}$ | $4.37 \times 10^{-5}$ | 1.49 | 1.09 | 0.63 | 13.51 | 4 |
| **Drill cuttings removal Option 2** (recover to surface, slurry to shore) | 2.00 | 7.13 | $1.10 \times 10^{-6}$ | $1.58 \times 10^{-5}$ | 1.49 | 0.83 | 0.53 | 11.98 | 5 |
| **Drill cuttings removal Option 3** (recover to surface, offshore re-injection) | 1.67 | 12.59 | $3.06 \times 10^{-6}$ | $5.17 \times 10^{-5}$ | 1.02 | 3.41 | 0.33 | 19.02 | 3 |
| **Drill cuttings Option 4** (redistribution of drill cuttings on the seabed) | 7.5 | 6.36 | $3.84 \times 10^{-6}$ | $5.17 \times 10^{-5}$ | 2.96 | 2.46 | 2.06 | 21.34 | 2 |
| **Drill cuttings Option 5** (leave in situ) | 30.00 | 13.30 | 3.35 | 3.35 | 20.00 | 10.00 | 20.00 | 100.00 | 1 |

*Technical feasibility is presented as the sum of the weightings assigned to the sub-criteria (technical feasibility, ease of recovery and use of proven technology and equipment).

The decommissioning option with the highest normalised/ weighted score represents the recommended option, and is ranked with 1 being the most recommended and higher numbers, with a maximum of 5 (for drill cutting removal options), being the least recommended.

Sections 5.1 to 5.5 highlight why the decommissioning options were considered differentiate from each other and provides a more detailed explanation for the scores awarded to each decommissioning option.

## 5.1 Safety Differentiation

PLL provides a quantitative index of safety that is commonly used in comparative assessments for decommissioning projects. This report follows the process detailed in the report from the Health and Safety Executive's Joint Industry Project on the Risk Analysis of Decommissioning Activities (Safetec, 2005).

Tables 5.3 and 5.4 provide the summed total values of risk to project personnel and other users of the sea/ commercial fisheries for the jacket decommissioning options and their subsequent normalised/ weighted scores. These assign a maximum score of 20 and 10 respectively to the best performing option, and then the remaining decommissioning options are ranked in order of their summed totals and then assigned a proportional weighting in relation to the highest ranked option.

Table 5.5 provides the qualitative risk scores for the drill cuttings pile decommissioning options. The scores are normalised/ weighted using a maximum score of 30 for the best performing option. The remaining decommissioning options are ranked in order of their summed totals and then assigned a proportional weighting in relation to the highest ranked option.

Appendix A provides a detailed breakdown of the activities and the individual scores associated with each decommissioning option along with the scoring matrix. A full description of the method used to calculate the PLL and total exposure values is also provided.

### 5.1.1 Quantitative assessment of safety impacts for the jacket decommissioning options

This section provides a comparison of the quantitative offshore safety risk score for both of the jacket decommissioning options including the methodology and assumptions.

CNRI commissioned Wood Group Frontier to facilitate a programme of Hazard Identification (HAZID) studies and Quantitative Risk Assessments (QRAs) for the decommissioning of the NNP. The Ninian North Platform Decommissioning Options QRA Report (CNRI, 2013d) provides the PLL and safety values used in this comparative assessment.

**Assumptions**

- Quantitative values for safety for jacket decommissioning have used the basis of the PLL for a HLV undertaking multiple lifts with Reverse Installation method as a worst case scenario, presented in Table 10 of the QRA report (CNRI, 2013d).
- To generate the values for partial removal, the subtotal for the partial removal jacket phase activities were used, this includes:
    - Mobilisation of HLV to NNP
    - Removal of jacket top section
    - Transit and offload of jacket
    - Removal of jacket middle section
    - Demobilisation of vessel
    - Construction Support Vessel (CSV)

  - Emergency Response and Rescue Vessel (ERRV)
  - Onshore dismantlement
- To generate the values for full removal, the subtotal for partial removal was implemented, as described above and additional values added to consider the removal of the jacket footings including:
  - Preparations and removal of footings
  - Tug to manoeuvre barge in NNP field
  - Tug to mobilise and demobilise cargo barge
  - Cargo barge preparation
  - CSV
- No diving activities are expected. All subsea work will be undertaken with ROVs.

**Table 5.3: Quantitative safety assessment (risk to project personnel offshore) results and normalised weightings for jacket decommissioning options**

| Decommissioning option | Summed total | Normalised/ weighted score | Ranking |
|---|---|---|---|
| **Jacket full removal** (multiple lifts) | $2.519 \times 10^{-2}$ | 7.80 | 2 |
| **Jacket partial removal** (multiple lifts) | $1.039 \times 10^{-2}$ | 20.00 | 1 |

The full and partial removal options considered for the decommissioning of the jacket infrastructure received normalised/ weighted scores of 7.80 and 20.00 respectively. The removal of the jacket via partial removal using multiple lifts reduces risk to personnel to the lowest level as reasonably practicable. This is primarily due to the reduced complexity and number of lifts required to undertake the scope of work. The partial removal reduces the number of sections required to be lifted by the removal vessel by three. This reduction will have a direct effect of reducing the overall length of time required to undertake the decommissioning work and therefore reduce the exposure risk to personnel undertaking the decommissioning activities.

The quantitative assessment of safety concerns the risk to other users of the sea such as commercial fishers. This assessment considered the potential residual footprint and the risk to other users encountering this obstruction post-decommissioning. These values were calculated by an independent study commissioned to assess and analyse the risk to commercial fishing (CNRI, 2013e). Table 5.4 provides the scores for each decommissioning option and each normalised/ weighted value. A maximum normalised/ weighting of 10 was applied to the lowest scoring option, the remaining decommissioning options were ranked in order of their summed totals and then assigned a weighting in relation to the highest ranked option.

**Table 5.4: Quantitative safety assessment (risk to other users of the sea/ commercial fisheries) results and normalised weightings for jacket decommissioning options**

| Decommissioning option | Summed total | Normalised/ weighted score | Ranking |
|---|---|---|---|
| **Jacket full removal** (multiple lifts) | 0* | 10.00 | 1 |
| **Jacket partial removal** (multiple lifts) | $2.30 \times 10^{-5}$ | 0.43 | 2 |

*For the purpose of mathematical calculations it was assumed that zero has a nominal value of $1 \times 10^{-6}$.

Jacket decommissioning option of full removal attained a higher normalised/ weighted score (10.00) than the partial removal option (0.43). Decommissioning by full removal can be considered to have a lower residual risk to other users of the sea, with specific reference to commercial fishers. CNRI acknowledges the fact that by leaving the footings in place under the partial removal option, this constitutes a greater risk to commercial fishermen than fully removing the infrastructure, however, when considering both the risk to personnel and other users of the sea in a combined manner, the partial removal of the jacket represents the option with the lowest overall risk that is reasonably practicable. It has been noted by CNRI that this leaving the footings in place may present a potential snagging risk over time, as a result, CNRI propose to undertake a series of mitigation measures to help reduce this residual risk as far as possible. These may include accurate recording of the location of the infrastructure at the point of decommissioning and notification to mariners via navigational charts and systems such as FishSafe.

### 5.1.2 Qualitative assessment of safety impacts for drill cuttings pile decommissioning options

This section provides a comparison of the offshore safety risk score for each of the drill cuttings pile decommissioning options. These scores were determined through a qualitative assessment for the drill cuttings management options, made in conjunction with NNP HAZID report (CNRI, 2013d) as there is a lack of data upon which to base a QRA. The assessment quantifies the risks of each drill cutting decommissioning option assessing likelihood, consequence and risk of incident (CNRI, 2016e).

**Table 5.5: Qualitative safety assessment (risk to project personnel offshore) results and normalised weightings for drill cuttings decommissioning options**

| Decommissioning option | Summed total | Normalised/ weighted score | Ranking |
|---|---|---|---|
| **Drill cuttings removal Option 1** (recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore) | 12 | 2.50 | 3 |
| **Drill cuttings removal Option 2** (recover to surface, slurry to shore) | 15 | 2.00 | 4 |
| **Drill cuttings removal Option 3** (recover to surface, offshore re-injection) | 18 | 1.67 | 5 |
| **Drill cuttings Option 4** (redistribution of drill cuttings on the seabed) | 4 | 7.50 | 2 |
| **Drill cuttings Option 5** (leave in situ) | 1 | 30.00 | 1 |

The drill cuttings pile decommissioning Option 5 of leaving in situ was ranked as resulting in the lowest risk to project personnel safety (Table 5.5). This is due to the limited or minimal operations associated with this option, reducing the risk of the activity. The other options for drill cuttings decommissioning scored higher, representing a relatively greater risk to project personnel safety.

Decommissioning Options 1, 2 and 3 scored very closely, with scores of 2.50, 2.00 and 1.67 respectively. Option 1 involves the platform crew and mobilisation of the cuttings to the platform for treatment. The increased risk, when compared to options 4 and 5 can be attributed to the greater duration of operations and increased personnel exposure, both onshore and offshore. Greater risk of accident or injury may be possible with the inclusion of using offshore drill cutting treatment equipment.

The risks which drive the weighted score (2.00) of Option 2 can be attributed to the increased ship collision risk due to a tanker vessel working alongside the platform to recover cuttings. Additionally, the increased personnel and on-deck risks as well as vessel crew and special vendor crew required for operation, increase the risk associated with this Option. An additional 490 days of onshore operations and offloading trips to shore, compound to the large amount of vessel working, which attribute to the risk of the Option.

Option 3 was weighted the lowest, indicating an increased risk to project personnel safety, this may be due to the increased duration of operations, and more hazardous working environment (wells under pressure, for example) associated with this option. The potential for multiple fatalities in the event of loss of well control is an identified issue with option 3 attributing to its summed total and weighted/normalised score.

Option 4 was considered the second best option in terms of personnel safety, attaining a higher score than Options 1, 2 and 3; with a score of 7.50. The reduced risk associated with Option 4, can be attributed to the lower level of personnel-dependant activities, when compared with all the options except for Option 5.

The qualitative assessment results and normalised weightings for economic risks to fisheries is captured in Section 5.4.1, Table 5.13.

## 5.2 Environmental Differentiation

The following section provides the qualitative and quantitative assessments for environmental impact of each of the decommissioning options for the NNP jacket and drill cuttings pile.

### 5.2.1 Qualitative assessment of environmental risk

A qualitative assessment of environmental risk was undertaken in the CA workshop. The assessment enabled a distinction to be made between four categories of risk; High, Moderate-High, Moderate and Low. Differentiation between decommissioning options was based on the level of risk assessed for each receptor and the total number of potentially impacted receptors per activity/ operation or endpoint. Appendix A provides a detailed breakdown of how these results were achieved.

The assessments included the completion of risk assessment worksheets (Appendix A) which address the general activities associated with decommissioning and specific activities associated with the seven decommissioning options (two for jacket and five for the drill cuttings pile). Totals (Table 5.6) were calculated from the worksheets by adding the risk values assigned to each activity (row-by-row) and summing the activity values relevant to each decommissioning method. The summed totals were normalised by the weightings assigned by CNRI with the maximum weighted value assigned to the decommissioning method with the lowest total. The subsequent normalised/ weighted values were then calculated in relation to this lowest risk method.

**Table 5.6: Environmental risk assessment results and normalised weightings for jacket decommissioning option**

| Decommissioning option | Summed total | Normalised/ weighted score | Ranking |
|---|---|---|---|
| **Jacket full removal** (multiple lifts) | 343 | 8.61 | 2 |
| **Jacket partial removal** (multiple lifts) | 222 | 13.30 | 1 |

The majority of the moderate or moderate-high environmental risk activities for the jacket decommissioning options are derived from activities common to all options (Appendix A; Tables A.4, A.5 and A.11). These include:

- Anchoring of vessels on seabed;
- Offshore removal of marine growth from jacket using high pressure jet cleaner;
- Use of land based facilities for the disposal of jacket waste; and
- Underwater noise associated with decommissioning activities (vessels and equipment).

The key environmental risks that differentiate the decommissioning options include:

- Anchoring of vessels on contaminated sediments within 500 m of NNP but not on the drill cuttings pile.
- Underwater cutting of jacket footings (piles would be cut 3 m below seabed).
- Physical presence of jacket footings left in situ (release of contaminants).

The method of partial jacket removal using multiple lifts was considered to have the smallest environmental impact, i.e. lowest total and therefore has the highest normalised/ weighted value of 13.30.

The main differentiation between the two options for the jacket decommissioning is in the treatment of the jacket footings. In full removal, the jacket footings must be removed, and the piles cut three metres below the seabed. Conversely, a key consideration identified in the partial removal option was the physical presence of the footings left in situ. It is evident that in a number of the scoring criteria, such as the offshore removal of marine growth and dismantling of recovered structures/ materials onshore, the partial removal option attains lower normalised/ weighted score due to less materials being handled, leading to its lower environmental risk.

**Table 5.7: Environmental risk assessment results and normalised weightings for drill cuttings pile decommissioning options**

| Decommissioning option | Summed total | Normalised/ weighted score | Ranking |
|---|---|---|---|
| **Drill cuttings removal Option 1**<br>(recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore) | 302 | 7.80 | 3 |
| **Drill cuttings removal Option 2**<br>(recover to surface, slurry to shore) | 330 | 7.13 | 4 |
| **Drill cuttings removal Option 3**<br>(recover to surface, offshore re-injection) | 187 | 12.59 | 2 |
| **Drill cuttings Option 4**<br>(redistribution of drill cuttings on the seabed) | 370 | 6.36 | 5 |
| **Drill cuttings Option 5**<br>(leave in situ) | 177 | 13.30 | 1 |

With the drill cuttings decommissioning options, there are potential environmental risks common to several of the Options, which range from low to medium risk (Appendix A; Table A.6 – A.10 and Table A.13). These include:

- Offshore discharge of treated oily fluids in offshore waters (shared by Options 1 and 2)
- Fluidisation of cuttings, blockage of suction dredging equipment during excavation of drill cuttings pile and recovery to surface (shared by Options 1, 2 and 3)
- Onshore disposal of the drill cuttings (shared by Options 1 and 2)
- Accidental spill/ release of cuttings during surface treatment, disposal or transport to shore (Options 1, 2 and 3)

The key environmental risks that differentiate the decommissioning options include:

- Onshore treatment of the solid waste (Option 1).
- Discharge of oily water under permit in a coastal environment (Option 2).
- Accidental spill/ release of cuttings during injection (Option 3).

- Fluidisation of cuttings, blockage of suction dredging equipment during excavation of drill cuttings pile and recovery to the surface using ROV dredge system and disposal of cuttings (Option 3).
- Fluidisation of cuttings, blockage of suction dredging equipment during excavation and redistribution of the drill cuttings pile (Option 4).
- Fishing gear interaction with redistributed drill cuttings (Option 4).
- Excavation of the drill cuttings pile and redistribution to another area of seabed (several locations 70m from the platform) (Option 4).
- Leave in situ to degrade naturally (Option 5).
- Long term degradation of footings leading to falling jacket members and structures (Option 5).
- Fishing gear interaction with peripheral drill cuttings (Option 5).

Options 1, 2 and 4 have scored similarly (7.80, 7.13 and 6.36 respectively) furthermore, Options 3 and 5 have scored similarly at 12.59 and 13.30 respectively. A higher weighted/normalised score indicates options with less environmental risk. Option 5 (leave in situ) was considered to have the least environmental risk, and thus the highest normalised/ weighted score at 13.30. Option 5 differs from the other options by the fact that the drill cuttings will not be removed and/ or there will be minimal disturbance to the current seabed state.

The normalised/ weighted score of Option 3 (12.59) was close to Option 5 (13.30). The main differentiators between these options are related to the fluidisation of cuttings, use of suction dredging equipment during excavation and redistribution of the drill cuttings pile and risk of accidental spill/ release of cuttings during re-injection, all included in Option 3, but absent in Option 5. These factors attributed to the greater risk and subsequent lower normalised/ weighted score in Option 3 ranking it overall as the second to be recommended, when compared to Option 5 which is the recommended option, with a ranking of “1”.

The differentiation between Options 1 and 2 is in the accidental spill/ release of cuttings during surface treatment, disposal or transport to shore in which Option 2 scored higher on risk; coupled with the greater risk of the discharge of oily water under permit in a coastal environment, lead to a lower normalised/ weighted score overall and hence considered a greater overall risk to the environment. Option 2 may be considered the second least favourable option in consideration of environmental risk, with a normalised/ weighted score overall for drill cuttings decommissioning at 7.13.

Option 4, although similar in overall normalised/ weighted score, shares no similar activities with Options 1 and/ or 2. It can be considered the least favourable option in terms of environmental risk, as it is the lowest normalised/ weighted score overall for drill cuttings decommissioning at 6.36 attaining the ranking of “5”. This score is most likely due to the environmental impact of the excavation and redistribution of the drill cuttings to another area of seabed.

### 5.2.2 Quantitative assessment of energy and emissions differentiation

The quantitative estimates of energy usage and emissions provide the basis for differentiating and scoring each option (CNRI, 2016d). The method outlined follows the "Guidelines for Calculation of Energy Use and Gaseous Emissions in Decommissioning" (IoP, 2000).

The method considers the fate of decommissioned material from pre-decommissioning preparation to an onshore end-point, such as recycling or disposal to landfill. The total quantities of energy use (and CO2 emissions) were calculated by:

1. Estimating quantities of diesel fuel consumed by vessels involved in the work programmes offshore.
2. Estimating quantities of aviation fuel used for helicopter operations.
3. Estimating quantities of diesel consumed during the haulage onshore of the materials to landfill, treatment or recycling facilities.
4. Estimating the energy required for the onshore dismantling and/ or processing of materials.
5. Estimating quantities of materials required to replace the materials left in situ in the jacket footings
6. Estimating the energy required for the recycling of materials.
7. Multiplying these quantities by energy content and emission factors (IoP, 2000).

Appendix B provides further detail on the Energy and Emissions methodology and results.

Tables 5.8 and 5.9 provide a summary of the energy use (in gigajoules (GJ)) and emissions (in tonnes of CO2) for each decommissioning method for jacket and drill cuttings pile, respectively. The maximum normalised/ weighted value has been assigned to the most preferable (lowest risk option). Energy and Emissions has been assigned a maximum weighting of 6.7, which has subsequently been divided between energy use and emissions (a maximum weighted value of 3.35 for each).

The scores for the remaining options have been calculated in inverse proportion to their overall summed totals.

**Table 5.8: Energy and emissions assessment results and normalised weightings for jacket decommissioning options**

| Decommissioning option | Energy | | Emissions | | Combined normalise/ weighted score | Ranking |
|---|---|---|---|---|---|---|
| | Energy usage (GJ) | Normalised weighted score | Emissions (Tonnes $CO_2$) | Normalised weighted score | | |
| **Jacket full removal*** (multiple lifts) | 297,654 | 3.35 | 24,277 | 3.35 | 6.70 | 1 |
| **Jacket partial removal** (multiple lifts) | 530,148 | 1.88 | 31,064 | 2.62 | 4.50 | 2 |

Source: CNRI (2016d)

*Full removal of jacket involves water jetting of the cuttings pile to access the footing. Energy use and emissions associated with jetting are not accounted for here.

Full removal is ranked as resulting in the lowest impact (6.70) from energy use and emissions compared to partial removal (4.50) due to the minimal requirement for new manufacture of materials decommissioned in situ (Table 5.8).

Option 5, leaving in situ, was ranked as resulting in the lowest impact in regards to energy use and emissions (Table 5.9). This is due to zero emissions and energy use associated with no action. The four remaining options scored considerably higher.

Options 3 and 4 were very similar in their scores, with Option 4 having a slightly higher score and lower impact in regards to energy use and emissions. Those options were closely followed by Option 1, involving offshore treatment and onshore disposal, with energy usage and emissions slightly higher. The lowest scoring option was Option 2, onshore treatment and disposal.

A full breakdown of the contributing factors and their relating energy and emission values for both jacket and drill cuttings pile decommissioning options is presented in Appendix B.

**Table 5.9: Energy and emissions assessment results and normalised weightings for drill cuttings pile decommissioning options**

| Decommissioning option | Energy | | Emissions | | Combined normalise/ weighted score | Ranking |
|---|---|---|---|---|---|---|
| | Energy usage (GJ) | Normalised weighted score | Emissions (Tonnes $CO_2$) | Normalised weighted score | | |
| **Drill cuttings removal Option 1** (recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore) | 120,821 | $2.77 \times 10^{-6}$ | 7,665.9 | $4.37 \times 10^{-5}$ | $4.65 \times 10^{-5}$ | 4 |
| **Drill cuttings removal Option 2** (recover to surface, slurry to shore) | 304,063 | $1.10 \times 10^{-6}$ | 21,137.8 | $1.58 \times 10^{-5}$ | $1.69 \times 10^{-5}$ | 5 |
| **Drill cuttings removal Option 3** (recover to surface, offshore re-injection) | 109,497 | $3.06 \times 10^{-6}$ | 6,480.0 | $5.17 \times 10^{-5}$ | $5.48 \times 10^{-5}$ | 3 |
| **Drill cuttings Option 4** (redistribution of drill cuttings on the seabed) | 87,278 | $3.83 \times 10^{-6}$ | 6,480.0 | $5.17 \times 10^{-5}$ | $5.55 \times 10^{-5}$ | 2 |
| **Drill cuttings Option 5** (leave in situ) | 0* | 3.35 | 0* | 3.35 | 6.70 | 1 |

Source: CNRI (2016d)

*For the purpose of mathematical calculations it was assumed that zero has a nominal value of $1 \times 10^{-1}$

## 5.3 Assessment of Technical Feasibility

For the decommissioning of the Ninian Northern jacket, five decommissioning options were assessed for their technical feasibility. The decommissioning options that were previously considered were:

- Full removal by single lift;
- Full removal by multiple lifts;
- Partial removal by single lift;
- Partial removal by multiple lifts; and
- Removal by BTA.

The options were assessed using CNRI's Technical Feasibility assessment, based on the following three technical sub-criteria detailed in CNRI's Consequence Matrix (Appendix A):

- Technical Feasibility (Consequence criteria 1);
- Ease of Recovery (Consequence criteria 2); and
- Use of Proven Technology and Equipment (Consequence criteria 3).

Following the workshop, three options were not taken forward for further assessment, due to the absence of suitable vessel capabilities available to lift the jacket in a single lift, or to the derogation depth of 88.5 m.

Drill cuttings removal options which were previously considered included; leave in situ; dispersal, redistribution of drill cuttings on seabed; recovery to surface, solids disposed onshore, liquids disposed offshore; recovery to surface, solids disposed onshore; liquids disposed offshore, solids and liquids slurry taken for disposal onshore; and re-injection of solids/ liquids slurry to disposal well offshore.

All five drill cuttings removal options were considered in the technical feasibility assessment and all options were taken forward for further assessment in the CA process. Although a number of these options were technically challenging none of the options scored a consequence rating of 6 from the CNRI consequence matrix (Appendix A) and were therefore carried forward for further assessment.

The results of the technical feasibility assessment are presented in Appendix C and summarised in Tables 5.10 and 5.11.

For each decommissioning option, the assessment criteria were scored and each score was assigned a normalised/ weighting. These weights were summed and a total normalised weighting value for technical feasibility was generated. Each sub-criterion had a maximum normalised weighting of 6.67 (Tables 5.17 and 5.18), representing one third of the total weighting allocated to the Technical Feasibility criterion (20) (Table 4.2). A weighted score of 6.67 was applied to the highest scoring (lowest risk) sub-criteria option. The subsequent normalised/ weighted values were then calculated in relation to this lowest risk method. Weightings of the sub-criterion for each option were summed to give an overall weighting out of 20.

**Table 5.10: Technical feasibility assessment results and normalised weightings for jacket decommissioning options**

| Decommissioning option | Technical feasibility | | Ease of recover from excursion | | Use of proven technology and equipment | | Total normalised/ weighted score | Ranking |
|---|---|---|---|---|---|---|---|---|
| | Summed total | Normalised/ weighted score | Summed total | Normalised/ weighted score | Summed total | Normalised/ weighted score | | |
| **Jacket full removal** (multiple lifts) | 16 | 1.67 | 16 | 5.00 | 12 | 2.22 | 8.89 | 2 |
| **Jacket partial removal** (multiple lifts) | 4 | 6.67 | 12 | 6.67 | 4 | 6.67 | 20.00 | 1 |

The jacket decommissioning option of partial removal is considered to have the least likelihood of failure with a higher normalised/ weighted score than the jacket full removal option (Table 5.10). This is the result of the greater risk of failure in the technical feasibility, ease of recovery and use of proven technology and equipment criteria in the full removal method. The reasoning behind this was associated with the increased complexity and scale of a full removal method when compared to the partial removal method proposed.

**Table 5.11: Technical feasibility assessment results and normalised weightings for drill cuttings pile decommissioning options**

| Decommissioning option | Technical feasibility | | Ease of recover from excursion | | Use of proven technology and equipment | | Sum total normalised/ weighted score | Ranking |
|---|---|---|---|---|---|---|---|---|
| | Summed total | Normalised/ weighted score | Summed total | Normalised/ weighted score | Summed total | Normalised/ weighted score | | |
| **Drill cuttings removal Option 1** (recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore) | 16 | 0.42 | 9 | 0.74 | 20 | 0.33 | 1.49 | 3 |
| **Drill cuttings removal Option 2** (recover to surface, slurry to shore) | 16 | 0.42 | 9 | 0.74 | 20 | 0.33 | 1.49 | 3 |
| **Drill cuttings removal Option 3** (recover to surface, offshore re-injection) | 20 | 0.33 | 25 | 0.27 | 16 | 0.41 | 1.02 | 4 |
| **Drill cuttings Option 4** (redistribution of drill cuttings on the seabed) | 9 | 0.74 | 6 | 1.11 | 6 | 1.11 | 2.96 | 2 |
| **Drill cuttings Option 5** (leave in situ) | 1 | 6.67 | 1 | 6.67 | 1 | 6.67 | 20.00 | 1 |

Drill cuttings Option 5 (leave in situ) attained the highest normalised/ weighted score, and therefore considered as the least likely of failure in terms of technical feasibility (Table 5.11). This can be attributed to the nature of leave in situ option for the drill cuttings, in which activities are absent and/ or kept to a minimum, resulting in lowered risk and a subsequent higher normalised/ weighted score.

Options 1 and 2 scored identically due to the likelihood of failure and consequences being assessed to be at the same levels. Options 1 and 2 shared moderate levels of uncertainties in the technical feasibility, and equal values of ease of recovery from excursion attributed to the availability of equipment, and time required to get other equipment to undertake both options. Furthermore, the use of proven technology and equipment of each option was assessed to be of the same value, due to the need for adaptation to current methods and equipment and associated uncertainties in these adaptations (Appendix C).

Option 4 scored the second highest normalised/ weighted score, and therefore may be considered the option second most likely to succeed, after Option 5. The reduced risk of failure of Option 4 can be attributed to the relatively simple process, ease of operations and sourcing of equipment. The greatest risk with Option 4 was in relation to the ease of recovery from excursion.

Option 3 attained the lowest normalised/ weighted score and therefore may be considered as the most likely to fail in terms of technical feasibility. This can be attributed to the high level of uncertainty on how to achieve the operation, lack of testing and previous knowledge and/ or experience undertaking the method.

A full breakdown of the contributing factors and their relating risk scoring values is presented in Appendix C.

## 5.4 Societal Impact Differentiation

The following section describes the societal impacts of the decommissioning options for both the jacket and drill cuttings pile and their subsequent qualitative scoring.

### 5.4.1 Qualitative assessment of societal impacts

Qualitative assessment of societal risk made a distinction between four categories of risk: High, Moderate-high, Moderate and Low. Differentiation between both of the jacket decommissioning options and the five drill cuttings pile options were based on the level of risk assessed for each receptor and the total number of potentially impacted receptors per activity/ operation or endpoint. Appendix A provides a detailed breakdown of how these results were achieved.

The assessments included the completion of risk assessment worksheets (Appendix A) which address the general activities associated with decommissioning and specific activities associated with both jacket decommissioning options and the five options for the drill cuttings pile. Totals were calculated from the worksheets by adding risk values assigned to each activity (row-by-row) and summing the activity values relevant to each decommissioning method (Tables 5.12 and 5.13). The summed totals were normalised by the weights assigned by CNRI with the maximum weighted value were assigned to the lowest risk method. The subsequent normalised/ weighted values were then calculated in relation to the lowest risk method.

**Table 5.12: Societal risk assessment results and normalised weightings for jacket decommissioning options**

| Decommissioning option | Summed total | Normalised/ weighted score | Ranking |
|---|---|---|---|
| **Jacket full removal** (multiple lifts) | 86 | 9.42 | 2 |
| **Jacket partial removal** (multiple lifts) | 81 | 10.00 | 1 |

The method for partial removal of the jacket had the highest normalised/ weighted score of 10 for societal risk. The method for full removal of the jacket scored slightly lower than partial removal with a normalised/ weighted score of 9.42. Therefore, although the scores for these options were insignificant it can be considered that decommissioning by partial removal will have a relatively lower societal impact than decommissioning by full removal (Appendix A, Table A.12). In terms of societal risk, these options are similar, however the difference in overall score can be attributed to the increased risk of societal impact when dismantling recovered materials onshore and the use of land based facilities for disposal of jacket waste of full removal when compared to the same activities when considering partial removal.

**Table 5.13: Societal risk assessment results and normalised weightings for drill cuttings pile decommissioning options**

| Decommissioning option | Summed total | Normalised/ weighted score | Rank |
|---|---|---|---|
| **Drill cuttings removal Option 1** (recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore) | 138 | 1.09 | 4 |
| **Drill cuttings removal Option 2** (recover to surface, slurry to shore) | 180 | 0.83 | 5 |
| **Drill cuttings removal Option 3** (recover to surface, offshore re-injection) | 44 | 3.41 | 2 |
| **Drill cuttings Option 4** (redistribution of drill cuttings on the seabed) | 61 | 2.46 | 3 |
| **Drill cuttings Option 5** (leave in situ) | 15 | 10.00 | 1 |

Option 5 had the highest normalised/ weighted score of 10 for societal risk, and therefore can be considered to be the option with the least societal impact. This is the result of leaving the drill cuttings pile in situ, and the absence/ minimisation of activity attributed within this option.

Options 1 and 2 scored similarly at 1.09 and 0.83, respectively. Option 1 has the higher normalised/ weighted score as it differs in treating solid waste onshore, whereas Option 2 has considered the discharge of oily water under permit in a coastal environment, regarded at moderate to moderate-high societal risk. Option 2 has the lowest of the normalised/ weighted scores, and therefore may be considered the option with the highest risk to incur societal impacts.

Options 3 and 4 have quite similar normalised/ weighted scores, with 3.41 and 2.46 respectively. Option 3 can be considered to have the second least risk to societal impact. The low risk of Option 3 is resultant of the relatively low risk to societal impact of accidental spill/ release of cuttings during injection. Option 4 scored lower than Options 3 and 5, due to the excavation of the drill cuttings and redistribution to another area of seabed which has the potential for interaction of fishing gear with the redistributed drill cuttings.

A full breakdown of the contributing factors and their relating risk scoring values is presented in Appendix A, Table A.14.

## 5.5 Economic Differentiation

This section provides cost estimates for the decommissioning options for both the jacket and the drill cuttings pile. Vessel costs have been estimated by vessel days and rates provided by CNRI. Tables 5.14 and 5.15 provide a comparison for the decommissioning options ranked by cost (economic). Appendix D provides a full description of estimated costs for each drill cuttings decommissioning option, jacket cost estimations were provided by CNRI (Table 5.14.). The maximum normalised/ weighted value was assigned to the option with the lowest cost. The values for the remaining options have been calculated in inverse proportion to their overall summed totals.

**Table 5.14: Economic (quantitative) risk assessment results and normalised weightings for jacket decommissioning options**

| Decommissioning option | Monitoring and ongoing liability (GBP) | Estimated cost of decommissioning jacket (GBP) | Summed total (GBP) | Normalised/ weighted score |
|---|---|---|---|---|
| **Jacket full removal** (multiple lifts) | -* | -* | -* | 10.71 |
| **Jacket partial removal** (multiple lifts) | -* | -* | -* | 20.00 |

*Values are not displayed due to their commercially sensitive nature.

Jacket decommissioning by partial removal is the least expensive option and has the highest normalised/ weighted score of 20. With a normalised/ weighted score of 10.71, decommissioning the jacket by full removal was found to be more expensive than the partial remove option. Decommissioning by partial removal requires less of the structure to be removed and is a less complex operation, which is considered to be the main drivers of the higher cost when assessing decommissioning by full removal.

**Table 5.15: Economic (quantitative) risk assessment results and normalised weightings for drill cuttings pile decommissioning options**

| Decommissioning option | Summed total (GBP) | Normalised/ weighted score | Rank |
|---|---|---|---|
| **Drill cuttings removal Option 1** (recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore) | -* | 0.63 | 3 |
| **Drill cuttings removal Option 2** (recover to surface, slurry to shore) | -* | 0.53 | 4 |
| **Drill cuttings removal Option 3** (recover to surface, offshore re-injection) | -* | 0.33 | 5 |
| **Drill cuttings Option 4** (redistribution of drill cuttings on the seabed) | -* | 2.06 | 2 |
| **Drill cuttings Option 5** (leave in situ) | -* | 20.00 | 1 |

*Values are not displayed due to their commercially sensitive nature.

Option 5 attained a significantly higher normalised/ weighted score of 20.00 and cost of £2,000,000 when compared with the other drill cuttings decommissioning options. This can be attributed to the minimal activity levels required to undertake Option 5, and therefore the economic savings associated.

Options 1, 2 and 3 scored similar normalised/ weighted results with values of 0.63, 0.53 and 0.33, respectively. Option 4 attained a higher score than Options 1, 2 and 3 with a score of 2.06, and therefore can be considered to be the option with the second least economic risk, after Option 5. The higher score of Option 4, and the subsequent reduced risk, can be attributed to the lower level of activities and operations associated with this option. Options 1, 2 and 3 all consider the full removal of the drill cuttings, which can not only be considered more technically challenging but also considered to have a greater economic risk to undertake and a higher associated cost. Summed total values are commercially sensitive, however a full cost report will be sent to BEIS for approval.

## 5.6 Interactions between the Jacket and Drill Cuttings Pile

The assessed decommissioning options for the NNP jacket and drill cuttings pile have been assessed separately, based on the individual merits and disadvantages of the options.

As the drill cuttings piles are located directly below, and in the area surrounding the jacket and footings, there must be consideration given to the combined impacts of disturbing the drill cuttings pile to access or fully remove the jacket.

The five drill cuttings pile decommissioning options were assessed against their interaction with the jacket removal options and the drill cuttings pile.

- **Options 1 to 3.** These three options were assessed to have similar seabed disturbance due to the fluidisation of the drill cuttings prior to recovery to surface.
- **Option 4**. This option was assessed to have the greatest impact and greatest interaction between the cutting pile and the jacket.
- **Option 5.** This option is only applicable to partial removal of the NNP jacket. Full removal of the jacket will disturb the drill cuttings pile.

For drill cuttings, when the leave in situ option is discounted the best preforming option is to redistribute over the adjacent seabed (drill cuttings decommissioning Option 4). The weighted scores for Option 4 was then combined with the weighted scores for each of the jacket decommissioning options to determine if the inclusion of the cuttings pile considerations would have an effect on the ranking of the jacket options. The combined recommended option (Section 6.0) is also provided for comparison.

**Table 5.16. Combined ranked decommissioning options for the Ninian Northern Jacket and Drill Cuttings pile**

| Jacket Decommissioning option | Jacket Decommissioning option total normalised/weighted score | Drill Cutting decommissioning option | Drill Cutting decommissioning option total normalised/weighted score | Combined Normalised/ weighted score | Rank |
|---|---|---|---|---|---|
| **Jacket full removal** (multiple lifts) | 62.13 | **Drill cuttings Option 4** (redistribution of drill cuttings on the seabed) | 21.35 | 83.87 | 3 |
| **Jacket partial removal** (multiple lifts) | 88.24 | | | 109.59 | 2 |
| **Jacket partial removal** (multiple lifts) | 88.24 | **Drill cuttings Option 5** (leave in situ) | 100.00 | 188.24 | 1 |

The inclusion of the drill cuttings scores supports the recommended decommissioning option for partial removal of the jacket by multiples lifts and leave in situ of the drill cuttings decommissioning option.

## 5.7 Sensitivity Analysis

A sensitivity analysis was conducted using a Monte-Carlo simulation to test whether the result of the Comparative Assessment would be any different if CNRI had selected different criteria weightings. The results of sensitivity analysis confirmed that CNRI CA results are robust and would not change with different weightings. The inclusion or exclusion of the economic criterion has also been determined to have no effect on the overall rankings of the decommissioning options, as shown in Tables 5.17. and 5.18.

**Table 5.17. Summary of the economic sensitivity analysis for the jacket decommissioning options**

| Criterion | Safety | | Environmental | | | Technical Feasibility | | | Societal | Economic | Normalised/ weighted total value (with economic) | Normalised/ weighted total value (without economic) | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Assessment scope (Sub-criteria):** | Risk to project personnel | Risk to other users of the sea (commercial fisheries) | Impact of Operations and End Points | Total Energy Consumed and $CO_2$ Emissions | | Technical Feasibility | Ease of Recovery from Excursion | Use of Proven Technology and Equipment | Commercial and socio-economic impacts | CAPEX and ongoing costs | | | |
| **Metric:** | Quantitative comparison | | Summed total of environmental risks | Quantity of energy used (GJ) | Quantity of $CO_2$ emitted | Qualitative comparison | | | Summed total of societal risks | Estimated project cost (GBP) (£) | | | |
| **Maximum possible normalised/ weighted value:** | **20.00** | **10.00** | **13.30** | **3.35** | **3.35** | **6.67** | **6.67** | **6.67** | **10.00** | **20.00** | **100.00** | **80.00** | |
| **Jacket Decommissioning Options** | | | | | | | | | | | | | |
| Option 1: Full removal by multiple lifts | | | | | | | | | | | | | |
| Assessment result | 2.519E-02 | 0* | 343 | 297654 | 24276.9 | 16 | 16 | 12 | 86 | -** | | | |
| Normalised/ weighted value | 7.80 | 10.00 | 8.61 | 3.35 | 3.35 | 1.67 | 5.00 | 2.22 | 9.42 | 10.71 | **62.13** | **51.43** | **2** |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Option 2: Partial removal by multiple lifts | | | | | | | | | | | | | |
| Assessment result | 1.039E-02 | 2.30E-05 | 222 | 530148 | 31064.1 | 4 | 12 | 4 | 81 | -** | | | |
| Normalised/ weighted value | 20.00 | 0.43 | 13.30 | 1.88 | 2.62 | 6.67 | 6.67 | 6.67 | 10.00 | 20.00 | **88.24** | **68.24** | **1** |

*For the purpose of mathematical calculations it was assumed that zero has a nominal value of 1 x $10^{-6}$

**Values are not displayed due to their commercially sensitive nature.

### Table 5.18. Summary of the economic sensitivity analysis for the drill cuttings pile decommissioning options

| Criterion | Safety | Environmental | | | Technical Feasibility | | | Societal | Economic | Normalised/ weighted total value (with economic) | Normalised/ weighted total value (without economic) | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Assessment scope (Sub-criteria):** | Risk to project personnel (offshore) | Impact of Operations and End Points | Total Energy Consumed and $CO_2$ Emissions | | Technical Feasibility | Ease of Recovery from Excursion | Use of Proven Technology and Equipment | Commercial and socio-economic impacts | CAPEX and ongoing calls | | | |
| **Metric:** | Qualitative comparison | Summed total of environmental risks | Quantity of energy used(GJ) | Quantity of $CO_2$ emitted | Qualitative comparison | | | Summed total of societal risks | Estimated project cost (GBP) (£) | | | |
| **Maximum possible normalised/ weighted value:** | **30** | **13.3** | **3.35** | **3.35** | **6.67** | **6.67** | **6.67** | **10** | **20** | **100** | **80** | |
| **Drill Cuttings Pile Decommissioning Options** | | | | | | | | | | | | |
| Option 1: Recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore | | | | | | | | | | | | |
| Assessment result | 12 | 302 | 120821 | 7665.9 | 16 | 9 | 20 | 138 | -** | | | |
| Normalised/ weighted value | 2.50 | 7.80 | 2.77E-06 | 4.37E-05 | 0.42 | 0.74 | 0.33 | 1.09 | 0.63 | **13.51** | **12.88** | **4** |

| Criterion | Safety | Environmental | | | Technical Feasibility | | | Societal | Economic | Normalised/ weighted total value (with economic) | Normalised/ weighted total value (without economic) | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Option 2: Recover to surface, slurry to shore | | | | | | | | | | | | |
| Assessment result | 15 | 330 | 304063 | 21137.8 | 16 | 9 | 20 | 180 | -** | | | |
| Normalised/ weighted value | 2.00 | 7.13 | 1.10E-06 | 1.58E-05 | 0.42 | 0.74 | 0.33 | 0.83 | 0.53 | **11.98** | **11.45** | **5** |
| Option 3: Recover to surface, offshore re-injection | | | | | | | | | | | | |
| Assessment result | 18 | 187 | 109497 | 6480 | 20 | 25 | 16 | 44 | -** | | | |
| Normalised/ weighted value | 1.67 | 12.59 | 3.06E-06 | 5.17E-05 | 0.33 | 0.27 | 0.42 | 3.41 | 0.33 | **19.02** | **18.69** | **3** |
| Option 4: Redistribution of drill cuttings on the seabed | | | | | | | | | | | | |
| Assessment Result | 4 | 370 | 87278 | 6480 | 9 | 6 | 6 | 61 | -** | | | |
| Normalised/ weighted value | 7.50 | 6.36 | 3.84E-06 | 5.17E-05 | 0.74 | 1.11 | 1.11 | 2.46 | 2.06 | **21.35** | **19.29** | **2** |
| Option 5: Leave in situ | | | | | | | | | | | | |
| Assessment result | 1 | 177 | 0* | 0* | 1 | 1 | 1 | 15 | -** | | | |
| Normalised/ weighted value | 30.00 | 13.30 | 3.35 | 3.35 | 6.67 | 6.67 | 6.67 | 10.00 | 20.00 | **100.00** | **80.00** | **1** |

*For the purpose of mathematical calculations it was assumed that zero has a nominal value of $1 \times 10^{-1}$

**Values are not displayed due to their commercially sensitive nature.

# 6.0 CONCLUSIONS

The cumulative scoring of the criteria for the two jacket decommissioning options and five drill cuttings pile decommissioning methods are presented below. The performances of the evaluation criteria for the methods are represented graphically, such that the higher normalised/ weighted value the better the outcome.

## 6.1 Jacket Decommissioning

This section details the final CA scores for the various assessment criteria in graphs for both jacket decommissioning options for the NNP.

**Full removal by multiple lifts**

Full removal scored lower (**62.13/ 100**) than the partial removal option for the NNP jacket and scored lower across all criteria assessed, it is therefore less recommended as a decommissioning option than the partial removal by multiple lifts option.

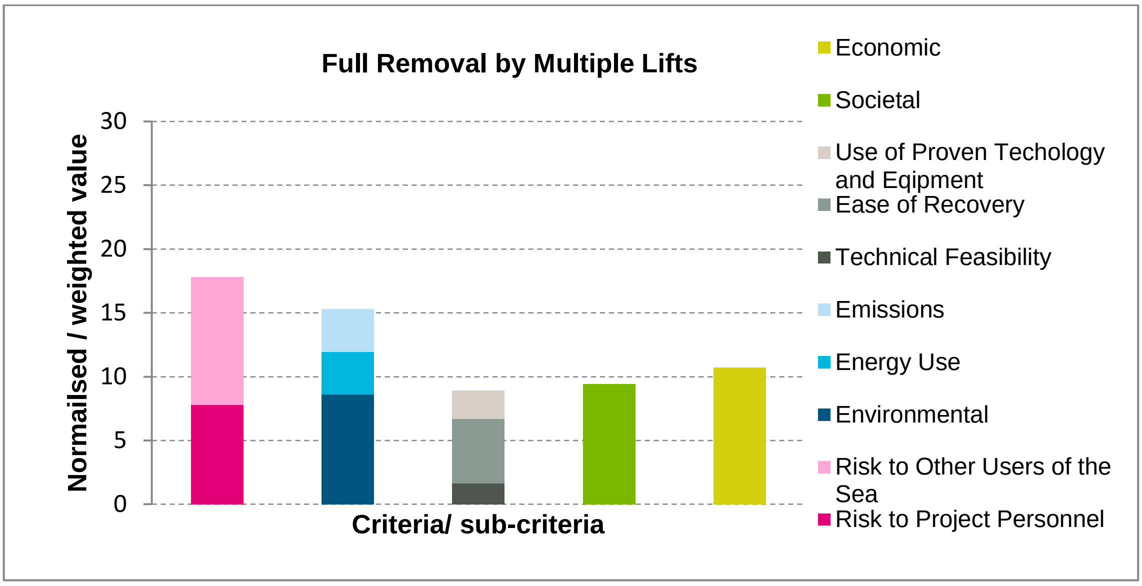



**Figure 6.1: Weighting per criteria for full removal of jacket by multiple lifts**

**Partial removal by multiple lifts**

Partial removal by multiple lifts scored higher (**88.24/ 100**) across all assessed criteria in the CA and would therefore be the recommended option for decommissioning, rather than full jacket removal by multiple lifts. This option had maximum scores in Risk to project Personnel (20), Societal criteria (10) and Economic (20) (Figure 6.2, Table 5.17). Additionally, this option is compatible with Option 5 for drill cuttings removal, the recommended drill cuttings removal option (Section 6.2).

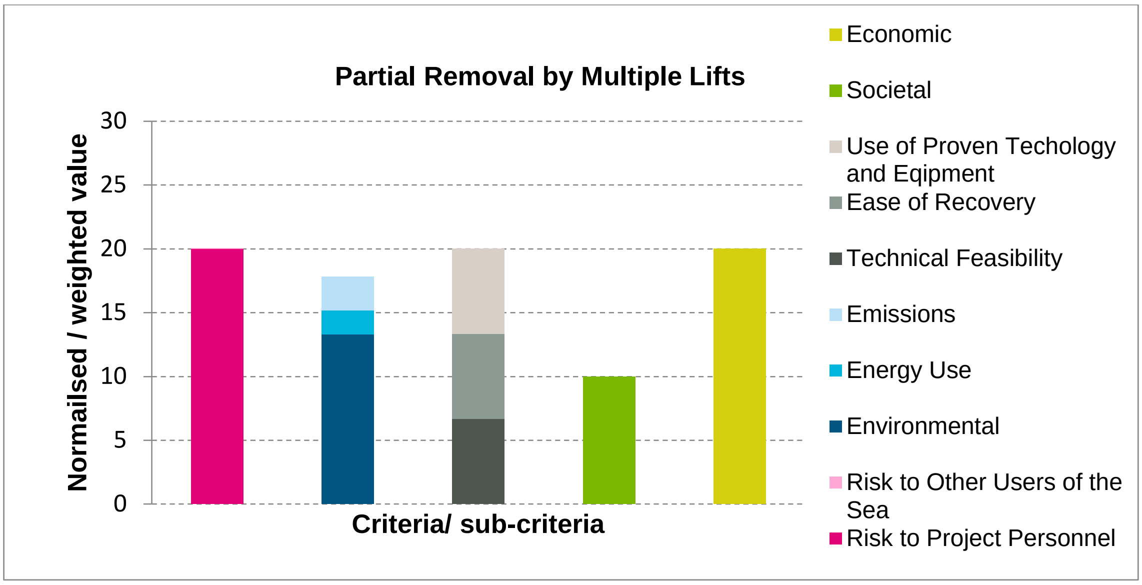



**Figure 6.2: Weighting per criteria for partial removal of jacket by multiple lift**

**The recommended option for jacket decommissioning is partial removal by multiple lifts.**

## 6.2 Drill Cuttings Pile Decommissioning

This section details the final CA scores for the various assessment criteria in graphs for all five drill cutting pile decommissioning options for the NNP.

**Drill cuttings removal Option 1** (recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore)

The drill cuttings removal Option 1 placed fourth (**13.51/ 100**), although there was little difference between this option and Option 2. The main difference is a lower potential to impact the environment, including energy and emissions.

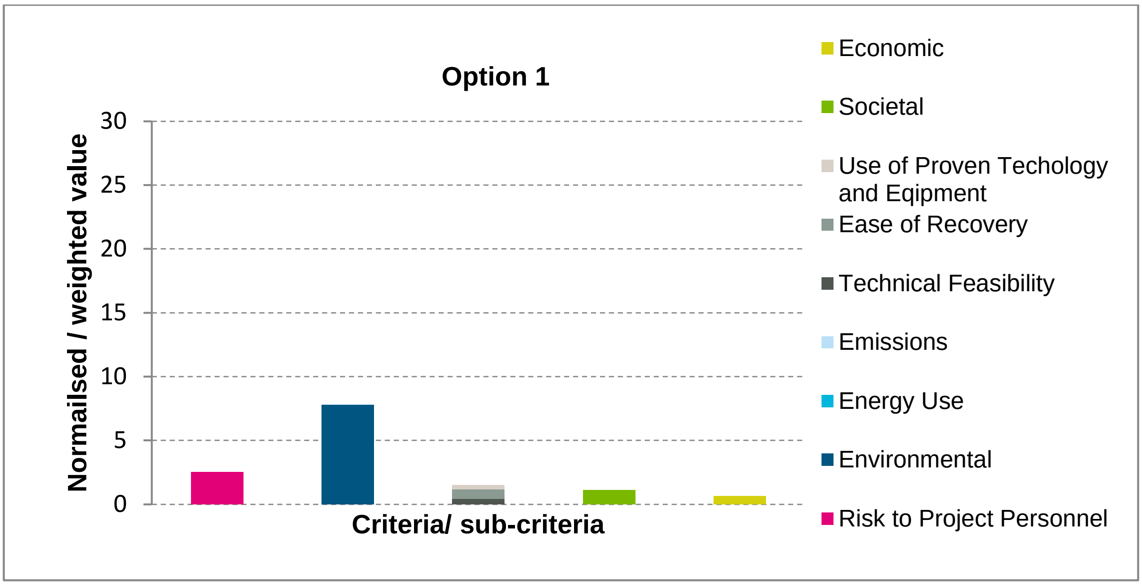



**Figure 6.3: Weighting per criteria for Option 1 - recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore**

**Drill cuttings removal Option 2** (recover to surface, slurry to shore)

The drill cuttings removal Option 2 placed fifth (**11.98/ 100**) out of all five drill cuttings pile decommissioning options.

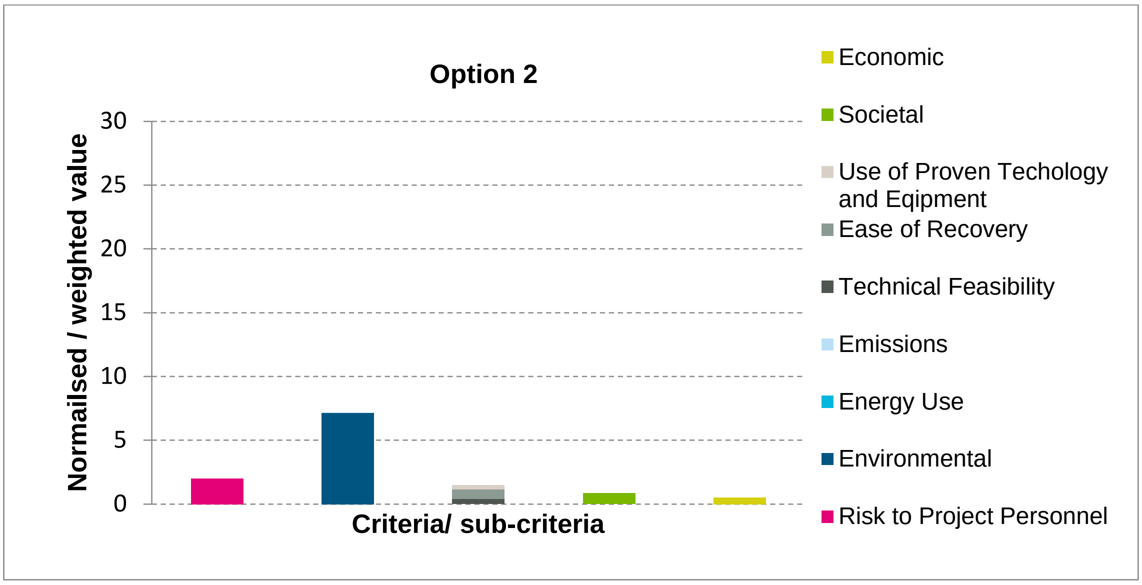



**Figure 6.4: Weighting per criteria for Option 2 - recover to surface, slurry to shore**

**Drill cuttings removal Option 3** (recover to surface, offshore re-injection)

The drill cuttings removal Option 3 ranked third (**19.02/ 100**) and scored similar to Option 4. The main differences were that Option 3 scored higher in Environmental and Societal but scored lower in all other criteria compared to Option 4.

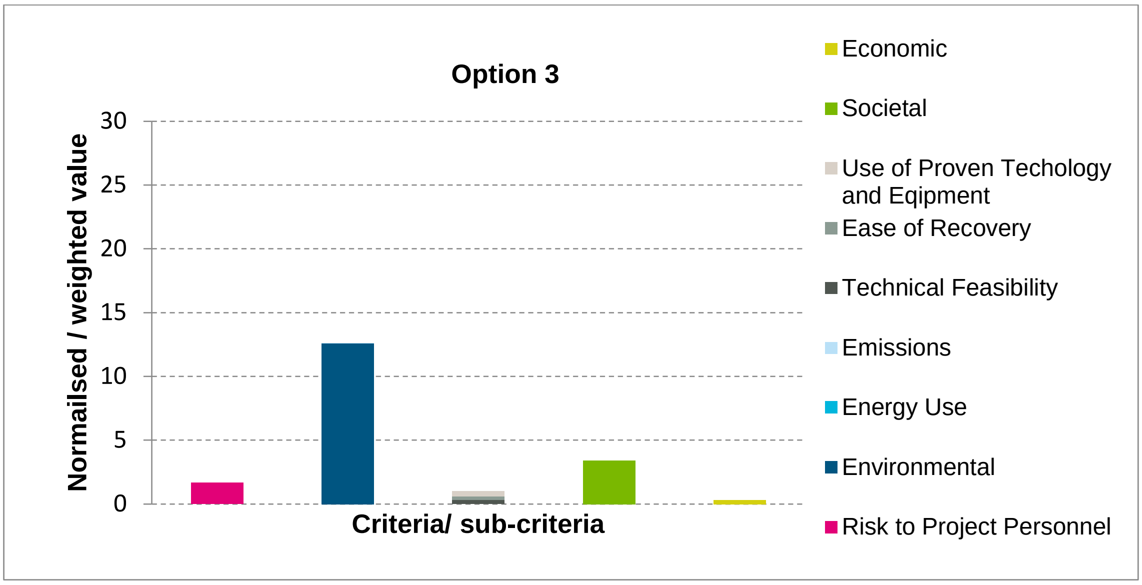



**Figure 6.5: Weighting per criteria for Option 3 - recover to surface, offshore re-injection**

**Drill cuttings removal Option 4** (redistribution of drill cuttings on the seabed)

The drill cuttings removal Option 4 ranked second (**21.35/ 100**) and was similar to Option 3 but scored higher in Safety, Technical Feasibility and Economic criteria.

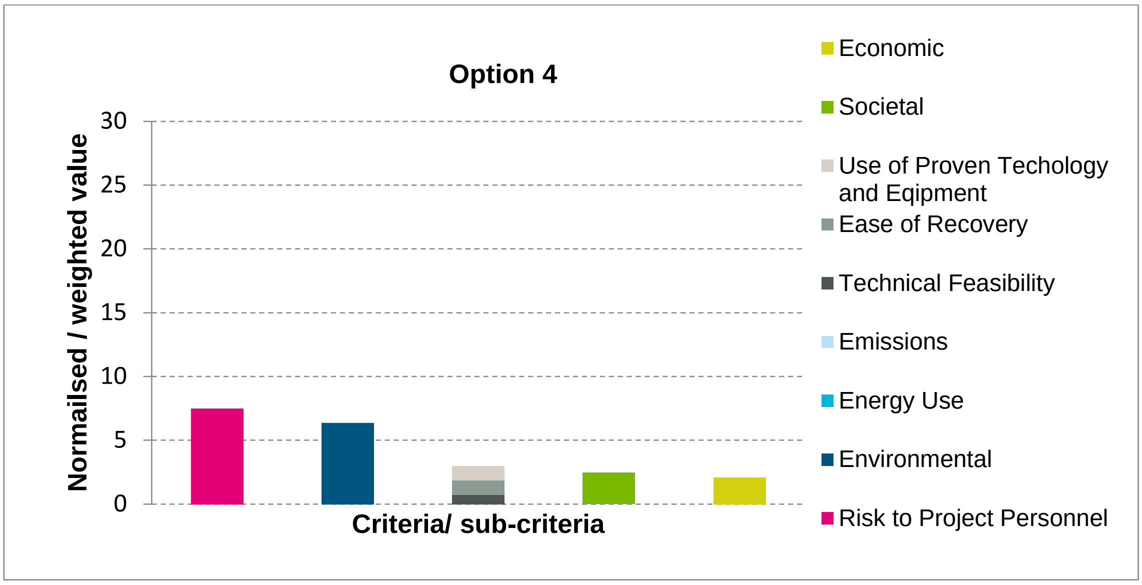



**Figure 6.6: Weighting per criteria for Option 4 - redistribution of drill cuttings on the seabed**

**Drill cuttings Option 5** (leave in situ)

The drill cuttings removal Option 5 ranked first (**100/ 100**) and scored maximum in all assessed criteria.

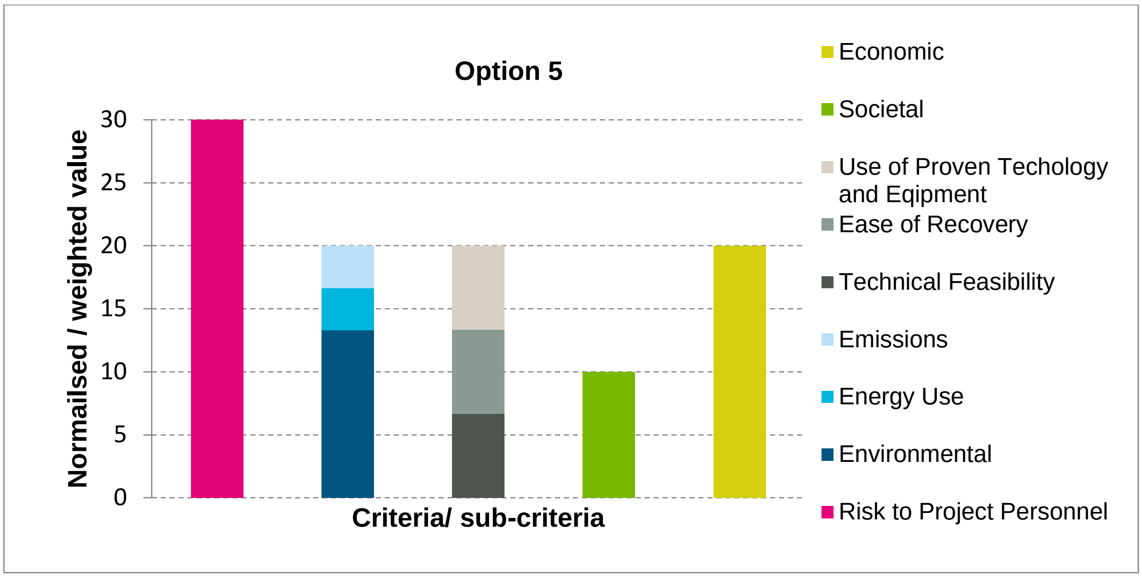



**Figure 6.7: Weighting per criteria for Option 5 - leaving drill cuttings pile in situ**

**The recommended option for the decommissioning of the drill cuttings pile is to leave in situ.**

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# APPENDIX A

## QUALITATIVE ASSESSMENT METHOD

The Comparative Assessment examined the risks and impacts for each of the two options for jacket decommissioning and five options for drill cuttings removal, utilising both a qualitative and quantitative approach. The use of a qualitative assessment of risk is necessarily limited to relatively high-level comparisons. Potential Loss of Life (PLL) index provides a quantitative index of safety that is also used in comparative assessments for decommissioning projects. Quantitative assessments have also been applied to criteria with attributable values, such as total energy consumed and emissions, and economic assessment.

This appendix provides the methodology and results of the qualitative assessment of environmental and societal risk. The assessment enabled a distinction to be made between four categories of risk: High, Moderate-High, Moderate and Low. Differentiation between the decommissioning methods was based on the total number and characteristics of potential impacts associated with each method assessed against these risk categories. The results of environmental and societal components of the risk assessment were compared separately.

### Method

Following the Feasibility Assessments, Environmental and Social Risk Assessments were undertaken for the two decommissioning options considered for jackets and the five decommissioning options considered for drill cuttings. These assessments were undertaken using the following process:

1. Each decommissioning method was broken into its component activities/ operations and end points (e g. underwater cutting, dismantling of recovered structures and waste in landfill).
2. Receptors at risk (elements of society or the environment) were identified from the potential operational impacts and end-point impacts:

- Environment (Physical, Chemical and Biological):

i. Marine environmental impacts/ risks, including operational and end-point impacts/ risks.

ii. Onshore environmental impacts/ risks, including operational and end-point impacts/ risks.

- Societal:

i. Risk to other users of the sea (i.e. commercial impact on fisheries).

ii. Risk to those on land (i.e. onshore transport, quayside lifting operations, waste management, recycling and disposal).

3. The significance of the potential environmental impacts and risks were assessed according to pre-defined criteria. These criteria recognise the likely effectiveness of planned mitigation measures to minimise or eliminate potential impacts/ risks, therefore scoring can be considered to represent post-mitigation.
4. Assessments were undertaken to determine what level of impacts/ risks the component activity/ operation could pose to the different groups of environmental or societal receptors. The following Scoring Criteria and Risk Matrix were applied to complete the worksheets:

- CNRI's Consequence Matrix (Table A.1).
- CNRI's Likelihood Matrix (Table A.2).

5. The overall risk for a particular activity was determined by CNRI's Risk Matrix and Risk Categories (Table A.3).

The results were noted on the environmental and societal risk assessment worksheets alongside any relevant comments (Tables A.4 to A.10).

The assessments resulted in the completion of risk assessment worksheets to address any general activities associated with decommissioning activities and specific activities associated with the two jacket decommissioning options and the five drill cuttings decommissioning options. Results are summarised in Tables A.11 to A.14.

**Table A.1: CNRI Consequence Matrix**

| Consequence criteria | Score | | | | | |
|---|---|---|---|---|---|---|
| | **1 (low)** | **2** | **3** | **4** | **5** | **6 (high)** |
| Environmental impacts of operations (both offshore and onshore). | Slight effect within site boundary; no offsite impact nor water body pollution; no breach of license nor statutory conditions; no regulatory notification required.<br><br>No effects, or very localised effects similar to those already experienced at the site. Effects would disappear once causal agent or event disappears. | Minor effect; short term incident impact within site boundary; single breech of license or statutory limits; minimal offsite impact or waterbody pollution.<br><br>Effects noticeable above existing effects, but not requiring any additional mitigation. Effects would disappear once causal agent or event disappears. Confined to within the 500 m zone offshore, or the environments of onshore site. Full recovery would occur naturally in less than 1 year. | Moderate environmental effect within site boundary with localised or limited offsite or waterbody pollution; remedial actions unlikely to last beyond 1 month; significant or repeated breech of license or statutory limit.<br><br>Effects would be experienced up to 1 to 2 km beyond the 500 m zone offshore, or beyond the site boundary onshore. Additional mitigation measures might be applied to reduce effects. Effects would continue even after causal agent or event disappears. Full recovery would take place naturally within 1 to 2 years. | Major environmental damage within site boundary and/ or significant offsite or waterbody pollution; extensive measures to restore contaminated environment; extended breeches of license or statutory limits with long term effects.<br><br>Effects would be experienced up to 5 km beyond the 500 m zone offshore, or beyond the site boundary onshore. Additional mitigation measures would be required to reduce effects. Effects would continue even after causal agent or event disappears. Full recovery would be likely to take place within 5 years. | Extensive widespread ecological damage beyond site boundary and/ or significant offsite or waterbody pollution with remedial actions unlikely to last beyond 12 months; persistent breeches of license or statutory limits.<br><br>Long-term impact would be experienced at distances of more than 5 km. Extensive mitigation measures would be required, and full recovery would take several years. | Uncontrolled release with extensive widespread ecological damage beyond site boundary with chronic offsite or waterbody pollution with remedial actions lasting over 12 months. |
| Environmental impacts of end-points" (both offshore and onshore) | Slight effect within site boundary; no offsite impact nor water body pollution.<br><br>No effects, or very localised effects similar to those already experienced at the site. Would continue until structure/ component disappeared. | Minor effect; short term incident impact within site boundary; minimal offsite impact or waterbody pollution.<br><br>Effects noticeable above existing effects. Confined to within the 500 m zone offshore, or the environs of onshore site. Would continue until structure/ component disappeared. | Moderate environmental effect within site boundary with localised or limited offsite or waterbody pollution; remedial actions unlikely to last beyond 1 month.<br><br>Effects would be experienced up to 1 to 2 km beyond the 500 m zone offshore, or beyond the site boundary onshore. Would continue until structure/ component disappeared. | Major environmental damage within site boundary and/ or significant offsite or waterbody pollution; extensive measures to restore contaminated environment.<br><br>Effects would be experienced up to 5 km beyond the 500 m zone offshore, or beyond the site boundary onshore. Additional mitigation measures would be required to reduce effects. Would continue until structure/ component disappeared. | Extensive widespread ecological damage beyond site boundary and/ or significant offsite or waterbody pollution with remedial actions unlikely to last beyond 12 months.<br><br>Long-term impact would be experienced at distances of more than 5 km. Extensive mitigation measures would be required. Would continue even after structure/ component disappeared. | Extensive widespread ecological damage beyond site boundary with chronic offsite or waterbody pollution with remedial actions lasting over 12 months. Would continue even after structure/ component disappeared. |
| Technical feasibility | Technological feasibility of the concept is beyond doubt. Expert opinion consistently concludes that the proposed solution is technically robust and complies with existing legislation. The proposed concept has been successfully implemented on multiple directly comparable assets in the past. The supply chain, assets, personnel and expertise to handle the completion of the project are generally readily available in the present market. Project schedule is reasonable and within the timetable assigned as part of the overall corporate strategy. | Technological feasibility of the concept is beyond doubt. Expert opinion consistently concludes that the proposed solution is technically robust and complies with existing legislation. The proposed concept has been successfully implemented on a single directly comparable asset in the past. The supply chain, assets, personnel and expertise to handle the completion of the project require some development. Project schedule is reasonable and within the timetable assigned as part of the overall corporate strategy. | Technological feasibility of the concept requires additional minor engineering to prove. Expert opinion is united in confidence that the proposed solution is generally technically sound and complies with existing legislation. The proposed concept has been seriously considered for several directly comparable assets in the past. The supply chain, assets, personnel and expertise to handle the completion of the project require some development. Project schedule is reasonable and within the timetable assigned as part of the overall corporate strategy. | Technological feasibility of the concept requires significant additional engineering to prove. Expert opinion is divided on whether the proposed solution is technically sound and complies with existing legislation. The proposed concept has been seriously considered for several directly comparable assets in the past. The supply chain, assets, personnel and expertise to handle the completion of the project require development. Project schedule is tight but remains within the timetable assigned as part of the overall corporate strategy. | Technological feasibility of the concept requires significant additional engineering to prove. Exert opinion is united in confidence that the proposed solution is not technically robust and/ or may not comply with existing legislation. The proposed concept has been addressed but not been seriously considered for directly comparable assets in the past. The supply chain, assets, personnel and expertise to handle the completion of the project require significant development. Project schedule is not in line with the timetable assigned as part of the overall corporate strategy. | Technical feasibility is at concept definition level only requiring substantial detail engineering to prove. Expert opinion has insufficient information on which to base a judgement on technical robustness and/ or whether the concept will comply with existing legislation. The proposed concept has not been considered for directly comparable assets in the past. The supply chain, assets, personnel and expertise to deliver the concept have not been identified. Schedule for development of the concept is not defined. |

| | | | | | | |
|---|---|---|---|---|---|---|
| Technical feasibility - ease of recovery from excursion | Assets and equipment are available offshore in the field to facilitate recovery and stabilise the situation after an incident. Speed of recovery is anticipated to be swift with a limited impact on schedule. No greater perceived risk to marine assets, or to personnel than during the routine operation. | Assets and equipment are rapidly available from offshore to facilitate recovery and stabilise the situation after an incident. Speed of recovery is anticipated to be swift once the required assets and equipment arrives. Limited impact on planned campaign schedule as remaining planned activities can continue in the interim. No greater perceived risk to marine assets, or to personnel than during the routine operation. | Assets and equipment are rapidly available from onshore to stabilise the situation after an incident. Speed of recovery is anticipated to be longer due to re-engineering. Considerable impact on the planned campaign schedule as remaining planned activities cannot continue in the interim. No greater perceived risk to marine assets, or to personnel than during the routine operations. | Emergency abandonment of project activities. Re-engineering required to develop procedures and identify assets and equipment to stabilise the situation after an incident. Speed of recovery is anticipated to be slow due to re-engineering. Significant impact on the planned campaign schedule as remaining planned activities cannot continue. Risk to marine assets and/ or personnel. | Catastrophic abandonment of project activities. Major re-engineering required to develop procedures and identify assets and equipment to stabilise the situation after an incident. Speed of recovery is anticipated to be very slow or not possible. Significant impact on the entire project schedule and company reputation. Significant risk to marine assets and/ or to personnel. | Catastrophic incident leading to total loss. Major engineering required to develop procedures/ methods/ schedule for recovery of wreck which is likely to be slow or not possible. Significant impact on the entire project schedule and company reputation. Significant risk to marine assets and to personnel. |
| Technical feasibility - use of proven technology and equipment | Marine assets and supporting equipment are industry standard with good track record of successful operation. No marine asset construction required. Limited or no equipment development required. | Marine assets are industry standard with a good track record of successful operation. Supporting equipment requires investment to aid development; however, it is anticipated that this will be completed successfully ahead of the project schedule. | Marine assets require significant investment to aid development and construction; however, there is widespread confidence within the industry that this shall be completed successfully. Marine asset design approved and major construction contracts awarded. Supporting equipment requires early investment to aid development; however, it is anticipated that this will be completed successfully ahead of the project schedule. | Marine assets require significant investment to aid their development and construction; there is uncertainty within the industry that this will be completed successfully ahead of the project schedule. Marine asset design approved and major construction contracts awarded. Supporting equipment requires early investment to aid development; there is uncertainty within the industry that this will be completed successfully ahead of the project schedule. | Unacceptably high risk that the construction and development of marine assets and supporting equipment will not be completed successfully. Uncertainty surrounding whether or not the required investment can be secured. | Development programme for marine assets and supporting equipment not defined. Uncertainty surrounding whether or not the required investment can be secured to support the development programme. |
| Commercial impact on fisheries | Neither operations nor end-points would have any effect on commercial fisheries. | Short-term disruption may occur during operations, but similar to existing disruptions caused from time to time by oilfield activities. | Option results in additional areas of ground or water column becoming inaccessible to fishing (either tangibly or de facto) to extent that up to 0.5% additional area is lost to fishing.. | Option results in additional areas of ground or water column becoming inaccessible to fishing (either tangibly or de facto) to extent that 0.5% to 1% additional area is lost to fishing. | Option results in additional areas of ground or water column becoming inaccessible to fishing (either tangibly or de facto) to extent that 1 to 10% additional area is lost to fishing. | Option results in additional areas of ground or water column becoming permanently inaccessible to fishing (either tangibly or de facto) to extent where area is lost to fishing. |
| Socio-economic impact to amenities | No change or impact on amenities*. | Short-term localised impact on amenities for some or all of the operations, but would cease and revert to previous condition on completion of operations, without the need for mitigation. | Some impact on local amenities, leading to some actual deterioration in quality of life. Deterioration would exist while actual operations were being carried out. Some mitigation/ work would be required when operations were completed to restore amenities to pre-operational condition. | Significant and long-term impact on local amenities, leading to noticeable deterioration in quality of life. Extensive mitigation/ work, taking less than 1 year, would be required when operations were completed to restore amenities to pre-operational condition. | Significant and long-term impact on local amenities, leading to noticeable deterioration in quality of life. Extensive mitigation/ work, taking between 1 to 5 years, would be required when operations were completed to restore amenities to something resembling pre-operational condition, although full restoration would be unlikely. | Significant and long-term impact on local amenities, leading to noticeable deterioration in quality of life. Extensive mitigation/ work, taking more than 5 years, would be required when operations were completed to restore amenities to something resembling pre-operational condition, although full restoration would be unlikely. |
| Socio-economic impact on communities | No change or impact on communities. | Short-term localised impact on communities for some or all of the operations, but would cease and revert to previous condition on completion of operations. | Some impact on local communities, leading to some actual deterioration in quality of life. Deterioration would exist while actual operations were being carried out, but would essentially cease as soon as operations were completed, and quickly revert to pre-operation condition. | Significant and long-term impact on local communities, leading to noticeable deterioration in quality of life. This would persist for less than 1 year after actual operations had ceased. | Significant and long-term impact on communities, leading to noticeable deterioration in quality of life. This would persist for several years after actual operations had ceased. | Significant and permanent impact on communities, leading to noticeable deterioration in quality of life. |

### Table A.2: CNRI Likelihood Matrix

| Likelihood rating | | |
|---|---|---|
| A | Rare | • Detailed definition and understanding of methodology, hazards and equipment.<br>• A rare combination of factors would be required for an incident to result.<br>• Extremely remote likelihood to occur.<br>• L≤1/10,000 Years |
| B | Remote | • High level definition and understanding of methodology, hazards and equipment.<br>• An unlikely combination of factors would be required for an incident to result.<br>• Very unlikely to occur, but not impossible; could occur within Industry.<br>• 1/10,000Years<L≤1/1000 Years |
| C | Unlikely | • Moderate likelihood.<br>• Moderate level of uncertainty.<br>• General definition and understanding of methodology, hazards and equipment.<br>• Could happen if a number of additional factors are present but otherwise unlikely to occur.<br>• Unlikely to occur during the life of a facility; but possible within Company/ known within Industry.<br>• 1/1000Years<L≤1/100 Years |
| D | Possible | • High likelihood.<br>• High level of uncertainty.<br>• Basic definition and understanding of methodology, hazards and equipment.<br>• Could possibly happen if a number of additional factors are present.<br>• Could occur within the life of a facility; known to happen within Company.<br>• 1/100Years<L≤1/10 Years |
| E | Probable | • Limited definition and understanding of methodology, hazards and equipment.<br>• Not certain but incident could occur with only one normally occurring additional factor.<br>• Likely to occur several times in life of a facility.<br>• 1/10Years<L≤1/ Year |
| F | Likely | • Almost Inevitable that an incident will occur under the circumstances.<br>• One or more occurrences per year.<br>• L>1/ Year |

### Table A.3: CNRI Risk Matrix

| | | Likelihood | | | | | |
|---|---|---|---|---|---|---|---|
| Consequence | | A<br>Rare | B<br>Remote | C<br>Unlikely | D<br>Possible | E<br>Probable | F<br>Likely |
| | 6 | 10 | 13 | 18 | 24 | 30 | 36 |
| | 5 | 5 | 10 | 15 | 20 | 25 | 30 |
| | 4 | 4 | 8 | 12 | 16 | 20 | 24 |
| | 3 | 3 | 6 | 9 | 12 | 15 | 18 |
| | 2 | 2 | 4 | 6 | 8 | 10 | 13 |
| | 1 | 1 | 2 | 3 | 4 | 5 | 10 |

**Table A.4: Activities associated with jacket decommissioning option - Full removal by multiple lifts**

| Operation/ End-point | Potential impact | Mitigation | Scoring criteria | Physical and chemical: Drill cuttings pile disturbance | Physical and chemical: Seabed disturbance | Physical and chemical: Water quality | Physical and chemical: Air quality | Physical and chemical: Land | Physical and chemical: Freshwater (including brackish) | Biological: Sediment biology (benthos) | Biological: Water column (plankton) | Biological: Finfish and shellfish | Biological: Marine mammals | Biological: Seabirds | Biological: Terrestrial flora and fauna | Societal: Commercial fishing | Societal: Shipping | Societal: Government, institution users (e.g. MOD) | Societal: Other commercial users | Societal: Recreation and amenity users | Societal: Onshore communities (Resources) | Justification for risk rating assigned |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Planned operations** | | | | | | | | | | | | | | | | | | | | | | |
| Physical presence of vessels during transport between port and the offshore site. | Localised and transient obstruction to fishing vessels and shipping. | • Route-planning.<br>• Collision Risk Assessment.<br>• Navigation aids.<br>• Communications.<br>• Good seamanship.<br>• Consent to locate for vessels.<br>• Notice to mariners and consultation with Scottish Fishermen's Federation (SFF).<br>• Fisheries Liaison Officer (FLO)/ Marine Mammal Observer (MMO) on board. | L | | | | | | | | | | | | | B | B | A | A | B | | Shipping/ fishing traffic can readily navigate around the individual vessels as they travel to and from the offshore site. |
| | | | C | | | | | | | | | | | | | 2 | 1 | 1 | 1 | 2 | | |
| | | | R | | | | | | | | | | | | | 4 | 2 | 1 | 1 | 4 | | |
| Anchoring of vessels on the seabed. | Physical disturbance to seabed and suspension of sediment into the water column from the cuttings pile. | • Anchor plan/ pre-planning of anchor pattern.<br>• Rolling anchors or piggyback anchor.<br>• Safe operation.<br>• Pre-surveys of area.<br>• As-left survey.<br>• Post-decommissioning monitoring programme.<br>• Remedial intervention in the event of any anchor mounds or scars. | L | A | F | F | | | | F | F | F | | | | | | | | | | Site survey data will be used to pre-determine an appropriate anchor plan with the minimum number of anchor moves. |
| | | | C | 2 | 2 | 2 | | | | 2 | 2 | 2 | | | | | | | | | | |
| | | | R | 2 | 13 | 13 | | | | 13 | 13 | 13 | | | | | | | | | | |
| Anchoring of vessels on contaminated sediments within 500 m of NNP but not on the drill cuttings pile. | Physical disturbance of contaminated sediments potentially releasing toxic contaminants into the water column and seabed, which may impact pelagic and demersal species. | • Anchor plan/ pre-planning of anchor pattern.<br>• Rolling anchors or piggyback anchor.<br>• Safe operation.<br>• Pre-surveys of area.<br>• As-left survey.<br>• Post-decommissioning monitoring programme.<br>• Remedial intervention in the event of any anchor mounds or scars. | L | A | F | F | | | | F | F | F | | | | | | | | | | Site survey data will be used to pre-determine an appropriate anchor plan, which will avoid drill cuttings pile and utilise the minimum number of anchor moves. |
| | | | C | 2 | 2 | 2 | | | | 2 | 2 | 2 | | | | | | | | | | |
| | | | R | 2 | 13 | 13 | | | | 13 | 13 | 13 | | | | | | | | | | |

| Operation/ End-point | Potential impact | Mitigation | Scoring criteria | Physical and chemical | | | | | | Biological | | | | | | Societal | | | | | | Justification for risk rating assigned |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Drill cuttings pile disturbance | Seabed disturbance | Water quality | Air quality | Land | Freshwater (including brackish) | Sediment biology (benthos) | Water column (plankton) | Finfish and shellfish | Marine mammals | Seabirds | Terrestrial flora and fauna | Commercial fishing | Shipping | Government, institution users (e.g. MOD) | Other commercial users | Recreation and amenity users | Onshore communities (Resources) | |
| Underwater noise associated with decommissioning activities (vessels and equipment). | Generation of underwater noise causing potential disturbance to marine life. | • Planned efficient cutting regime to achieve as few cuts as possible.<br>• Evidence suggest that noise generated will be low frequency (200 Hz), potentially resulting in a zone of radius 4 km within which marine mammals may experience disturbance.<br>• Regular maintenance to vessel engines and equipment.<br>• Power management systems will be in place. | L | | | | | | | | | F | F | | | | | | | | | Full removal – slight increase in the likelihood of impact<br><br>Marine Mammal Observers (MMOs) will be on-board the vessels during routine decommissioning operations. |
| | | | C | | | | | | | | | 2 | 3 | | | | | | | | | |
| | | | R | | | | | | | | | 13 | 18 | | | | | | | | | |
| Offshore removal of marine growth from jacket using high pressure jet cleaner. | Release of organic matter at offshore site. | • Compliance with UK waste legislation and duty of care.<br>• | L | B | E | F | | | | F | F | F | | | | | | | | | | Seabed disturbance – D (1), E (10)<br>Water quality, sediment biology, water column, finfish – slight increase in likelihood<br><br>CNRI will define options for cleaning marine growth. If any marine growth is transported to shore CNRI will assess the restrictions for disposal onshore in Environmental Management Plan. |
| | | | C | 1 | 2 | 2 | | | | 2 | 2 | 2 | | | | | | | | | | |
| | | | R | 2 | 10 | 13 | | | | 13 | 13 | 13 | | | | | | | | | | |
| Underwater cutting of jacket footings (piles will be cut 3 m below seabed) | Disturbance to seabed sediments and benthos. | • Planned efficient cutting regime to achieve as few cuts as possible. | L | | F | F | | | | F | F | F | | | | | | | | | | Seabed disturbance – F (12); 2 (9), 3 (3)<br>Water quality – F (12), 1 (2), 2 (10),<br>Sediment biology F (12); 2 (9), 3 (3)<br>Water column – F (12); 1(3), 2 (9),<br>Finfish and shellfish – F (12); 1 (1), 2 (10), 3 (1) |
| | | | C | | 2 | 2 | | | | 2 | 2 | 2 | | | | | | | | | | |
| | | | R | | 13 | 13 | | | | 13 | 13 | 13 | | | | | | | | | | |
| Dismantling recovered structures/ material onshore. | Generation of dust and noise in air. | • CNRI to audit contractor's yards to ensure appropriate licences and processes are in place to manage risk. | L | | | | F | D | C | | | | | D | D | | | | | E | F | Air quality – increase in material including concrete and marine growth, increased time<br>Seabirds, terrestrial flora and fauna – increased time period<br>Recreational users – 3(11) – increased duration |
| | | | C | | | | 2 | 1 | 1 | | | | | 2 | 2 | | | | | 3 | 3 | |

| Operation/ End-point | Potential impact | Mitigation | Scoring criteria | Physical and chemical | | | | | | Biological | | | | | | Societal | | | | | | Justification for risk rating assigned |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Drill cuttings pile disturbance | Seabed disturbance | Water quality | Air quality | Land | Freshwater (including brackish) | Sediment biology (benthos) | Water column (plankton) | Finfish and shellfish | Marine mammals | Seabirds | Terrestrial flora and fauna | Commercial fishing | Shipping | Government, institution users (e.g. MOD) | Other commercial users | Recreation and amenity users | Onshore communities (Resources) | |
| | | | R | | | | 13 | 4 | 3 | | | | | 8 | 8 | | | | | 15 | 18 | Onshore communities – 3(11) – increased duration |
| Trench left from cutting activities | Snagging risk | • Overtrawl remediation | L | | | | | | | | | | | | | A | | | | | | Commercial fishing (end point rather than the activity, post mitigation) – A (12); 2 (12) – short term impact,<br><br>Small positive impact of adding additional sea space |
| | | | C | | | | | | | | | | | | | 2 | | | | | | |
| | | | R | | | | | | | | | | | | | 2 | | | | | | |
| Use of land based facilities for the disposal of jacket waste. | Use of landfill space | • Minimise waste and recycle where possible | L | | | | | F | | | | | | | | | | | F | F | F | Costs for disposal are increasing annually and availability of landfill space is becoming more restricted. |
| | | | C | | | | | 2 | | | | | | | | | | | 2 | 2 | 2 | |
| | | | R | | | | | 13 | | | | | | | | | | | 13 | 13 | 13 | |

**Table A.5: Activities associated with jacket decommissioning option - Partial removal by multiple lifts**

| Operation/ End-point | Potential impact | Mitigation | Scoring criteria | Physical and chemical | | | | | | Biological | | | | | | Societal | | | | | | Justification for risk rating assigned |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Drill cutting pile disturbance | Seabed disturbance | Water quality | Air quality | Land | Freshwater (including brackish) | Sediment biology (benthos) | Water column (plankton) | Finfish and shellfish | Marine mammals | Seabirds | Terrestrial flora and fauna | Commercial fishing | Shipping | Government, institution users (e.g. MOD) | Other commercial users | Recreation and amenity users | Onshore communities (Resources) | |
| **Planned operations** | | | | | | | | | | | | | | | | | | | | | | |
| Physical presence of vessels during transport between port and the offshore site, and including vessels and equipment during operations | Localised and transient obstruction to fishing vessels and shipping. | • Route-planning.<br>• Weather planning.<br>• Navigation aids.<br>• Communications.<br>• Good seamanship.<br>• Notice to mariners and consultation with SFF. | L | | | | | | | | | | | | | B | B | A | A | B | | Shipping/ fishing traffic can readily navigate around the individual vessels as they travel to and from the offshore site.<br>Route plan should take into account fishing areas for sheltering.<br>Commercial Fishing – A (1), B (7), C (5); 1 (1), 2 (12)<br>Shipping – A (3), B (9), C (1); 1 (8) – positive generator of socio-economic impact, 2 (5)<br>Government, institution users (MOD) – A (9) B (4); 1 (12), 2 (1)<br>Other commercial users – A (10), B (2), C (1); 1 (8), 2 (5)<br>Recreation - A (6), B (7) – recreational closer to shore; 1 (3), 2(10) |
| | | | C | | | | | | | | | | | | | 2 | 1 | 1 | 1 | 2 | | |
| | | | R | | | | | | | | | | | | | 4 | 2 | 1 | 1 | 4 | | |
| Anchoring of vessels on the seabed. | Physical disturbance to seabed and suspension of sediment into the water column from the cuttings pile. | • Anchor plan/ pre-planning of anchor pattern.<br>• Rolling anchors or piggyback anchor.<br>• Safe operation.<br>• Pre-surveys of area.<br>• As-left survey.<br>• Post-decommissioning monitoring programme.<br>• Remedial intervention in the event of any anchor mounds or scars. | L | A | F | F | | | | F | F | F | | | | | | | | | | Site survey data will be used to pre-determine an appropriate anchor plan with the minimum number of anchor moves.<br>Drill cuttings - A (11), B (2); 1 (4), 2 (8), 3 (1)<br>Seabed disturbance – F (13); 1 (11), 2 (2)<br>Water quality – F (13); 1 (13)<br>Sediment biology (benthos) – F (13); 1 (12), 2(1)<br>Water column (plankton) – F (13) 1(13)<br>Finfish and shellfish – F (13), 1(12), 2 (1) |
| | | | C | 2 | 1 | 1 | | | | 1 | 1 | 1 | | | | | | | | | | |
| | | | R | 2 | 10 | 10 | | | | 10 | 10 | 10 | | | | | | | | | | |
| Underwater noise associated with decommissioning activities.<br>(vessels and equipment). | Generation of underwater noise causing potential disturbance to marine life. | • Planned efficient cutting regime to achieve as few cuts as possible.<br>• Evidence suggest that noise generated will be low frequency (200 Hz), potentially resulting in a zone of radius 4 km within which marine mammals may experience disturbance.<br>• Regular maintenance to vessel engines and equipment.<br>• Power management systems will be in | L | | | | | | | | | F | F | | | | | | | | | Divers won't be operating subsea in an area where lots of acoustic activity is expected.<br>MMOs will be on-board the vessels during routine decommissioning operations.<br>Key factor is duration of activities between full and partial removal based on worst case noise profile circa 2km.<br>Finfish and shellfish – F (12); 2 (10), 3(2)<br>Sea mammals – F (12); 2 (5), 3(7)<br>Transboundary issues – not scored, not applicable |
| | | | C | | | | | | | | | 2 | 3 | | | | | | | | | |
| | | | R | | | | | | | | | 13 | 18 | | | | | | | | | |

| Operation/ End-point | Potential impact | Mitigation | Scoring criteria | Physical and chemical | | | | | | Biological | | | | | | Societal | | | | | | Justification for risk rating assigned |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Drill cutting pile disturbance | Seabed disturbance | Water quality | Air quality | Land | Freshwater (including brackish) | Sediment biology (benthos) | Water column (plankton) | Finfish and shellfish | Marine mammals | Seabirds | Terrestrial flora and fauna | Commercial fishing | Shipping | Government, institution users (e.g. MOD) | Other commercial users | Recreation and amenity users | Onshore communities (Resources) | |
| | | place. | | | | | | | | | | | | | | | | | | | | |
| Offshore removal of marine growth from jacket using high pressure jet cleaner. | Release of organic matter at offshore site. | • Compliance with UK waste legislation and duty of care. | L | B | B | F | | | | F | F | F | | | | | | | | | | CNRI will define options for cleaning marine growth. If any marine growth is transported to shore CNRI will assess the restrictions for disposal onshore in Environmental Management Plan.<br>Drill cuttings pile – A (2) B (9), F (1); 1(12) (perception of drift of material and the resulting impact)<br>Seabed disturbance – A (1) B (10), F (1); 1(12)<br>Water quality – F (12), 1 (9), 2 (3)<br>Sediment biology (benthos) – F (10) E (1) A (1); 1(11), 2 (2) (perception of drift of material and the resulting impact)<br>Water column – F (12); 1 (10), 2 (2)<br>Finfish and shellfish – F (12); 1(10), 2(2)<br>Transboundary boundary – taken out |
| | | | C | 1 | 1 | 1 | | | | 1 | 1 | 1 | | | | | | | | | | |
| | | | R | 2 | 2 | 10 | | | | 10 | 10 | 10 | | | | | | | | | | |
| Dismantling recovered structures/ material onshore. | Generation of dust and noise in air.<br>Odour pollution. | • CNRI to audit contractor's yards to ensure appropriate licences and processes are in place to manage risk. | L | | | | F | D | C | | | | | D | D | | | | | E | F | Air quality - F (11), D (1); 1(7), 2(4)<br>Land – D (12); 1 (12)<br>Freshwater – C (8), B (4); 1(12)<br>Seabirds – E (3), D (7) C (2); 1(12)<br>Terrestrial flora and fauna – E (1), D (8) C (3); 1(12)<br>Recreational users (temporary) – F (3), E (7), D (1), C (1); 1(2), 2(10)<br>Onshore communities (community there all the time)– F (5), E (4), D (2) C (1); 1(2), 2(9), 3(1)<br>Transboundary issues – not applicable, covered in the ES |
| | | | C | | | | 1 | 1 | 1 | | | | | 1 | 1 | | | | | 2 | 2 | |
| | | | R | | | | 10 | 4 | 3 | | | | | 4 | 4 | | | | | 10 | 13 | |
| Physical presence of jacket footings left in situ (commercial consequences). | Commercial consequences of snagging fishing gear on the jacket footings.<br>Loss of access for commercial fisheries. | • Notice to Mariners, Kingfisher, Fishsafe.<br>• Environmental Management Plan. | L | | | | | | | | | | | | | E | A | | | | | Commercial fishing – F (1), E (6), D (4); 3 (11)<br>Shipping – B (1), A (11); 1 (10), 2(1)<br>Discretionary safety zone to be put in place. |
| | | | C | | | | | | | | | | | | | 3 | 1 | | | | | |
| | | | R | | | | | | | | | | | | | 15 | 1 | | | | | |
| Physical presence of | Release of contaminants | • No mitigation proposed | L | | F | F | | | | F | F | F | F | | | | | | | | | Seabed disturbance – 1(11) |

| Operation/ End-point | Potential impact | Mitigation | Scoring criteria | Physical and chemical | | | | | | Biological | | | | | | Societal | | | | | | Justification for risk rating assigned |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Drill cutting pile disturbance | Seabed disturbance | Water quality | Air quality | Land | Freshwater (including brackish) | Sediment biology (benthos) | Water column (plankton) | Finfish and shellfish | Marine mammals | Seabirds | Terrestrial flora and fauna | Commercial fishing | Shipping | Government, institution users (e.g. MOD) | Other commercial users | Recreation and amenity users | Onshore communities (Resources) | |
| jacket footings left in situ (release of contaminants). | from degrading metal footings and anodes which may contain components toxic to marine life. | | C | | 1 | 1 | | | | 1 | 1 | 1 | 1 | | | | | | | | | Water quality – 1(11)<br>Sediment biology (benthos) – 1(10) 2 (1)<br>Water column (plankton) – 1 (10) 2 (1)<br>Finfish and shellfish – 1 (11)<br>Marine mammals – 1 (11) |
| | | | R | | 10 | 10 | | | | 10 | 10 | 10 | 10 | | | | | | | | | |
| Long-term degradation of footings leading to falling jacket members and structures. | Physical disturbance to the drill cuttings pile potentially releasing toxic contaminants to the water column and seabed, which may impact pelagic and demersal species. | • No mitigation proposed | L | | | | | | | | | | | | | | | | | | | Modelling data to be used. Scored offline on the results of the modelling on a worst case scenario (see comments made during drilling cutting pile assessment) |
| | | | C | | | | | | | | | | | | | | | | | | | |
| | | | R | | | | | | | | | | | | | | | | | | | |
| Use of land based facilities for the disposal of jacket waste. | Use of landfill space | • Minimise waste and recycle where possible | L | | | | | F | | | | | | | | | | | F | F | F | Amenities – F, 1 (full removal to be F,2 for a comparison), values based on the tonnage of waste to be sent to landfill as a comparison<br>Land – F,1<br>Onshore communities – F,1<br>Other commercial users – F, 1 |
| | | | C | | | | | 1 | | | | | | | | | | | 1 | 1 | 1 | |
| | | | R | | | | | 10 | | | | | | | | | | | 10 | 10 | 10 | |

L – likelihood; C – consequence; R – risk

**Table A.6: Activities associated with drill cuttings removal Option 1 – Recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore**

| | | | | Physical and chemical | | | | | Biological | | | | | | Societal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operation/ End-point** | **Potential impact** | **Mitigation** | Scoring criteria | Seabed disturbance | Water quality | Air quality | Land | Freshwater (including brackish) | Sediment biology (benthos) | Water column (plankton) | Finfish and shellfish | Marine mammals | Seabirds | Terrestrial flora and fauna | Commercial fishing | Shipping | Government, institution users (e.g. MOD) | Other commercial users | Recreation and amenity users | Onshore communities (Resources) | Transboundary issues | **Justification for risk rating assigned** |
| **Planned operations** | | | | | | | | | | | | | | | | | | | | | | |
| Physical presence of vessels during transport of drill cuttings waste to shore. | Localised and transient obstruction to fishing vessels and shipping. | • Route-planning.<br>• Navigation aids.<br>• Communications.<br>• Good seamanship.<br>• Notice to mariners and consultation with Scottish Fishermen's Federation (SFF) and other relevant stakeholders. | L | | | | | | | | | | | | C | C | B | B | B | | | Shipping/ fishing traffic can readily navigate around the individual vessels as they travel to and from the offshore site.<br>Commercial fishing - A (1), c (5) – more frequent vessel traffic than the jacket example; 1(1), 2 (5)<br>Shipping – A (1), C (5); 1 (1), 2 (5)<br>Government – A (2), B (4) 1 (6)<br>Other commercial users – B (6) 1 (2), 2 (4) travel in and out of port more impact, positive – more jobs<br>Recreational – A (1), B (3), C (2), 1 (1), 2 (5) |
| | | | C | | | | | | | | | | | | 2 | 2 | 1 | 2 | 2 | | | |
| | | | R | | | | | | | | | | | | 6 | 6 | 2 | 4 | 4 | | | |
| Offshore discharge of treated oily fluids in offshore waters. | Planned release of treated oily fluids resulting in release of contaminants to the offshore environment. | • Separation systems for oil recovery from bilge.<br>• Discharges of oil fluids to marine environment will be within permitted levels. | L | | F | | | | | F | F | F | | | | | | | | | | • Any discharge will be within permitted limits.<br>• Discharge will be readily dispersed in the offshore environment.<br>• This will result in a localised transient impact with the discharge dissipating to background concentrations within relatively short distance.<br>• Water quality – 2 (2), 3(4)<br>• Water column – 2 (5) – comparably less than PW, 3 (1) – composition slightly difference from produced water<br>• Finfish and shellfish – 1 (2), 2 (3), 3 (1)<br>• Marine mammals – 1 (4), 2 (1), 3 (1) |
| | | | C | | 3 | | | | | 2 | 2 | 1 | | | | | | | | | | |
| | | | R | | 18 | | | | | 13 | 13 | 10 | | | | | | | | | | |

| Operation/ End-point | Potential impact | Mitigation | | Physical and chemical | | | | | Biological | | | | | | Societal | | | | | | | Justification for risk rating assigned |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Scoring criteria | Seabed disturbance | Water quality | Air quality | Land | Freshwater (including brackish) | Sediment biology (benthos) | Water column (plankton) | Finfish and shellfish | Marine mammals | Seabirds | Terrestrial flora and fauna | Commercial fishing | Shipping | Government, institution users (e.g. MOD) | Other commercial users | Recreation and amenity users | Onshore communities (Resources) | Transboundary issues | |
| Fluidisation of cuttings, blockage of suction dredging equipment during excavation of drill cuttings pile and recovery to surface | Release of drill cuttings potentially releasing particles to the water column and seabed (water quality and smothering). Back-flushing if required | • Use of best operating practices<br>• Maintain equipment | L | F | F | | | | F | F | F | | | | | | | | | | | Seabed disturbance – 3 (1), 4 (1), 5 (4)<br>Water quality – 3 (1), 4(4), 5 (1)<br>Sediment biology – 3 (1), 4 (3), 5 (2)<br>Water column – 3 (1), 4 (4), 5 (1)<br>Finfish and shellfish – 2 (3), 3(2), 4 (1)<br>Longevity of contamination considered,<br>High volume of material. |
| | | | C | 5 | 4 | | | | 4 | 4 | 2 | | | | | | | | | | | |
| | | | R | 30 | 24 | | | | 24 | 24 | 13 | | | | | | | | | | | |
| Onshore treatment of the solid waste. | The treatment of solid wastes at onshore waste treatment and landfill sites could result in impacts to the air quality, hydrology, flora and fauna, and socioeconomic aspects of such sites. | • The solids will be contained, then shipped to shore for treatment and disposal by a licensed company in full compliance with UK waste legislation and Duty of Care.<br>• Use of designated licensed onshore waste disposal / transfer /handling facilities only.<br>• Auditing of waste management contractor to ensure compliance. | L | | | F | | F | | | | | | F | | | | | F | F | | Documentation will be in place to ensure that contractors store, transport, treat and dispose of solids in accordance with all relevant regulations and CNRI's requirements.<br>Air quality – F (6), 1 (2), 2 (3)<br>Freshwater – F (6); 1 (5)<br>Terrestrial flora and fauna – 1 (5)<br>Recreational and amenity users – F (6) 1 (2), 2 (4)<br>Onshore communities – F (6) 1 (2), 2 (4) |
| | | | C | | | 2 | | 1 | | | | | | 1 | | | | | 2 | 2 | | |
| | | | R | | | 13 | | 10 | | | | | | 10 | | | | | 13 | 13 | | |

| Operation/ End-point | Potential impact | Mitigation | Scoring criteria | Physical and chemical | | | | | Biological | | | | | | Societal | | | | | | | Justification for risk rating assigned |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Seabed disturbance | Water quality | Air quality | Land | Freshwater (including brackish) | Sediment biology (benthos) | Water column (plankton) | Finfish and shellfish | Marine mammals | Seabirds | Terrestrial flora and fauna | Commercial fishing | Shipping | Government, institution users (e.g. MOD) | Other commercial users | Recreation and amenity users | Onshore communities (Resources) | Transboundary issues | |
| Onshore disposal of the drill cuttings. | The disposal of solid wastes at onshore waste treatment and landfill sites could result in impacts to the air quality, hydrology, flora and fauna, and socioeconomic aspects of such sites. | • Use of designated licensed onshore waste disposal / transfer /handling facilities only.<br>• Auditing of waste management contractor to ensure compliance. | L | | | F | F | F | | | | | | F | | | | | F | F | | Air quality – 1 (4), 2 (1)<br>Land – 2 (1), 3 (2) – volume impact on landfill, 4 (2)<br>Terrestrial flora and fauna – 1 (5), 2 (1)<br>Recreational – 1 (1), 2 (4) 3 (1)<br>Onshore communities – 1 (1), 2 (4), 3 (1) |
| | | | C | | | 1 | 3 | 1 | | | | | | 1 | | | | | 2 | 2 | | |
| | | | R | | | 10 | 18 | 10 | | | | | | 10 | | | | | 13 | 13 | | |
| **Unplanned operations** | | | | | | | | | | | | | | | | | | | | | | |
| Accidental spill/ release of cuttings during surface treatment, disposal or transport to shore. | Contamination of the local marine environment, loss of access to area during clean up. | • SOPEP<br>• Good operating practice<br>• Well maintained equipment<br>• Closed system | L | | D | | | | D | D | D | D | D | D | D | D | D | D | D | D | D | Water quality –D (4), E (1), F (1), 1 (1), 2 (2), 3 (3)<br>Sediment biology – 1 (2), 2 (3), 3 (1),<br>Water column – 2 (4), 3 (2)<br>Finfish and shellfish – 2 (5), 3 (1)<br>Sea mammals – 1 (2), 2 (3), 3 (1),<br>Seabirds – 1 (3), 2 (1), 3(2)<br>Terrestrial flora and fauna – 1 (4), 2 (1), 3 (1)<br>Commercial fishing – 2 (2), 3 (4),<br>Shipping – 1 (1), 2 (2), 3 (3)<br>Government – 1 (1), 2 (5)<br>Other commercial users - 1 (1), 2 (5)<br>Recreational – 2 (5) – potential cuttings on the beach, 3 (1)<br>Onshore communities – 2 (4), 3 (2)<br>Transboundary - 2 (4), 3 (1), 4 (1) |
| | | | C | | 3 | | | | 2 | 2 | 2 | 2 | 1 | 1 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | |
| | | | R | | 12 | | | | 8 | 8 | 8 | 8 | 4 | 4 | 12 | 12 | 8 | 8 | 8 | 8 | 8 | |

**Table A.7: Activities associated with drill cuttings removal Option 2 – Recover to surface, slurry to shore**

| | | | | Physical and chemical | | | | | Biological | | | | | | Societal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operation/ End-point** | **Potential impact** | **Mitigation** | Scoring criteria | Seabed disturbance | Water quality | Air quality | Land | Freshwater (including brackish) | Sediment biology (benthos) | Water column (plankton) | Finfish and shellfish | Marine mammals | Seabirds | Terrestrial flora and fauna | Commercial fishing | Shipping | Government, institution users (e.g. MOD) | Other commercial users | Recreation and amenity users | Onshore communities (Resources) | Transboundary issues | **Justification for risk rating assigned** |
| **Planned operations** | | | | | | | | | | | | | | | | | | | | | | |
| Physical presence of vessels during transport of drill cuttings waste to shore. | Localised and transient obstruction to fishing vessels and shipping. | • Route-planning.<br>• Navigation aids.<br>• Communications.<br>• Good seamanship.<br>• Notice to mariners and consultation with Scottish Fishermen's Federation (SFF) and other relevant stakeholders. | L | | | | | | | | | | | | D | D | C | C | C | | | Shipping/ fishing traffic can readily navigate around the individual vessels as they travel to and from the offshore site.<br>Increase of vessels. |
| | | | C | | | | | | | | | | | | 2 | 2 | 1 | 2 | 2 | | | |
| | | | R | | | | | | | | | | | | 8 | 8 | 4 | 8 | 8 | | | |
| Fluidisation of cuttings, blockage of suction dredging equipment during excavation of drill cuttings pile and recovery to surface | Release of drill cuttings potentially releasing particles to the water column and seabed (water quality and smothering). Back-flushing if required. | • Use of best operating procedures<br>• Maintain equipment | L | F | F | | | | F | F | F | | | | | | | | | | | Seabed disturbance – 3 (1), 4 (1), 5 (4)<br>Water quality – 3 (1), 4(4), 5 (1)<br>Sediment biology – 3 (1), 4 (3), 5 (2)<br>Water column – 3 (1), 4 (4), 5 (1)<br>Finfish and shellfish – 2 (3), 3(2), 4 (1)<br>Longevity of contamination considered,<br>High volume of fluidised material which would disperse over a large area if containment is lost |
| | | | C | 5 | 4 | | | | 4 | 4 | 2 | | | | | | | | | | | |
| | | | R | 30 | 24 | | | | 24 | 24 | 13 | | | | | | | | | | | |

| Operation/ End-point | Potential impact | Mitigation | Scoring criteria | Physical and chemical | | | | | Biological | | | | | | Societal | | | | | | | Justification for risk rating assigned |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Seabed disturbance | Water quality | Air quality | Land | Freshwater (including brackish) | Sediment biology (benthos) | Water column (plankton) | Finfish and shellfish | Marine mammals | Seabirds | Terrestrial flora and fauna | Commercial fishing | Shipping | Government, institution users (e.g. MOD) | Other commercial users | Recreation and amenity users | Onshore communities (Resources) | Transboundary issues | |
| Discharge of oily water under permit in a coastal environment. | Planned release of treated seawater resulting in release of contaminants to the coastal environment. | • Separation systems for oil recovery from bilge.<br>• Discharges of oil fluids to marine environment will be within permitted levels. | L | | F | | | F | | F | F | F | F | | | F | F | | | | F | Any discharge will be within permitted limits.<br>Discharge will be readily dispersed in the offshore environment.<br>This will result in a localised transient impact with the discharge dissipating to background concentrations within relatively short distance.<br>Water quality – 1 (1), 2 (5)<br>Freshwater – 1 (1), 2(5)<br>Water column – 1 (1), 2 (4), 3 (1)<br>Finfish and shellfish – 1 (1) – licensed site that normally undertakes this type of work, within permitted impacts 2 (5) – cumulative effects of the volume<br>Seabirds – 1 (3), 2 (2), 3 (1) – all birds considered including ducks<br>Sea mammals – 1 (5), 3 (1)<br>Terrestrial flora and fauna – 1 (3), 2 (2), 3 (1)<br>Commercial fishing – 1 (3), 2 (1), 3 (1)<br>Recreational – 1 (4), 3 (1)<br>Cumulative accounts for higher outliers |
| | | | C | | 2 | | | 2 | | 2 | 2 | 1 | 1 | | | 1 | 2 | | | | 1 | |
| | | | R | | 13 | | | 13 | | 13 | 13 | 10 | 10 | | | 10 | 13 | | | | 10 | |
| Onshore disposal of the drill cuttings. | The disposal of solid wastes at onshore waste treatment and landfill sites could result in impacts to the air quality, hydrology, flora and fauna, and socioeconomic aspects of such sites. | • The cuttings material will be contained, then shipped to shore for treatment and disposal by a licensed company in full compliance with UK waste legislation and Duty of Care.<br>• Use of designated licensed onshore waste handling facilities only.<br>• Auditing of waste management contractor to ensure compliance. | L | | | F | F | F | | | | | | F | | | | | F | F | | Documentation will be in place to ensure that contractors store and dispose of solids in accordance with all relevant regulations and CNRI's requirements.<br>Score same a landfill (Option 1) |
| | | | C | | | 1 | 3 | 1 | | | | | | 1 | | | | | 2 | 2 | | |
| | | | R | | | 10 | 18 | 10 | | | | | | 10 | | | | | 13 | 13 | | |

| | | | | Physical and chemical | | | | | Biological | | | | | | Societal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operation/ End-point** | **Potential impact** | **Mitigation** | Scoring criteria | Seabed disturbance | Water quality | Air quality | Land | Freshwater (including brackish) | Sediment biology (benthos) | Water column (plankton) | Finfish and shellfish | Marine mammals | Seabirds | Terrestrial flora and fauna | Commercial fishing | Shipping | Government, institution users (e.g. MOD) | Other commercial users | Recreation and amenity users | Onshore communities (Resources) | Transboundary issues | **Justification for risk rating assigned** |
| **Unplanned Operations** | | | | | | | | | | | | | | | | | | | | | | |
| Accidental spill/ release of cuttings during onshore treatment or transport to shore. | Contamination of the local marine environment, loss of access to area during clean up. | • Spill prevention and action plan<br>• Good operating practice<br>• Well maintained equipment<br>• Closed system | L | | E | | | | E | E | E | E | E | | | E | E | E | E | E | E | More likely because of the increased duration |
| | | | C | | 4 | | | | 3 | 3 | 3 | 3 | 3 | | | 2 | 4 | 3 | 2 | 3 | 3 | |
| | | | R | | 20 | | | | 15 | 15 | 15 | 15 | 15 | | | 10 | 20 | 15 | 10 | 15 | 15 | |

**Table A.8: Activities associated with drill cuttings removal Option 3 – Recover to surface, offshore re-injection**

| Operation/ End-point | Potential impact | Mitigation | Scoring criteria | Physical and chemical | | | | | Biological | | | | | | Societal | | | | | | | Justification for risk rating assigned |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Seabed disturbance | Water quality | Air quality | Land | Freshwater (including brackish) | Sediment biology (benthos) | Water column (plankton) | Finfish and shellfish | Marine mammals | Seabirds | Terrestrial flora and fauna | Commercial fishing | Shipping | Government, institution users (e.g. MOD) | Other commercial users | Recreation and amenity users | Onshore communities (Resources) | Transboundary issues | |
| **Planned operations** | | | | | | | | | | | | | | | | | | | | | | |
| Fluidisation of cuttings, blockage of suction dredging equipment during excavation of drill cuttings pile and recovery to the surface using ROV dredge system and disposal of cuttings via a disposal well. | Blockages of suction dredge equipment leading to the release of drill cuttings particles to the water column and seabed (water quality and smothering). | • Good operating practice<br>• Maintain equipment | L | F | F | | | | F | F | F | | | | | | | | | | | Same as options 1 and 2<br>Seabed disturbance – 3 (1), 4 (1), 5 (4)<br>Water quality – 3 (1), 4(4), 5 (1)<br>Sediment biology – 3 (1), 4 (3), 5 (2)<br>Water column – 3 (1), 4 (4), 5 (1)<br>Finfish and shellfish – 2 (3), 3(2), 4 (1)<br>Longevity of contamination considered<br>High volume of fluidised material |
| | | | C | 5 | 4 | | | | 4 | 4 | 2 | | | | | | | | | | | |
| | | | R | 30 | 24 | | | | 24 | 24 | 13 | | | | | | | | | | | |
| **Unplanned operations** | | | | | | | | | | | | | | | | | | | | | | |
| Accidental spill/ release of cuttings during injection | Contamination of the local marine environment, loss of access to area during clean up. | • Spill prevention and action plan<br>• Good operating practice<br>• Well maintained equipment<br>• Closed system | L | | D | | | | D | D | D | D | D | | D | D | D | D | | | D | Water quality – due to slurry and pressure<br>Seabirds – less birds offshore<br>Terrestrial flora and fauna – considered but not considered a spill risk<br>D chosen, comparison to operation failures, in line with general production operations |
| | | | C | | 4 | | | | 3 | 3 | 3 | 3 | 2 | | 3 | 2 | 2 | 2 | | | 2 | |
| | | | R | | 16 | | | | 12 | 12 | 12 | 12 | 8 | | 12 | 8 | 8 | 8 | | | 8 | |

**Table A.9: Activities associated with drill cuttings removal Option 4 – Redistribution of drill cuttings on the seabed**

| Operation/ End-point | Potential impact | Mitigation | Scoring criteria | Physical and chemical: Seabed disturbance | Physical and chemical: Water quality | Physical and chemical: Air quality | Physical and chemical: Land | Physical and chemical: Freshwater (including brackish) | Biological: Sediment biology (benthos) | Biological: Water column (plankton) | Biological: Finfish and shellfish | Biological: Marine mammals | Biological: Seabirds | Biological: Terrestrial flora and fauna | Societal: Commercial fishing | Societal: Shipping | Societal: Government, institution users (e.g. MOD) | Societal: Other commercial users | Societal: Recreation and amenity users | Societal: Onshore communities (Resources) | Societal: Transboundary issues | Justification for risk rating assigned |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Planned operations** | | | | | | | | | | | | | | | | | | | | | | |
| Excavation of the drill cuttings pile and redistribution to another area of seabed (several locations 70m from platform) | Physical disturbance to the entire drill cuttings pile releasing contaminants to the water column and seabed.<br>Deposition of dispersed cuttings material onto adjacent seabed.<br>(leaching) | • Accurately map extent of pile at point of decommissioning<br>• Inform other users of location and extent of pile<br>• Monitoring programme | L | F | F | | | | F | F | F | F | | | F | | F | | | | F | Seabed – 4 (2), 5 (2), 6 (1)<br>Water quality – 4 (3), 5 (2)<br>Sediment biology – 5 (4), 6 (1)<br>Water column – 4 (5)<br>Finfish and shellfish – 4 (2), 5(3)<br>Marine mammals – 3 (2), 4(3)<br>Commercial fishing – 2 (2), 3 (2), 4 (1)<br>Government – 1 (3), 2 (2)<br>Transboundary – 1 (5) |
| | | | C | 5 | 4 | | | | 5 | 4 | 5 | 4 | | | 3 | | 1 | | | | 1 | |
| | | | R | 30 | 24 | | | | 30 | 24 | 30 | 24 | | | 18 | | 10 | | | | 10 | |
| Fishing gear interaction with redistributed drill cuttings. | Fouling/ damage to nets and catch. Physical disturbance to the entire drill cuttings pile releasing contaminants to the water column and seabed. Deposition of dispersed cuttings material onto adjacent seabed. | • Accurately map extent of pile at point of decommissioning<br>• Inform other users of location and extent of pile<br>• Monitoring programme | L | F | F | | | | F | F | F | F | | | F | | F | | | | | Seabed disturbance – 3 (4) 2(1)<br>Water quality – 4(1), 2 (4)<br>Sediment biology – 4 (2), 3(2), 2 (1)<br>Water column – 2 (5)<br>Finfish and shellfish – 3 (3), 2 (2)<br>Sea mammals – 1 (2), 2(3)<br>Commercial fisheries – 3 (1), 2 (4)<br>Government – 1 (5) |
| | | | C | 3 | 2 | | | | 3 | 2 | 3 | 2 | | | 2 | | 1 | | | | | |
| | | | R | 18 | 13 | | | | 18 | 13 | 18 | 13 | | | 13 | | 10 | | | | | |
| Fluidisation of cuttings, blockage of suction dredging equipment during excavation and redistribution of the drill cuttings pile. | Blockages of suction dredge equipment leading to the release of drill cuttings particles to the water column and seabed (water quality and smothering). | • Use of best operating procedures<br>• Maintain equipment | L | F | F | | | | F | F | F | | | | | | | | | | | Seabed disturbance – 3 (1), 4 (1), 5 (4)<br>Water quality – 3 (1), 4(4), 5 (1)<br>Sediment biology – 3 (1), 4 (3), 5 (2)<br>Water column – 3 (1), 4 (4), 5 (1)<br>Finfish and shellfish – 2 (3), 3(2), 4 (1)<br>Longevity of contamination considered<br>High volume of fluidised material |
| | | | C | 5 | 4 | | | | 4 | 4 | 2 | | | | | | | | | | | |
| | | | R | 30 | 24 | | | | 24 | 24 | 13 | | | | | | | | | | | |

**Table A.10: Activities associated with drill cuttings removal Option 5 – Leave in situ**

| Operation/ End-point | Potential impact | Mitigation | Scoring criteria | Physical and chemical: Seabed disturbance | Physical and chemical: Water quality | Physical and chemical: Air quality | Physical and chemical: Land | Physical and chemical: Freshwater (including brackish) | Biological: Sediment biology (benthos) | Biological: Water column (plankton) | Biological: Finfish and shellfish | Biological: Marine mammals | Biological: Seabirds | Biological: Terrestrial flora and fauna | Societal: Commercial fishing | Societal: Shipping | Societal: Government, institution users (e.g. MOD) | Societal: Other commercial users | Societal: Recreation and amenity users | Societal: Onshore communities (Resources) | Societal: Transboundary issues | Justification for risk rating assigned |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Planned operations** | | | | | | | | | | | | | | | | | | | | | | |
| Leave in situ to degrade naturally | Leaching of contaminants including hydrocarbon and metals into the water column from an undisturbed cuttings pile. | • Accurately map extent of pile at point of decommissioning<br>• Inform other users of location and extent of pile<br>• Monitoring programme | L | F | F | | | | F | F | F | | | | | | | | | | | Seabed disturbance – 1 (5)<br>Water quality – 1 (2), 2 (2) 3 (1)<br>Sediment biology – 1 (1), 2 (3), 3 (1)<br>Water column – 1 (2) 2 (3)<br>Finfish and shellfish – 1 (2), 2 (2), 3 (1) |
| | | | C | 1 | 2 | | | | 2 | 2 | 2 | | | | | | | | | | | |
| | | | R | 10 | 13 | | | | 13 | 13 | 13 | | | | | | | | | | | |
| Long term degradation of footings leading to falling jacket members and structures. | Physical disturbance to the drill cuttings pile potentially releasing contaminants to the water column and seabed, which may impact pelagic and demersal species. | • No mitigation proposed | L | E | E | | | | E | | E | | | | | | | | | | | Seabed disturbance – 1 (2), 2 (3)<br>Water quality – 1 (2), 2 (3)<br>Sediment biology – 1 (2) 2 (3)<br>Finfish and shellfish – 1 (1), 2(4) |
| | | | C | 2 | 2 | | | | 2 | | 2 | | | | | | | | | | | |
| | | | R | 10 | 10 | | | | 10 | | 10 | | | | | | | | | | | |
| Fishing gear interaction with peripheral drill cuttings. | Fouling/ damage to nets and catch. Physical disturbance to the entire drill cuttings pile releasing contaminants to the water column and seabed. Deposition of dispersed cuttings material onto adjacent seabed. | • Notification of cuttings pile footprint on navigational aids such as FishSafe | L | E | E | | | | E | E | E | E | | | | | E | | E | | | Seabed disturbance – 2 (5)<br>Water quality – 2 (4) 1 (1)<br>Seabed – 2 (4), 3 (1)<br>Water column - 1 (1) 2 (4)<br>Finfish – 2 (5)<br>Mammals – 1 (4) 2 (1)<br>Fishing – 2 (5)<br>Government – 1 (5)<br><br>Core protected therefore main contaminated material isn't at risk for fishing gear |
| | | | C | 3 | 2 | | | | 3 | 2 | 3 | 2 | | | | | 2 | | 1 | | | |
| | | | R | 15 | 10 | | | | 15 | 10 | 15 | 10 | | | | | 10 | | 5 | | | |

**Table A.11: Summary of environmental risk assessment and contribution numbers of receptors per risk class for Jacket Decommissioning Options**

| Activity | Environmental | | | |
|---|---|---|---|---|
| | Full Removal | | Partial Removal | |
| | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class |
| Physical presence of vessels during transit between port and the offshore site | | | | |
| Anchoring of vessels on seabed. | 67 | 1<br>0<br>5<br>0 | 52 | 1<br>5<br>0<br>0 |
| Anchoring of vessels on contaminated sediments within 500 m of NNP but not on the drill cuttings pile. | 67 | 1<br>0<br>5<br>0 | | |
| Underwater noise associated with decommissioning activities. | 31 | 0<br>0<br>1<br>1 | 31 | 0<br>0<br>1<br>1 |
| Offshore removal of marine growth from jacket using high pressure jet cleaner. | 64 | 1<br>1<br>4<br>0 | 44 | 2<br>4<br>0<br>0 |
| Underwater cutting of jacket footings (piles will be cut 3 m below seabed) | 65 | 0<br>0<br>5<br>0 | | |
| Dismantling recovered structures/ material onshore. | 36 | 4<br>0<br>1<br>0 | 25 | 4<br>1<br>0<br>0 |
| Physical presence of jacket footings left in situ (commercial consequences). | | | | |
| Physical presence of jacket footings left in situ (release of contaminants). | | | 60 | 0<br>6<br>0<br>0 |
| Trench left from cutting activities. | | | | |
| Use of land based facilities for the disposal of jacket waste. | 13 | 0<br>0<br>1<br>0 | 10 | 0<br>1<br>0<br>0 |
| **TOTAL** | 343 | | 222 | |

Key:

| | | |
|---|---|---|
| Green | Low risk | Scoring: 1 to 9 |
| Yellow | Moderate risk | Scoring: 10 to 12 |
| Orange | Moderate to High | Scoring: 13 to 16 |
| Red | High risk | Scoring: 18 to 36 |

**Table A.12: Summary of societal risk assessment and contribution numbers of receptors per risk class for Jacket Decommissioning Options**

| Activity | Societal | | | |
|---|---|---|---|---|
| | Full Removal | | Partial Removal | |
| | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class |
| Physical presence of vessels during transit between port and the offshore site | 12 | 5<br>0<br>0<br>0 | 12 | 5<br>0<br>0<br>0 |
| Anchoring of vessels on seabed. | | | | |
| Anchoring of vessels on contaminated sediments within 500 m of NNP but not on the drill cuttings pile. | | | | |
| Underwater noise associated with decommissioning activities. | | | | |
| Offshore removal of marine growth from jacket using high pressure jet cleaner. | | | | |
| Underwater cutting of jacket footings (piles will be cut 3 m below seabed) | | | | |
| Dismantling recovered structures/ material onshore. | 33 | 0<br>0<br>1<br>1 | 23 | 0<br>1<br>1<br>0 |
| Physical presence of jacket footings left *in situ* (commercial consequences). | | | 16 | 1<br>0<br>1<br>0 |
| Physical presence of jacket footings left in situ (release of contaminants). | | | | |
| Trench left from cutting activities. | 2 | 1<br>0<br>0<br>0 | | |
| Use of land based facilities for the disposal of jacket waste. | 39 | 0<br>0<br>3<br>0 | 30 | 0<br>3<br>0<br>0 |
| **TOTAL** | 86 | | 81 | |

Key:

| | | |
|---|---|---|
| Green | Low risk | Scoring: 1 to 9 |
| Yellow | Moderate risk | Scoring: 10 to 12 |
| Orange | Moderate to High | Scoring: 13 to 16 |
| Red | High risk | Scoring: 18 to 36 |

**Table A.13: Summary of environmental risk assessment and number of receptors per risk class for Drill Cutting Decommissioning options**

| Activity | Environmental | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Option 1 – Recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore | | Option 2- Recover to surface, slurry to shore | | Option 3- Recover to surface, offshore re-injection | | Option 4- Redistribution of drill cuttings on the seabed | | Option 5- Leave in situ | |
| | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class |
| Physical presence of vessels during transport of drill cuttings waste to shore. | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| Excavation of the drill cuttings pile and redistribution to another area of seabed (several locations 70m from platform) | | | | | | | 162 | 0 | | |
| | | | | | | | | 0 | | |
| | | | | | | | | 0 | | |
| | | | | | | | | 6 | | |
| Leave in situ to degrade naturally | | | | | | | | | 62 | 0 |
| | | | | | | | | | | 1 |
| | | | | | | | | | | 4 |
| | | | | | | | | | | 0 |
| Long term degradation of footings leading to falling jacket members and structures. | | | | | | | | | 40 | 0 |
| | | | | | | | | | | 4 |
| | | | | | | | | | | 0 |
| | | | | | | | | | | 0 |
| Fishing gear interaction | | | | | | | 93 | 0 | | |

| Activity | Environmental | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Option 1 – Recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore | | Option 2- Recover to surface, slurry to shore | | Option 3- Recover to surface, offshore re-injection | | Option 4- Redistribution of drill cuttings on the seabed | | Option 5- Leave in situ | |
| | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class |
| with redistributed drill cuttings. | | | | | | | | 0<br>3<br>3 | | |
| Fishing gear interaction with peripheral drill cuttings. | | | | | | | | | 75 | 0<br>3<br>3<br>0 |
| Offshore discharge of treated oily fluids in offshore waters. | 54 | 0<br>1<br>2<br>1 | | | | | | | | |
| Fluidisation of cuttings, blockage of suction dredging equipment during excavation of drill cuttings pile and recovery to surface | 115 | 0<br>0<br>1<br>4 | 115 | 0<br>0<br>1<br>4 | | | | | | |
| Fluidisation of cuttings, blockage of suction dredging equipment during excavation of drill cuttings pile and recovery | | | | | 115 | 0<br><br>1<br>4 | | | | |

| Activity | Environmental | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Option 1 – Recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore | | Option 2- Recover to surface, slurry to shore | | Option 3- Recover to surface, offshore re-injection | | Option 4- Redistribution of drill cuttings on the seabed | | Option 5- Leave in situ | |
| | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class |
| to the surface using ROV dredge system and disposal of cuttings | | | | | | | | | | |
| Fluidisation of cuttings, blockage of suction dredging equipment during excavation and redistribution of the drill cuttings pile. | | | | | | | 115 | 0<br>0<br>1<br>4 | | |
| Discharge of oily water under permit in a coastal environment. | | | 72 | 0<br>2<br>4<br>0 | | | | | | |
| Onshore treatment of the solid waste. | 33 | 0<br>2<br>1<br>0 | | | | | | | | |
| Onshore disposal of the drill cuttings. | 48 | 0<br>3<br>0<br>1 | 48 | 0<br>3<br>0<br>1 | | | | | | |

| Activity | Environmental | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Option 1 – Recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore | | Option 2- Recover to surface, slurry to shore | | Option 3- Recover to surface, offshore re-injection | | Option 4- Redistribution of drill cuttings on the seabed | | Option 5- Leave in situ | |
| | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class |
| Accidental spill/ release of cuttings during surface treatment, disposal or transport to shore. | 52 | 6<br>1<br>0<br>0 | 95 | 0<br>0<br>5<br>1 | | | | | | |
| Accidental spill/ release of cuttings during injection | | | | | 72 | 1<br>4<br>1<br>0 | | | | |
| **TOTAL** | 302 | | 331 | | 187 | | 370 | | 177 | |

Key:

| | | |
|---|---|---|
| (green) | Low risk | Scoring: 1 to 9 |
| (yellow) | Moderate risk | Scoring: 10 to 12 |
| (orange) | Moderate to High | Scoring: 13 to 16 |
| (red) | High risk | Scoring: 18 to 36 |

**Table A.14: Summary of societal risk assessment and number of receptors per risk class for Drill Cutting Decommissioning options**

| Activity | Societal | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Option 1 – Recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore | | Option 2- Recover to surface, slurry to shore | | Option 3- Recover to surface, offshore re-injection | | Option 4- Redistribution of drill cuttings on the seabed | | Option 5- Leave in situ | |
| | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class |
| Physical presence of vessels during transport of drill cuttings waste to shore. | 22 | 5<br>0<br>0<br>0 | 36 | 5<br>0<br>0<br>0 | | | | | | |
| Excavation of the drill cuttings pile and redistribution to another area of seabed (several locations 70m from platform) | | | | | | | 38 | 0<br>2<br>0<br>1 | | |
| Leave in situ to degrade naturally | | | | | | | | | | |
| Long term degradation of footings leading to falling jacket members and structures. | | | | | | | | | | |
| Fishing gear interaction | | | | | | | 23 | 0 | | |

| Activity | Societal | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Option 1 – Recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore | | Option 2- Recover to surface, slurry to shore | | Option 3- Recover to surface, offshore re-injection | | Option 4- Redistribution of drill cuttings on the seabed | | Option 5- Leave in situ | |
| | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class |
| with redistributed drill cuttings. | | | | | | | | 1 | | |
| | | | | | | | | 1 | | |
| | | | | | | | | 0 | | |
| Fishing gear interaction with peripheral drill cuttings. | | | | | | | | | 15 | 1 |
| | | | | | | | | | | 1 |
| | | | | | | | | | | 0 |
| | | | | | | | | | | 0 |
| Offshore discharge of treated oily fluids in offshore waters. | | | | | | | | | | |
| Fluidisation of cuttings, blockage of suction dredging equipment during excavation of drill cuttings pile and recovery to surface | | | | | | | | | | |
| Fluidisation of cuttings, blockage of suction dredging equipment during excavation of drill cuttings pile and recovery | | | | | | | | | | |

| Activity | Societal | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Option 1 – Recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore | | Option 2- Recover to surface, slurry to shore | | Option 3- Recover to surface, offshore re-injection | | Option 4- Redistribution of drill cuttings on the seabed | | Option 5- Leave in situ | |
| | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class |
| to the surface using ROV dredge system and disposal of cuttings | | | | | | | | | | |
| Fluidisation of cuttings, blockage of suction dredging equipment during excavation and redistribution of the drill cuttings pile. | | | | | | | | | | |
| Discharge of oily water under permit in a coastal environment. | | | 33 | 0<br>2<br>1<br>0 | | | | | | |
| Onshore treatment of the solid waste. | 26 | 0<br>0<br>2<br>0 | | | | | | | | |
| Onshore disposal of the drill cuttings. | 26 | 0<br>0<br>2<br>0 | 26 | 0<br>0<br>2<br>0 | | | | | | |

| Activity | Societal | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Option 1 – Recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore | | Option 2- Recover to surface, slurry to shore | | Option 3- Recover to surface, offshore re-injection | | Option 4- Redistribution of drill cuttings on the seabed | | Option 5- Leave in situ | |
| | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class | Total score | Number of receptors per risk class |
| Accidental spill/ release of cuttings during surface treatment, disposal or transport to shore. | 64 | 5 | 85 | 0 | | | | | | |
| | | 2 | | 2 | | | | | | |
| | | 0 | | 3 | | | | | | |
| | | 0 | | 1 | | | | | | |
| Accidental spill/ release of cuttings during injection | | | | | 44 | 4 | | | | |
| | | | | | | 1 | | | | |
| | | | | | | 0 | | | | |
| | | | | | | 0 | | | | |
| **TOTAL** | **138** | | **180** | | **44** | | **61** | | **15** | |

Key:

| | | |
|---|---|---|
| (green) | **Low risk** | **Scoring: 1 to 9** |
| (yellow) | **Moderate risk** | **Scoring: 10 to 12** |
| (orange) | **Moderate to High** | **Scoring: 13 to 16** |
| (red) | **High risk** | **Scoring: 18 to 36** |

# APPENDIX B

## ENERGY AND EMISSIONS

CNRI commissioned BMT Cordah Limited (BMT Cordah) to undertake a separate Energy and Emissions Assessment. This appendix provides a summary of the data and results of the energy use and gaseous emissions assessment for each decommissioning method, as detailed with the Energy and Emissions Assessment Report (CNRI, 2016b). Further detail on the methodology, data and results are provided within the Energy and Emissions Assessment Report (CNRI, 2016b).

### Assumptions and Calculations

The data used to calculate the energy use and gaseous emissions for each of the decommissioning methods (Tables B.1 thru B.5) were based on the IoP (2002) energy consumption factors for different activities and can be found in CNRI (2016b) document.

**Table B.1: Energy consumption and gaseous emissions factors used in the calculations for the recycling of materials**

| Material | Energy Consumption (GJ/tonne) | Gaseous Emissions (tonnes/tonne) | | | | Source |
|---|---|---|---|---|---|---|
| | | $CO_2$ | $NO_x$ | $SO_2$ | $CH_4$ | |
| Standard steel | 9 | 0.960 | 0.0016 | 0.0038 | ND | IoP (2000) |
| Aluminium | 15 | 1.080 | 0.0013 | 0.017 | ND | IoP (2000) |
| Copper | 25 | 0.300 | 0.0013* | 0.120 | ND | IoP (2000) |
| Zinc | 10 | 0.480 | 0.0013* | 0.017* | ND | IoP (2000) |
| Lead | 15* | 1.080* | 0.0013* | 0.017* | ND | IoP (2000)* |

*These values have been supplemented based on the values for the recycling of aluminium in the absence of an agreed industry figure for these materials.

**Table B.2: Energy consumption and gaseous emissions factors used in the calculations for the new manufacture of materials**

| Material | Energy Consumption (GJ/tonne) | Gaseous Emissions (tonnes/tonne) | | | | Source |
|---|---|---|---|---|---|---|
| | | $CO_2$ | $NO_x$ | $SO_2$ | $CH_4$ | |
| Standard steel | 25.0 | 1.889 | 0.0035 | 0.0055 | ND | IoP (2000) |
| Aluminium | 215.0 | 3.589 | 0.0041 | 0.0249 | ND | IoP (2000) |
| Copper | 100.0 | 7.175 | 0.020 | 0.200 | ND | IoP (2000) |
| Zinc | 65.0 | 0.024 | 0.0003 | 0.0037 | ND | IoP (2000) |
| Cement | 1.0 | 0.880 | 0.0054 | 0.0001 | ND | IoP (2000) |
| Aggregate | 0.1 | 0.005 | ND | ND | ND | University of Bath (2008) |
| Wood | 5.2 | ND | ND | ND | ND | IoP (2000) |
| Rock wool | 6.8 | 0.680 | 0.00001 | 0.002 | ND | IoP (2000) |
| Rubber | 100.0 | ND | ND | ND | ND | IoP (2000) |

**Table B.3: Energy consumption and gaseous emissions factors used in the calculations for fuel use**

| Fuel Type | Energy Consumption (GJ/tonne) | Gaseous Emissions (tonnes/tonne) | | | | Source |
|---|---|---|---|---|---|---|
| | | $CO_2$ | $NO_x$ | $SO_2$ | $CH_4$ | |
| Marine diesel | 43.1 | 3.20 | 0.0594 | 0.004 | 0.00018 | UKOOA (2008) |
| Aviation fuel | 46.1 | 3.20 | 0.0125 | 0.004 | 0.000087 | UKOOA (2002)* |
| Diesel fuel | 44.0 | 3.18 | 0.004 | 0.001 | ND | IoP (2000) |
| Turbine generator | 44.0 | 3.20 | 0.0135 | 0.004 | 0.0000328 | DECC (2015) |
| Engine generator | 44.0 | 3.20 | 0.059 | 0.004 | 0.00018 | DECC (2015) |

*Aviation fuel emissions factors were not updated in the UKOOA (2008) report.

**Table B.4: Energy consumption and gaseous emissions factors used in the calculations for onshore deconstruction**

| Operation | Energy Consumption (GJ/tonne) | Gaseous Emissions (tonnes/tonne) | | | | Source |
|---|---|---|---|---|---|---|
| | | $CO_2$ | $NO_x$ | $SO_2$ | $CH_4$ | |
| Overall dismantling | 1.15 | ND | ND | ND | ND | IoP (2000) |

**Table B.5: Energy consumption factors used in the calculations for vessel fuel consumption**

| Vessel | Energy Consumption Factors (tonnes/day) | | | | Source/comments |
|---|---|---|---|---|---|
| | In port | In transit | Working | Waiting on weather | |
| Heavy Lift Vessel (HLV) | 23 | 301 | 61 | 40 | Contractor factor values CNRI (CNRI, 2012a). |
| | 25 | 25 | 30 | 30 | Values based on Murchison operations (BMT, 2012) |
| Supply vessel | 2 | 10 | 5 | 5 | IoP (2000) |
| Standby vessel/ Guard vessel | 1 | 8 | 4 | 4 | Based on values for safety vessel (IoP, 2000) |
| Support vessel/CSV | 2 | 26 | 18 | 9 | Based on values for MSV (IoP,2000) |
| MSV (flotel) | 2 | 26 | 18 | 9 | IoP (2000) |
| Tug (AHV) | 2 | 50 | 5 | 30 | Based on values for AHV (IoP, 2000) |
| Survey vessel | 3 | 22 | 18 | 10 | IoP (2000) factors for DSV as agreed with CNRI |
| Tug (inshore) | 1 | 10 | 17 | 17* | Based on values for cargo barge tug (IoP, 2000) |
| Rock dump vessel | 2 | 8 | 15 | 15 | Based on values for pipeline vessel (IoP 2000) |
| Trawler | 0.2 | 0.8 | 0.7 | 0.7 | Based on values for standby vessel (IoP, 2000) |
| ROVSV | 3 | 22 | 18 | 10 | Values for DSV (IoP, 2000) |

**Results Summary**

Table B.6 provides a summary of the predicted total energy use and gaseous emissions for each of the decommissioning options.

**Table B.6: Summary of predicted total energy use and gaseous emissions for all decommissioning options**

| Decommissioning option | Energy | Gaseous emissions (kg) | | |
|---|---|---|---|---|
| | Energy Usage (GJ) | $CO_2$ | $NO_x$ | $SO_2$ |
| **Jacket full removal** (multiple lifts) | 297,654 | 24,276.9 | 245.3 | 48.5 |
| **Jacket partial removal** (multiple lifts) | 598,148 | 31,064.1 | 300.9 | 90.7 |
| **Drill cuttings removal Option 1** (recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore) | 120,821 | 7,665.9 | 138.9 | 9.0 |
| **Drill cuttings removal Option 2** (recover to surface, slurry to shore) | 304,063 | 21.137.8 | 359.8 | 21.3 |
| **Drill cuttings removal Option 3** (recover to surface, offshore re-injection) | 109,497 | 6.480.0 | 120.3 | 8.1 |
| **Drill cuttings Option 4** (redistribution of drill cuttings on the seabed) | 87,278 | 6.480.0 | 120.3 | 8.1 |
| **Drill cuttings Option 5** (leave in situ) | 0 | 0 | 0 | 0 |

# APPENDIX C

## TECHNICAL FEASIBILITY ASSESSMENT

Tables C.1 and C.2 detail the desktop assessment of the two jacket decommissioning methods and five drill cuttings pile decommissioning methods which were carried forward from the CA workshop for the decommissioning of the NNP jacket and drill cuttings pile. The three Technical Feasibility sub-criteria, as described in **Appendix A**, were considered for each method of decommissioning. Scores were assigned against each of scoring criteria as defined in **Appendix A,** Tables A.1 and A.3. For each decommissioning method, the assessment criteria were scored and combined feasibility score was calculated by adding these scores together for each method.

**Table C.1: Technical Feasibility assessment – jacket decommissioning**

| Technical Feasibility sub-criteria | Scoring criteria | | |
|---|---|---|---|
| | Likelihood | Consequence | Risk |
| **Full removal by multiple lifts** | | | |
| 1. Technical feasibility | D | 4 | 16 |
| 2. Ease of recovery from excursion | D | 4 | 16 |
| 3. Use of proven technology and equipment | D | 3 | 12 |
| **Summed total** | | | **44** |
| **Partial removal by multiple lifts** | | | |
| 1. Technical feasibility | B | 2 | 4 |
| 2. Ease of recovery from excursion | C | 4 | 12 |
| 3. Use of proven technology and equipment | B | 2 | 4 |
| **Summed total** | | | **20** |

### Table C.2: Technical Feasibility assessment – drill cuttings decommissioning

| Technical Feasibility sub-criteria | Scoring criteria | | |
|---|---|---|---|
| | Likelihood | Consequence | Risk |
| **Drill cuttings removal Option 1** – recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore | | | |
| 1. Technical feasibility | D | 4 | 16 |
| 2. Ease of recovery from excursion | C | 3 | 9 |
| 3. Use of proven technology and equipment | E | 4 | 20 |
| **Summed total** | | | **45** |
| **Drill cuttings removal Option 2** – recover to surface, slurry to shore | | | |
| 1. Technical feasibility | D | 4 | 16 |
| 2. Ease of recovery from excursion | C | 3 | 9 |
| 3. Use of proven technology and equipment | E | 4 | 20 |
| **Summed total** | | | **45** |
| **Drill cuttings removal Option 3** – recover to surface, offshore re-injection | | | |
| 1. Technical feasibility | D | 5 | 20 |
| 2. Ease of recovery from excursion | E | 5 | 25 |
| 3. Use of proven technology and equipment | D | 4 | 16 |
| **Summed total** | | | **61** |
| **Drill cuttings Option 4** – redistribution of drill cuttings on the seabed | | | |
| 1. Technical feasibility | C | 3 | 9 |
| 2. Ease of recovery from excursion | C | 2 | 6 |
| 3. Use of proven technology and equipment | B | 3 | 6 |
| **Summed total** | | | **21** |
| **Drill cuttings Option 5** – leave in situ | | | |
| 1. Technical feasibility | A | 1 | 1 |
| 2. Ease of recovery from excursion | A | 1 | 1 |
| 3. Use of proven technology and equipment | A | 1 | 1 |
| **Summed total** | | | **3** |

# APPENDIX D

## ECONOMIC (COST) ASSESSMENT

This appendix provides cost estimates for the eight different methods which were taken forward by CNRI. Vessel days and rates have been estimated based on information from other recent CNRI projects utilising similar vessel types and market rates for specialist vessels.

### Estimated Costs and Assumptions

In the estimation of cost, CNRI have assumed that jacket removal will be awarded on a lump sum basis. The basis of the lump sum, prepared by CNRI, includes engineering, preparations, removal and disposal. CNRI included a value, unspecified here due to its commercially sensitive nature, for ongoing liability under the partial removal option.

The estimated costs for the removal of drill cuttings were provided by CNRI and detailed in Table D.1. In this version of the report appendices, the economic cost values have been removed, due to their commercially sensitive nature, however, a complete version, inclusive of these values, has been sent to BEIS.

**Table D.1: Estimated costs for drill cutting removal options**

| Item: unit | Option 1<br>Recover to surface, separation of cuttings offshore, liquids treated and released offshore, solids transported onshore | | Option 2<br>Recover to surface, slurry to shore | | Option 3<br>Recover to surface, offshore re-injection | | Option 4<br>Redistribution of drill cuttings on the seabed | | Option 5<br>Leave in situ | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Days | Cost /day (£) | Days | Cost /day (£) | Days | Cost /day (£) | Days | Cost /day (£) | Days | Cost /day (£) |
| Offshore cuttings Processing unit (i.e. Rotomill) | 579 | -* | - | - | - | - | - | - | - | - |
| Working ROV unit to recover cuttings | 579 | -* | - | - | 1520 | -* | - | - | - | - |
| Platform Operating (OPEX) | 579 | -* | - | - | 1520 | -* | - | - | - | - |
| Vessel + ROV to recover cuttings | - | - | 579 | -* | - | - | 145 | -* | - | - |
| CRI Processing unit | - | - | - | - | 1520 | -* | - | - | - | - |
| Disposal cost | -* | | -* | | - | - | - | - | - | - |
| Ongoing Liability | - | - | - | - | - | - | -* | | -* | |
| **TOTAL** | -* | | -* | | -* | | -* | | -* | |

*Values are not displayed due to their commercially sensitive nature.