Auk, Fulmar & Auk North Area Decommissioning

Environmental Appraisal Report

Repsol Sinopec Resources UK
163 Holburn Street, Aberdeen AB10 6BZ, UK

Tel: +44 (0) 1224 352500
www.repsolsinopecuk.com

DOCUMENT CONTROL

Approvals

	Name	Signature	Date
Prepared by	Tim Hollis		29.10.20
Checked by	Kilian Palop		29.10.20
Reviewed by	Robbie Dunbar-Smith		29.10.20
Approved by	Teresa Munro	T.Munro	29.10.20

Revision Control

Revision No	Reference	Changes/Comments	Issue Date
1	Issued for Comment	N/A	16/02/2018
2	Issued for Review	Initial internal review comments incorporated	12/07/2018
3	Re-Issued for Review	Further comments incorporated	11/10/2018
4	Re-Issued for Review	Further comments incorporated	14/12/2018
5	Re-Issued for Use	Further comments incorporated	21/11/2019
6	Re-Issued for Use	Further comments incorporated	08/01/2020
7	Re-Issued for Use	Further comments incorporated	11/05/2020
8	Re-Issued for Use	Further comments incorporated	14/05/2020

Distribution List

Name	Company	No of Copies
OPRED	Department for Business, Energy and Industrial Strategy	1

Contents

Terms and Abbreviations

Abbreviation	Explanation
AD	Advanced Drilling
BAC	Background Assessment Concentration
BEIS	Department for Business, Energy and Industrial Strategy
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CA	Comparative Assessment
CEMP	Coordinated Environmental Monitoring Programme
cm	Centimetre
CNS	Central North Sea
DECC	Department of Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
DNV	Det Norske Veritas
DP	Decommissioning Programme
EA	Environmental Appraisal
EC	European Community
EIA	Environmental Impact Assessment
ELSBM	Exposed Location Single Buoy Mooring
ENVID	Environmental issues Identification
ERL	Effects Range Low
ES	Environmental Statement
EU	European Union
EUNIS	European Nature Information System
FSU	Floating Storage Unit
GC	Gas Chromatograph
HLV	Heavy Lift Vessel
HRA	Habitats Regulations Assessment
ICES	International Council for the Exploration of the Sea
IEEM	Institute of Ecology and Environmental Management
IEMA	Institute of Environmental Management and Assessment
IMO	International Maritime Organisation
IOGP	International Association of Oil & Gas Producers
IUCN	International Union for Conservation of Nature and Natural Resources
JNCC	Joint Nature Conservation Committee

Abbreviation	Explanation
km	Kilometre
km^2	Kilometre squared
km^2yr	Kilometre squared year (in relation to the persistence of cuttings piles - the area of seabed where the concentration of oil remains above 50 μgg^{-1} and the duration that this contamination level remains)
LAT	Lowest Astronomical Tide
LTOBF	Low Toxicity Oil Based Fluid
m	Metre
mm	Millimetre
m^2	Metre squared
m^3	Metre cubed
MCZ	Marine Conservation Zone
MPA	Marine Protected Area
nm	nanometre
NM	Nautical mile
NORM	Naturally Occurring Radioactive Material
NMPi	Scottish National Marine Plan Interactive
NRV	Non-Return Valve
OBM	Oil Based Mud
OGUK	Oil and Gas UK
OPEP	Oil Pollution Emergency Plan
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSPAR	Oslo Paris Convention
P&A	Plugging and Abandonment
PAH	Polycyclic Aromatic Hydrocarbon
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SACFOR	Superabundant, Abundant, Common, Frequent, Occasional, Rare
SALM	Single Anchor Leg Mooring
SMRU	Sea Mammals Research Unit
SPA	Special Protection Area
SLV	Single Lift Vessel
SOSI	Seabird Oil Sensitivity Index
SSIV	Subsea Isolation Valve

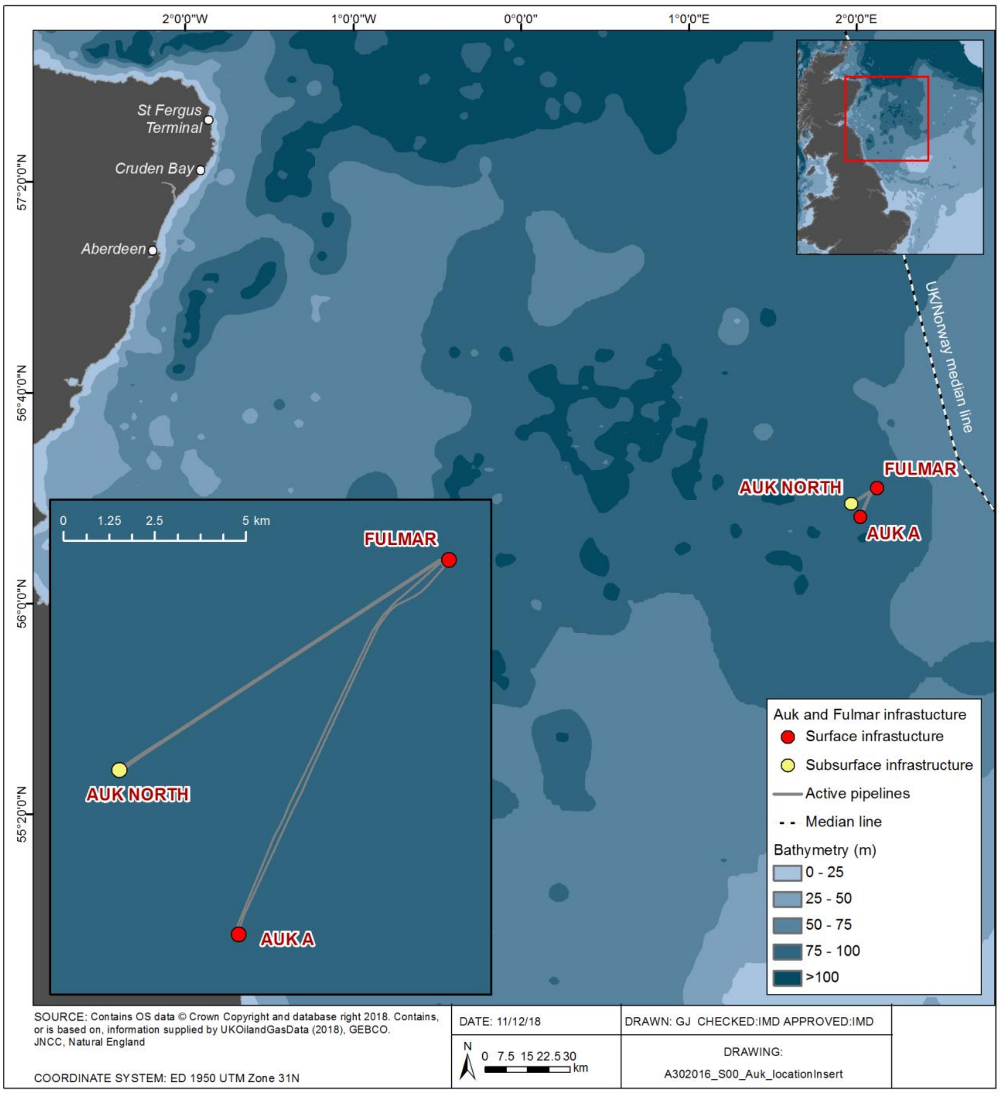
Abbreviation	Explanation
STL	Submerged Turret Loading
te/h	Tonnes equivalent per hour
THC	Total Hydrocarbon
µm	Micrometre
μgg^{-1}	Microgram per gram
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
UKOOA	United Kingdom Offshore Operators Association
UNESCO	United Nations Educational, Scientific and Cultural Organisation
"	Inches

NON-TECHNICAL SUMMARY

Introduction

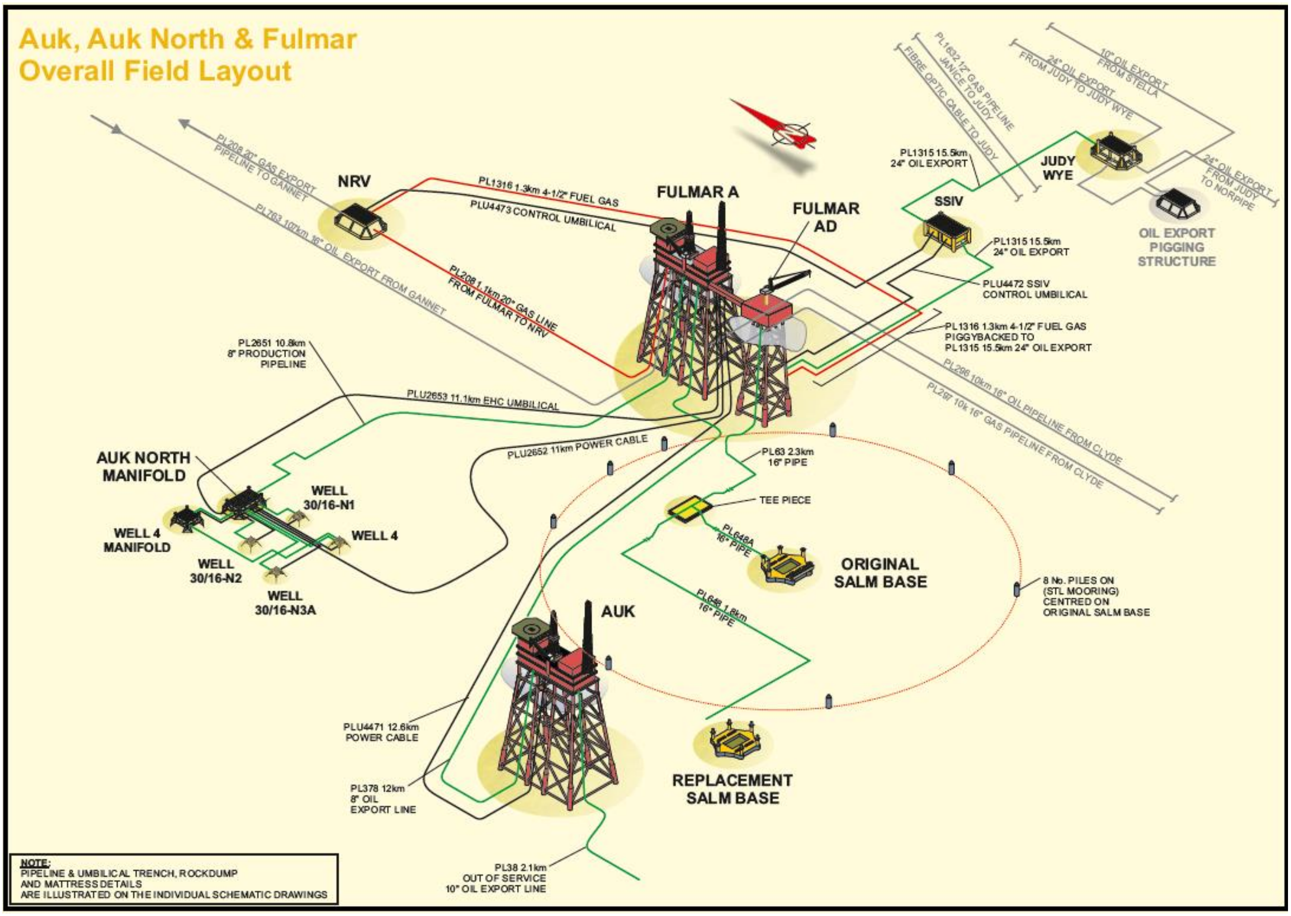
This summary outlines the findings of the Environmental Appraisal (EA) conducted by Repsol Sinopec Resources UK Limited for the proposed decommissioning of the Auk, Fulmar and Auk North oil fields located in the central North Sea (CNS) in Blocks 30/11 and 30/16 (Figure 1).

Figure 1: Location of Auk, Fulmar and Auk North Facilities



Auk has been producing oil since 1975 from an integrated drilling, production and living quarters platform located in 85 m water depth approximately 252 km from the nearest UK coastline. Oil is exported through a 12 km 8" export pipeline to the Fulmar Alpha (A) platform. The Fulmar complex consists of drilling, production and accommodation facilities on two bridge-linked jacket structures, Fulmar A (the main platform) and the Fulmar Advanced Drilling (AD) wellhead platform in a water depth of 83 m. Operating since 1982, Fulmar is a hub for several other fields, including Auk, Auk North Clyde and Halley, collecting oil and gas for onward export via pipelines to the UK. The Auk and Clyde Fields remain in production at this time. Auk North has four subsea wells in 80 to 83 m water depth that are tied back to Fulmar with an 11 km 8" export pipeline, a control umbilical and a power cable. The layout of infrastructure in the Auk, Fulmar and Auk North fields is illustrated in Figure 2.

Figure 2: Schematic Summary of Facilities at Auk, Fulmar and Auk North to be Decommissioned (Items Coloured Light Grey are not in Decommissioning Scope and Shown for Context Only)



As part of the planning for decommissioning and to obtain regulatory approval for the activities, three Decommissioning Programme (DP) documents have been drafted, covering installations and pipelines for the Auk, Fulmar and Auk North fields. The scope of these, and therefore the scope of this EA, cover:

- The Auk, Fulmar A and Fulmar AD topsides[1];
- The Auk, Fulmar A and Fulmar AD jackets[2];
- Associated drill cuttings piles;
- Subsea structures[3]: subsea isolation valve (SSIV), non-return valve (NRV) protection structure, Auk North Production Manifold, Auk Well 4 manifold, SALM[4] bases and STL[5] anchor piles, the Fulmar Igloo (covering the SALM Tee-Piece), the piled Fulmar AD Template, mattresses, grout bags; and
- Pipelines, umbilicals and cables.

---

[1] On an offshore installation, the topsides is the deck and all the modular facilities on it including accommodation, drilling unit, processing equipment, cranes and helideck.

[2] In an offshore installation, the jacket is the steel lattice tower sitting on the seabed that supports the topsides.

3 The four Auk North integrated wellhead protection structures recorded in the Fulmar and Auk North topsides and subsea facilities DPs document are being removed as part of well abandonment and are therefore outside the scope of this EA.

[4] SALM = Single Anchor Leg Mooring. For the first years of production, oil export was to a floating storage unit via an offloading buoy/mooring system attached to the SALM base by a flexible riser.

[5] STL = Submerged Turret Loading; the name of the submerged mooring buoy system, which was also tethered by load-bearing lines to a circular arrangement of anchor piles at the seabed (the STL anchor piles).

This EA is therefore area wide, covering the Fulmar, Auk and Auk North oil fields. It should be noted that the Auk field is still in production, and therefore the Auk field DP is not in progress at this stage. When the Auk field DP is submitted, this EA will be updated as necessary to reflect the DP.

The DP documents and the EA do not cover well plugging and abandonment, or the flushing and cleaning operations that will be undertaken on the topsides and subsea (pipelines, umbilicals, manifolds etc) as part of the preparatory work preceding decommissioning.

Stakeholder Engagement

Consulting with stakeholders is an important part of the decommissioning EA process as it allows any concerns or issues which stakeholders may have to be communicated and addressed. In December 2017, as part of the informal stakeholder engagement process a Scoping Report was issued to a number of stakeholders. The Scoping Report provided an overview of the Auk, Fulmar and Auk North fields, the proposed decommissioning activities as known at the time and an overview of the impacts to be assessed in this EA. Stakeholders were invited to comment on the decommissioning proposals and planned EA with respect to any concerns they may have. In addition to issuing the Scoping Report, Repsol Sinopec Resources UK Limited organised a number of of informal stakeholder engagement sessions. These have included separate meetings with individual stakeholders, together with a Stakeholder Engagement Workshop to which many stakeholders were invited. Comments received through the process have been summarised in this EA Report and used to inform the impact assessments.

Options for Decommissioning and Comparative Assessment

The potential opportunities for re-use of the Auk, Fulmar and Auk North infrastructure were considered. Options to re-use the Auk, Fulmar and Auk North infrastructure *in-situ* for future hydrocarbon developments were considered, but none have yielded a viable commercial opportunity. Reasons for this include the absence of remaining hydrocarbon reserves in the vicinity, and the limited remaining design life of the infrastructure.

In line with the latest Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) guidelines on decommissioning, Repsol Sinopec Resources UK Limited has committed to recovering the Auk, Fulmar A and Fulmar AD topsides to shore. Similar decisions have been reached for platform jackets weighing <10,000 tonnes (Auk and Fulmar AD) and for subsea structures, in line with OPRED decommissioning guidance.

The Fulmar A jacket is >10,000 tonnes and a case for derogation (i.e. for leaving its footings *in-situ*) and has therefore been subject to a Comparative Assessment (CA) process in which all feasible options for decommissioning have been scored against each other with respect to criteria including technical feasibility, environmental impact and safety in order to establish the best option for decommissioning.

Beneath the Auk and the Fulmar bridge-linked platform complex, there are piles of mud and cuttings containing oil deposited on the seabed when the wells were drilled many years ago. Detailed survey work has shown that the two cuttings piles are below internationally agreed thresholds for oil leaching and persistence, which means that the best option for the environment is for the piles to be left *in-situ* to degrade naturally.

With regards to pipelines, umbilicals and cables, these were considered on a case-by-case basis. OPRED decommissioning guidance states that a CA is required for pipelines and that all feasible decommissioning options should be considered.

The recommendations made for decommissioning, supported by appropriate specialist studies, are summarised in Table 1. The full justification for each decision is presented in the CA; justifications are not reproduced in this document, which focuses instead on the potential environmental impacts of the selected options.

Table 1: Decommissioning Recommendations for Auk, Fulmar and Auk North

Item	Subject to CA?	Recommendation
Topsides	No	Full removal
Jackets <10,000 tonnes (Auk and Fulmar AD)	No	Full removal
Jackets >10,000 tonnes (Fulmar A)	Yes	Partial removal, leaving footings *in-situ*
Subsea structures	No	Full removal
Drill cuttings	No	Leave *in-situ*
Pipelines: Group 1 - 24" concrete coated pipeline, surface laid and exposed (PL1315)	Yes	Leave *in-situ*: pipeline to be fully trenched and buried including ends
Pipelines: Group 2 - 10" concrete coated pipeline, surface laid and exposed (PL38[6])	Yes	Leave *in-situ*; pipeline to be fully trenched and buried including ends
Pipelines: Group 3 - Pipelines and umbilicals, surface laid and rock covered (PL208, PL1316, PLU4472 (aka N0878), PLU4473 (aka N0879)	Yes	Leave *in-situ*: disconnect/remove ends and minimal remediation
Pipelines: Group 4 - Pipelines, fully trenched and buried (PL378, PL2651)	Yes	Leave *in-situ*: disconnect/ remove ends and minimal remediation
Pipelines: Group 5 - Pipelines, partially trenched and buried (PL63 & PL648)	Yes	Leave *in-situ* with remedial intervention: rock placed on exposures/ends
Pipelines: Group 6 - Umbilicals and cables – trenched and buried (PLU4471 (aka FAPWC), PLU2652, PLU2653)	Yes	Leave *in-situ*: disconnect/ remove ends and minimal remediation

Decommissioning Activities

At this stage, the specific method by which each activity will take place has not been determined. These decisions will depend to some degree on the proposals made by the eventual contractor. The outline methods anticipated are summarised in Table 2.

Table 2: Decommissioning Activities for Auk, Fulmar and Auk North

Item	Method
Topsides (Auk, Fulmar A and Fulmar AD)	Complete removal and recovery to shore for re-use, recycling or disposal. Removal as a single unit, as component modules, or cut into small pieces prior to removal or a combination of these methods.
Jackets (Auk and Fulmar AD)	Total removal to shore for re-use, recycling or disposal. Jacket removed as single or multiple components to shore.
Jacket (Fulmar A)	Partial removal to shore for re-use, recycling or disposal. Cut jacket above footings, retrieve top part of jacket as single or multiple components and leave footings *in-situ*.
Subsea structures	All subsea infrastructure will be disconnected, fully removed and recovered to shore for re-use, recycling or disposal.
Pipelines: Group 1 (PL1315)	Leave *in-situ*: major intervention. Tie-in spools will be disconnected and removed for recovery to shore. Pipeline will be fully trenched, including the cut ends, which will therefore not require rock armour. The exception will be two of the four locations where PL1315 is crossed by other lines, which will be left alone. Trench will be backfilled to achieve a clear seabed. However, if this cannot be achieved due to difficulties in executing trenching and burying, then spot rock placement or full rock armouring may be considered. OPRED will be consulted on any proposed use of additional rock.
Pipelines: Group 2 (PL38)	Leave *in-situ*: major intervention. Tie-in spools will be disconnected and removed for recovery to shore. Pipeline will be fully trenched, including the cut ends, which will therefore not require rock armour. Trench will be backfilled to achieve a clear seabed. However, if this cannot be achieved due to difficulties in executing trenching and burying, then spot rock placement or full rock armouring may be considered. OPRED will be consulted on any proposed use of additional rock.
Pipelines: Group 3 (PL208, PL1316,	Leave *in-situ*: minimal intervention.

[6] PL38 is not included in the Fulmar and Auk North DPs, it will be covered in the Auk DP and associated documents.

Item	Method
PLU4472/N0878, PLU4473/N0879)	Tie-in spools and umbilicals will be disconnected and removed for recovery to shore. Exposed sections of pipeline / umbilical (including sections exposed due to removal of mattresses) will also be cut and recovered. Remaining cut ends will be made safe to mitigate snagging hazards for other sea users, for example by burial or adding rock cover.
Pipelines: Group 4 (PL378, PL2651)	Leave *in-situ*: minimal intervention. Tie-in spools will be disconnected and removed for recovery to shore. Remaining cut ends will be made safe, for example by burial or adding rock cover.
Pipelines: Group 5 (PL63 & PL648)	Leave *in-situ*: major intervention. Tie-in spools will be disconnected and removed for recovery to shore. Remaining cut ends and sections that are not adequately buried will be made safe by covering with rock armour to a target depth of 0.6 m over the top of the pipes.
Pipelines: Group 6 (PLU4471, PLU2652, PLU2653)	Leave *in-situ*: minimal intervention. Exposed umbilical and cable ends will be cut and removed for recovery to shore. The remaining cut ends will be made safe, for example by burial or adding rock cover.
Protection and support items	Protection and support items such as mattresses and grout bags that are accessible (e.g. not buried or under a pipeline) and are safe to recover will be lifted for transfer to shore. Items that are not accessible or safe to recover will be decommissioned *in-situ*; this will be discussed with OPRED during the decommissioning operations.

Schedule

Topsides:

The Fulmar, Halley and Auk North fields ceased production in October 2018. However, Fulmar Platform will continue operating as an export hub for Auk, Clyde and Gannet production until they reach cessation of production or by-pass Fulmar. Platform wells in Fulmar are expected to be P&A'd during this export hub period to minimise the abandonment support cost. Once all platform wells are P&A'd and the Platform is no longer operating as export hub, the topsides will be decommissioned subject to market availability of cost effective removal services.

Auk platform wells will be P&A'd following the cessation of production. Once all platform wells were P&A'd the topsides will be decommissioned subject to market availability of cost effective removal services.

Jackets:

The Fulmar Alpha, AD and Auk Jackets are protected by sacrificial anodes that will remain in-situ with their structural integrity uncompromised for extended periods. This allow the possibility for a cost-effective approach to jacket decommissioning, in which Jackets could be bundled with other Repsol Sinopec Resources UK Limited infrastructure into a campaign to leverage economies of scale. Moreover, this approach also allows newly emerging technologies to be considered in future.

Subsea Infrastructure:

Subject to market availability of cost effective removal services, the Fulmar, Auk and Auk North subsea infrastructure will be decommissioned following P&A of the Auk North Area subsea wells and the topsides removal on Fulmar and Auk.

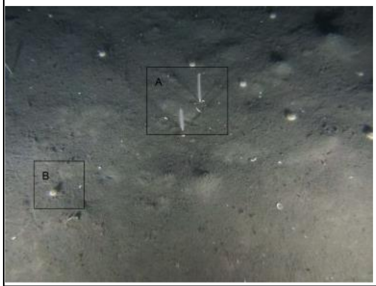
Environmental and Socio-Economic Baseline

The key environmental and social sensitivities in the Auk, Fulmar and Auk North area have been summarised in Table 3.

Table 3: Key Environmental and Social Sensitivities for Auk, Fulmar and Auk North

Sediment type and seabed features
Water depths across the three survey areas ranged between 70 m and 86 m relative to Lowest Astronomical Tide (LAT). The seabed at all three fields consists primarily of sediments with very little hard substrata. The most widespread sediments present were muddy sand or sandy mud. Mapped information on seabed type classifies this region of the North Sea as the EUNIS broadscale habitat A5.27 deep circalittoral sand.

Seabed habitats and species



Species living on the seabed observed through photography across the survey area were generally sparse, and similar over the whole area surveyed. The more frequently observed species included sea-pens, sea urchins, hydroids, soft coral, starfish, hermit crabs, hagfish and polychaetes. Sea-pens and faunal burrows were observed in the video footage and stills throughout the Auk, Fulmar and Auk North survey areas.

Invertebrate communities living within the sediments and sampled by grab were similar across the three fields, and the most abundant species at most stations away from the influence of cuttings piles were the mainly polychaete species characteristic of background conditions in this part of the CNS, and evident in the earliest baseline surveys. The clam species known as ocean quahog was not seen in the photographic data, but small numbers of individuals were seen in some of the sediment samples taken by grab.

Cuttings Piles

There are bathymetrically distinct cuttings piles present on the seabed beneath the jackets at Auk and Fulmar A. Detailed survey work has shown that the pile at Auk has a surface area of 5,000 m^2, a volume of 2,336 m^2 and a maximum depth of 1.2 m. The pile beneath the jackets at Fulmar is larger, with a surface area of 11,000 m^2, a volume of 18,746 m^2, and a maximum depth of 6.9 m. Each pile is surrounded by a zone of hydrocarbon contamination in which total hydrocarbon concentrations are ≥50 μgg^{-1}. At both piles, the size of this area has decreased to 0.134 km^2 at Auk, and to 0.262 km^2 at Fulmar relative to previous survey data, indicative of gradual recovery.

Fish and shellfish

The Auk, Fulmar and Auk North fields lie within the spawning areas for cod, lemon sole, plaice, sandeel and whiting.

The site also falls into a high intensity nursery area for cod. It is a low intensity nursery ground for anglerfish, blue whiting, hake, herring, ling, mackerel, plaice, sandeel, spotted ray, spurdog and whiting. However, published sensitivity maps indicate that the probability of aggregations of juvenile anglerfish, blue whiting, hake, cod, haddock, herring, mackerel, plaice, and whiting occurring in the offshore decommissioning Project area is low.

Seabirds

Large numbers of moulting auks (e.g. razorbills, guillemots, puffins) disperse from their coastal colonies and into offshore waters from July onwards and are sensitive to surface pollution as they are flightless at this time. Of these species, puffins are listed as IUCN 'Vulnerable' and razorbills are IUCN 'Near Threatened'; all other species in the area are listed as IUCN 'Least Concern'. The most abundant seabird species found in the Project area are northern fulmar, black-legged kittiwake and common guillemot. Herring gulls, glaucous gull and great black-backed gulls also use the area in winter. Following the 'Seabird Oil Sensitivity Index' developed by Oil and Gas UK, the vulnerability of seabirds to surface oil pollution in the vicinity of Auk, Fulmar and Auk North and the surrounding blocks is considered low for all months of the year.

Marine mammals

The harbour porpoise and the white-beaked dolphin are the most frequently recorded cetaceans in the vicinity of the Auk, Fulmar and Auk North fields, with sightings in eight months of the year which is reflective of these being the most abundant and widely distributed cetaceans in the North Sea. The predicted density of harbour porpoises in the vicinity of the decommissioning Project is average compared to the rest of UK waters, with an estimate of around 0.3 – 0.4 animals per km^2.

Grey seal densities vary across the offshore waters of the Project area, ranging between 1 and 5 seals per 25 km^2 which is considered low. Harbour seal density varies across the Project area, ranging between 0 and 1 animals per 25 km^2, also low. Additionally, from June to September harbour seals are on shore more often than at other times of the year.

Conservation

The only designated site in the immediate vicinity of the proposed Decommissioning Project is the Fulmar Marine Conservation Zone (MCZ), in which Auk, Fulmar and Auk North fields are all located. The site has an area of 2,439 km^2, and water depths of 50 – 100 m. The Fulmar MCZ is designated mainly for seabed types (or habitats), representative of Subtidal sands, Subtidal muds, Subtidal mixed sediments, in addition to a mollusc species, a clam known as the ocean quahog.

The ocean quahog is listed by OSPAR as a threatened and/or declining species, is also listed as a Scottish Priority Marine Feature (PMF); records of this species occur throughout the CNS region around the Auk, Fulmar and Auk North Area. From site-specific survey work conducted, adult specimens were observed at one station at Auk, one station at Auk North, and four stations at Fulmar. No Annex I habitat such as rocky, stony or biogenic reef, or submarine features made by leaking gases were recorded within the Auk, Fulmar and Auk North Area.

Fisheries and shipping

According to fisheries statistics for the UK provided by Marine Scotland, the areas around Auk, Fulmar and Auk North are targeted primarily for demersal fish. Both fishing effort and landings have been low over the last six years of statistics. Summer months are generally busiest, and although effort is multinational it is dominated by UK demersal trawlers. Overall, the fishing effort in the vicinity of the Auk, Fulmar and Auk North fields is low compared to other UK offshore areas.

Shipping density in the CNS in the vicinity of the proposed decommissioning activities is low. Average densities range from 0.2 vessels up to approximately five vessels per week and are mainly cargo and supply vessels.

Other sea users

The proposed decommissioning operations are located in a well-developed area for oil and gas extraction. Although several pipelines and two cables are located in the vicinity of the Project area (apart from those specific to Auk, Fulmar and Auk North), the closest active field, Clyde, is almost 10 km to the south-east of Fulmar A.

Impact Assessment Process

This EA Report has been prepared in line with the OPRED and Oil and Gas UK Guidelines and also with Decom North Sea's EA Guidelines for Offshore Oil and Gas Decommissioning. The OPRED Guidance states that an EA in support of a DP should be focused on the key issues related to the specific activities proposed; and that the impact assessment write-up should be proportionate to the scale of the project and to the environmental sensitivities of the project area.

The Auk, Fulmar and Auk North Decommissioning Project EA has been informed by a number of different processes, including engagement with the Regulators and their statutory advisors, an environmental issues identification workshop with specialists and the CA process. This workshop identified the key environmental sensitivities, discussed all the sources of potential impact and ultimately highlighted those interactions requiring further assessment. The decision on which issues required specific assessment in the EA Report was based on technical familiarity with the proposed decommissioning activities, knowledge of the environmental sensitivities in the Auk, Fulmar and Auk North Area (informed by site-specific environmental survey work together with shipping and fisheries studies), a review of industry experience of decommissioning impact assessment and on an assessment of wider stakeholder interest, informed in part by the stakeholder engagement undertaken. Those issues that were not assessed as key environmental or social sensitivities were scoped out, with reasoned justification.

For the potentially significant impacts identified, detailed impact assessment has been undertaken, using tried and tested methodology following best practice. Measures to mitigate and eliminate or reduce environmental and social impacts have been applied where appropriate; these include both industry standard and project-specific measures. The intention is that such measures should remove, reduce or manage the impacts to a point where the resulting residual significance is at an acceptable or insignificant level. Mitigation has also been proposed in some instances to ensure impacts that are predicted to be not significant remain so.

Where there is a possibility of impacts overlapping with or acting additively with those of other projects, a cumulative impact assessment has been undertaken. The likelihood of impacts from Auk, Fulmar and Auk North Decommissioning overlapping UK national boundaries into adjacent states (transboundary impacts) has also been considered.

Table 4 presents the findings of the assessment for the potentially significant impacts identified for the Auk, Fulmar and Auk North Decommissioning Project. The potential for cumulative and transboundary impacts was also considered.

Table 4: Impacts Summary for Decommissioning Activities at Auk, Fulmar and Auk North

Key Potential Impacts Assessed
Impacts of Seabed Disturbance including Disturbance of Drill Cuttings Piles
Impacts of Seabed Disturbance: Decommissioning activities at Auk, Fulmar and Auk North will cause a physical disturbance to the local seabed environment due to subsea infrastructure removal. The estimated area of direct physical disturbance from decommissioning activities amounts to 0.285 km^2 without the final overtrawl surveys conducted as part of safe seabed assurance, and 11.435 km^2 if included. An additional 9.7 km^2 is expected to be affected by peripheral settlement of sediment plumes (based on a worst case scenario including overtrawling). The predominantly infaunal organisms present in the area are similar to those that were present prior to the original development. Such communities have long accommodated background levels of seabed disturbance, both direct (e.g. recovery from overturned sediments) and indirect (temporarily increased levels of suspended sediments) such as those arising from fishing effort in the area. By comparison, the disturbance from decommissioning activities are temporary and localised in area; published monitoring and modelling studies indicate that recovery will occur within five years or so. *Impacts of Drill Cuttings Disturbance:* Seabed disturbance also includes any dredging or jetting of the cuttings piles that may be needed as part of jacket removal. Whilst potential disturbance of the Auk and Fulmar cuttings piles will cause redistribution of contaminated material, modelling for such activities at Auk and Fulmar AD indicated that most material will remain confined to the area of seabed already affected by the original drilling discharges. The modelling also indicated little change to sediment hydrocarbon content within the deposition area, whilst also predicting a recovery period of more than 10 years. This impact will be taking place within an area that has been subject to similar continuous impact for four decades and where the fauna has long been highly modified and opportunistic in nature. The modelling results mirror published studies into the effects of cuttings pile disturbance. It is therefore considered that the impact of potential dredging or jetting activities is not likely to significantly alter the state of the benthic environment at or around the cuttings piles in the longer term or cause significant impact.

Impacts of Adding to Existing Hard Substrata on Seabed: Most of the hard substrata being left *in-situ* has been in place for the life of the Auk, Fulmar and Auk North fields, this comprises the footings of the Fulmar A jacket (0.005 km^2) and existing rock cover over pipelines (0.068 km^2). To this will be added a further 0.02 km^2 of new rock armour. The proposed introduction of small additional rock placements will not add significantly to the artificial hard substrate already in place. In addition, it is not expected that leaving these hard substrata in place will result in any significant change to the species typically present in the wider area as a whole. *Impacts of Degradation of Materials Decommissioned in-situ:* The following information was reviewed for each of the material types to be left in-situ: > Inhibited (chemically treated) – Fulmar pipelines; > Pipeline scale containing naturally occurring radioactive material (NORM); > Steel; > Sacrificial anodes (zinc and aluminium); > Concrete; and > Plastic coatings. Structural degradation of pipelines/umbilicals/cables and jacket footings left *in-situ* will be a long-term process leading to eventual collapse under their own weight. Degradation products from these structures (or any materials contained) will be released. The small scale and gradual nature of these types of releases, over a timescale in which the chemicals or materials will have become degraded and ineffective (in terms of their original purpose) will mean that any impacts to biota in the vicinity are likely to be negligible. The Fulmar A footings could last for several hundred years before collapsing through corrosion; when this eventually occurs, it may cause a secondary impact due to further disturbance of drill cuttings. However, by this time it is likely the cuttings pile will have largely if not completely disappeared, meaning the impact would be expected to be minimal. *Impacts of Disturbance to Fulmar Marine Conservation Zone:* The benthic environment is part of the Fulmar MCZ. Decommissioning impacts to the seabed will be highly localised and largely temporary in nature with good recovery potential and are not expected to significantly affect the management objectives for the site. *Mitigation:* Rock placement will be undertaken using a vessel with a flexible fall pipe, assisting with positional accuracy and minimising the spread of material. No vessel anchoring is planned during decommissioning operations. The cuttings piles will be marked on Kingfisher charts and FishSAFE plotter files, to highlight their presence to fishermen and reduce the frequency of trawling interactions (over which time the cuttings piles will continue to naturally degrade). *Cumulative and Transboundary Impacts:* Decommissioning activities are approximately 15 km west of the UK/Norway median line at their closest point. Planned activities are not anticipated to create any significant transboundary impacts with regards to disturbance of the seabed and cuttings piles. *Conclusion:* Combining these, the level of impact to the seabed, benthic communities, and to the MCZ conservation objectives is considered Low and not significant.
Impacts to Other Sea Users of Items Decommissioned *In-situ*
Impacts to Other Sea Users: At this location, sea users other than fisheries mainly relates to shipping. In offshore deep waters, shipping is generally not directly sensitive or vulnerable to infrastructure being decommissioned *in-situ* at the seabed and makes limited use of the Auk, Fulmar and Auk North area. Shipping will experience only very localised effects including the beneficial returned availability of areas formerly occupied in the long-term by installations and safety exclusion zones. On this basis, the consequence is negligible and the impact low and not significant. The fishing industry is expected to be tolerant of short-term interference on a very localised basis whilst decommissioning is underway; also, the removal of infrastructure and safety exclusion zones at Auk, Fulmar A and AD and Auk North means that fisheries will regain the use of sea areas from which they have been excluded, which is considered a positive impact. Fishing effort in the area is low, as are recorded catch values; however, snagging risk will remain from the Fulmar A jacket footings decommissioned *in-situ*. *Mitigation:* The approach and design of decommissioning activities, stakeholder consultation, updates to Admiralty Charts and FishSAFE, as well as post-decommissioning monitoring of items decommissioned *in-situ*, is expected to reduce the impact on other sea users. *Cumulative and Transboundary Impacts:* Decommissioning activities are approximately 15 km west of the UK/Norway median line at their closest point. Fishing effort in the locality is low, and most of the fishing here is by UK trawlers. Significant transboundary impacts are not anticipated. *Conclusion:* Combining these, the impact consequence is considered to be Low and not significant.

Conclusion

A review of potentially significant environmental and social interactions has been completed and, considering the mitigation measures that will be built into the project activities, there is expected to be no significant impact on receptors. As part of this review, cumulative and transboundary impacts were assessed and determined to be not significant.

The potential for the Auk, Fulmar and Auk North Decommissioning activities to impact European or nationally designated sites was considered. Given the location of the decommissioning project activities, of key importance is the potential for impact to the Fulmar MCZ within which the Auk, Fulmar and Auk North fields are located. This site is designated for seabed features, namely subtidal sands, subtidal muds, subtidal mixed sediments, and the ocean quahog. Having reviewed the decommissioning project activities, there is not expected to be a significant impact on any of these features or the site's conservation objectives.

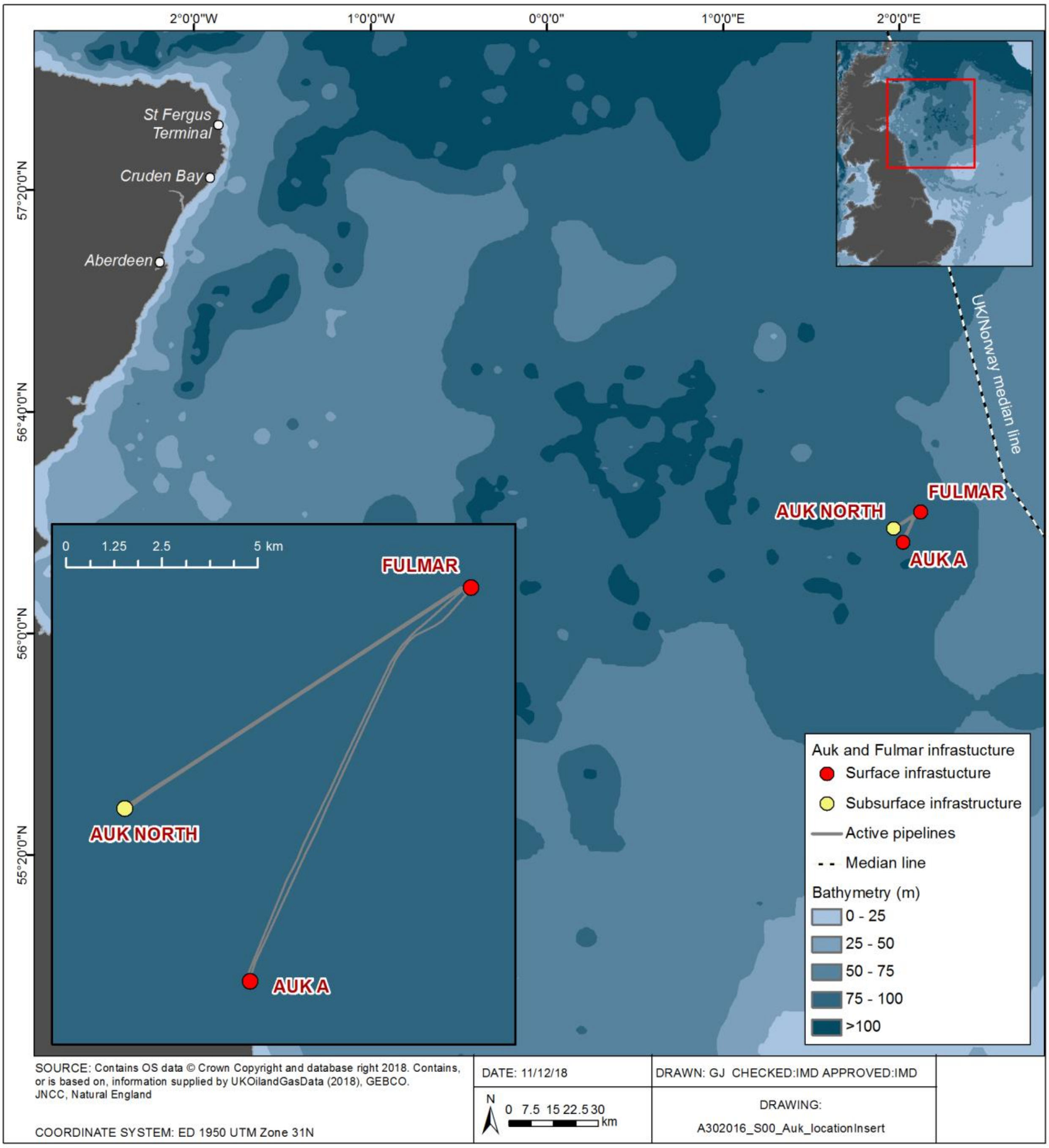
Finally, this EA has considered the Marine Policy Statement issued as the framework for preparing UK Marine Plans and taking decisions affecting the marine environment, until the North East Inshore and North East Offshore Marine Plans are developed and adopted. Repsol Sinopec Resources UK Limited considers that the proposed decommissioning activities are in broad alignment with such objectives and policies.

1. INTRODUCTION

1.1 Background

Repsol Sinopec Resources UK Limited has commenced planning for the decommissioning of the Auk, Fulmar and Auk North oil fields and is undertaking studies to support the preparation of Decommissioning Programmes (DPs) for each of these assets. The planned decommissioning activities have been the subject of Environmental Appraisal (EA) in order to understand their potential environmental impact. This document is the resulting EA Report. The locations of the Auk, Fulmar and Auk North fields in the central North Sea (CNS) are shown in Figure 1.1.

Figure 1.1: Location of Auk, Fulmar and Auk North Facilities



1.2 Overview of the Auk, Fulmar and Auk North Facilities

The facilities in the Auk, Fulmar and Auk North fields are illustrated schematically in Figure 1.2.

The Auk field was discovered in September 1970, with the platform being installed in July 1974 in a water depth of 85 m, and production starting in December 1975. Located approximately 252 km from the nearest UK coastline in northeast England, in CNS Block 30/16, the Auk platform (Figure 1.3) is an integrated drilling, production and living quarters facility supported on an 8-leg jacket structure with 12 well slots, all of which have been utilised for production wells, though one has been plugged and abandoned and an additional well is suspended. Oil production was initially exported by tankers via an Exposed Location Single Buoy Mooring (ELSBM). Following completion of the 12 km 8" export pipeline to the Fulmar Alpha (A) platform in 1986, the ELSBM was removed. At Fulmar A, Auk oil production is combined with that from Fulmar, Clyde/Orion, Gannet and Auk North before being exported via the Norpipe system to Teesside. The weight of the Auk jacket structure is estimated at 5,567 tonnes, and the weight of the topsides is 5,835 tonnes. There are no other fields tied back to Auk.

The Fulmar field is located 12 km northeast of Auk, mainly in Block 30/11b but overlaps slightly into Block 30/16 to the north. Development of the Fulmar field began in 1978, with installation of the Fulmar complex in 1981 and first oil occurring in 1982. The Fulmar complex (Figure 1.3) sits in a water depth of 83 m and consists of drilling, production and accommodation facilities on two bridge-linked jacket structures: Fulmar A (the main platform) and the Fulmar Advanced Drilling (AD) wellhead platform. Fulmar A comprises a large steel jacket with eight legs weighing 10,352 tonnes, and a topsides weighing 23,583 tonnes[7]. Fulmar AD is a small steel four-legged jacket weighing 1,366 tonnes together with a topsides of 502 tonnes. The Fulmar A and AD installations have 36 and 6 wells each respectively. Oil export was initially by tanker via a Floating Storage Unit (FSU) connected to a single anchor leg mooring (SALM) base sited approximately 2 km southwest of Fulmar A. Following an incident in which the FSU broke free from the SALM base in December 1988 causing production to be shut down, a second SALM base was installed. However, in 1997 production was re-routed through the Norpipe system to Teesside; since then both the original and the replacement SALM bases have not been used. Fulmar A receives oil from the Clyde/Orion, Auk, Gannet, Halley and Auk North fields for onward combined export. Fulmar A also receives conditioned metered Clyde gas for export via the St. Fergus pipeline.

The Auk North field is situated approximately 11 km west of the Fulmar Platform. Developed in 2010, the Auk North field produces from four wells tied back to the Auk North subsea manifold, and on to Fulmar A via an electro hydraulic control umbilical, flowline and risers.

Additional detail on the installations and associated subsea pipelines covered by this EA can be found in the DP documents **[Refs. 1, 2, 105]** and in Section 2.3.

[7] Dry weight

Figure 1.2: Schematic Summary of Facilities at Auk, Fulmar and Auk North to be Decommissioned (Items Coloured Light Grey are not in Decommissioning Scope and Shown for Context Only)

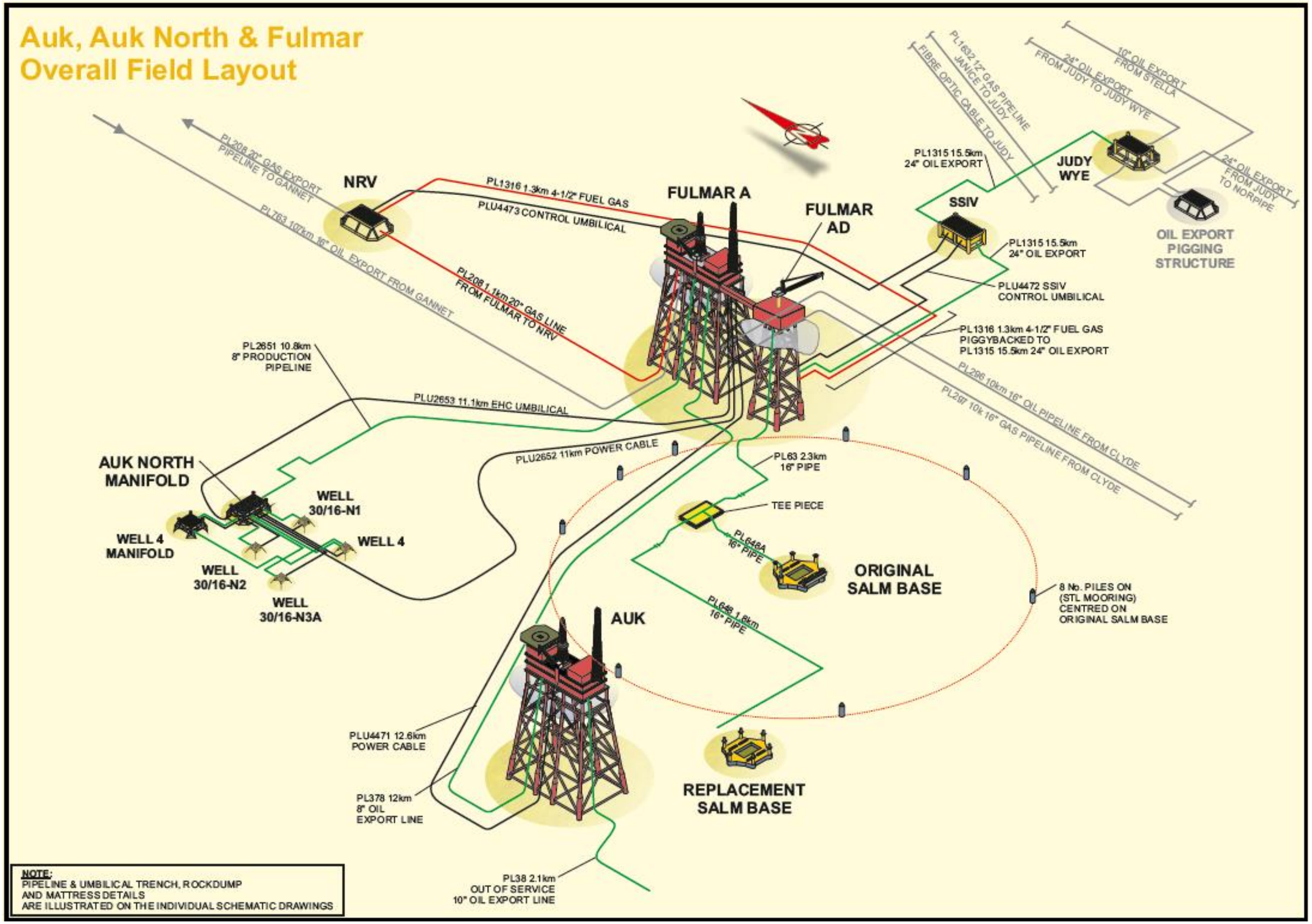
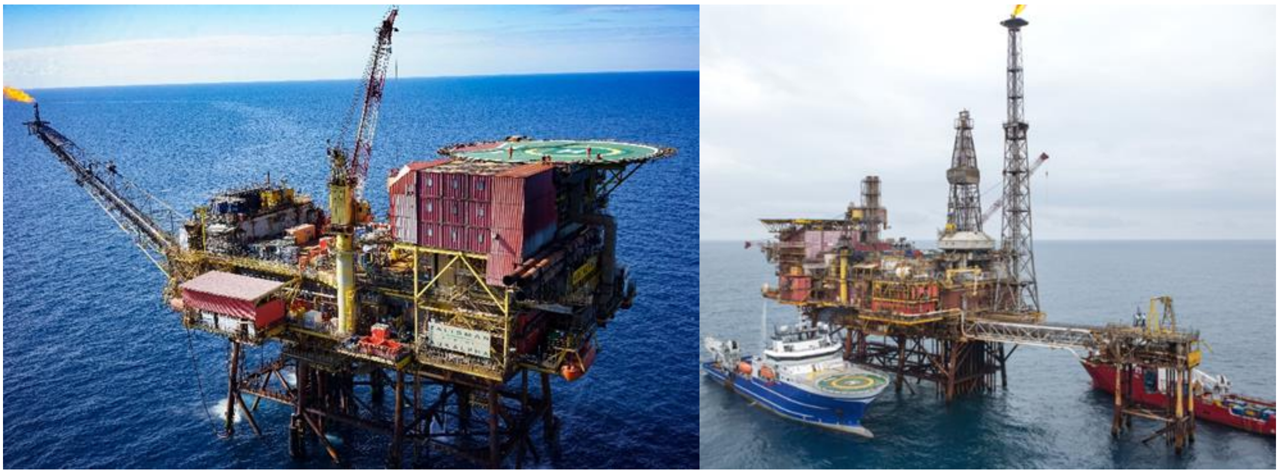


Figure 1.3: The Auk platform (Left) and Fulmar A and AD Platforms (Right)



1.3 Regulatory Context

The Petroleum Act 1998 (as amended by the Energy Act 2008) governs the decommissioning of offshore oil and gas infrastructure, including pipelines, on the United Kingdom Continental Shelf (UKCS). The Act requires the operator of an offshore installation or pipeline to submit a draft DP for statutory and public consultation, and to obtain approval of the DP from the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED), part of the Department for Business, Energy and Industrial Strategy (BEIS), before executing decommissioning work. The DP outlines in detail the infrastructure being decommissioned and the method by which the decommissioning will take place.

Formal Environmental Impact Assessment (EIA) to support the DP is not explicitly required under existing UK legislation. However, the primary guidance for offshore decommissioning that was published by the Department of Energy and Climate Change (DECC), the fore-runner to OPRED, in 2011 detailed the need for an Environmental Statement (ES) to be submitted in support of the DP. In response to lessons learned and experience gained from the numerous DPs which have been submitted to the Regulator since 2011, the OPRED Guidelines have been updated. The latest guidance **[Ref.3]** sets out a new framework for the required environmental inputs and deliverables throughout the approval process. It also describes a more focussed environmental process that culminates in a streamlined EA Report.

In the context of marine planning and being located in the English offshore waters of the CNS, the Auk, Fulmar and Auk North fields fall within the area of the North East Marine Plan. The North East Marine Plan is currently under development, but it includes the North East Inshore and the North East Offshore marine plan areas. These plans are being developed to help ensure sustainable development of the UK marine area; until the marine plan is adopted, the Marine Policy Statement should be used when making decisions and proposals **[Ref.4]**. Although the Statement does not specifically address decommissioning of oil and gas, the challenges and opportunities that such activities can bring are noted. The broad aims and policies outlined in the Marine Policy Statement have therefore been considered in this EA.

1.4 Scope of the EA

This EA covers the assets listed in the three DP documents **[Refs. 1, 2, 105]**, which can be summarised as:

- The Auk, Fulmar A and Fulmar AD topsides;
- The Auk, Fulmar A and Fulmar AD jackets;
- Associated drill cuttings piles;
- Subsea structures[8]: subsea isolation valve (SSIV), non-return valve (NRV) protection structure, Auk North Production Manifold, Auk Well 4 manifold, SALM[9] bases and STL[10] anchor piles, the Fulmar Igloo (covering the SALM Tee-Piece), the piled Fulmar AD Template, mattresses, grout bags; and
- Pipelines, umbilicals and cables.

This EA is therefore area wide, covering both the Fulmar, Auk North and Auk oil fields. It should be noted that the Auk field is still in production, and therefore the Auk field DP is not in progress at this stage. When the Auk field DP is submitted, this EA will be updated as necessary to reflect the DP.

The DP documents and the EA do not cover well plugging and abandonment, or the flushing and cleaning operations that will be undertaken on the topsides and subsea (pipelines, umbilicals, manifolds etc) as part of the preparatory work preceding decommissioning.

1.5 EA structure

This EA Report sets out to describe, in a proportionate manner, the potential environmental impacts of the proposed activities associated with Auk, Fulmar and Auk North decommissioning and to demonstrate the extent to which these can be mitigated and controlled to an acceptable level. The key components and structure of this report are laid out as follows:

- Introduction to the decommissioning project for Auk, Fulmar and Auk North, the regulatory context and guidance for undertaking a decommissioning EA, plus a description of the EA (Section 1);
- An outline of the options considered for decommissioning and the decision-making process undergone by Repsol Sinopec Resources UK Limited to arrive at the selected decommissioning strategy (Section 2);
- A description of the proposed decommissioning activities (Section 2);
- A summary of the baseline sensitivities relevant to the activities taking place and the assessments that support this EA (Section 3);
- An outline of the EA method used, a review of the potential impacts from the proposed decommissioning activities and justification for scoping potential impacts in or out of assessment in this EA Report (Section 4);
- Assessment of key potential impacts (Section 5); and
- Conclusions (Section 6).

This EA Report has been prepared in line with OPRED Guidelines **[Ref. 3]** and also with Decom North Sea's EA Guidelines for Offshore Oil and Gas Decommissioning **[Ref. 5]**.

8 The four Auk North integrated wellhead protection structures recorded in the Fulmar and Auk North topsides and subsea facilities DPs document are being removed as part of well abandonment and are therefore outside the scope of this EA.

9 SALM = Single Anchor Leg Mooring. For the first years of production, oil export was to a floating storage unit via an offloading buoy/mooring system attached to the SALM base by a flexible riser.

10 STL = Submerged Turret Loading; the name of the submerged mooring buoy system, which was also tethered by load-bearing lines to a circular arrangement of anchor piles at the seabed (the STL anchor piles).

2. PROJECT DESCRIPTION

2.1 Consideration of Alternatives and Selected Approach

This section outlines the key legislation and guidance that influences how decommissioning may or may not proceed, the options considered for decommissioning and the evaluation and decision-making process by which Repsol Sinopec Resources UK Limited has arrived at the selected decommissioning strategy.

2.1.1 Decision-Making Context

2.1.1.1 Platforms

As a Contracting Party of the Convention for the Protection of the Marine Environment of the North-East Atlantic ('OSPAR'), the UK has agreed to implement OSPAR Decision 98/3, which prohibits leaving offshore installations wholly or partly in place. The legal requirement for Operators to comply with the OSPAR Convention is effected through the Petroleum Act 1998 (as amended by the Energy Act 2008). OSPAR Decision 98/3 states that the topsides of all installations should be returned to shore and that all jackets with a weight of less than 10,000 tonnes are completely removed for reuse, recycling or final disposal on land. This applies to the Fulmar AD jacket structure and the Auk jacket structure. The Decision recognises that there may be difficultly in removing the footings of large steel jackets weighing >10,000 tonnes. As a result, there is a facility for derogation from the main prohibition for steel jackets >10,000 tonnes installed prior to 9 February 1999.

The Fulmar A jacket is more than 10,000 tonnes and was installed in 1981 and has therefore been subject to a Comparative Assessment (CA) process in which all feasible options for decommissioning have been scored against each other with respect to criteria including technical feasibility, environmental impact and safety in order to establish the best option for decommissioning **[Ref. 6]**.

2.1.1.2 Subsea Infrastructure

The current OPRED Guidelines **[Ref. 3]** state that subsea installations (e.g. drilling templates, wellheads and their protective structures, production manifolds and risers) must, where practicable, be completely removed for reuse or recycling or final disposal on land. Any piles used to secure such structures in place should be cut below natural seabed level at such a depth to ensure that any remains are unlikely to become uncovered. Should an Operator wish to make an application to leave in place a subsea installation because of the difficulty of removing it, justification in terms of the environmental, technical, societal, cost or safety reasons would be required.

With regards to pipelines (including flowlines and umbilicals), these should be considered on a case-by-case basis. **[Ref. 3]** states that a CA will be required in all pipeline DPs and that all feasible decommissioning options should be considered, taking account of safety, environmental, technical, societal and economic factors to arrive at a preferred decommissioning solution. In addition, the guidance states:

- Any removal or partial removal of a pipeline should be performed in such a way as to cause no significant adverse effects upon the environment;
- Any decision that a pipeline may be left in place should have regard to the likely deterioration of the material involved and its present and possible future effect on the marine environment; and
- Account should also be taken of other users of the sea, and the future use by fishing activities in the area.

The guidance also highlights instances where pipelines could be decommissioned *in-situ*; for example, pipelines that are adequately buried or trenched or which are expected to self-bury over a sufficient length within a reasonable time and remain so buried.

Finally, the guidance states that mattresses and grout bags installed to protect pipelines should be removed for disposal onshore, if their condition allows. If the condition of the mattresses or grout bags is such that they cannot be removed safely or efficiently, any proposal to leave them in place must be supported by an appropriate CA of the options and evidence that the deposits will not interfere with other users of the sea. This EA refers to mattresses and grout bags being left *in-situ* where they are considered not safe to recover based on current understanding of seabed conditions. However, all relevant methods for safely accessing and removing mattresses and grout bags across the Auk, Fulmar and Auk North fields will be kept under consideration and discussed with OPRED throughout the decommissioning phase.

2.1.2 Alternative to Decommissioning

The potential opportunities for re-use of the Auk, Fulmar and Auk North infrastructure were considered as part of the asset cessation of production (CoP) approval process with the Oil and Gas Authority (OGA). Options to re-use the Auk, Fulmar and Auk North infrastructure *in-situ* for future hydrocarbon developments were considered, but none have yielded a viable commercial opportunity. Reasons for this include the absence of remaining hydrocarbon reserves in the vicinity, and the limited remaining design life of the infrastructure. Dates for CoP have therefore been granted (see Section 2.2) and, as such, there is no reason to delay decommissioning in a way that is safe and environmentally and socio-economically acceptable.

2.1.3 Comparative Assessment

Repsol Sinopec Resources UK Limited has undertaken two CAs in line with the OPRED and Oil and Gas UK guidance **[Refs. 3, 7]**, in order to arrive at an optimal decommissioning method; one for subsea infrastructure **[Ref. 8]** and the other for the Fulmar A jacket **[Ref. 6]**.

A summary of the infrastructure for which a CA of decommissioning options was made, the options considered and the selected option (based on consideration of safety, environmental, technical, societal and economic factors) is given in Table 2.1. Note that to facilitate the CA process, facilities infrastructure was grouped according by type/size and other characteristics.

The CA for the subsea infrastructure focussed on six decommissioning groups for pipelines, umbilicals and cables (groups 1, 2, 3, 4, 5 and 6). This grouping is evident in Table 2.1, and is referred to in other parts of this EA. Decommissioning groups 7 (subsea installations/structures), 8 (SALM bases and base piles) and 9 (mattresses and grout bags) were confirmed at the CA scoping and screening stages as being full removal without any further assessment, in line with guidance.

A CA was conducted for the Fulmar A jacket (group 10a), as required in OPRED Guidance **[Ref. 3]** for jacket structures of >10,000 tonnes. The Auk A and Fulmar AD jackets (group 10b; <10,000 tonnes) are being fully removed in line with guidance.

The justification for the selected option for each decommissioning group is presented in the CA and is not discussed in this document.

Table 2.1: Options Considered for Auk, Fulmar and Auk North Decommissioning, With Selected Option Highlighted in Green

Group	Infrastructure Type	Option 1	Option 2a	Option 2b	Option2c	Option 3a	Option 3b
1	24" concrete coated pipeline, surface laid and exposed (PL1315)	Leave *in-situ*: disconnect/ remove ends, make safe remaining ends and minimal remediation.	Leave *in-situ* after disconnecting ends; cut and remove exposures	Leave *in-situ* with remedial intervention: rock placed on exposures and ends	Leave *in-situ:* major intervention, pipeline to be fully trenched and buried	Full removal: cut into small sections and recover	Full removal: recover using reverse s-lay or reverse reeling
2	10" concrete coated pipeline, surface laid and exposed (PL38)	Leave *in-situ*: disconnect/ remove ends and minimal remediation.	Leave *in-situ* after disconnecting ends; cut and remove exposures	Leave *in-situ* with remedial intervention: rock placed on exposures and ends	Leave *in-situ;* major intervention, pipeline to be fully trenched and buried	Full removal: cut into small sections and recover	Full removal: recover using reverse s-lay or reverse reeling
3	Pipelines & umbilicals, surface laid and rock covered (PL208, PL1316, PLU4472/N0878, PLU4473/N0879)	Leave *in-situ*: minimal intervention, cut ends to be made safe using burial or rock armour.	Leave *in-situ* after disconnecting ends; cut and remove exposures	Leave *in-situ* with remedial intervention: rock placed on exposures/ends	Leave *in-situ* with remedial intervention: trench and bury exposures/ends	Full removal: cut into small sections and recover	Full removal: recover using reverse s-lay or reverse reeling
4	Pipelines, fully trenched and buried (PL378, PL2651)	Leave *in-situ*: minimal intervention, cut ends to be made safe using burial or rock armour.	Leave *in-situ* after disconnecting ends; cut and remove exposures	Leave *in-situ* with remedial intervention: rock placed on exposures/ends	Leave *in-situ* with remedial intervention: trench and bury exposures/ends	Full removal: cut into small sections and recover	Full removal: unbury and recover using reverse s-lay or reverse reeling
5	Pipelines, partially trenched and buried (PL63 & PL648)	Leave *in-situ*: disconnect/ remove ends and minimal remediation.	Leave *in-situ* after disconnecting ends; cut and remove exposures	Leave *in-situ*: major intervention, cut ends, spans and exposures to be made safe using rock armour	Leave *in-situ* with remedial intervention: trench and bury exposures/ends	Full removal: de-bury, cut into small sections and recover	Full removal: recover using reverse s-lay or reverse reeling
6	Umbilicals & cables – trenched and buried (PLU4471, PLU2652, PLU2653)	Leave *in-situ*: minimal intervention, cut ends to be made safe using burial or rock armour.	Leave *in-situ* after disconnecting ends; cut and remove exposures	Leave *in-situ* with remedial intervention: rock placed on exposures/ends	Leave *in-situ* with remedial intervention: trench and bury exposures/ ends	Full removal: cut into small sections and recover	Full removal: recover using reverse s-lay or reverse reeling
7	Subsea installations/structures				Full removal		
8	SALM bases & base piles				Full removal		
9	Mattresses and grout bags				Full removal unless inaccessible / unsafe, in this case decommissioning *in-situ* will be discussed with OPRED		
10a	Jacket structures >10,000 tonnes	Leave *in-situ*: minimal intervention – remove topsides and leave jacket structure in place	Partial removal: leave footings in place. Remove jacket piece-small/ medium using heavy lift vessel (HLV)	Partial removal: leave footings in place. Remove jacket in one piece with single lift vessel (SLV)	Full removal including footings; piles cut 3 m below seabed. Piece-small/ medium using HLV	Full removal including footings; piles cut 3 m below seabed. Single lift using SLV	Full removal including footings; piles cut 3m below seabed. Re-float jacket in one piece using buoyancy tanks
10b	Jacket structures <10,000 tonnes				Full removal		

Key	Option screened out early in CA process	Options taken through CA	Selected option

2.2 Proposed Schedule

Topsides:

The Fulmar, Halley and Auk North fields ceased production in October 2018. However, Fulmar Platform will continue operating as an export hub for Auk, Clyde and Gannet production until they reach cessation of production or by-pass Fulmar. Platform wells in Fulmar are expected to be P&A'd during this export hub period to minimise the abandonment support cost. Once all platform wells are P&A'd and the Platform is no longer operating as an export hub, the topsides will be decommissioned subject to market availability of cost effective removal services.

Auk platform wells will be P&A'd following the cessation of production. Once all platform wells were P&A'd the topsides will be decommissioned subject to market availability of cost effective removal services.

Jackets:

The Fulmar Alpha, AD and Auk Jackets are protected by sacrificial anodes that will remain in-situ with their structural integrity uncompromised for extended periods. This allows the possibility for a cost-effective approach to jacket decommissioning, in which Jackets could be bundled with other Repsol Sinopec Resources UK Limited infrastructure into a campaign to leverage economies of scale. Moreover, this approach also allows newly emerging technologies to be considered in future.

Subsea Infrastructure:

Subject to market availability of cost effective removal services, the Fulmar, Auk and Auk North subsea infrastructure will be decommissioned following P&A of the Auk North Area subsea wells and the topsides removal on Fulmar and Auk.

2.3 Decommissioning Activities

2.3.1 Preparation for Decommissioning

2.3.1.1 Well Plug and Abandonment

Note: well plugging and abandonment (P&A) is not within the scope of this EA and will be assessed as updates/variations to existing operational permits.

The 41 wells associated with the decommissioning of the Auk, Fulmar and Auk North fields will be plugged and abandoned prior to any of the platform and subsea decommissioning activities progressing. This means that each well will be systematically and permanently closed (most likely through the placement of cement plugs in the well) in accordance with well abandonment best practice (e.g. **[Ref. 9]**).

2.3.1.2 Flushing and Cleaning Operations

Note: flushing and cleaning operations are not within the scope of this EA and will be assessed in updates/variations to existing operational permits prior to decommissioning.

Platform

Platform cleaning will be completed in line with the Repsol Sinopec Resources UK Limited Drain, Flush, Purge and Vent philosophy ahead of the preparatory work to support removal of the topsides. During the final cleaning and disconnect activities, all the processing systems on the platform will be progressively depressurised, purged with inert gas (most likely nitrogen) and rendered safe for removal operations. The pipework and tanks will be visually inspected where possible and may be further treated should any sources of solids, oils and other fluids be identified.

Pipelines

The pipelines will be cleaned and left flooded with either inhibited seawater or untreated seawater. The use of untreated seawater is preferred for environmental and resource use reasons, but there is a decision-making process to be completed which may, depending on timing and operational requirements, necessitate the use of inhibited seawater.

2.3.2 Platform Decommissioning

2.3.2.1 Topsides Removal

The Auk A, Fulmar A and AD topsides will be completely removed and returned to shore. At this stage, Repsol Sinopec Resources UK Limited has not finalised the specific method for removal. However, the options expected to be considered at the time of decommissioning are summarised in Table 2.2. Further detail is provided in the relevant DP documents **[Refs. 1, 105]**.

Table 2.2: Options for Topsides Removal

Reverse installation in multiple lifts, piece large, by heavy lift vessel (HLV)
Removal of separated topsides modules by HLV for transportation to onshore facility for deconstruction. Selected equipment to be re-used, and deconstructed material to be recovered for recycling and/or disposal.
Offshore deconstruction, piece-small, by monohull crane vessel (this option being considered for Auk only)
Removal of topsides by breaking up offshore and transporting to shore using monohull crane vessel and work barge. Selected equipment to be re-used, and deconstructed material to be recovered for recycling and/or disposal.
Single lift removal by single lift vessel (SLV)
Removal of topsides as a complete unit using a SLV, and transportation to onshore facility for deconstruction. Selected equipment to be re-used, and deconstructed material to be recovered for recycling and/or disposal.
Combination of removal methods
A combination of piece-small and reverse installation methods using a HLV. Selected equipment to be re-used, and deconstructed material to be recovered for recycling and/or disposal.

2.3.2.2 Jacket Removal

For Fulmar A, the base case is that the jacket will be partially removed, cutting and removing the jacket structure above the footings, which will be transported to shore for recycling, leaving the jacket footings decommissioned *in-situ*.

The Fulmar AD and Auk jackets will be fully removed and transported to shore for recycling.

As with topsides removal, Repsol Sinopec Resources UK Limited has not determined the specific method by which the jackets will be removed and returned to shore. The removal options under consideration are summarised in Table 2.3.

Following jacket removal, the 500 m zones around Auk and Fulmar A/AD will be surveyed as part of the process to ensure that risks to third party users of the sea are minimised.

Table 2.3: Options for Jacket Removal

Total removal, single lift using SLV
A vessel capable of lifting the entire jacket in one lift (SLV) would be used. The jacket piles would be cut from inside and the jacket then lifted and transported by the SLV or barge to an onshore disposal yard.
Total removal, section cut and lift using HLV
The steel pieces that make up the jacket would be cut into sections (size dictated by vessel lift capacity). Each jacket section will be lifted and taken to an onshore disposal yard, either on a barge or on the HLV hooks.
Partial removal; derogation of footings

Partial removal of the Fulmar Alpha jacket/substructure can be achieved by cutting the jacket/substructure above the footings and retrieving the top part of the jacket/substructure as a single component by SLV or in multiple components by a HLV. Transported to an onshore disposal yard either by HLV, SLV or barge.

2.3.3 Subsea Infrastructure

A full inventory of subsea infrastructure to be decommissioned is provided in the three DP documents **[Refs. 1, 2, 105]** and the methodologies and activities to be used in undertaking the decommissioning works are detailed in the CAs **[Refs. 6, 8]**.

Following survey of the pipelines and umbilicals, any protective mattresses and grout bags that can be removed safely and efficiently from the tie-ins will be recovered back to the vessel. Mattresses and grout bags that are not accessible / safe to remove will be considered for decommissioning *in-situ*, in discussion with OPRED. Pipelines and umbilicals will then be physically disconnected from subsea structures and prepared for decommissioning as summarised in Table 2.4.

Table 2.4: Pipeline and Umbilical Decommissioning Summary

Group	Option	Decommissioning approach [Ref. 1] [Ref. 105]
1	Trench and bury	PL1315: 24" concrete-coated oil export pipeline, 15,550 m long, surface laid and exposed. Tie-in spools will be disconnected and removed for recovery to shore. Pipeline will be fully trenched, including the cut ends, which will therefore not require rock armour. The exception will be two of the four locations where PL1315 is crossed by other lines, which will be left alone. Trench will be backfilled to achieve a clear seabed. Based on the lack of self-burial to date, the pipeline is thought to be laid on stable seabed, and as such, exposures are not expected to occur once the pipeline is trenched to target depth. However, if this cannot be achieved due to difficulties in executing trenching and burying, then spot rock placement or full rock armouring may be considered. OPRED will be consulted on any proposed use of additional rock.
2	Trench and bury	PL38: 10" concrete-coated oil export pipeline, 2,125 m long, surface laid and exposed. Tie-in spools will be disconnected and removed for recovery to shore. Pipeline will be fully trenched, including the cut ends, which will therefore not require rock armour. Trench will be backfilled to achieve a clear seabed. Based on the lack of self-burial to date, the pipeline is thought to be laid on stable seabed, and as such, exposures are not expected to occur once the pipeline is trenched to target depth. However, if this cannot be achieved due to difficulties in executing trenching and burying, then spot rock placement or full rock armouring may be considered. OPRED will be consulted on any proposed use of additional rock.
3	Leave *in-situ*	PL208: 20" gas export pipeline, 1,008 m long, surface laid and rock covered for ~88% of length, exposed for ~12% of length at approach to Fulmar A tie-in, and two small exposures at KP 288.65 and KP 288.92, each ~1 m in length. Pipeline has maintained a consistent burial status to date. PL1316: 4.5" fuel gas pipeline, 1,182 m long, rock-covered for ~95% of length. Remaining ~5% mattress covered. No recorded exposures since installation. PLU4472 (static section): 2" umbilical, 290 m long, surface laid and rock covered for 61% of length, mattress covered for 32% of length, exposed for 7% of length. No recorded spans since installation, and no recorded exposures in latest survey. The remaining 200 m length of this line is the section which approaches and runs through the J-tube on Fulmar AD. PLU4473: 2" umbilical, 1,404 m long, surface laid and rock covered for 97% of length, exposed for 3% of length. Tie-in spools and umbilicals will be disconnected and removed for recovery to shore. Exposed sections of pipeline / umbilical (including sections exposed due to removal of mattresses) will also be cut and recovered. Remaining cut ends will be made safe to mitigate snagging hazards for other sea users, for example by burial or adding rock cover.
4	Leave *in-situ*	PL378: 8" oil pipeline, 11,942 m long, fully trenched and buried with no exposures or spans. PL2651: 8" production pipeline, 10,488 m long, fully trenched and buried with 23 areas of spot rock placement to mitigate insufficient burial, and further rock armour at the trench transition at the Auk North manifold. Tie-in spools will be disconnected and removed for recovery to shore. Remaining cut ends will be made safe, for example by burial or adding rock cover.

Group	Option	Decommissioning approach [Ref. 1] [Ref. 105]
5	Leave *in-situ*	PL63: 16" concrete-coated oil pipeline, 2,200 m long, ~43% adequately trenched and buried, ~57% either inadequately trenched and buried, or exposed. PL648: 16" concrete-coated oil pipeline, 1,776 m long, ~64% adequately trenched and buried, ~36% either inadequately trenched and buried, or exposed. Tie-in spools will be disconnected and removed for recovery to shore. Remaining cut ends and sections that are not adequately buried will be made safe by covering with rock armour to a target depth of 0.6 m over the top of the pipes.
6	Leave *in-situ*	PLU4471: 119 mm Auk Fulmar power cable, 12,560 m long, adequately trenched and buried except for 180 m at Auk Alpha and 450 m at Fulmar Alpha which are exposed. PLU2652: 153.4 mm Fulmar to Auk North Manifold power cable, 10,950 m long, fully trenched and buried with fourteen areas of spot rock placement to mitigate insufficient burial. PLU2653: 122.7 mm Fulmar to Auk North Manifold umbilical, 11,070 m long, – fully trenched and buried with seventeen areas of spot rock cover placement to mitigate insufficient burial. Mattress protected at either end at trench transitions. Exposed umbilical and cable ends will be cut and removed for recovery to shore. The remaining cut ends will be made safe, for example by burial or adding rock cover.
7	Full removal	All subsea infrastructure, including spools, protection structures, NRV, SSIV, Template and manifolds will be disconnected, fully removed and recovered for transfer to shore.
8	Full removal	SALM bases (original and replacement). base piles and eight STL anchor piles: It is proposed that the two SALM bases, base piles and STL anchor piles are fully removed. Each SALM buoy base has six piles that will be internally cut below natural seabed level following removal of internal soil using a soil plug removal tool and a subsea dredge system. The dredged material will be deposited in heaps at agreed locations around each SALM base location. An internal cutting system using high pressure water and abrasive will cut each pile, following which each SALM buoy base will be lifted by a HLV.
9	Full removal	Protection and support items: Protection and support items such as mattresses and grout bags that are accessible (e.g. not buried or under a pipeline) and are safe to recover will be lifted for transfer to shore. Mattresses and grout bags that are not accessible / safe to remove will be considered for decommissioning *in-situ*, in discussion with OPRED.

2.3.4 Drill Cuttings

During early drilling campaigns at the Auk and Fulmar locations, drill cuttings and oil-based mud (OBM) were discharged to sea. There are bathymetrically distinct cuttings piles containing OBM still present on the seabed at Auk and Fulmar. Although located around the well conductors beneath each platform for the most part, the piles at both locations extend slightly beyond the jacket footprints as can be seen in the sonar imagery shown in Figure 2.1 and Figure 2.2. Beneath the Auk platform, the pile is small, and projects thinly to either side of the jacket footprint. At Fulmar A, the pile is deep enough to cover some of the lower jacket bracing and it extends to the south towards the Fulmar AD jacket footings. There is no discernible drill cuttings pile at Auk North **[Refs. 11**, **12**, **13]**.

In describing the footprints of cuttings piles, the United Kingdom Offshore Operators Association (UKOOA), now Oil and Gas UK (OGUK) used the analogy of a fried egg, in which the ‘yolk’ represents the bathymetrically distinct part of the pile, while the ‘white’ represents the contaminated area of seabed surrounding the pile in which hydrocarbon levels are ≥50 $\mu g g^{-1}$ (also referred to as the 50 $\mu g g^{-1}$ sediment hydrocarbon footprint[11]).

The piles have been surveyed and their volume, surface area, height and 50 $\mu g g^{-1}$ sediment hydrocarbon footprints mapped as summarised in Table 2.5. Table 2.5 also shows how the 50 $\mu g g^{-1}$ sediment hydrocarbon footprints have shrunk since 2008. Further detail on the results of cuttings pile survey work and maps of the 50 $\mu g g^{-1}$ sediment hydrocarbon footprint at each pile is provided in Sections 3.3.4 and 3.3.5 for Auk and Fulmar respectively.

A six-year Joint Industry Programme (JIP) was instigated by UKOOA, to understand better the physical characteristics of cuttings piles, their environmental impact and the options for long-term management **[Ref. 14]**. This resulted in OSPAR Recommendation 2006/5 **[Ref. 10]**, relating to

[11] 50 $\mu g g^{-1}$ total hydrocarbons has been taken as the threshold above which measurable ecological effects are expected in seabed invertebrate communities.

cuttings piles derived from more than one well, where oil based muds were used and discharged, and the requirement for these to be assessed against thresholds for persistence and for oil release rate.

Table 2.5: Cuttings Pile Data for Auk and Fulmar A/AD, and Variation Over Time

	Pile surface area (m^2)	Pile volume (m^3)	Maximum depth (m)	50 μgg^{-1} sediment hydrocarbon footprint (km^2)
Auk 2008 **[Ref. 11]**	5,000	2,336	1.2	0.260
Auk 2017 **[Ref. 12]**	No update	No update	No update	0.134
Fulmar 2008 **[Ref. 11]**	11,000	18,746	6.9	0.278
Fulmar 2017 **[Ref. 13]**	No update	No update	No update	0.262

Note: There was no update to the Auk and Fulmar cuttings pile properties following the 2017 surveys because collecting the detailed bathymetry data necessary to estimate pile dimensions was not included in the survey scopes of work.

Based on the UKOOA JIP and OSPAR Recommendation 2006/5, the following calculations were carried out to calculate the persistence and yearly oil loss rate of cuttings piles at Auk and Fulmar:

Persistence (km^2.year) = 50 μgg^{-1} sediment hydrocarbon footprint (km^2) × conversion factor (70.7)

Note: estimated area of 50 μgg^{-1} sediment hydrocarbon footprint is derived from detailed survey of hydrocarbon concentrations, and conversion factor derived from a model developed as part of the UKOOA JIP **[Ref.14]**.

$$\text{Yearly oil loss (tonnes/year)} = \frac{\text{Area of cuttings pile } (m^2) \times \text{leaching rate } (521\ mg/m^2/day) \times 365}{1{,}000{,}000{,}000}$$

Note: estimated surface area of drill cuttings from detailed bathymetry survey, and estimated hydrocarbon leach rate derived from a mesocosm study carried out as part of the UKOOA JIP **[Ref.14]**.

The results are shown in Table 2.6, alongside the OSPAR Recommendation 2006/5 thresholds **[Ref.10]**. Table 2.6 shows calculated cuttings pile persistence values based on 50 μgg^{-1} sediment hydrocarbon footprint data from 2008 **[Ref.11]** together with updated values based on the most recent surveys **[Refs.12, 13]**. Detailed bathymetry data necessary for obtaining the area of cuttings piles in order to calculate yearly oil loss rates were last collected in 2008, so no update for oil loss is possible.

Persistence and oil loss figures for both the Auk and Fulmar cuttings piles are well below the OSPAR 2006/5 thresholds. In addition, the decline in cuttings pile persistence since 2008 (based on the decrease in size of the 50 μgg^{-1} sediment hydrocarbon footprint) is evident. According to OSPAR 2006/5, where both the rate and persistence are below the thresholds and no other discharges have contaminated the cuttings pile, no further action is necessary, and the cuttings pile may be left *in-situ* to degrade naturally.

Table 2.6: Estimates of Cuttings Pile Persistence and Annual Oil Loss for Auk and Fulmar A/AD in Relation to OSPAR 2006/5 Thresholds

Site	Persistence (km^2year)		Yearly oil loss (tonnes/year)	
	Calculated value	OSPAR threshold	Calculated value	OSPAR threshold
Auk 2008 **[Ref. 11]**	18.4	500	0.95	10
Auk 2017 **[Ref. 12]**	9.5		No data update	
Fulmar A/AD 2008 **[Ref. 11]**	19.7		2.09	
Fulmar A/AD 2017 **[Ref. 13]**	18.5		No data update	

On this basis, it is proposed that both cuttings pile will be left *in-situ*. The potential environmental impact of disturbance of these piles, either during or following decommissioning, is discussed in Section5.1.3.4.

Figure 2.1: Seabed Bathymetry Data Showing Cuttings Pile at Auk in Plan View (Left) and in 3D (Right)

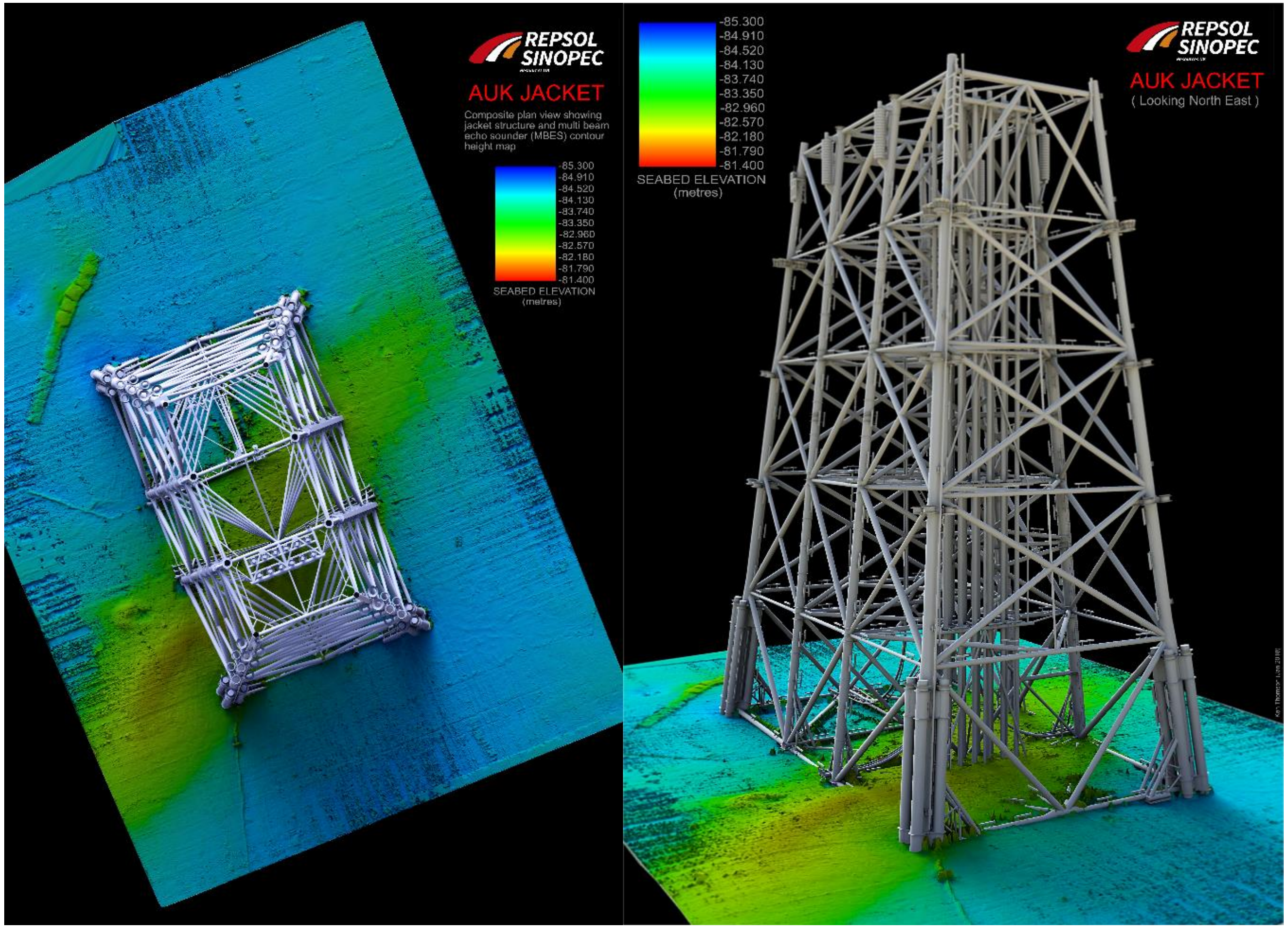
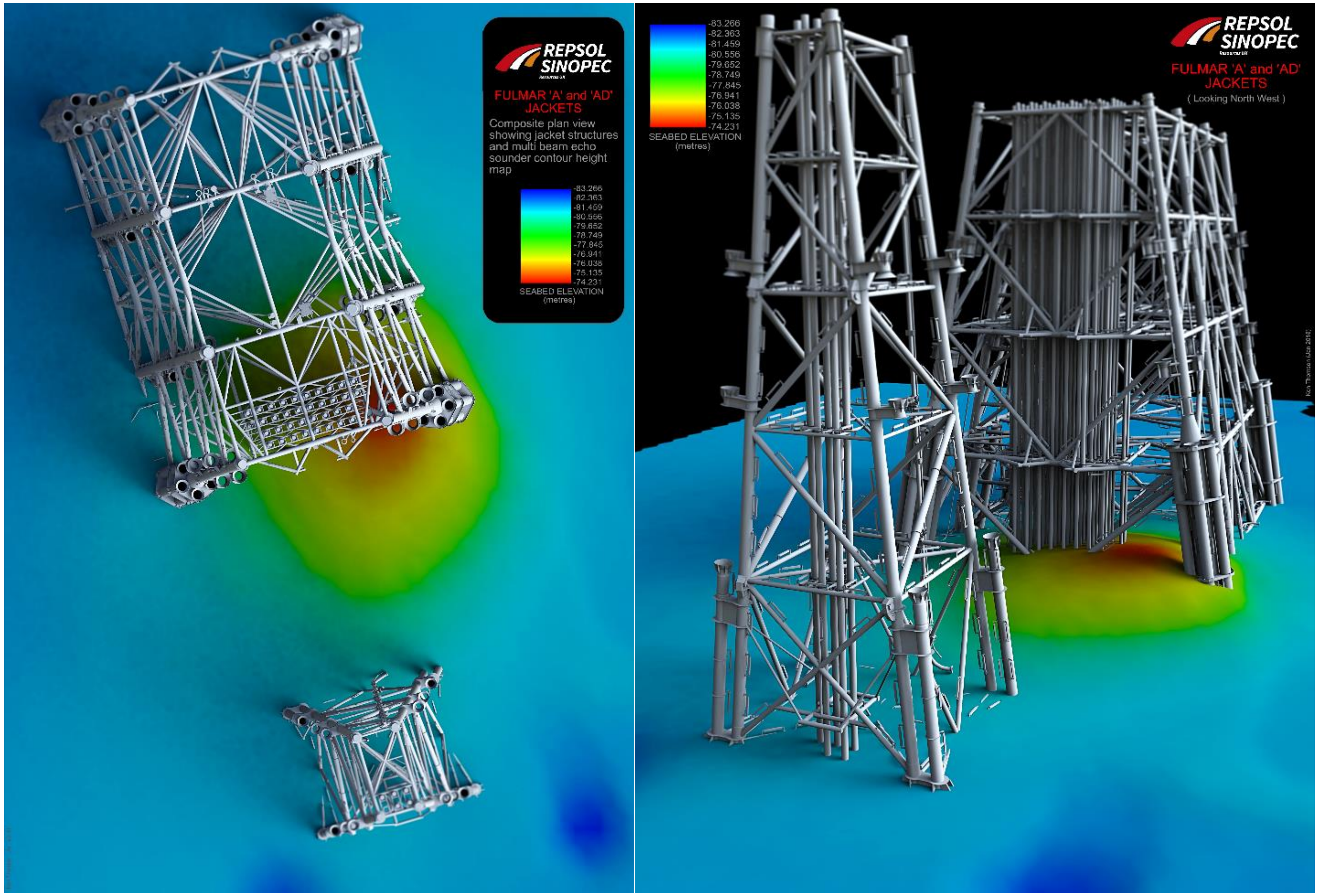


Figure 2.2: Seabed Bathymetry Data Showing Cutting Pile at Fulmar A and AD in Plan View (Left) and in 3D (Right)



2.4 Post-Decommissioning

Following decommissioning activities, Repsol Sinopec Resources UK Limited will conduct post-decommissioning survey work. Part of this will be to provide assurance of a safe seabed for other sea users, cleared of significant debris items, within a 500 m radius of each platform and within 100 m corridors along the pipeline and umbilical routes.

Generally, both debris removal and subsequent verification of clearance would involve the use of fishing gear or chain systems towed over the seabed. However, the use of further tools including sidescan sonar and other acoustic systems will be investigated as a means to identify possible snagging hazards. ROVs could be used to assist in the recovery of large debris items, and overtrawling to clear smaller items of debris. Any significant oil and gas-related seabed debris will be recovered for onshore recycling and disposal. In this way, the current decommissioning practice of overtrawling using fishing gear to verify a snag-free seabed may not be required across the entire footprint of the Project area.

Subject to certification of seabed clearance by an appropriate body and to acceptance of the DP documents **[Refs. 1, 2, 105]** and Decommissioning Close-out Report by OPRED, all safety zones around platforms and subsea infrastructure will be removed.

A post-decommissioning monitoring programme covering the jacket footings, pipelines and umbilicals remaining *in-situ* will be agreed with OPRED.

3. ENVIRONMENTAL BASELINE

3.1 Background and Survey Data Sources

The North Sea is a large shallow sea with a surface area of around 750,000 km^2. Water depths in the CNS gradually deepen from south to north between approximately 40 m at the Dogger Bank and 100 m at the Fladen/Witch Ground **[Ref. 15]**. Auk, Fulmar and Auk North sit mostly within UKCS Block 30/16 (with Fulmar overlapping into Block 30/11 to the north) almost in the centre of the North Sea just over 250 km from the nearest UK coastlines in England and Scotland, and 30 km from the UK/Norway median line.

In June – July 2017, Fugro completed a pre-decommissioning benthic environmental survey across the Auk, Fulmar and Auk North fields. The report outputs from this work include:

- A field report issued soon after the survey work **[Ref. 16]**, summarising the sampling undertaken, methods, intended and actual sampling locations, and listing the samples obtained;
- A habitat assessment covering all three locations together **[Ref. 17]**, based on video, still images and field-assessment of the sediment samples retrieved was prepared for Auk, Fulmar and Auk North to identify seabed features, classify benthic communities and identify any features highlighted as important under Annex I of the European Habitats Directive, the OSPAR list of threatened/declining species/habitats or the Marine and Coastal Access Act 2009;
- An environmental baseline survey report for each of the three main locations Auk, Fulmar and Auk North **[Refs. 18, 19, 20]** in which the results of analysis of sediment samples for physico-chemical and macrofaunal determinants are presented and discussed; and
- A drill cuttings pile assessment report for both the Auk and Fulmar A/AD locations **[Refs. 12, 13]** respectively).

A total of 96 environmental stations were sampled, with 70 grab sampling stations positioned asset-wide (i.e. around platforms and subsea infrastructure/pipelines), and 26 stations for core sampling on the Auk and Fulmar drill cuttings piles. Of the 96 stations, 23 grab stations and 11 core stations were located at Auk; 13 grab stations were located at Auk North; and 32 grab stations and 15 core stations were located at Fulmar. Additionally, two reference stations were sampled remote from all infrastructure, at stations FULREF01 and FULREF02 lying 6 km south and 9 km northwest of Fulmar A respectively. The locations of the asset-wide (including along pipeline routes) environmental sampling stations are shown in Figure 3.1, and in greater detail for each of the three survey centres in Figure 3.2**.** The cuttings pile sampling locations are shown in Figure 3.3.

The work by Fugro **[Refs. 12, 13, 16, 17, 18, 19, 20]** follows a history of environmental survey undertaken at these three fields since the 1970s, summarised in Table 3.1.

Figure 3.1: Location of Environmental Sample Stations Around the Auk, Fulmar and Auk North Assets [Ref. 16]. For Detail and Station Numbering See Figure 3.2 Overleaf

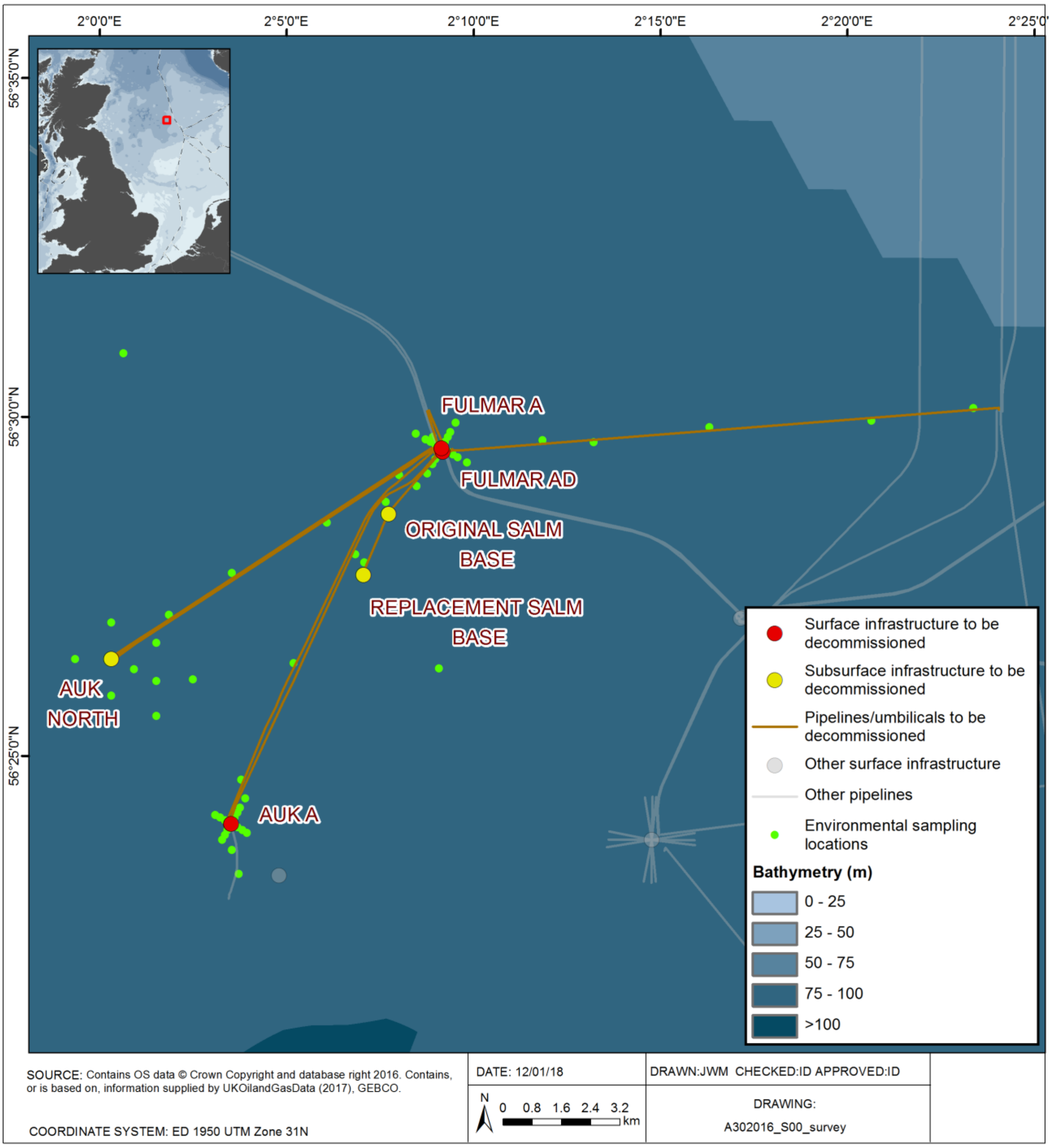


Figure 3.2: Detail of Survey Station Locations Around the Survey Centres and Interconnecting Pipeline Routes at Auk and Auk North (Left), and Fulmar (Right); from [Ref. 16]

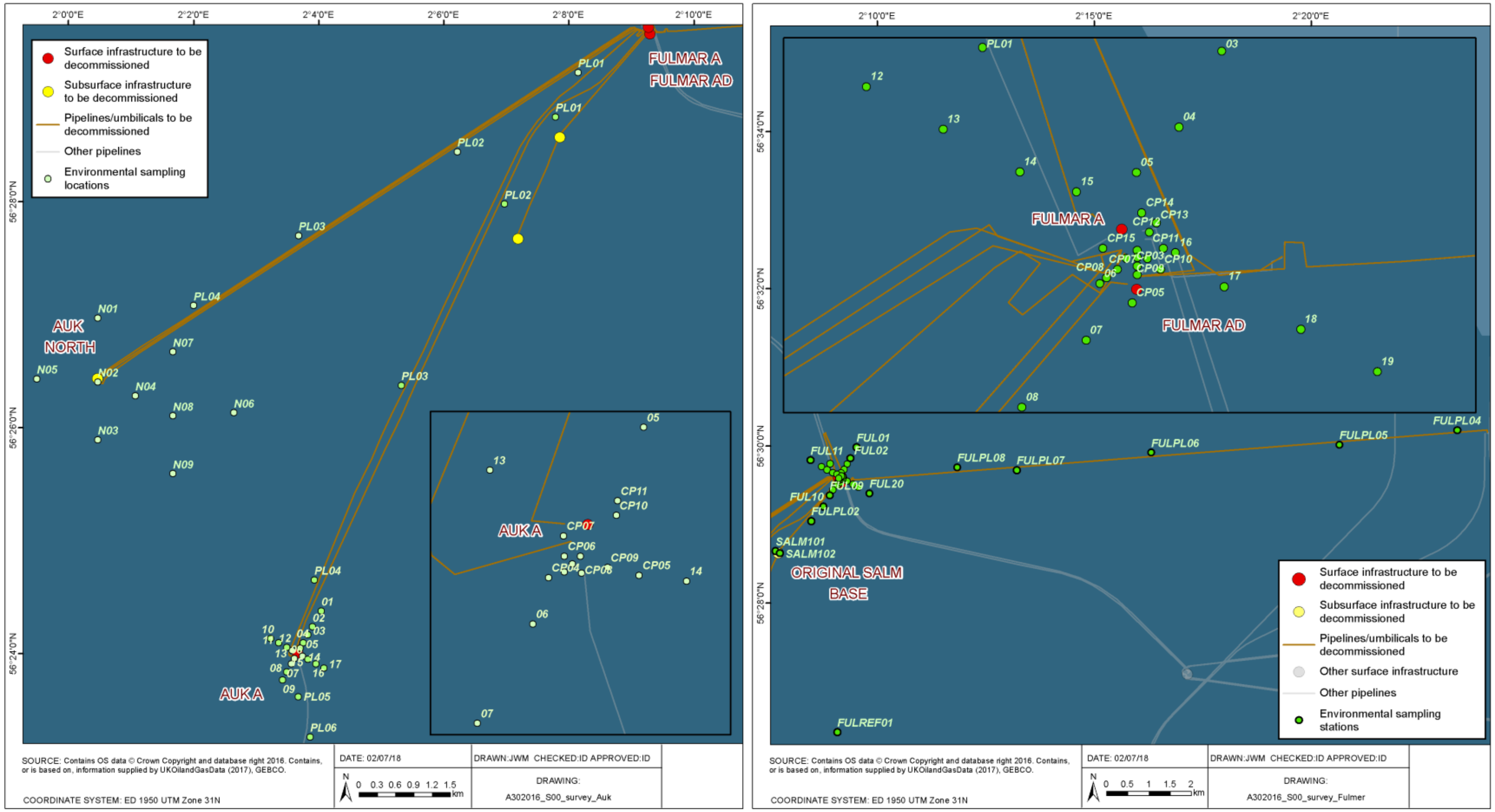


Figure 3.3: Location of Environmental Sample stations in the Auk (Left) and Fulmar (Right) Cuttings Piles [Refs. 12, 13]

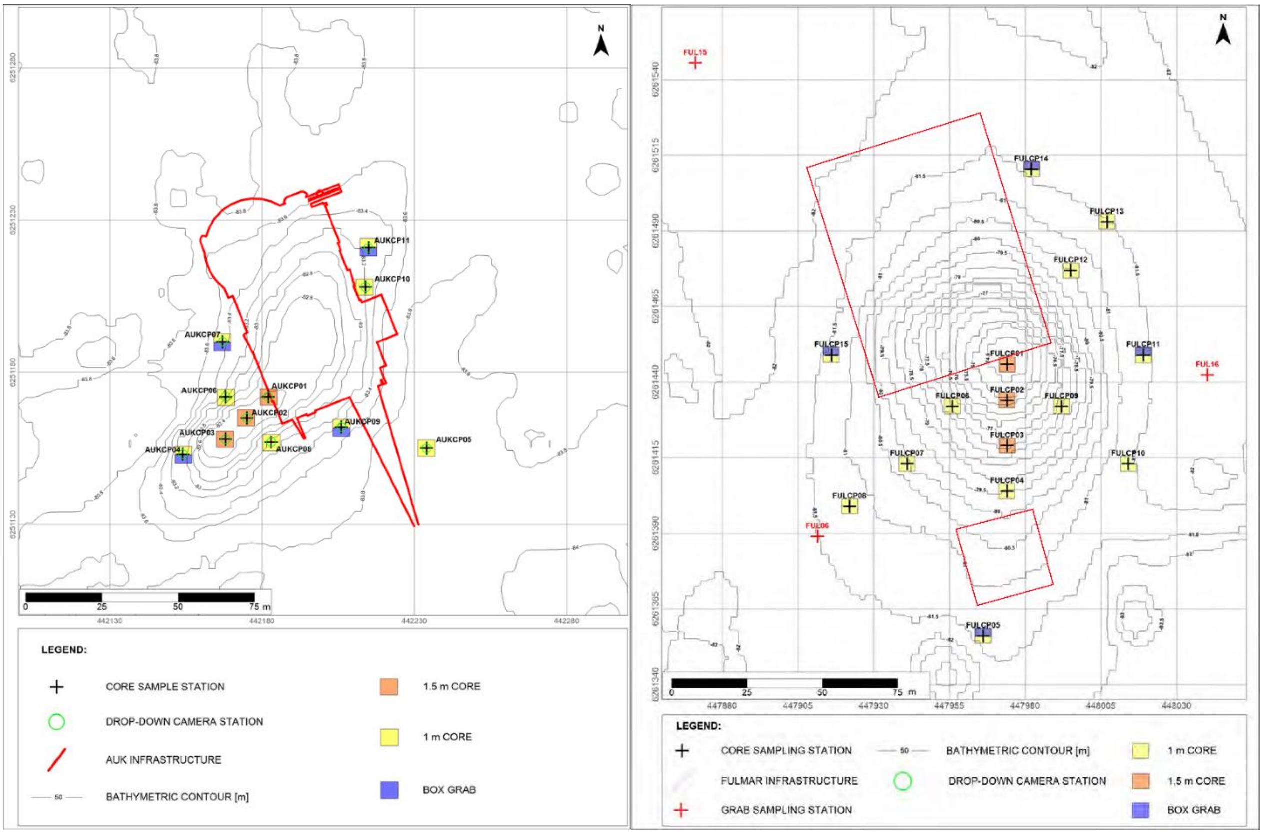


Table 3.1: History of Environmental Survey Work Undertaken at Auk, Fulmar and Auk North

Survey year	Contractor	Location	Type of survey	Report date	Report outputs
2017	Fugro	Auk, Fulmar and Auk North fields	Broad-scale acoustic survey with ground truth sampling (photography/sediment sampling) and physico-chemical and biological analyses	2017	**[Ref. 16]** Field Report
				2017	**[Ref. 17]** Habitat Assessment
				2018	**[Ref. 18]** Environmental Baseline Report for Auk
				2018	**[Ref. 19]** Environmental Baseline Report for Auk North
				2018	**[Ref. 20]** Environmental Baseline Report for Fulmar
			Cuttings pile sampling using cores, grabs and photography, with physico-chemical and biological analyses	2018	**[Ref. 12]** Cuttings Pile Assessment Report Auk
				2018	**[Ref. 13]** Cuttings Pile Assessment Report Fulmar
2008	ERT (Scotland) Ltd	Auk and Fulmar cuttings piles	Sediment sampling/hydrocarbon analysis	2010	**[Ref. 11]** Review of Environmental Monitoring at Talisman's North Sea Assets

Survey year	Contractor	Location	Type of survey	Report date	Report outputs
2007	Fugro	Auk ANC	Rig site survey incorporating bathymetry, sediment sampling/physico-chemical analysis (no photography)	2007	**[Ref. 21]** Rig Site Survey Auk North Prospect; Volume 3 Environmental Baseline and Habitat Assessment
1997	Britsurvey	Fulmar cuttings pile	Bathymetry survey of Fulmar cuttings pile	1997	**[Ref. 22]** Drill Cuttings Survey 1997 Fulmar
1992	Environment & Resource Technology Ltd	Fulmar	Sediment sampling/physico-chemical, radionuclide and toxicity analysis	1993	**[Ref. 23]** Shell Fulmar A Environmental Survey July 1992
1992	Shell Group	Fulmar field	Toxicity analysis of sediment samples collected during ERT's 1992 survey	1993	**[Ref. 24]** Assessment of the Toxicity of Sediments Around Fulmar A
1990	British Gas Engineering Research Station	Fulmar cuttings pile	3D Sonar survey of the cuttings pile	1990	**[Ref. 25]** Shell Fulmar Alpha Drill Cutting Mound 3D Sonar Survey
1988	Aberdeen University Marine Studies Ltd	Fulmar field	Sediment sampling/physico-chemical analysis	1989	**[Ref. 26]** Shell Fulmar Field Post-Drilling Environmental Survey
1985	M-Scan Ltd	Auk and Fulmar fields	Sediment sampling/physico-chemical analysis	1986	**[Ref. 27]** Sediment Hydrocarbon Concentrations Around Auk and Fulmar Fields
1977	Oil Pollution Research Unit	Auk field	Sediment sampling/infauna	1978	**[Ref. 28]** Biological Survey of the Auk Oil Field
1977	Institute of Offshore Engineering	Brent and Auk fields	Sediment sampling/physico-chemical analysis	1978	**[Ref. 29]** Brent-Auk Fields Hydrocarbon Baseline Study

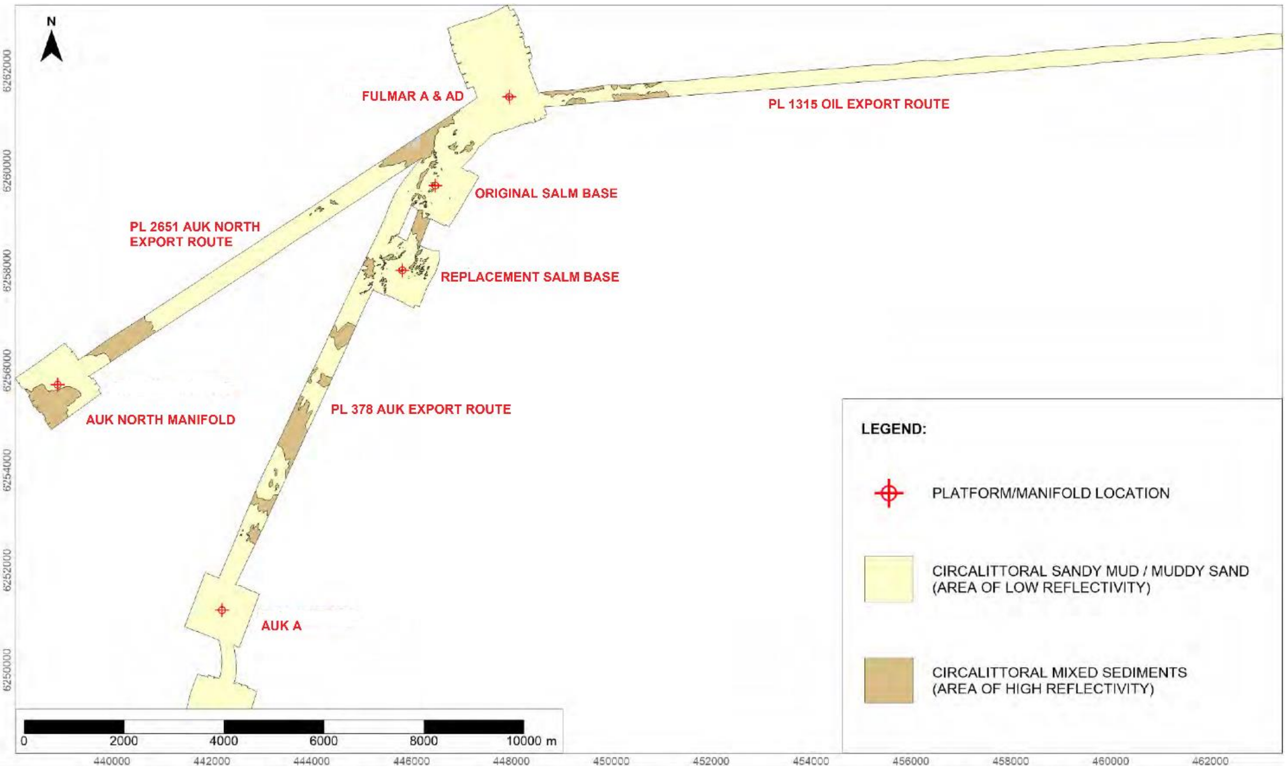
3.2 Seabed Habitat – Physical

From the habitat assessment report commissioned for the Auk, Fulmar and Auk North Decommissioning Project **[Ref. 17]** water depths across the three survey areas ranged between 70 m and 86 m relative to Lowest Astronomical Tide (LAT). The seabed at all three fields consists primarily of sediments with very little hard substrata. The most widespread sediments present were muddy sand or sandy mud, which corresponded to widespread areas of low reflectivity in the acoustic survey data (Figure 3.4). Smaller areas of higher reflectivity corresponded to patches of mixed sediments with pebbles, cobbles, and accumulations of shell debris. The extensive areas of sandy mud and muddy sand were classified as a mix of two EUNIS broadscale habitats 'circalittoral sandy mud' (A5.35) and 'circalittoral muddy sand' (A5.26). The higher reflectivity mixed sediments were classified as 'circalittoral mixed sediments' (A5.44).

In addition to the natural benthic habitat, the cuttings piles at the Auk and Fulmar platforms, together with infrastructure covered with rock or mattresses, were classified as 'industrial waste' (J6.5). Example images of the four broadscale habitats identified in survey work are shown in Figure 3.5 and Figure 3.6.

This corresponds with earlier data from the region as reviewed by **[Ref. 30]**, in which the seabed was characterised as sand with a significant but variable silt/clay (particles of <63 µm diameter) content. An early site survey conducted around the Auk North prospect in 2007 also recorded a seabed of muddy sand in which faunal tracks were evident **[Ref. 21]**. Mapped information on seabed type classifies this region of the North Sea as the EUNIS broadscale habitat A5.27 deep circalittoral sand **[Ref. 31]**.

Figure 3.4: Distribution of Broad Sediment Types Across the Auk, Fulmar and Auk North fields [Ref. 17]



Numerous contacts were observed across the survey area, predominantly around the platform and manifold locations, associated with debris including scaffolding. Anchor scars were also visible in sidescan imagery from around the Auk North manifold and one of the SALM moorings.

Figure 3.5: Example of A5.35 Sandy Mud with Faunal Burrows (Left) and A5.26 Muddy Sand with Faunal Burrows (Right) in the Auk Field [Ref. 17]

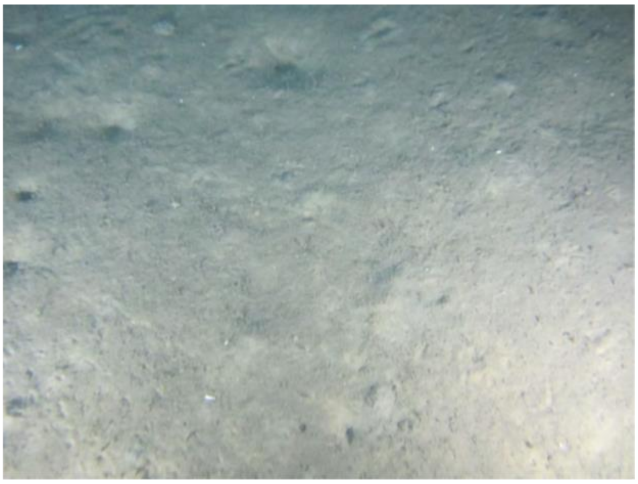
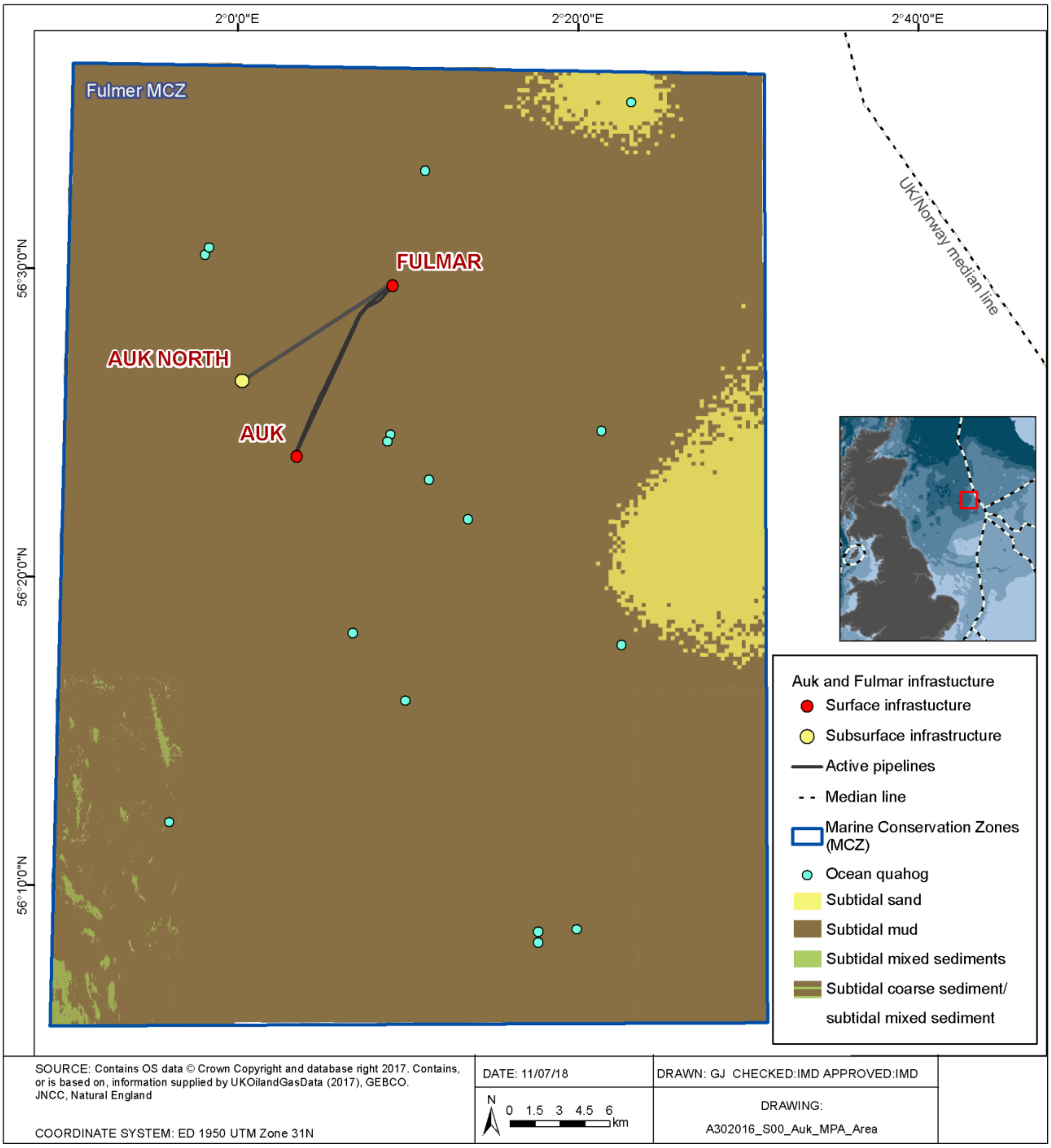


Figure 3.6: Example of A5.44 Mixed Sediments with Shells (Left) and A6.5 Industrial Waste (Right) in the Auk Field [Ref. 17]

The conclusions on benthic habitat types from Fugro's 2017 survey work tie in with the results from acoustic survey, sediment sampling and seabed photography conducted over the Fulmar Marine Conservation Zone (MCZ) in 2012, followed by statistical analysis by JNCC and reporting in **[Ref. 32]**. The Auk, Fulmar and Auk North fields are located entirely within the Fulmar MCZ. The same authors **[Ref. 32]** reported that EUNIS habitat 'A5.3 subtidal mud' extended across most of the site (Figure 3.7), with large patches of 'A5.2 subtidal sand' of >30 km^2 to the north-east and >110 km^2 to the east of the site respectively. Small patches of 'A5.4 subtidal mixed sediments' were located in the centre and to the south-west of the site.

Figure 3.7: Fulmar MCZ Map of Biotopes Assigned Based on Infaunal and Epifaunal Data [Ref. 32]



3.3 Seabed Sediment Characteristics

3.3.1 Auk

Across the Auk field, and including stations along the PL378 pipeline route to Fulmar, sediments were mostly classified by **[Ref. 18]** as very fine or fine sand (mean particle size 110 – 130 µm) with silt/clay content ranging mostly between approximately 7.5 – 24% **[Ref. 18]**. The sediment type was similar at both reference stations, lying between 6 km and 9 km from Fulmar A. Stations within 200 m of the platform generally contained the highest proportions of both coarse material (gravel and coarse sand) and silt/clay. The difference in sediment size distribution in the stations close to the platform most likely reflects the presence of drill cuttings material on the seabed. Sediment particle sizes around the Auk platform and pipeline routes were very similar to those recorded in earlier surveys of the Auk field **[Refs. 29, 30]**.

Total hydrocarbon (THC) concentrations in sediments ranged from 6 μgg^{-1} at Station AUK11 (350 m north-west of the platform) to 2,040 μgg^{-1} at Station AUK06 (100 m south-west). THC levels were elevated above the mean background reference concentration for the central North Sea (9.5 μgg^{-1}; UKOOA, 2001) at distances of up to 800 m from Auk A. At five stations (AUK03 to AUK07), THC levels also exceeded values, above which, changes might be expected in benthic communities (50 μgg^{-1}) - the OSPAR 'ecological effect' threshold **[Ref. 18]**. Gas chromatograph (GC) traces indicated that many stations around the Auk platform were contaminated to some degree with heavily weathered diesel based drilling fluid, particularly within 500 m of the platform, and that some stations also showed evidence of low toxicity oil based fluid (LTOBF) residues.

THC concentrations along the pipeline route to Fulmar and the reference stations were below the mean background concentration for the region. THC levels and spatial distribution around the Auk platform were similar to those reported in an earlier survey by ERT **[Ref. 11]** and levels were slightly lower than those reported in **[Ref. 18]** consistent with gradual weathering of contaminants (see Section 3.3.4 for further discussion of contamination in the context of cuttings pile survey work).

Around the Auk platform, total 2 - 6 ring polycyclic aromatic hydrocarbon (PAH) concentrations ranged from 0.125 μgg^{-1} at AUK11 to 20.4 μgg^{-1} at AUK06 and showed a similar pattern of distribution as outlined above for THC. Total PAH along the pipeline route ranged from 0.098 μgg^{-1} to 0.155 μgg^{-1}, in line with the reference station concentrations of 0.073 μgg^{-1} and 0.132 μgg^{-1} and less than the mean background reference concentration of 0.23 μgg^{-1} reported for the central North Sea **[Ref. 34]**.

The concentration ranges for barium and other selected metals found around the Auk platform and along the Auk to Fulmar export pipeline route are summarised in Table 3.2. Total barium concentrations are typically monitored as a potential marker of drilling mud influence; in the Auk field, levels ranged from 238 μgg^{-1} at reference station FULREF01 (and also at one station along the Auk to Fulmar pipeline route) to 38,300 μgg^{-1} at station AUK06 100 m from the platform. Total barium concentrations highest in the immediate vicinity of the cuttings pile but were elevated at most stations sampled, including along the pipeline route, compared to reference station values and the mean background reference of 348 μgg^{-1} reported for the central North Sea **[Ref. 34]**. In conjunction with the elevated THC concentrations and weathered diesel material identified in the GC traces, this indicates that most stations across the Auk field were subject to at least low-level influence from drilling mud discharges.

Table 3.2: Concentration Ranges for Selected Metals (Hydrofluoric Acid Extraction) in Auk Survey Area [Ref. 18]

	Ranges in metal concentrations recorded (μgg^{-1} dry weight)					
	Barium	**Total Barium**	**Cadmium**	**Mercury**	**Lead**	**Zinc**
Auk platform	775 – 16,600	270 – 38,300	0.04 – 1.17	0.005 – 0.456	11.3 - 221	20.1 – 5,530
Auk PL378 export pipeline route	294 – 1,340	238 - 661	0.035 – 0.045	0.003 – 0.008	10.3 – 14.0	15.9 – 57.1
Mean reference background level (UKOOA, 2001)	-	348	0.76	0.17	12.6	21.3
Effects Range Low (OSPAR, 2014)[12]	-	-	1.20	0.15	47.0	150

[12] Adopted for use in assessments by OSPAR, based on United States Environmental Protection Agency (EPA) sediment quality guidelines. The ERL value is defined as the lower tenth percentile of the data set of concentrations in sediments which were associated with biological effects. Adverse effects on organisms are rarely observed when concentrations fall below the ERL value.

Many other metals analysed showed elevated concentrations within 200 – 500 m of the Auk platform in comparison to both the reference stations and to published background reference levels, particularly at those stations on the north-east to south-west axis (aligned with the main axis of tidal flow). However, exceedance of Effects Range Low (ERL) threshold levels generally only occurred within 100 – 200 m of the Auk platform. Stations on the pipeline route showed metal concentrations at or below the published mean background and ERL concentrations, but slightly elevated compared to the reference stations. The elevated metal concentrations at stations close to the platform are further evidence of drilling mud contamination.

3.3.2 Fulmar

Across the Fulmar field, and including stations along the pipeline/cable routes PL208, PL63/648 and PL1315 and by the SALM bases (Figure 3.1 and Figure 3.2), sediments were mostly classified as fine or very fine sand and had a silt/clay content of 5 – 19% **[Ref. 19]**. The sediment type was similar at both reference stations, lying between 6 and 9 km from Fulmar A. At Stations Ful06 and Ful16, 100 m from the south side of Fulmar A (Figure 3.2), sediments contained much higher proportions of silt/clay (35 – 43%) and slightly higher proportions of coarser material compared to other stations, reflecting their proximity to the Fulmar cuttings pile. Sediments recorded in the current survey were generally finer than those in earlier surveys **[Refs. 23, 26, 27]** .

The GC traces from sediments at all stations within 800 m of the Fulmar platforms exhibited evidence of contamination by partially weathered diesel, or a diesel-like drilling fluid. Evidence of LTOBF with varying degrees of weathering was also evident at some stations around the Fulmar platform. At stations further out along the pipeline/cable routes PL208, PL63/648 and PL1315 and by the SALM bases, GC traces were much closer to the background conditions seen at the two reference stations, with only small amounts of material indicative of weathered diesel and/or land run-off.

Sediment THC concentrations at stations around the Fulmar platforms ranged from 10.0 $\mu g g^{-1}$ at 800 m distance to 3,960 $\mu g g^{-1}$ at 100 m. The mean background THC concentration published for the CNS is 9.5 $\mu g g^{-1}$ **[Ref. 34]** indicating that THC are generally elevated in the immediate vicinity of the Fulmar platforms, particularly within 500 m or so. The THC levels along the pipeline/cable routes PL208, PL63/648 and PL1315 and at the SALM stations were generally lower (6 - 15 $\mu g g^{-1}$) and more comparable to background levels, although sediment THC concentrations at the two reference stations were less than 4 $\mu g g^{-1}$. The survey report **[Ref. 19]** observed that THC levels recorded in 2017 were all lower than those recorded in earlier surveys **[Refs. 23, 26, 27]**, and there is evidence that the general level of hydrocarbon contamination generally has become reduced and more weathered.

Concentrations of total 2 - 6 ring PAH at stations around the Fulmar platforms ranged from 0.217 $\mu g g^{-1}$ at 500 m distance to 34.3 $\mu g g^{-1}$ at 100 m. Concentrations were generally at or around background levels for the CNS (0.233 $\mu g g^{-1}$; **[Ref. 34]**) beyond 350 m but were elevated within 350 m of the platforms. Total 2 - 6 ring PAH levels along the pipeline/cable routes PL208, PL63/648 and PL1315 and at the SALM stations were generally lower (0.076 – 0.555 $\mu g g^{-1}$) and more comparable to background levels but were lowest at the two reference stations (less than 0.132 $\mu g g^{-1}$). The concentrations of the PAH compounds specifically listed in the Coordinated Environmental Monitoring Programme (CEMP; **[Ref. 36]**) were below the OSPAR ERL threshold levels at all stations, and are unlikely to cause adverse effects in marine organisms. PAH concentrations in 2017 were lower than those recorded in 1992 **[Ref. 23, 19]**.

Concentration ranges recorded by **[Ref.19]** for selected metals are summarised in Table 3.3. Values for total barium around Fulmar A ranged from 115 $\mu g g^{-1}$ at Station Ful14 200 m east of the platform, to 11,000 $\mu g g^{-1}$ at Ful07 200 m south-west of the platform. Concentrations exceeded the published CNS background level at most stations within 350 – 500 m of Fulmar A.

Table 3.3: Concentration Ranges for Selected Metals (Hydrofluoric Acid Extraction) in Fulmar [Ref. 19]

	Ranges in metal concentrations recorded (µgg^{-1} dry weight)					
	Barium	**Total Barium**	**Cadmium**	**Mercury**	**Lead**	**Zinc**
Fulmar platform	379 – 1,800	115 – 11,000	<0.03 – 1.96	0.004 – 0.619	10.5 - 128	13.4 – 3,550
Fulmar PL1315 export pipeline route	218 – 1,180	27.3 - 780	<0.03 – 0.046	0.002 – 0.009	8.66 – 19.7	9.01 – 19.6
SALM bases	252 - 325	123 – 1,250	<0.03 – 0.052	0.002 – 0.007	9.43 – 17.7	36.3 - 134
Mean reference background level **[Ref.34]**	-	348	0.76	0.17	12.6	21.3
Effects Range Low **[Ref.35]**	-	-	1.20	0.15	47.0	150

Many other metals analysed in the present survey (cadmium, mercury, arsenic, chromium, copper, nickel, lead and zinc) exceeded their respective background and/or ERL threshold values within 100 – 200 m of Fulmar A. The total barium concentrations in sediments around Fulmar were highest at stations close to the north-north-east and south-south-west of the platforms as well as 100 m to the east-south-east. The high concentrations at these stations indicate the presence of drilling mud deposits on the seabed around the Fulmar platform. On the pipeline route and around the SALM bases, metal levels were slightly elevated above background values at one or two stations although zinc appeared to be elevated at all stations close the SALM bases. At the two reference stations, all metal levels were well below their respective background and ERL values.

3.3.3 Auk North

Mean sediment sizes at Auk North were predominantly fine sand or very fine sand, with one station (AUKN02, the closest station to the manifold) classified as coarse silt **[Ref.20]**). Silt and clay content ranged from 8.82% at AUKN03 1,000 m south of the manifold, to 45.5% at AUKN02 50 m south of the manifold (Figure 3.2). AUKN02 also had the highest gravel content of the stations around the manifold at 1.67%. Sorting of sediments was generally poor or extremely poor. The increased proportions of both fines and gravel close to the manifold may suggest drill cuttings contamination.

Mean sediment sizes along the PL2651 pipeline route to Fulmar were either fine sand or very fine sand. Fines content ranged from 9.22% to 14.5%, while gravel content ranged from 0% to 3.98%, and sediment sorting was poor or very poor.

Gas chromatograph (GC) traces indicated that most stations around the Auk North manifold and along the pipeline route contained low-level weathered petroleum residues consistent with background contamination found across the CNS. Station AUKN02 exhibited evidence of weathered LTOBF, indicative of historical drilling fluid discharges. GC traces were comparable to those produced following earlier survey work at Auk North in 2007 **[Ref.21]**, with the exception of the evidence of drilling inputs at Station AUKN02.

Sediment THC around Auk North ranged from 2.7 µgg^{-1} at Station AUKN06 2.3 km from the manifold, to 37.9 µgg^{-1} at Station AUKN02 50 m south of the manifold (Figure 3.2). Excluding AUKN02, all stations exhibited THC values below the UKOOA regional mean background concentration of 9.5 µgg^{-1}. While slightly elevated, the result at AUKN02 was still below the UKOOA 95th percentile value of 40.1 µgg^{-1}. The pipeline stations all recorded THC concentrations of between 5.2 µgg^{-1} and 7.7 µgg^{-1}. The reference station THC values were 3.7 µgg^{-1} and 3.8 µgg^{-1}. This suggests that some of the manifold and pipeline stations might be slightly elevated relative to baseline concentrations for the area, but the differences are so small and inconsistent that this might also be explained by natural variation.

Total 2 - 6 ring PAH concentrations ranged from 0.092 µgg^{-1} (AUKN05 and AUKN06) to 0.391 µgg^{-1} at Station AUKN02. Values for all stations were below the UKOOA mean background concentration

(0.233 μgg^{-1}) with the exception of AUKN02, which exceeded the mean concentration but was well below the 95th percentile concentration of 0.736 μgg^{-1}. Total 2 - 6 ring PAH concentrations for the pipeline stations ranged from 0.12 μgg^{-1} to 0.172 μgg^{-1}, similar to the reference station results of 0.073 μgg^{-1} and 0.132 μgg^{-1}. With the exception of AUKN02, total 2 – 6 ring PAH concentrations across the manifold and pipeline stations were also slightly elevated compared to the mean of 0.120 μgg^{-1} recorded in 2007 **[Ref. 21]**.

Concentration ranges recorded for selected metals in recent survey work **[Ref. 20]** are summarised in Table 3.4. Total barium concentrations ranged from 43.6 μgg^{-1} at station AUKN03 to 4,160 μgg^{-1} at station AUKN04 (676 m east-south-east of the manifold). The UKOOA mean background concentration for the central North Sea (348 μgg^{-1}) was exceeded at Stations AUKN02, AUKN04, AUKN05 AUKN07 and AUKN09 at distances of up to 2,000 m from the manifold.

At the pipeline stations, total barium concentrations ranged from 67.2 μgg^{-1} (AUKPL02) to 390 μgg^{-1} (AUKPL04), similar to or less than the UKOOA mean concentration for the CNS. Total barium concentrations at the reference stations were 238 μgg^{-1} and 256 μgg^{-1}. Total barium extraction was not performed in 2007 **[Ref.21]**; therefore, a comparison is made instead with barium extraction by hydrofluoric acid. The mean barium concentration recorded using this method in 2007 was 1,688 μgg^{-1}, compared to a mean of 496 μgg^{-1} in the current survey, indicative of a general reduction over the last ten years.

The concentration ranges of other metals recorded in 2017 **[Ref. 20]** were generally below UKOOA mean concentrations and in line with the results from the reference stations. Station AUKN02 exhibited concentrations of zinc (and other metals including chromium, copper and nickel) above UKOOA mean concentrations, although no OSPAR ERL concentrations were exceeded. Along the pipeline route, metal concentrations were generally lower than or equivalent to the UKOOA means. Metal concentrations at the reference stations were generally in line with the majority of the manifold and pipeline results and were all below UKOOA mean concentrations. The mean results for all metals from the current survey were below those recorded in 2007 **[Ref. 21]**.

Table 3.4: Concentration Ranges for Selected Metals (Hydrofluoric Acid Extraction) in Auk North Survey Area [Ref. 20]

	Ranges in metal concentrations recorded (μgg^{-1} dry weight)					
	Barium	**Total Barium**	**Cadmium**	**Mercury**	**Lead**	**Zinc**
Auk North manifold	356 – 1,790	43.6 – 4,160	0.027 – 0.061	0.003 – 0.093	9.7 – 11.1	16.1 – 42.2
Auk North PL2651 export pipeline route	258 – 351	67.2 - 390	0.028 – 0.047	0.003 – 0.014	10.1 – 11.0	15.1 – 23.7
Mean reference background level (UKOOA, 2001)	-	348	0.76	0.17	12.6	21.3
Effects Range Low (OSPAR, 2014)	-	-	1.20	0.15	47.0	150

3.3.4 Auk cuttings pile

Sampling for the Auk cuttings pile survey in 2017 with cores taken from accessible and representative locations, was concentrated on that part of the pile that was visible on bathymetric data, and within 55 m of the approximate pile centre (Figure 3.3; **[Ref. 12]**). As noted in Section 2.3.4, the area of the main cuttings pile present at Auk is estimated to be approximately 5,000 m^2 with a volume of 2,336 m^3 and a maximum depth of 1.2 m.

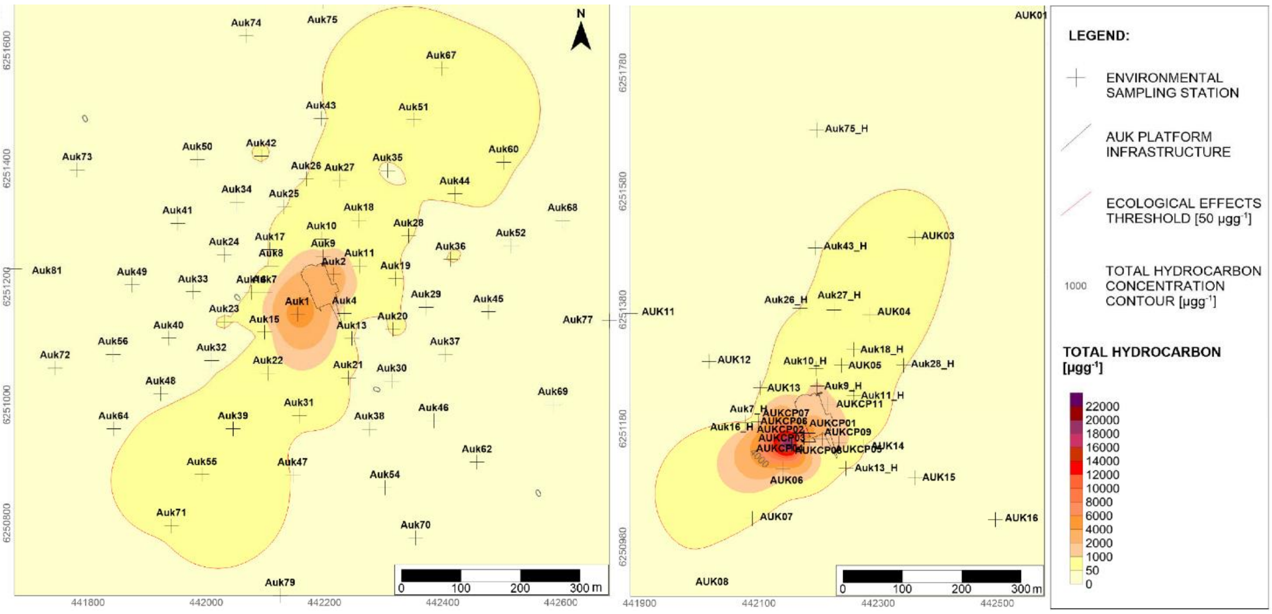
High variability in sediment type was recorded across the Auk cuttings pile, ranging from fine silt to medium sand. Fine particles <63 μm (fines, or silt/clay, or mud) were the dominant sediment component at the majority of stations, and at most core depth levels. However, coarser sediments more similar to those on natural seabed away from the main pile, were apparent in some of the samples from around the outer edge of the pile, particularly at deeper levels where the core may have penetrated through cuttings material to the seabed below. The total organic carbon (TOC) and total organic matter (TOM) concentrations recorded were moderately variable across the cuttings pile.

The GC profiles of the surface core sections across the cuttings pile all exhibited evidence of an input of a polyalphaolefin-based synthetic drilling fluid. Diesel and LTOBF inputs were noted in the subsurface sediment layers in varying stages of weathering. Cores at stations AUKCP05 and AUKCP09, on the south-eastern edge of the cuttings pile, penetrated underlying sediments and showing GC profiles typical of background sediments within the deepest layers.

THC concentrations in surface sediments ranged from 720 μgg^{-1} to 24,700 μgg^{-1} and were highest in sediments within the main body of the cuttings pile, located beneath the south-west edge of the Auk platform. THC concentrations in the deepest horizon of each core sample ranged from 2.4 μgg^{-1} to 22,800 μgg^{-1}; the cores at stations on the outer edge of the pile reached the natural sandy seabed beneath, and THC levels at two such locations were comparable to background concentrations in the CNS. There was a tendency in most of the deeper cores from the main body of the pile for THC levels to increase with depth. However, this was not always the case, and overall there was no clear correlation between THC concentrations and depth within the pile.

The approximate 'ecological effect' threshold for THC levels in surface sediments of 50 μgg^{-1} was defined by OSPAR to estimate the environmental impacts of cuttings piles in the North Sea **[Ref. 10]**. THC levels exceeded the 50 μgg^{-1} threshold at all stations in this cuttings pile survey, but when combined with the wider-scale recent Auk survey data **[Ref. 18]** and data from 2008 **[Ref. 11]**, the footprint of the zone within which THC levels exceed 50 μgg^{-1} was calculated to be approximately 0.134 km^2 (Fugro, 2018d). This represents a decrease in the size of the 50 μgg^{-1} footprint since survey work in 2008, when it was estimated to be 0.260 km^2 **[Ref. 11]**. These footprints have been plotted for comparison in Figure 3.8**.**

Figure 3.8: Contour Maps of THC Concentrations Around the Auk Field Cuttings Pile, Highlighting the zone Within Which THC Levels Exceed 50 μgg^{-1} and the Change Between 2008 (Left) and the Present Day (Right) [Ref. 12][13]



Concentrations of 2 – 6 ring PAH in surface sediments within the pile ranged between 1.5 – 39.5 μgg^{-1}, and in deeper layers between 0.046 – 829 μgg^{-1}. PAH concentrations exceeded OSPAR ERL levels threshold values in most core sections, with the highest PAH concentrations recorded in deeper horizons (>18 cm), particularly those core sections where diesel based inputs were noted.

[13] Note that although higher THC concentrations were recorded in 2017 at the central stations than in 2008, this is because in 2017 more samples were collected from within the main body of the cuttings pile, compared to 2008.

Results indicated a predominantly petrogenic source for the aromatic compounds in the sediments. The concentrations of benzene, toluene, ethylbenzene and xylene (BTEX) in the sediment samples collected within the Auk cuttings pile were below the estimated BTEX chronic toxicity threshold of 5 μgg^{-1} **[Ref. 36]** at all stations.

Elevated levels of barium together with other metals including cadmium, chromium, copper, mercury, nickel, lead and zinc were recorded at all stations. Metals levels exceeded ERL thresholds and the mean background concentrations calculated for CNS sediments >5 km from active installations **[Ref. 34]**. In addition, of the metals included within the OSPAR CEMP[14] for which 'Background Assessment Concentrations (BAC)' **[Ref. 37]** have been set, all (cadmium, mercury, arsenic, chromium, copper, nickel, lead and zinc) exceeded BAC thresholds at all stations. The main exceptions to this were in the deepest core sections at stations where the cores had penetrated through to natural sediments beneath the pile. The concentrations recorded for the seabed cuttings deposits at Auk were comparable to results recorded for other North Sea installations. The metals results indicate minimum depths of drill cuttings deposition within the survey area ranging between approximately 10 cm at the south-east edge of the pile to 60 cm at the apex of the cuttings pile.

3.3.5 Fulmar Cuttings Pile

The information presented here is summarised from **[Ref. 13]**.

Sampling for the Fulmar cuttings pile survey was concentrated on that part of the pile that was visible on bathymetric data, and within 130 m of the approximate pile centre (Figure 3.3). As noted in Section 2.3.4, the area of the main cuttings pile present at Fulmar is estimated to be approximately 11,000 m^2 with a volume of 18,746 m^3 and a maximum depth of 6.9 m.

High variability in sediment type was recorded across the Fulmar cuttings pile, ranging from very fine silt to medium sand. Fine particles <63 µm (silt and clay) dominated the samples at most stations, with the proportion of fine sediments increasing with proximity to the centre of the cuttings pile. Proportions of fines were higher at stations north-east and south-west axis through the pile centre. Proportions of coarse sediment increased with distance from the cuttings pile centre, particularly to the north, north-west and east. Mean particle size in the core samples generally decreased with depth, although at Station FULCP13 this pattern was reversed. Sediment TOC ranged from 0.31% at Station FULCP14 (20 – 30 cm core, which may represent breakthrough to the natural seabed) to 5.12% at FULCP11 (15 – 25 cm), and was generally higher towards the centre of the pile.

The GC profiles for the surface and core samples all showed evidence of sediment drilling fluid contamination. Contamination profiles were often mixed, within single samples showing a range of drilling mud types. Weathered LTOBF was evident at most stations within the pile, with the exception of FULCP01 at the centre of the pile, and two stations located at the edge of the pile. Towards the centre of the pile, at Stations FULCP01 to FULCP03 and FULCP06, the main hydrocarbon material was un-weathered synthetic-olefin-based fluid throughout the sediment cores. Synthetic-base fluid inputs were also observed in the surface samples from Stations FULCP02 to FULCP04, FULCP06, FULCP07, and FULCP09 to FULCP13. Several stations exhibited un-weathered diesel inputs; these stations tended to be towards the outer limits of the cuttings pile.

THC concentrations in surface sediments ranged from 1,080 μgg^{-1} to 99,800 μgg^{-1}. The highest concentrations were at Stations FULCP02 (54 m south-south-east of the pile centre), FULCP03 (68 m south-south-east), FULCP10 (95 m south-east) and FULCP13 (60 m east-north-east). THC values were higher at Station FULCP02 (82,000 μgg^{-1}) than at a similar sampling location recorded in 2008 **[Ref. 11]** (Station FM70 located 50 m south of the Fulmar platform with recorded THC of 13,700 μgg^{-1}).

[14] Background Assessment Concentrations (BAC) have been statistically derived for many contaminants monitored in the OSPAR CEMP, and essentially may be thought of concentrations that are at or near background levels (OSPAR, 2008).

THC concentrations within the core samples often exceeded those at the surface, with a maximum value of 132,000 $\mu g g^{-1}$ recorded at Station FULCP13 (25 – 35 cm section). THC concentration in some cores decreased with depth, but overall the highest concentrations tended to be from sub-surface samples. Weathering was more apparent in the surface samples, and at stations furthest from the centre of the pile. At some of these more distant stations, a sharp reduction in THC in the deepest core sampled indicated that the core consisted partly of natural seabed (FULCP05, FULCP14 and possibly FULCP13).

The 50 $\mu g g^{-1}$ 'ecological effect' threshold for THC was exceeded at all stations and at all core depths sampled during the survey. The size of the area where THC concentrations exceed the ecological effect threshold has decreased over time. In 1992 the extent of this area was estimated at 1.26 km^2 **[Ref. 23]** and in 2008 at 0.278 km^2 **[Ref. 11]**. The current survey estimated this area at 0.262 km^2. The relative size of the area of ecological effect in 2008 compared to 2017 is illustrated in Figure 3.9. Note that although higher THC concentrations were recorded in 2017 at the central stations than in 2008, this is because in 2017 samples were collected from within the main body of the cuttings pile close to Fulmar Alpha and to a greater depth than in 2008.

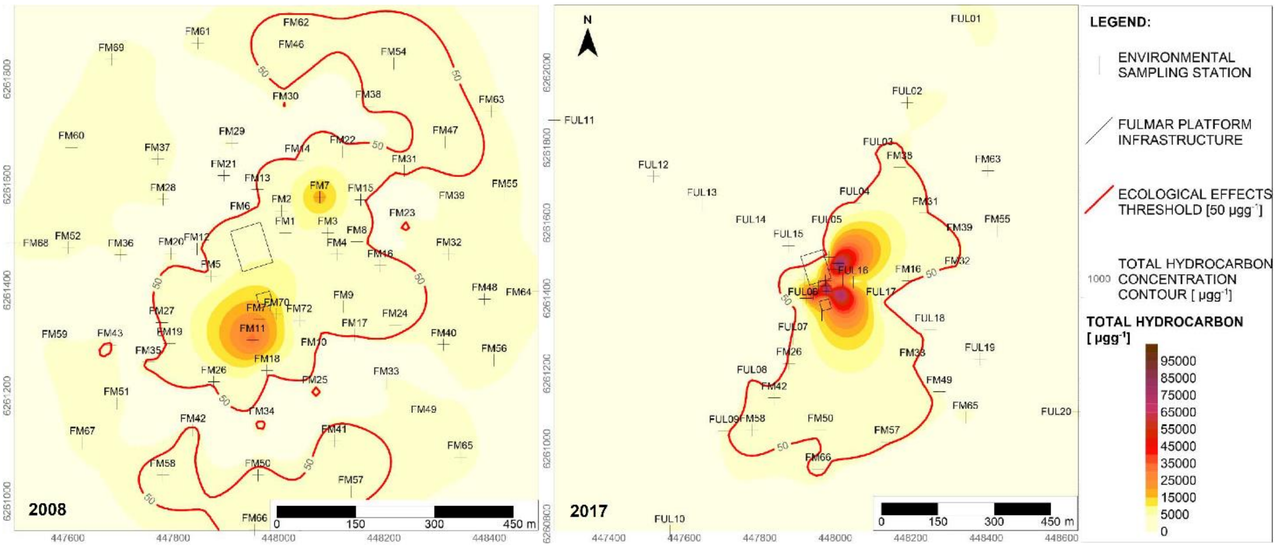
Concentrations of 2 – 6 ring PAH in surface sediments within the pile ranged from 23.4 $\mu g g^{-1}$ at FULCP14 to 1,990 $\mu g g^{-1}$ at FULCP13. The highest concentration overall was 6,850 $\mu g g^{-1}$, measured in the 25 – 35 cm core section from FULCP13. OSPAR ERL concentrations for individual PAHs and OSPAR mean total PAH concentrations for samples collected within 500 m of active platforms were exceeded by large margins at all stations and across most sample depths. The highest total PAH concentrations were recorded in deeper cores at the stations where diesel-based drilling fluids had been identified. The proportion of petrogenic PAH[15] in the total PAH recorded ranged from 36% at Station FULCP09 (0 – 10 cm section) to 99% at several stations. Total BTEX concentrations ranged from 0.032 $\mu g g^{-1}$ at Station FULCP14 (20 - 30 cm section) to 61.5 $\mu g g^{-1}$ at Station FULCP13 (25 – 35 cm section). The estimated BTEX chronic toxicity threshold is 5 $\mu g g^{-1}$ **[Ref. 36]**, and this was exceeded at stations FULCP13, FULCP03, FULCP07 and FULCP08 (all at depths of between 25 – 45 cm). BTEX concentrations appeared more elevated at stations on a broadly north-north-east to south-south-west bearing to the cuttings pile centre, and the highest concentrations were at stations towards the outer edge of the cuttings pile.

Total barium was elevated across the survey area. There were occasional low results (179 $\mu g g^{-1}$ at Station FULCP15, in the 25 - 35 cm section), but all stations exhibited elevated total barium in at least one sample. The maximum was 118,000 $\mu g g^{-1}$ at Station FULCP12 (25 – 35 cm core).

Copper, mercury, lead and zinc were present at concentrations above OSPAR ERL thresholds in the majority of samples analysed; cadmium and chromium also exceeded their ERL in several samples. UKOOA mean concentrations for stations within 500 m of active platforms were exceeded for cadmium, chromium, copper, iron, mercury, nickel and zinc. The highest concentrations were generally recorded in surface sediment samples from Stations FULCP02, FULCP04, FULCP06, FULCP07, FULCP08 and FULCP09. The lowest concentrations were recorded in the deepest cores at Station FULCP13 (48 – 58 cm) and FULCP14 (20 – 30 cm), which may represent partial breakthrough to the natural seabed.

[15] Petrogenic (from petroleum sources) rather than biogenic (synthesised by organisms). Both types of material are typically found in marine sediments, though in background conditions it is usually the biogenic component that is dominant.

Figure 3.9: Contour Maps of THC Concentrations Around the Fulmar Field Cuttings Pile, Highlighting the Zone Within Which THC Levels Exceed 50 µgg^{-1} and the Change Between 2008 (Left) and the Present Day (Right) [Ref. 13] [16]



3.4 Benthos

3.4.1 Introduction

The biota living near, on or in the seabed is collectively termed benthos; the term infauna refers to those species living predominantly within the sediment, whilst the term epifauna refers to those species living predominantly on or just above the sediment and visible in photographs. The type, diversity and biomass of the benthos is dependent on a number of factors including substrata (e.g. sediment, rock), water depth, salinity, the local hydrodynamics and degree of organic enrichment.

3.4.2 Epifauna and Sensitive Habitats

From the habitat assessment **[Ref. 17]** epifaunal species observed across the survey area were generally sparse, and similar over the whole area surveyed. The more frequently observed species included sea-pens (*Virgularia mirabilis, Pennatula phosphorea*), sea urchins (*Gracilechinus acutus, Echinus* sp.), hydroids (*Tubularia indivisa*, *Abietinaria abietina* and others), soft coral (*Alcyonium digitatum*), starfish (including *Astropecten irregularis, Asterias rubens*), hermit crabs (including *Pagurus bernhardus*), hagfish *Myxine glutinosa* and polychaetes (including *Ditrupa arietina*). Other infrequently recorded species included the crab *Lithodes maja*, whelks, brittlestars, horse mussels (*Modiolus modiolus*) and octopus, and various fish including the pogge *Agonus cataphractus*, rays and pollack *Pollachius pollachius*. The earlier site survey and habitat assessment at Auk North in 2007 **[Ref. 21]** conducted limited photography and did not report specifically on the epifauna present.

Within the cuttings piles at Auk and Fulmar, species observed included flatfish, the anemone *Metridium dianthus* and mussels (both the common mussel *Mytilus edulis* and horse mussels).

Due to the observation of the sea-pens, as well as faunal burrows, there is the potential for the presence of the OSPAR-listed threatened and/or declining biotope ‘sea-pens and burrowing megafauna communities’ to occur within the survey area. Sea-pens and faunal burrows were observed in the video footage and stills throughout the Auk, Fulmar and Auk North survey areas. Fugro **[Ref. 17]** assessed the abundance of sea-pens and faunal burrows in the photographic data

[16] Note that although higher THC concentrations were recorded in 2017 at the central stations than in 2008, this is because in 2017 a higher proportion of the samples were collected from within the main body of the cuttings pile, compared to 2008.

for each field, using the JNCC SACFOR scale[17]. Guidelines state that sea-pens need not be present, but that burrows should be at least ‘frequent’ on the SACFOR scale to be classified as a ‘sea-pens and burrowing megafauna community’. Although burrows were present at an abundance of frequent or higher at many stations across the Auk, Fulmar and Auk North fields, Fugro judged that the seabed was not sufficiently “heavily bioturbated by burrowing megafaunal with burrows and mounds typically forming a prominent feature of the sediment surface”. Examples of seabed photographs showing some of the species present including sea-pens are shown in Figure 3.10 and Figure 3.11.

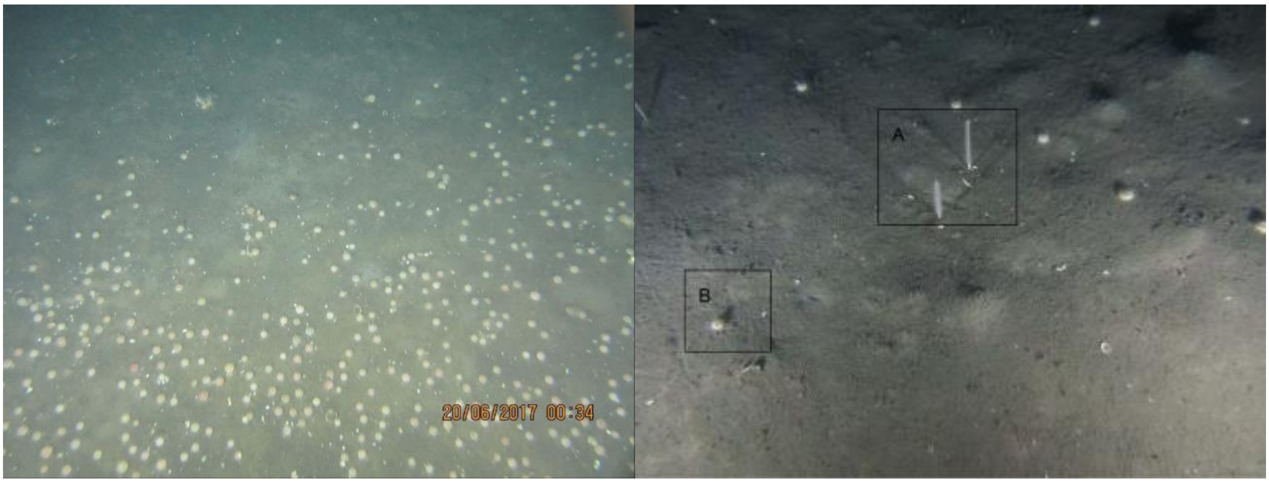
Figure 3.10: Examples of Benthic Fauna Recorded in the Auk Field (Left) - Horse Mussels, Sea-Pens, Hydroid/Bryozoan Turf, Hermit Crabs and Sea Urchins, and Auk North (Right) - Sea Urchin and Sea Pen [Ref. 17]

All areas of mixed sediment identified along transects were assessed according to the JNCC Annex I stony reef quality or ‘reefiness’ criteria **[Ref. 38]**[18]. None of the transect sections assessed for stony reef exhibited ‘high reefiness’ for any of the assessment criteria. The highest level of ‘reefiness’ classified during the current survey for any of the criteria was ‘medium reefiness’ for elevation above seabed, occurring at locations around Auk North (transects AUKNTR02, AUKNTR03, AUKNTR04 and station AUKN05). However, all areas with the potential to be classified as stony reef were described as ‘not a reef’ for the cover of epifauna criterion. As none of the transects/stations assessed met the minimum ‘low’ threshold for all three criteria, the areas of mixed sediment assessed were not considered to constitute an Annex I Stony Reef habitat.

[17] A measure of abundance based on numbers per unit area (taking into account size of individuals/colonies, density and growth form): Superabundant; Abundant; Common, Frequent, Occasional and Rare.

[18] Irving **[Ref. 38]** outlined the criteria and thresholds necessary to decide whether an area of seabed should be considered a reef (rocky, stony or biogenic) or not, namely the proportion of rocky material present (cobbles or larger), degree of elevation above surrounding seabed, patchiness, extent and cover of epifauna.

Figure 3.11: Examples of Benthic Fauna Recorded in the Fulmar Field. Left: Sea Urchins *Gracilechinus acutus*. Right: A Sea Pen *Virgularia mirabilis*; B G. acutus [Ref. 17]



Seabed photographic data and macrofaunal data were reviewed in detail for presence of the OSPAR-listed threatened and/or declining species, the clam ocean quahog or *Arctica islandica*. From the seabed photographs alone, no live adult *A. islandica* were observed across the survey area and siphons were not visible at the sediment surface in any of the seabed photographs. From the sediment sampling work, adult *A. islandica* were observed at one station at Auk, one station at Auk North, and four stations at Fulmar. Overall, seven individuals were counted from the entire Auk, Fulmar and Auk North survey area.

Although small patches of horse mussels and their shells (e.g. as shown in Figure 3.10) were occasionally recorded, including on cuttings piles, these were not dense enough to constitute beds. The Fulmar MCZ study reported by **[Ref. 32]** also recognised patches of horse mussels at the centre of the site and considered these were not sufficiently dense to constitute beds and they did not dominate the habitat where they occurred.

No other Annex I habitats or OSPAR threatened/declining species or habitats were present within the survey area, based on review of sidescan sonar data, and environmental ground-truth data (seabed photography and sediment samples).

3.4.3 Infauna

The macrofaunal invertebrate communities living within the sediments and sampled by grab were similar across the Auk, Fulmar and Auk North fields, in spite of the slight variations in sediment type evident over the area as a whole (Section 3.1.1). The most abundant species at most stations away from the influence of cuttings piles were the polychaetes *Paramphinome jeffreysii, Galathowenia oculata, Spiophanes bombyx, Phyllodoce groenlandica*, and *Pholoe assimilis* **[Refs. 18, 19, 20]**.

Similar species were dominant around Auk North in 2007 **[Ref. 21]**; at that time the most abundant species were the polychaetes *G. oculata, Amphictene auricoma* and *P. jeffreysii* and *Spiophanes kroyeri*. However, the list of top 15 dominant species also included the brittlestar *Amphiura filiformis* and the burrowing sea cucumber *Labidoplax buski*. Similar species were also present around Fulmar in 1992 **[Ref. 23]**; at that time the four most abundant species were the polychaetes *Ampharete falcata, G. oculata* and *P. assimilis* (then known as *P. inornata*) although all the top ten listed species were still present as part of the fauna in 2017. A macrofaunal survey conducted around the Auk field in 1977 **[Ref. 28]** found that the most abundant species included the brittlestar *A. filiformis*, the burrowing sea cucumber *L. buski*, and the polychaetes *Chone* (now *Dialychone*) *collaris, Nephtys* spp. and *Pectinaria* (now *Amphictene*) *auricoma*. It is evident, therefore, that while the rank order of individual species has shown variation over the last 40 years or so as species populations have increased or decreased in relative terms, the overall infaunal species list found in recent years shares many similarities with that present in the 1970s.

In terms of the EUNIS biotope classification, Fugro **[Refs. 18, 20]** considered the infaunal community around Auk and Fulmar to be closest to ‘A5.253 medium to very fine sand, 100-120 m, with polychaetes *Spiophanes kroyeri, Amphictene auricoma, Myriochele* sp., *Aricidea wassi* and amphipods *Harpinia antennaria*’ (a sub-level of A5.25 circalittoral fine sand). On the other hand, for Auk North, the chosen infaunal biotope (Fugro, 2018b) was ‘A5.252 *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand’ (also a sub-level of A5.25 circalittoral fine sand).

For comparison, the JNCC study of the Fulmar MCZ **[Ref. 32]** identified the following three biotopes within Fulmar MCZ:

- ‘A5.376 *Paramphinome jeffreysii, Thyasira* spp. and *Amphiura filiformis* in offshore circalittoral sandy mud’ - Characterised by a range of polychaetes, including *P. jeffreysii*, brittlestars *A. filiformis*, nemertean worms and the holothurian *Labidoplax digitata*, with the bivalve *Thyasira* recorded at some stations. This biotope was reported as widespread across the three sedimentary features/habitat types;
- ‘A5.354 *Virgularia mirabilis* and *Ophiura* spp. with *Pecten maximus* on circalittoral sandy or shelly mud’ - Dominated by sea-pens (most likely to be *Virgularia mirabilis*), brittlestars, which could be *Ophiura*, and hermit crabs. Scallops (potentially *Pecten maximus*) were also recorded in a small number of transects. This biotope was recorded predominantly in areas comprising A5.3 subtidal mud; and
- ‘A5.44 Circalittoral mixed sediments’ – It was not possible to match this to an existing biotope within the UK or EUNIS habitat classification system. This habitat was found to be present in small patches within the wider area of A5.3 subtidal mud.

3.4.3.1 Auk Cuttings Pile

The macrofaunal community across the cuttings pile at Auk has been affected by the discharge and continued presence of oil based drilling muds on the seabed, being largely dominated by primary and secondary colonising taxa in areas of organic enrichment such as *Capitella, Ophryotrocha* and *Cirratulus* **[Ref. 12]**, as reported in published literature **[e.g. Ref. 39]**. The transition zone between this central heavily modified community, and the unaffected background community further out, is considered to extend out to between 200 m and 350 m (extending furthest in the direction of residual current flow). All stations located within the Auk cuttings pile contained anemones, which were found colonising the *Mytilus edulis* shells that had fallen from the platform legs.

The predominant biotope identified across the cuttings pile is broadly similar to biotope ‘*Capitella* sp. and *Thyasira* spp. in organically enriched offshore circalittoral mud and sandy mud’. The polychaete *Paramphinome jeffreysii* was abundant in the majority of the samples and is common throughout most of the North Sea. This species is considered to be a hydrocarbon-tolerant scavenger **[Ref. 40]** and, while often found in uncontaminated areas, may also be found in high numbers in areas of contamination **[Ref. 41]**. The majority of the cuttings pile could be classified as the habitat ‘sandy mud’, and with the modified community present, as the biotope ‘A5.374 *Capitella capitata* and *Thyasira* spp. in organically-enriched offshore circalittoral mud and sandy mud’.

3.4.3.2 Fulmar Cuttings Pile

As at Auk, the macrofaunal community in the cuttings pile at Fulmar was dominated by primary and secondary colonising taxa such as *Capitella*, and *Cirratulus* **[Refs. 13, 39]**. The modification of the community structure was interpreted as an impact of the discharge and continued presence of oil based drilling muds on the seabed. All stations located within the Fulmar cuttings pile contained anemones (probably *Metridium dianthus*), which were found colonising the *Mytilus edulis* shells that had fallen from the platform legs. Crustacean taxa known to live commensally with *M. dianthus* were also observed. Surface-dwelling taxa thought to be sensitive to hydrocarbon pollution such as the brittlestars *Ophiura albida* and *Ophiopholis aculeata* were observed, suggesting that deposition of uncontaminated sediments from the surrounding area may be providing more favourable conditions on the surface of the pile.

As for the Auk cuttings pile, the predominant biotope identified across the cuttings pile at Fulmar was broadly similar to biotope 'A5.374 *Capitella* sp and *Thyasira* spp. in organically enriched offshore circalittoral mud and sandy mud'. The faunal community exhibited reduced numbers of taxa with low species diversity and evenness compared to samples gathered from the wider area. The community structure was very similar to that observed at the Auk cuttings pile **[Ref. 12]** and is typical of cuttings piles contaminated with oil elsewhere in the North Sea **[Ref. 39]**. Reduced species diversity and evenness was observed out to Stations FUL06 and FUL16 (100 m south-west and 100 m east of the cuttings pile centre). The heavily modified cuttings pile community is considered to extend out to between 100 m to 150 m from the cuttings pile centre. The transition zone between this and the unaffected background community is thought to extend out to between 350 m and 500 m from the cuttings pile centre (extending furthest in the direction of residual current flow). Samples collected in 1992 **[Ref. 23]** showed the community was heavily modified out to 500 m from the cuttings pile centre, indicating that recovery of the macrofaunal community is in progress.

3.5 Fish and Shellfish

The Auk, Fulmar and Auk North fields lie within the spawning areas for cod *Gadus morhua*, lemon sole *Microstomus kitt*, plaice *Pleuronectes platessa*, sandeel (various taxa) and whiting *Merlangus merlangus* **[Refs. 42, 43]**. The site also falls into a high intensity nursery area for cod. It is a low intensity nursery ground for anglerfish *Lophius piscatorius*, blue whiting *Micromesistius poutassou*, hake *Merluccius merluccius*, herring *Clupea harengus*, ling *Molva molva*, mackerel *Scomber scombrus*, plaice, sandeel, spotted ray *Raja montagui*, spurdog *Squalus acanthias* and whiting. the area is also identified as nursery ground for haddock *Melanogrammus aeglefinus* **[Ref. 42]**.

Fisheries sensitivity maps **[Ref. 44]** detail the likelihood of aggregations of fish species in the first year of their life (i.e. group 0 larvae or juvenile fish) occurring around the UKCS. The sensitivity maps indicate that the probability of aggregations of juvenile anglerfish, blue whiting, European hake, cod, haddock, herring, mackerel, plaice, and whiting occurring in the offshore decommissioning Project area is low.

3.6 Seabirds

Large numbers of moulting auks (e.g. razorbills, guillemots, puffins) disperse from their coastal colonies and into offshore waters from July onwards and are sensitive to surface pollution as they are flightless at this time. Of these species, puffins are listed as IUCN 'Vulnerable' and razorbills are IUCN 'Near Threatened'; all other species in the area are listed as IUCN 'Least Concern'. The most abundant seabird species found in the Project area are northern fulmar, black-legged kittiwake and common guillemot. Herring gulls, glaucous gull and great black-backed gulls also use the area in winter. Following the 'Seabird Oil Sensitivity Index' (SOSI) developed by Oil and Gas UK, the vulnerability of seabirds to surface oil pollution in the Block 30/16 (Auk field), Block 30/11 (Fulmar field) and the surrounding blocks is considered low for all months of the year **[Ref. 45]**.

3.7 Marine Mammals

3.7.1 Cetaceans

According to the Atlas of Cetacean Distribution in North-West European Waters **[Ref. 46]** the harbour porpoise and the white-beaked dolphin are the most frequently recorded cetaceans in the vicinity of the Auk, Fulmar and Auk North fields with sightings in eight months of the year which is reflective of these being the most abundant and widely distributed cetaceans in the North Sea.

The predicted density of harbour porpoises in the vicinity of the decommissioning Project area from recent Small Cetaceans in European Atlantic waters (SCANS-III) surveys is average compared to the rest of the UK waters, with an estimate of around 0.3 – 0.4 animals per km^2 **[Ref. 47]**.

Minke whales are well distributed in the northern and CNS with higher densities being reported in spring and summer months. The predicted density of minke whale in the vicinity of the decommissioning Project area from recent Small Cetaceans in European Atlantic waters (SCANS-III) surveys is estimated to be <0.01 animals per km^2 **[Ref. 47]**.

3.7.2 Pinnipeds

Approximately 38% of the world's grey seals breed in the UK with 88% of these breeding at colonies in Scotland with the main concentrations in the Outer Hebrides and in Orkney. Grey seal densities vary across the offshore waters of the Project area, ranging between 1 and 5 seals per 25 km^2 which is considered low **[Ref. 48]**.

In the case of harbour seals, approximately 30% of the world's population are found in the UK. Pupping season is between June and July, and the moult occurs in August and September; therefore, from June to September harbour seals are on shore more often than at other times of the year. Harbour seal density varies across the Project area, ranging between 0 and 1 animals per 25 km^2 **[Ref. 48]**.

3.8 Sites of Conservation Importance

3.8.1 Overview of Sites and Features

Sites or potential features of conservation importance located are shown in Figure 3.12. The only designated site in the immediate vicinity of the proposed Decommissioning Project is the Fulmar Marine Conservation Zone (MCZ), in which Auk, Fulmar and Auk North fields are all located. The site has an area of 2,437 km^2, and water depths of 50 – 100 m.

Other sites of conservation importance in the region, including the Swallow Sand MCZ and the East of Gannet and Montrose Nature Conservation Marine Protected Area, are located more than 50 km from the Auk, Fulmar and Auk North fields and are therefore not discussed in detail here. The features for which the Fulmar MCZ was designated are listed in Table 3.5.

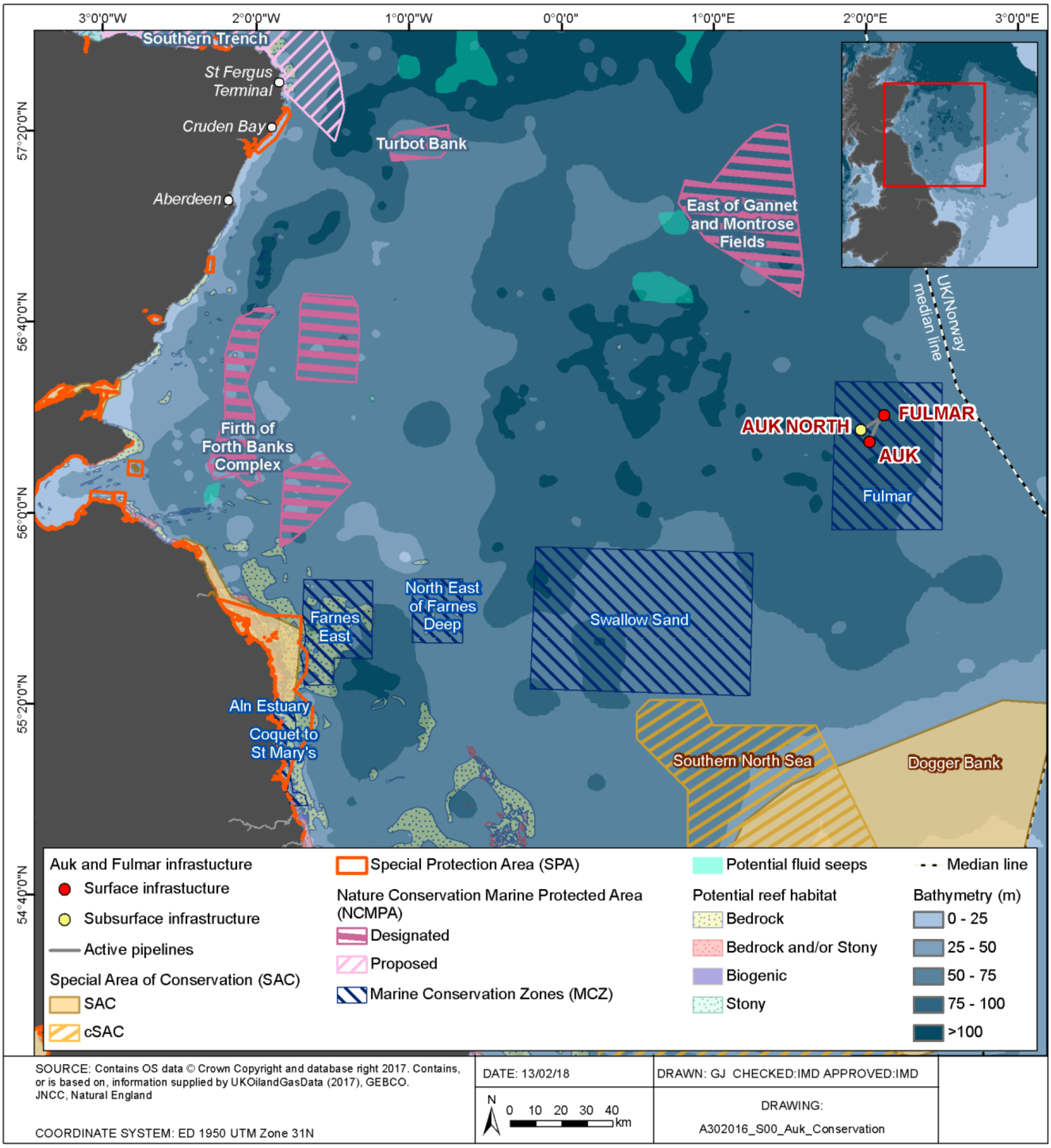
Table 3.5: Qualifying Features of the Fulmar MCZ, in Which the Auk, Fulmar and Auk North fields are Located

Protected feature	Conservation status	Management objective
Fulmar MCZ		
Subtidal sand (EUNIS A5.2)	Annex I list of the EU Habitats Directive	Maintain in favourable condition
Subtidal mud (EUNIS A5.3)	Annex I list of the EU Habitats Directive	
Subtidal mixed sediments (EUNIS A5.4)	Annex I list of the EU Habitats Directive	
Ocean quahog (*Arctica islandica*)	OSPAR list of threatened and/or declining species and habitats	

Quantitative information and a map showing the distribution of these benthic habitats across the MCZ is provided above in Section 3.1.1.1.

In addition to site designations, the location (or potential location, pending further survey/study) of marine habitat or species features of conservation importance in the CNS are also shown in Figure 3.12. Examples include rocky, stony or biogenic reefs, and subsea fluid seeps (submarine features made by leaking gases), that are highlighted in the EU Habitats Directive Similarly, or included in the OSPAR list of threatened/declining species or habitats. However, the closest of these is located 83 km north-west from the decommissioning Project area.

Figure 3.12: Offshore Designated Sites and Potential Features of Marine Conservation Importance in the CNS Region, in Relation to the Auk, Fulmar and Auk North Fields



3.8.2 Fulmar Conservation Zone

As outlined above, this site was selected for designation due to the presence of representative examples of subtidal sand, subtidal mud, and subtidal mixed sediments (the relative distributions of which are illustrated in Figure 3.7).

The site is also designated for the presence of the ocean quahog **[Ref. 49]**. Ocean quahog is a long-lived species (over 500 years) with a very slow growth rate, taking up to 50 years to reach adult size. They are thought to reach sexual maturity between 5-7 years, although this is dependent on locality and growth rates. The spawning period can vary also depending on location. Recent studies have found the population of ocean quahog in the North Sea has declined in abundance, which has been linked to the impacts of human activities on the seabed.

Seabirds, such as gannets, have been shown to forage in the region **[Ref.50]**. According to the JNCC **[Ref.51]**, there is no direct evidence of Fulmar MCZ being especially important for seabirds' due to the depth of the site and distance from the coast. Published evidence does indicate that the area around Fulmar MCZ may perform some supporting function for grey seals **[Refs. 52, 53]**. Individuals that travel to the region from haul out sites on the east coast of Scotland and England are most likely to be using these areas to forage **[Refs. 52, 54]**. Other studies suggest that this region more broadly may be important for marine mammals such as harbour porpoise **[Refs. 55, 56, 57]**, but there is no evidence suggesting the site is especially important for marine mammals.

The conservation objectives of the site are:

- So far as already in favourable condition, remain in such condition; and
- So far as not already in favourable condition, be brought into such condition, and remain in such condition.
    - With respect to a habitat within the MCZ, means that its extent is stable or increasing and its structures and functions, its quality, and the composition of its characteristic biological communities are such as to ensure that it remains in a condition which is healthy and not deteriorating;
    - With respect to the species of marine fauna within the MCZ, means that the quality and quantity of its habitat and the composition of its population in terms of number, age and sex ratio are such as to ensure that the population is maintained in numbers which enable it to thrive.

3.9 Commercial Fisheries

The Auk, Fulmar and Auk North field are located in ICES rectangles 41F2 and 42F2 (Figure 3.13). According to fisheries statistics for the UK provided by Marine Scotland, these areas are targeted primarily for demersal fish. Table 3.6 shows fisheries data from 2014 – 2018 **[Ref. 58]**[19]).

Landings value and tonnage are undisclosed[20] between 2015 and 2018 for rectangle 41F2. Demersal fish accounted for >99% of landings value and tonnage for 2014, the last year for which data are available (Table 3.6).

Landings value and tonnage are also undisclosed for rectangle 42F2 for 2018, although data from 2017 is available. In 2017, demersal fish accounted for approximately 85% of landings value and 92% of tonnage, with shellfish accounting for the bulk of the remaining landings (approximately 15% of value and 6% of tonnage). Pelagic fish accounted for a very low proportion of the catch in all years, with the exception of 2015 where they accounted for approximately 8% of landings value and 31% of tonnage (Table 3.6).

While demersal fish dominate the landings for these two rectangles, the catch is very low in comparison most other ICES rectangles **[Ref. 58]**.

[19] Fisheries statistics for the whole of the UK are available from the Scottish Government. Landings data provide the quantity (live weight) and value of landings of sea fish by UK vessels into the UK and abroad, and landings into the UK by foreign vessels. Effort data covers voyages by UK vessels of over 10 m in length.

[20] The term disclosive (data that cannot be disclosed) refers to situations when the statistics for an area result from fewer than five vessels, bringing the need to preserve the privacy of individuals.

Table 3.6: Live Weight and Value of Fish and Shellfish from ICES Rectangle 41F2 and 42F2 [Ref. 58]

Species type	2018		2017		2016		2015		2014	
	Value (£)	Live weight (tonnes)	Value (£)	Live weight (tonnes)	Value (£)	Live weight (tonnes)	Value (£)	Live weight (tonnes)	Value (£)	Live weight (tonnes)
ICES rectangle 41F2										
Demersal	D	D	D	D	D	D	D	D	177,347	134
Pelagic	D	D	D	D	D	D	D	D	65	0.04
Shellfish	D	D	D	D	D	D	D	D	1,103	0.34
Total	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**178,515**	**135**
ICES rectangle 42F2										
Demersal	D	D	18,785	12	70,339	50	52,335	43	392,919	271
Pelagic	D	D	75	0.05	0	0	5,360	20	735	0.3
Shellfish	D	D	3,249	0.74	12,583	3	7,109	2	7,334	2
Total	**D**	**D**	**22,109**	**13**	**82,923**	**52**	**64,805**	**65**	**400,651**	**273**

D = Disclosive data

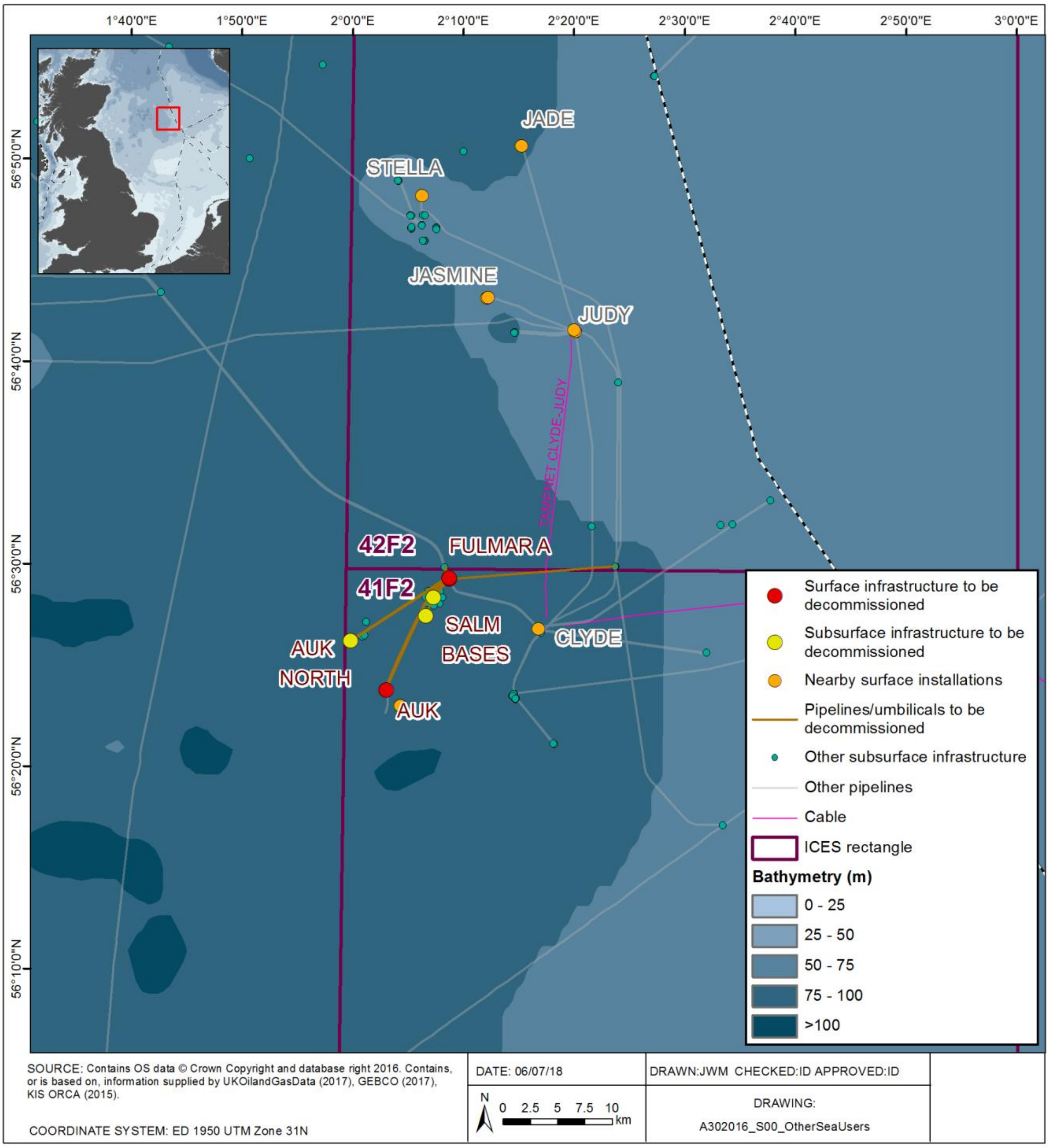
With regard to effort over 2018, in ICES rectangle 41F2 fewer than five vessels undertook fishing activity and the number of days effort was not disclosed, although it is recorded that fishing occurred in June, July, and August only. The same applied in ICES rectangle 42F2, although fishing occurred each month between May and August. Over 2017, fishing occurred in June only in ICES rectangle 41F2 and in January, May, June and August in ICES rectangle 42F2. Effort data were again not disclosed in 2017 for 41F2 and 42F2. Trawls have been the only gear type recorded as used in 41F2 and in 42F2 since 2014.

The foregoing data broadly corresponds with the findings of a baseline fishing activity analysis undertaken for Auk, Fulmar and Auk North **[Ref. 59]**. This indicates that there are demersal fishing vessels operating within 10 NM of the Auk, Fulmar and Auk North infrastructure, with the maximum monthly count of vessels in November 2016 being 45 vessels. In terms of vessel numbers, the annual count was fairly steady throughout 2012 - 2016 with the busiest year being 2014 when 208 fishing vessels were recorded in total. The busiest season was summer. All activity was by demersal vessels including single trawlers, pair trawlers, beam trawlers, twin trawlers and Scottish seiners.

The fishing study **[Ref. 59]** also reported that of all the nationalities observed, fishing was dominated by UK demersal trawlers (41%) and took place in the eastern half of the Auk, Fulmar and Auk North areas, while 14% of vessels were from Norway. The intensity of fishing activity over the majority of the subsea infrastructure was considered to be very low, with moderate fishing levels to the east of the Fulmar field.

Overall, the fishing effort in the vicinity of the Auk, Fulmar and Auk North fields is low compared to other UK offshore areas.

Figure 3.13: Oil and Gas Activities in the Vicinity of Auk, Fulmar and Auk North



3.10 Offshore Oil and Gas Activities, Pipelines and Cables

The proposed decommissioning operations are located in a well-developed area for oil and gas extraction. Several pipelines and two cables are located in the vicinity of the Project area. Oil and gas installations, pipelines and cables in the vicinity of the Project area are described in Table 3.7 and Table 3.8, and shown in Figure 3.13.

Table 3.7: Oil and Gas Activity in the Vicinity of the Project Area

Field	Operator	Block
Judy	Maersk	30/7a
Jasmine	ConocoPhillips	30/7a
Stella	Shell	30/6a
Jade	ConocoPhillips	30/2c
Clyde	Repsol Sinopec Resources UK Limited	30/17b

Table 3.8: Third Party Pipelines and Cables in the Vicinity of the Project Area

Pipeline/ Cable number	Pipeline/Cable name	Location relative to the decommissioned infrastructure
PL19	Ekofisk 2/4J to Teesside oil line	South-east
PL998	Judy Oil Export	East
PLU2410	Affleck Chemical Inject Umbilical	North-east
PL1632	Janice Gas Export Flowline	North-east
PL296	Clyde A to Fulmar A Oil Line	North-east
PL297	Clyde A to Fulmar A Gas Line	North-east
PL1570	Shearwater to Bacton (Seal)	West

3.11 Shipping

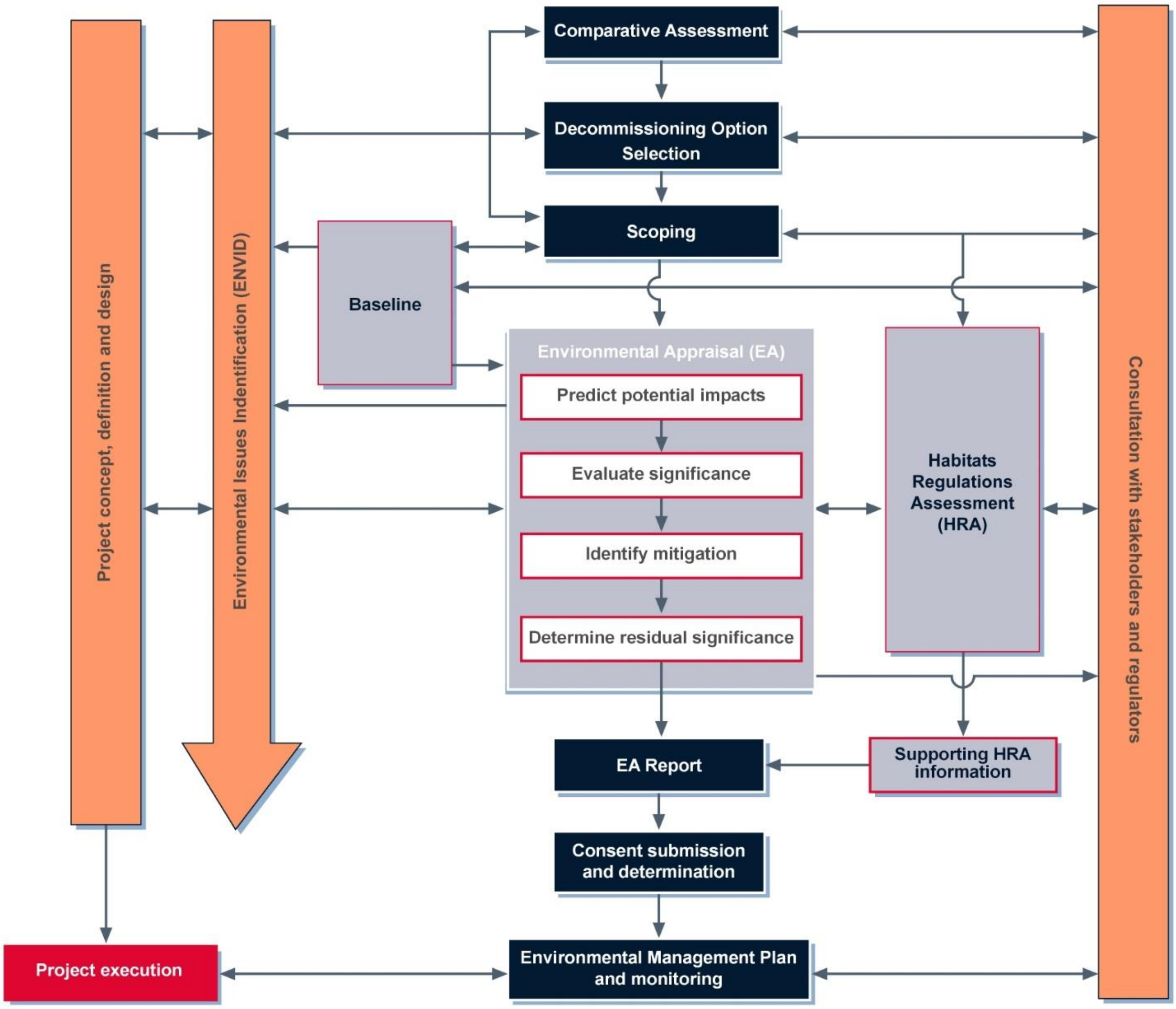
Shipping density in the CNS in the vicinity of the proposed decommissioning activities is low. Average densities range from 0.2 vessels up to approximately five vessels per week **[Ref. 60]**. Ships travelling within and in the vicinity of the decommissioning Project area are mainly cargo and supply vessels **[Ref. 60]**.

4. EA METHODOLOGY

4.1 Identification of Environmental Issues

The OPRED Decommissioning Guidance **[Ref. 3]** states that an EA in support of a DP should be focused on the key issues related to the specific activities proposed; and that the impact assessment write-up should be proportionate to the scale of the project and to the environmental sensitivities of the project area. This does not mean, however, that the impact assessment process should be any less robust than for a statutory EIA or consider any fewer impact mechanisms. A flowchart outline of the EA process followed is shown in Figure 4.1.

Figure 4.1: Overview of EA Process



Early in the EA process, Repsol Sinopec Resources UK Limited undertook a thorough environmental issues identification (ENVID) workshop attended by technical experts including the project engineering and environmental delivery leads. This workshop identified the key environmental sensitivities, discussed all the sources of potential impact and ultimately highlighted those impacts which required further assessment. The decision on which issues required further assessment was based on the specific proposed activities and environmental sensitivities, a review of industry experience of decommissioning impact assessment and on an assessment of wider stakeholder interest (informed in part by the stakeholder engagement described below in Section 4.2). The ENVID workshop was recorded in a matrix format and reported in an ENVID report. The ENVID matrix is shown in full in Appendix A, in addition to which the salient points, providing justification for the inclusion and exclusion of impact mechanisms through subsequent EA, are summarised in Table 4.1.

Table 4.1: Summary of the Issues Identification Workshop, with Justification for the Inclusion and Exclusion of Impact Sources

Impact	Further assessment?	Rationale
Energy use and emissions to air, including vessel use, power generation and material recycling/ replacement	No	Emissions during decommissioning activities, (largely comprising fuel combustion gases) will occur in the context of the cessation of production. As such, emissions from operations and vessels associated with Auk, Fulmar and Auk North will cease. Reviewing historical European Union (EU) Emissions Trading Scheme data and comparison with the CA study suggests that emissions relating to decommissioning will be small relative to those during production. A review of previous decommissioning ESs shows that atmospheric emissions in highly dispersive offshore environments are exclusively concluded to have no significant impact and are usually extremely small in the context of UKCS/global emissions. Vessels, combustion machinery and fuel use conform to UK and international emissions standards, will be optimised/minimised for the decommissioning activities, and established contractors with appropriate capability, licences and maintenance procedures will be selected and audited. Most submissions also note that emissions from short-term decommissioning activities are small compared to those previously arising from the asset over its operational life. Considering the above, atmospheric emissions are not assessed further herein.
Seabed interaction: Disturbance to the seabed, including to cuttings piles	Yes – Section 5.1	Auk, Fulmar and Auk North infrastructure is located within the Fulmar Marine Conservation Zone (MCZ). The qualifying and protected features of this designated site are benthic in nature and at risk of impact from the proposed decommissioning activities. On this basis, further assessment has been undertaken.
Physical presence of vessels in relation to other sea users (including commercial shipping)	No	The presence of vessels for decommissioning activities will be relatively short-term in the context of the life of the Auk, Fulmar and Auk North fields. Activity will occur using similar vessels to those currently deployed for oil and gas across the CNS. Vessels will also generally be in use around existing infrastructure and will not occupy ‘new’ areas. Other sea users will be notified in advance of activities occurring, meaning those stakeholders will have time to make any necessary alternative arrangements for the limited period of operations. A review of previous decommissioning ESs shows that some projects indicate a greater potential issue with short-term vessel presence, but those largely relate to project-specific sensitive locations, which is not the case for this decommissioning project. Considering the above, temporary presence of vessels is not assessed further herein.
Physical presence of infrastructure decommissioned *in-situ* and dropped objects in relation to other sea users, both in terms of possible exclusion and risk of snagging	Yes – Section 5.2	The preferred option from the CAs is to decommission certain pipelines/umbilicals and the Fulmar A jacket footings *in-situ*. These may have an exclusion effect and pose a risk of snagging. Although protection/support materials (mattresses and grout bags) are to be removed, there may be circumstances where removal of certain items is not feasible. Subsea structures, towhead, umbilicals and spool/jumpers will be recovered in full so are not considered further here. If objects are dropped during decommissioning, their location will be recorded. Significant objects will be recovered where practicable. Debris clearance surveys will ensure no dropped object that could pose a risk remains on the seabed. As such, dropped objects are not considered further. The general preferred approach from a Regulatory perspective is for full removal of infrastructure, where possible (taking into account safety, environmental, technical feasibility, societal and economic factors). Additionally, decommissioning infrastructure *in-situ* has been raised as a key stakeholder concern in many previous decommissioning projects. On this basis, further assessment has been undertaken.

Impact	Further assessment?	Rationale
Physical presence of cuttings piles left *in-situ* in relation to other sea users.	Yes – Section 5.2	Interactions between fishing gear and the cuttings pile at Fulmar A will be prevented by the jacket footings decommissioned *in-situ*. The consequence of interactions with the cuttings pile at the Auk location is expected to be low due to small size of this pile. However, there is the potential for regulatory and local public awareness and concerns about the pile interactions. On this basis, further assessment has been undertaken.
Discharges to sea (short-term): Release of hydrocarbons, chemicals, metals etc. as cuttings disturbed during dredging etc.	Yes – Section 5.1.3.4	While dredging or jetting cuttings is likely to raise sediment and associated contaminants into the water column, modelling such interactions shows that water column impacts are short-term and localised near the seabed. Also, much of the disturbed material will quickly return to the seabed. Cuttings pile disturbance, particularly if extensive, is likely to be a stakeholder concern. On this basis, further assessment has been undertaken.
Discharges to sea (short-term): Routine vessel discharges (e.g. grey water, black water, ballast) Minor chemical, hydrocarbon and NORM discharges during decommissioning (e.g. disconnections)	No	Discharges from vessel systems are typically well-controlled activities that conform to UK and international standards. Discharges from infrastructure occurring during decommissioning activities will be limited to small volumes of relatively 'clean' fluids, or those that will be assessed in more detail as part of the environmental permitting process (e.g. through Master Application Templates/Subsidiary Application Templates). Whilst these routine discharges are not generally considered to be a major oil and gas issue, a review of previous decommissioning ESs shows that these discharges are often included in assessment. However, the level of detail varies and is often limited; the permitting system is considered a more appropriate location for any specific risk assessment of such discharges. Considering the above, discharges to sea during decommissioning activities are not assessed further herein.
Discharges to sea (long-term): Release of hydrocarbons, chemicals, metals, NORM, plastic etc. as material (including structures) decommissioned *in-situ* degrades	Yes – Section 5.1.3.3	Degradation of materials left *in-situ* is also an area of increased stakeholder interest, especially for materials such as plastics, and assessment of this is a requirement of the decommissioning guidance. Since most structures or materials decommissioned *in-situ* are on or buried in the seabed, this has been assessed as a seabed impact. On this basis, further assessment has been undertaken.
Discharges to sea (long-term): Release of hydrocarbons, chemicals, metals and NORM as cuttings piles degrade	No	The drill cuttings are expected to leach contents, but the drill cuttings assessment has shown this to be below the OSPAR 2006/5 threshold (Section 2.3.3). Considering the above, discharges to sea during decommissioning activities are not assessed further in this report.
Underwater noise emissions from vessels and cutting or dredging and rock placement operations	No	No use of explosives, piling or seismic sources will be used, so no high-energy impulsive noises (which would be the most likely to cause injury to biota). The project will not be using any new activities that have not previously been assessed as 'acceptable' through previous permit applications in the area. This project is not located within an area protected for marine mammals. With mitigation measures, EIAs for offshore oil and gas decommissioning typically show no injury, or significant disturbance. For projects outside of protected marine mammal habitats, this issue could be scoped out. On this basis, underwater noise assessment for decommissioning activities is not assessed further herein.
Resource use Use of landfill space	No	Generally, resource use from the proposed activities will require limited raw materials and be largely restricted to fuel use. Such use of resources is not typically an issue of concern in offshore oil and gas. Material will be returned to shore as a result of project activities, and most that is returned is expected to be recycled. There may be instances where infrastructure returned to shore is contaminated and cannot be recycled, but the weight/volume of such material is not expected to result in substantial landfill use. Considering the above, resource use and landfill take is not assessed further herein.

Impact	Further assessment?	Rationale
Offshore light on living receptors, particularly seabirds	No	There will be vessels present on site for a short duration, in an area of low vessel activity. Therefore, it is considered this will have a negligible environmental effect. Additionally, existing lighting from the operational platform will be removed. Considering the above, lighting is not assessed further in this report.
Onshore dismantling yard activities including airborne noise, odour, light, dust and aesthetics	No	All onshore yards at which decommissioned material will be handled already deal with potential environmental and social issues as part of their existing site management plans. There is anticipated to be no change in potential for impact as a result of any of the material proposed for recovery. Multiple disposal facilities are likely. Whilst the yards are yet to be selected, they will be in the UK or Europe. Repsol Sinopec Resources UK Limited procedures require suitably approved facilities, including site visits, review of permits and consideration of how new facility and construction and design has been developed to minimise impact. Considering the above, onshore interactions are not assessed further herein.
Waste, including non-hazardous, hazardous, radioactive and marine growth	No	Reference to Table 1 of the Decommissioning Guidance **[Ref.**3**]**, confirms there is no expectation for the EA to include an assessment of wastes or waste management returned to shore for treatment or disposal. Considering the above, waste is not assessed further in this report.
Employment	No	The variable potential for impact from project activities was not identified as a differentiator in the CA. Whilst it is recognised that there could be a negative effect resulting from cessation of production, there will be a countering benefit in the additional work required to effect the decommissioning activities. It is expected that the main mechanisms for socio-economic impact will be through potential interaction with fisheries (assessed in Section 5.2). Considering the above, changes in employment (positive or negative) are not assessed further herein.
Unplanned events - chemical/hydrocarbon release	No	Well plugging and abandonment is outside of the scope of this specific impact assessment, since it is not dependent on approval of the DPs. The possibility of a well blowout therefore does not require consideration in this assessment (it is assessed as part of separate well intervention and marine licence applications). Pipelines and umbilicals will have been flushed and cleaned prior to the decommissioning activities described herein being carried out. Release of a live hydrocarbon and chemical inventory is therefore also out of scope of this assessment. The heavy lift vessel potentially to be used for removing the Fulmar and Auk jackets in a single lift will have the largest fuel inventory of any vessel involved in the decommissioning activities. The SLV *Pioneering Spirit* has a fuel inventory amounting to 18,846 m^3 in total, predominantly of heavy fuel oil. This is much less than the worst-case crude oil spill from loss of well containment modelled and assessed in the Fulmar field oil pollution emergency plan (OPEP), and approximately equivalent to the volume modelled and assessed for a similar incident type in the Auk field OPEP. In addition, the vessel's fuel inventory is split between 11 separate fuel tanks, significantly reducing the likelihood of an instantaneous release of a full inventory. Overall, therefore, the potential impact from fuel inventory release will be at worst equivalent to that already assessed and mitigated for the operational phase of these fields. If field infrastructure undergoing transport to shore were dropped on to live infrastructure (such as wellheads or pipelines) associated with other oil and gas facilities, this could potentially result in an unplanned release of hydrocarbons. However, dropped object procedures are industry-standard and there is only a very remote probability of any interaction with any live infrastructure. As noted above, Auk, Fulmar and Auk North flowlines will be flushed and cleaned, and wells abandoned prior to the removal of any subsea infrastructure, therefore there is no possibility of dropped objects resulting in a hydrocarbon release from the Auk, Fulmar or Auk North fields. Considering the above, the potential impacts from accidental chemical/hydrocarbon releases during decommissioning activities are not assessed further herein.

4.2 Stakeholder Engagement

A scoping letter was prepared and issued to the following stakeholders in December 2017 **[Ref. 102]**.

- OPRED;
- JNCC;
- SNH; and
- Northern Lighthouse Board.

The issues raised in response to the scoping letter are summarised in Table 4.2.

Table 4.2: Stakeholder Issues and Concerns Raised in Response to Scoping Letter

Issues/concerns	Outline response and EA section where addressed
OPRED	
Repsol Sinopec Resources UK Limited should note that Habitats Regulations Assessment (HRA) is only required if the decommissioning proposals are considered to have a significant effect on a Special Area of conservation (SAC) or a Special Protected Area (SPA). Any relevant SACs or SPAs which could be impacted by the proposed activities must be provided in the environmental baseline description. Details of other protected habitats and species which may be affected, such as the Fulmar MCZ, should also be included but these would not require a HRA. Further guidance on this is included at the following link https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/82706/habitats-simplify-guide-draft-20121211.pdf	Noted. Auk, Fulmar and Auk North are 50 km or more from the nearest SAC or SPA. However, they are located within the Fulmar MCZ. Details of the latter are provided in Sections 3.2, 3.4.2 and 3.4.3 (physical and biological nature of the benthic environment); and in Section 3.8 (protected sites).
Note 2 for Table 1 states 'It is understood from the OSPAR 98/3 that concrete anchor bases/piles that do not, and are likely to, interfere with other legitimate users of the sea (i.e. buried to >0.6 m beneath the surface) are excluded from the definition of a 'disused offshore installation'. Please note this definition applies to the concrete anchor bases but not to piles. As per Section 7.9 of the draft guidance notes for the Decommissioning of Offshore Oil and Gas Installations and Pipelines issued in December 2017, 'any piles should be severed below the natural seabed level at such a depth to ensure that any remains are unlikely to become uncovered. Operators should aim to achieve a cut depth of 3 m below the natural seabed level; however, consideration will be given to the prevailing seabed conditions and currents and this should be detailed in the decommissioning programme and discussed with the relevant decommissioning team.' In addition, a burial depth of 0.6 m is not applicable in either case and applies only to pipelines, mattresses and related items.	Noted. This applies to the SALM bases and associated STL anchor piles. As noted in Section 2.3.4, piles will be cut to 3 m below seabed level as far as practicable dependent on prevailing seabed conditions.
Repsol Sinopec Resources UK Limited should satisfy themselves that the current environmental survey data and any proposed future surveys cover the full area of where the decommissioning activities are to occur, and consideration should be given to any gaps and how these will be filled.	Noted. An account of the surveys commissioned for Auk, Fulmar and Auk North decommissioning is provided in Section 3.1.
Consideration should be given to the proposed operation(s) in the context of any relevant Marine Plan. This should include recognition of the operation(s) as being located within the Marine Plan area, identification of the relevant policies in the Plan and a brief consideration as to how the operation(s) complies with those requirements	Noted. The Marine Plan area, policies and how this decommissioning project complies is given in Sections 1.3 and 6.
JNCC	
The scoping document states that the last environmental survey in the Auk, Fulmar and North Auk area was carried out in the summer of 2017. We ask that a copy of the report be provided to the JNCC for review when available.	Copies of all environmental reports from the surveys carried out for Auk, Fulmar and Auk North Decommissioning will be provided to JNCC.
The scoping document also highlights the presences of Horse Mussels, Ocean Quahog and Sea-pens in the Auk, Fulmar and North Auk area. We would like to establish if these conservation important species have been found in close proximity to the intended operations, and if so: • Where are they located; • At what distance are they located from the intended operation(s); • What form do they take i.e. have aggregations or reefs been recorded;	The incidence of these and other features of conservation interest noted from survey reports has been noted in Section 3.4, with accounts of their numbers/aggregations and whether they qualify as reefs or other features.

Issues/concerns	Outline response and EA section where addressed
• And what impacts, if any, are there expected to be on these features.	The potential impacts on these and other features are assessed in Section 5.
The scoping document states that a number of cutting operations will be carried out during the decommissioning works, in particular relating to the jacket and piles. We would ask Repsol to state if the use of explosives would be necessary during such operations, or considered as an alternative if initial cutting methods aren't possible.	As stated in Section 2.4, the use of explosives is not planned in relation to cutting activities.
The scoping document highlights the introduction of hard substrate into a mainly sedimentary environment. Although the changes are not necessarily considered as having a significant impact in this instance, we still encourage the operator to continue working to minimise the amount of hard substrate material used. We note that the long-term effect of the introduction of substratum into naturally sandy or muddy seabeds is not fully understood at present and should be carefully considered by the regulators.	Noted. The introduction of rock cover is being limited to pipeline cut end burial and protection. This remains a subject for detailed design but, for assessment purposes the worst case is that rock placement could occur at each end of the nine pipelines being decommissioned *in-situ* (i.e. 18 locations).
We welcome detailed commentary on stabilisation operations to allow further understanding of their actual nature conservation impact. This would include: • Location of dump sites • Size/grade of rock to be used • Tonnage/volume to be used • Contingency tonnage / volume to be used • Method of delivery to the seabed • Footprint of rock • Assessment of the impact • Expected fate of deposit after end of production, i.e. will it be left *in-situ* or recovered Where stabilisation material cannot be avoided, we recommend using a more targeted placement method e.g. fallpipe vessels rather than using vessel-side discharge methods, in such areas where protected species/ habitats have been recorded.	Noted. Information on the locations for rock introduction, the tonnage and the footprint is provided in Section 5.1.2.5. The use of a fallpipe system of rock delivery to the seabed is noted in Section 5.1.6.
Whilst JNCC appreciates that not all of the detailed project design is finalised at this time, JNCC notes that best practice would not be to submit applications where stabilisation / protection material requirements are incrementally increased. The worst-case scenario should be assessed in the application to enable a meaningful assessment of the whole environmental impact of the project to be undertaken. It is understood that activities evolve over time, and that subsequent stages are often contingent on the outcome of the earlier activities. However, every effort should be made to predict the likely outcome and carry out an assessment on that basis so that all the elements have been assessed and presented accordingly.	Noted. Worst-case requirements have been assessed.
There is a requirement for assessing the cumulative effects of a project under the EIA Directive. JNCC suggests that the proposed decommissioning operations are assessed alongside approved developments under construction, approved developments that have not yet commenced construction, developments submitted for approval but not yet approved, as well as any other significant appropriate development for which some realistic figures are available.	Cumulative impacts have been assessed against other infrastructure (e.g. platforms. pipelines) in the region.
We would request that potential impacts on the MCZ's protected features, associated with decommissioning work should be considered, or what extent of each protected feature could be affected. To help make this clear, a detailed map of the protected features in relation to proposed operations/ operator infrastructure should be provided in subsequent applications. We suggest Repsol consults the following webpage for further information on Fulmar MCZ http://jncc.defra.gov.uk/page-6774. This will provide Repsol with the most up-to date site information and will allow them to ensure that their applications contain correct evidence.	The link provided has been used, including the Fulmar MCZ site map, evidence base and supporting information.
JNCC considers that recovery should be considered in relation to the habitats present in the site. For the protected features of the Fulmar MCZ the following should be considered: • *Arctica islandica* has low resilience to high rates of siltation rate changes meaning it could take 10-25 years to recover. The scores are dependent on the amount of siltation occurring, thus habitats will recover more quickly from low rates of siltation (around 5cm) compared with high (around 30cm). • Subtidal mud is not sensitive to siltation at low rates but has medium sensitivity at high rates (suggesting recovery rates of around 2-10 years). • Subtidal mixed sediments have high resilience to low rates of siltation but medium resilience to high rates of siltation (2-10 years of recovery).	Estimates of recovery rates following impact have been provided where appropriate in Section 5.

Issues/concerns	Outline response and EA section where addressed
• • Subtidal sand has medium resilience at low rates of siltation and low resilience at high rates of siltation (10-25 years to recover).	
We would like to highlight that the JNCC is currently reviewing its conservation advice for the United Kingdom's Marine Protected Areas (MPA).	Noted.
We would ask if Repsol could provide the results from the drill cutting analysis taken during the summer of 2017.	Copies of all environmental reports from all surveys carried out for Auk, Fulmar and Auk North Decommissioning will be provided to JNCC.
Northern Lighthouse Board	
We would advise that the Northern Lighthouse Board would only comment on any navigational impact that the decommissioning operations may have and will recommend the appropriate marking and lighting to reduce the risk to surface marine traffic by the structures in their various transitional states, along with any vessels, barges and/or heavy lift cranes involved with the operations.	Noted. Impacts associated with marine traffic during the execution stage for decommissioning have been considered but were scoped out of the Environmental Assessment for the Auk, Fulmar and Auk North decommissioning project.
We would expect that the decommissioning process will allow the platforms and their supporting substructures (jackets) to be completely removed, or as much as is practicably possible to be removed from each location once the comparative assessment has been carried out and all stakeholder responses have been considered.	Noted. Information on the CA process, the chosen options and which structures are being removed or left in place is provided in Section 2.

4.3 Impact Assessment Methodology for Planned Activities

4.3.1 Overview

The potential impact for the planned activities has been assessed in accordance with Repsol Sinopec Resources UK Limited's Environmental Assessment Methodology. As part of this methodology, it is necessary to determine the significance of the environmental/social impact of planned activities on each of the susceptible receptors. This is achieved as follows:

The Sensitivity of the Receptor x The Magnitude of the Effect on the receptor = The Significance of the Impact

The significance of the impact can then be categorised as Low, Medium, High or Very high. In the event that an impact is considered to be significant (i.e. Medium or above) in the initial assessment, it is necessary to identify further, project-specific, mitigations which aim to prevent or reduce the Magnitude of Effect and to conduct a second assessment to determine the significance of the residual impact. All residual impacts will be reduced to ALARP.

4.3.2 Receptor Sensitivity

Assessment of the 'Sensitivity of Receptor' draws upon the Environmental Baseline (Section 3 of this report) condition and in alignment with best practice **[Refs. 61, 62, 63]** considers a number of factors including, but not limited to:

- The relative importance of the local population size;
- The conservation status of the habitat or species e.g. does it sit within an IUCN (International Union for Conservation of Nature) threat category, is it listed in the OSPAR list of threatened and/or declining species or is it a Habitats Directive Annex II species;
- Whether the habitat is a designated conservation site e.g. a Habitats Directive Annex I Special Area of Conversation (SAC);
- The seasonal migrations and abundance of species and populations e.g. whether or not the species or population is likely to be in the area at the time of the proposed activity; and
- Awareness of vulnerable periods of a species' lifecycle.

High level guidelines were developed to inform the assessment of receptor sensitivity (Table 4.3). These guide descriptions are purposefully kept at a high level to afford a degree of flexibility and judgement during the assessment. Detail on the rationale behind the allocation of a category e.g. 'Low' is provided in the narrative in the impact assessment chapters and, again, a precautionary approach must be taken. For example, each descriptor may not be applicable to each receptor and/or some receptors may be classified within two different categories. In practise, where a receptor has an IUCN status of 'Least Concern' ('Low') but is listed as an Annex II species ('High'), the worst-case category ('High') is applied.

Four categories of Receptor Sensitivity are applied ranging from 'Low' to 'Very High' as shown in Table 4.3.

While the sensitivity of most receptors is based on local conditions, it is acknowledged that emissions have a global impact on climate change. Consequently, the sensitivity of the atmosphere, or global climate, as a receptor is not included within the sensitivity guidelines in Table 4.3, as it is considered to be 'Very High' in line with the 2014 Climate Change Report produced by the Intergovernmental Panel on Climate Change **[Ref. 64]**.

Table 4.3: Receptor Sensitivity

Nature	Definition
Low (1)	**Flora/Fauna/Habitats within the zone of influence:** • Population sizes are considered to be of little to no geographical importance. • Species do not have designated conservation status and/or are of IUCN 'Least Concern'. • No designated habitat/sites. • Impacted species are widespread in the North East Atlantic region. **Air quality:** Emissions may impact on other nearby installations. **Water quality:** Open offshore water body. **Cultural heritage sites:** Site has no heritage importance. **Resource availability:** (e.g. landfill sites, diesel use) Resource is renewable and/or abundant. **Third party users:** have capacity to absorb change without impact.
Medium (2)	**Flora/Fauna/Habitats within the zone of influence:** • Significant numbers of at least one receptor of national importance (e.g. Priority Marine Features (PMFs)). • Significant numbers of a species which is listed as IUCN 'Near Threatened'. • Nationally designated habitat/sites (e.g. PMFs). • Species may be of regional value. **Air quality:** Sparsely populated areas nearby. **Water quality:** Semi-enclosed water body with good flushing. **Cultural heritage sites:** Site is of local heritage importance. **Resource availability:** (e.g. landfill sites, diesel use) Resource is renewable and/or available. **Third party users:** have capacity to absorb change without significant impact.
High (3)	**Flora/Fauna/Habitats within the zone of influence:** • Significant numbers of at least one receptor of regional (European) importance (e.g. Habitats/Bird Directive Annex I, II or IV species and OSPAR designations). • Significant numbers of a species which are listed as IUCN 'Vulnerable'. • Regionally designated habitats/sites (e.g. OSPAR designations and Annex I habitats: SACs and Special Protection Areas (SPAs)). • Locally distinct sub-populations of some species may occur. **Air quality:** Densely populated areas nearby. **Water quality:** Semi-enclosed water body with limited flushing. **Cultural heritage sites:** Site is of regional heritage importance. **Resource availability:** (e.g. landfill sites, diesel use) Resource is not renewable and/or has limited availability. **Third party users:** have low capacity to absorb change and significant impact is likely to occur.
Very High (4)	**Flora/Fauna/Habitat within the zone of influence:** • Significant numbers of at least one receptor of international importance. • Significant numbers of a species which are listed as IUCN 'Endangered' or 'Critically Endangered'. • Internationally designated habitats/sites (e.g. Ramsar sites). • At least one receptor is endemic (unique) to the area. **Air quality:** Very densely populated area with sensitive receptors such as schools and hospitals.

Nature	Definition
	Water quality: Enclosed water body with no flushing. **Cultural heritage sites:** Site is of international heritage importance. **Resource availability:** (e.g. landfill sites, diesel use) Resource is not renewable and/or has scarce availability. **Third party users:** have no capacity to absorb change e.g. unemployment due to long term closure of fisheries.

4.3.3 Magnitude of Effect

High level guidelines for assessing the Magnitude of Effect on the receptors are presented in Table 4.4. Prior to determining the Magnitude of Effect during the initial assessment, it is assumed that all legal compliance requirements have been met and that industry-standard/best-practice has been applied.

Table 4.4: Magnitude of Effect

Magnitude Level	Description	
	Environmental Impact	**Social Impact**
Positive/No Effect (0) *Regulatory compliance or Company goals are not a concern.*	**No environmental concerns** • Positive environmental impact *e.g. retaining a 500 m zone resulting in a 'protected area'.* • No significantly negative environmental effects.	**No public concerns** • Possible enhancement in the availability of a resource benefitting the persons utilising the area *e.g. removal of 500 m zones results in return of access to fishing grounds.* • No impacts on sites or features of cultural heritage. • No impact on resource or landfill availability.
Negligible (1) *Regulatory compliance or Company goals are not breached.*	**Negligible environmental effects** • Negligible environmental effect, change not detectable above background variability, rapidly and fully reversible once activity ceases; highly localised effects. No habitat / population effects. • Negligible contribution to global emissions (e.g. when compared to annual UKCS emissions or annual emissions during production operations).	**Limited local public awareness and no concerns** • An intermittent short-term decrease in the availability of a resource which is unlikely to be noticed *e.g. project vessels working out-with the existing 500 m exclusion zones could temporarily impact on a shipping route or fishing area.* • Undiscernible changes to a site or feature of cultural heritage that do not affect key characteristics and are not above background changes. • Undiscernible use of a resource (e.g. diesel, rock cover or landfill).
Minor (2) *Regulatory compliance is not breached.*	**Minor, localised, short term, reversible effect** • Any change to the receptor is considered low and at same scale as existing variability. • Recover naturally with no Company intervention required. • Low contribution to global emissions (e.g. when compared to annual UKCS emissions or annual emissions during production operations)	**Some local public awareness and concern** • A temporary (<1 year) decrease in the availability or quality of a resource *e.g. access to fishing grounds may temporarily be inhibited due to presence of project vessels.* • Minor changes to a site or feature of cultural heritage that do not affect key characteristics. • Minor use of a resource (e.g. diesel, rock cover or landfill).
Serious (3) *Possible minor breach of regulatory compliance.*	**Detectable environmental effect within the project area** • Medium localised changes to the receptor are possible. • Localised Company response may be required. • Moderate contribution to global emissions (e.g. when compared to annual UKCS emissions or annual emissions during production operations)	**Regional/local concerns at the community or stakeholder level which could lead to complaints** • Medium decrease in the short-term (1-2 years) availability or quality of a resource affecting usage *e.g. bring a rig on site for 1-2 years*. • Nuisance impacts *e.g. marine growth odour coming from yards*. • Partial loss of a site or feature of cultural heritage. • Moderate use of a resource (e.g. diesel, rock cover or landfill).
Major Effect (4) *Possible major breach of regulatory compliance.*	**Severe environmental damage extending beyond the project area** • High, widespread mid-term (2-5 years) degradation of the receptor which is eventually reversible. • Company response (with Corporate support) required to restore the environment. • Large contribution to global emissions (e.g. when compared to annual UKCS emissions or annual emissions during production operations)	**National stakeholder concerns leading to campaigns affecting the Company's reputation** • High mid-term (2-5 year) decrease in the availability or quality of a resource affecting usage *e.g. closure of fishing grounds.* • Substantial loss or damage to a site or feature of cultural heritage. • High use of a resource (e.g. diesel, rock cover or landfill).
Critical Effect (5) *Major breach of regulatory compliance resulting in project delays and prosecution.*	**Persistent severe environmental damage** • Very high, widespread long-term (>5 years) degradation to the receptor that cannot be readily rectified and is not reversible. • Major impact on the conservation objectives of internationally/nationally protected sites. • Full Corporate response required. • Extensive contribution to global emissions (e.g. when compared to annual UKCS emissions or annual emissions during production operations)	**International public concern and media interest affecting the Company's reputation** • Very high decrease in availability of a resource and potentially livelihood of users for >5 *years e.g. hydrocarbons on beaches affecting tourism or tainting of fish resulting in the long-term closure of fishing grounds.* • Total loss of a site or feature of cultural heritage. • Significant use of a resource (e.g. diesel, rock cover or landfill).

4.3.4 Impact Significance

The 'Sensitivity of Receptor' and the 'Magnitude of Effect' are combined using the matrix presented in Table 4.5 to determine the significance of the impact of planned activities.

Table 4.5: Matrix for Determining the Overall Significance of the Impact of Planned Activities

Impact Significance		Receptor Sensitivity			
		Low (1)	Medium (2)	High (3)	Very High (4)
Magnitude of Effect	Critical (5)	High	High	High	High
	Major (4)	Moderate	Moderate	High	High
	Serious (3)	Moderate	Moderate	Moderate	High
	Minor (2)	Low	Low	Moderate	Moderate
	Negligible (1)	Low	Low	Low	Low
	Positive/No Effect (0)	Positive	Positive	Positive	Positive

Impact Significance	Description
Positive/No Effect	• Positive or no environmental or social impact. • No public interest or positive public support.
Low	• No/negligible environmental and social impact. • No concerns from consultees.
Moderate	• Discernible environmental and social impacts. • Requirement to identify project-specific mitigation measures. • Concerns by consultees which can be adequately addressed by the Company.
High	• Substantial environmental and social impacts. • Serious concerns by consultees requiring Corporate support. • Alternative approaches should be identified.

4.4 Impact Assessment Methodology For Unplanned Events

4.4.1 Overview

To determine the environmental and social risk associated with an unplanned event, the following approach considers firstly the significance of the environmental impact of an unplanned event should it occur, and secondly the likelihood of the event occurring as follows.

(---------------------Impact significance-------------------)

The Sensitivity of the Receptor	x	Magnitude of the Effect on the receptor	x	The Likelihood of Occurrence of the unplanned or accidental event	=	The significance of the risk

As with the impact assessment process, should a risk be considered significant (i.e. Moderate or above) in the initial assessment, it is necessary to identify project-specific mitigations designed to prevent or reduce the Magnitude of Effect, or to reduce the Likelihood of Occurrence and to conduct a second assessment to determine the significance of the residual risk. All residual risks will be reduced to As Low As Reasonably Practical (ALARP).

4.4.2 Significance of the Impact Associated with an Unplanned Event

The significance of the impact that may result from an unplanned or accidental event is determined using the methodology described above for planned events.

4.4.3 Likelihood of an Unplanned Event

Once the significance of the impact that may result from an unplanned event has been determined, it is necessary to assess the likelihood of the unplanned event occurring in order to determine the risk. Five categories of 'Likelihood of Occurrence' have been identified as presented in Table 4.6.

Table 4.6: Likelihood of an unplanned event

Likelihood category	Definition
Extremely Remote (1)	Has never occurred within industry or similar industry but theoretically possible.
Remote (2)	Similar event has occurred elsewhere but unlikely to occur with current practices.
Unlikely (3)	Event has occurred in the industry during similar activities.
Possible (4)	Event could occur during project activities.
Likely (5)	Event is likely to occur more than once during the project.

4.4.4 Risk Significance

The significance of the environmental / social risk can be determined using the matrix presented in Table 4.7. Note the potential for a beneficial impact significance has been removed as it is not expected that an unplanned event could lead to any beneficial environmental impact.

Table 4.7: Matrix for Determining the Overall Significance of the Impact of Planned Activities

Risk significance		Impact Significance[1]		
		Low	**Moderate**	**High**
Likelihood of event	**Likely**	Low	High	High
	Possible	Low	Moderate	High
	Unlikely	Low	Moderate	Moderate
	Remote	Low	Low	Moderate
	Extremely Remote	Low	Low	Low

[1]Determined using methodology for planned events

Risk Significance	Description
Low	• Negligible environmental and social risks. • Mitigation measures are industry standard and no project specific mitigation required. • No consultee concerns.
Moderate	• Discernible environmental and social risks. • Consultee concerns can be adequately resolved. • Local public interest.
High	• Significant environmental and social risks. • Serious consultee concerns. • Media interest and reputational impacts.

4.5 Mitigation

Where potentially significant impacts (i.e. those ranked as being of moderate impact level or higher in Table 4.5 or Table 4.7) are identified, mitigation measures must be considered. The intention is that such measures should remove, reduce or manage the impacts to a point where the resulting residual significance is at an acceptable or insignificant level. Mitigation is also proposed in some instances to ensure impacts that are predicted to be not significant remain so.

4.6 Residual Impacts

Residual impacts are those that remain once all options for removing, reducing or managing potentially significant impacts (i.e. all mitigation) have been taken into account.

4.7 Cumulative Impact Assessment

Although the scope of this impact assessment is restricted to the decommissioning of the Auk, Fulmar and Auk North facilities as outlined in Section 2, it is recognised that the decommissioning workscope will also occur in the context of other oil and gas and non-oil and gas activities, with which there is the potential to interact. To this end, the impact assessments presented in the following sections specifically consider the potential for cumulative impact within the definition of significance.

4.8 Transboundary Impact Assessment

For most potential impacts from decommissioning, the likelihood of transboundary impact is low. However, where impacts on mobile receptors are of concern, the likelihood of a transboundary impact is higher. The impact assessments presented in the following sections have identified the potential for transboundary impacts and the potential for transboundary impact is considered within the definition of significance.

4.9 Habitats Regulations Assessment and Marine Conservation Zone (MCZ) Assessment

Under Article 6.3 of the Habitats Directive, it is the responsibility of the Competent Authority (OPRED) to undertake Appropriate Assessment, if necessary, of the potential impacts of a plan, programme or project, alone or in combination, on a Natura site (SAC or Special Protection Area; SPA) in view of the site's conservation objectives and the overall integrity of that site. In a similar process of assessing impact on protected sites, there is also a requirement under the Marine and Coastal Access Act for the Competent Authority to consider the potential for the proposed activities to impact upon MCZs. As with SACs and SPAs, OPRED is the Competent Authority for MCZs with respect to oil and gas development. Where relevant, the impact assessments presented provide information on the potential for the proposed activities to affect the protected features of SPA, SAC and MCZs, or to affect ecological or geomorphological processes on which the SPAs, SACs and MCZs are dependent.

5. IMPACT ASSESSMENT

5.1 Seabed

5.1.1 Introduction

This section discusses the potential environmental impacts associated with seabed disturbance resulting from the proposed decommissioning activities. The measures planned by Repsol Sinopec Resources UK Limited to minimise these impacts are detailed in Section 5.1.6.

The decommissioning activities have been assessed as having the potential to impact the seabed in the following main ways:

- Direct impact through:
    - Removal of subsea infrastructure;
    - Presence of subsea infrastructure left *in-situ*;
    - Excavation and cutting of pipeline/umbilical/cable ends;
    - Disturbance of drill cuttings
    - Rock placement for exposed pipeline/umbilical;
    - Rock-placement for pipeline/umbilical termination points and exposure/free span remediation; and
    - Overtrawl surveys by chain mats.
- Indirect impacts through:
    - The re-settling of sediment raised in sediment plumes; and
    - The opening of the area to fishing activity.

5.1.2 Description and Quantification of Impact

In order to assess the impacts of the proposed activities, the area of potential disturbance must be quantified. The area of direct disturbance expected for each activity is presented in Table 5.1 to Table 5.6 and summarised in Table 5.7. Areas where decommissioning activities overlap have been accounted for, ensuring that the extent of impact is not unrealistically overestimated. The sub-sections below re-cap briefly on some of the information provided in Section 2.

5.1.2.1 Jacket Removal

The Fulmar A jacket is to be partially removed leaving the footings in place, as presented in Section 2.3.2. Selection of this option means that no seabed disturbance and corresponding impact associated with jacket removal is expected.

Conversely, the Fulmar AD and Auk jackets are being fully removed.

The piles of both jackets will be cut at 3 m below the natural level of the seabed to ensure that any remains are unlikely to become uncovered or snagged and should be suitable for removal using internal cutting methods. However, access will only be confirmed when internal camera inspections are completed for all platforms. The excavation of the seabed around each jacket pile to allow external cutting has therefore been considered here as a worst-case scenario for this activity.

If excavation of the footings is needed, removal of the two jackets will directly impact the seabed as quantified in Table 5.1. Sediment will be excavated and re-deposited down-current of the jacket piles, where it will undergo natural dispersal.

Table 5.1: Potential Direct Impact Area on Seabed as a Result of Jacket Removal

Structure	Dimensions[1]	Short-term disturbance (m^2)
Fulmar AD	177 m^2 x 4 legs	707
Auk	177 m^2 x 8 legs	1,414
	TOTAL	**2,121**

[1] Dimensions excavated were based on the worst-case assumption of a 15 m diameter pit centred on each leg

The area of seabed occupied by the footings of the Fulmar A jacket and piles being left *in-situ* is shown in Table 5.2. The disturbance area associated with the decommissioning of the jacket and piles is assumed to be equal to the dimensions of the jacket. At the seabed, the piles will be inside the pile guides, and therefore incorporated within the jacket footprint.

Table 5.2: Footprint Remaining on Seabed as a Result of Fulmar A Footings to be Decommissioned in-situ

Structure	Dimensions	Long-term disturbance (m^2)
Fulmar A jacket footings	80 m x 66 m	5,280
	TOTAL	**5,280**

5.1.2.2 Subsea Structures Removal

As discussed in Section 2, the recommended option for decommissioning subsea structures of this type is full removal. Table 5.3 quantifies the potential direct impact to the seabed.

For piled structures including the SALM bases, it is anticipated that it will be possible to cut the piles internally, at up to 3 m below mean seabed level. Pile sections would be recovered to deck, and a suitable vessel used to recover each structure (e.g. SSIV or SALM Base). It is therefore anticipated that the disturbance footprint both for piled and non-piled structures will be equal to the dimensions of the infrastructure removed. All mattresses and grout bags will be removed if safe and feasible to do so.

Table 5.3: Potential Direct Impact Area on Seabed as a Result of Subsea Structure Removal[1]

Structure	Dimensions	Short-term disturbance (m^2)
PL1315 piled SSIV (piled)	8.6 m x 6.1 m	52.5
Non-return valve (NRV) Protection Structure	21.8 m x 25.3 m	551.5
Auk North Production Manifold	11.9 m x 9.5 m	113.1
Auk Well 4 Manifold	9.2 m x 9.2 m	84.6
SALM Bases x 2 (piled and grouted)	24.4 m x 20 m	976.0
STL anchor piles x 8	1.8288 m diameter	21.0
Fulmar Igloo (covers the SALM Tee-Piece)	Approx. 10 m x 5 m	50.0
Fulmar AD Template (piled)	Approx. 10.6 m x 8.1 m	85.9
All spools and surface-laid umbilicals	Total length of 2,747 m x various diameters (max 0.725 m, min 0.051 m)	739.2
Mattresses	6 m x 3 m x 488 concrete mattresses[2]	8,784.0
	4 m x 4 m x 3 bitumen mattresses	48.0
Grout Bags	0.6 m x 0.3 m x 3,650 grout bags[3]	657.0
	TOTAL	**12,162.8**

[1] The infrastructure listed here is taken from the Auk DP document, the Fulmar sub-structures DP document and the Fulmar and Auk North topsides and subsea facilities DP document. The Auk North integrated wellhead protection structures mentioned in the Fulmar and Auk North topsides and subsea facilities DP document are outside the scope of

this EA, as noted in Section 2.3.1.1. The totals presented do not always equal the sum of the line items, this is due to rounding of the line items.
[2] Assuming all mattresses are removed. The numbers presented are the totals from the Auk DP document, the Fulmar sub-structures DP document and the Fulmar and Auk North topsides and subsea facilities DP document.
[3] Assuming all grout bags are removed. The numbers presented are the totals from the Auk DP document, the Fulmar sub-structures DP document and the Fulmar and Auk North topsides and subsea facilities DP document.

5.1.2.3 Pipelines to be Fully Trenched and Buried for Decommissioning in-situ

PL1315 and PL38 are currently surface-laid and exposed, but the intention is to fully trench and bury these lines to a target depth of 0.6 m and decommission them *in-situ*. First, the PL1315 pipeline will be cut with hydraulic shears at the two points where it is crossed by other pipelines/cables. PL38 will not require cutting. Trenching equipment will then be used, followed by backfilling, to trench and bury them to a target depth of 0.6 m. Table 5.4 presents the approximate footprint of seabed affected by trenching and burial activities, assuming a 15 m corridor (7.5 m each side).

Table 5.4: Seabed Disturbance Footprint as a Result of Pipeline/Umbilical/Cable Trenching/Burial, and/or Rock Armour, Prior to Decommissioning *in-situ*

Structure	Dimensions	Short-term disturbance (m^2)	Long-term disturbance (m^2)
PL1315	15.55 km x 15 m trenching corridor	233,250	N/A
PL38	2.125 km x 15 m trenching corridor	31,875	N/A
PL1315	15.55 km x 8 m rock armour berm	N/A	124,400
PL38	2.125 km x 6 m rock armour berm	N/A	12,750
	TOTAL	**265,125**	**137,150**

If it is found that PL1315 and PL38 cannot be trenched and buried to an adequate depth due to difficulties in executing trenching and burying, spot rock placement may be utilised on sections of pipeline exhibiting shallow burial to ensure the safety of other sea users. However, as a worst-case scenario, it is been assumed that the full length of both pipelines may have to be covered by a rock armour berm. Along PL1315 and PL38, these berms would be approximately 8 m and 6 m in width, respectively, to achieve a 3:1 gradient profile to ensure both are fully overtrawlable. OPRED will be consulted prior to the use of any additional rock. Table 5.4 presents the approximate footprint of seabed permanently impacted by rock armouring activities.

5.1.2.4 Pipelines to be Decommissioned in-situ *with ends made safe*

Pipelines, umbilicals and cables in CA Groups 3, 4, 5 and 6 (see Table 2.4) are to be decommissioned *in-situ* with minimal intervention. The seabed disturbance associated with these activities is presented in Table 5.5.

These lines will be prepared by removing any mattresses and cutting and removing tie-in spools for recovery to shore (all covered in Table 5.3). Exposed pipeline sections will then be cut and recovered. The remaining cut ends, as well as areas of inadequate burial, will then be made safe for other sea users by either burying or covering with rock armour. Because rock armour represents a longer term and therefore worst case impact, it has been assumed here that rock armour will be used.

Sections of pipeline that are already adequately buried below the seabed are not represented in Table 5.5 except in the "Total length" column, since there is no short- or long-term disturbance to the seabed associated with these sections.

Cutting of pipeline ends is expected to remove approximately 20 m from each end of the cut line. The activity associated with doing this (which may include some excavation by ROV to expose the lines) is expected to disturb sediment up to 10 m either side of the line. As such, each end cut is expected to disturb approximately 400 m^2 of seabed.

Each new end cut is assumed to be subsequently protected with a rock armour berm, which will cover a 10 m length extending slightly past the cut end of the line in a 5 m wide corridor, covering an area of 50 m^2. The berm will be configured with a 3:1 profile providing a burial depth over the top of the pipeline/umbilical/cable to at least 0.6 m. Each berm will require approximately 40 tonnes of rock. The cutting activity and the rock armour deposition will occur in the same places, but the cutting activity will disturb bigger areas and as such rock armour is ignored in the total short-term disturbance calculations in Table 5.5. However, the rock armour is included in the long-term disturbance calculations. Existing rock armour, as well as new rock armour required to cover longer exposures, rather than just cut ends, is assumed to be laid in a 10 m wide berm, as opposed to the 5 m wide berms used for the cut ends.

For simplicity, there has been no attempt to either subtract the cut end sections from the total pipeline lengths, or to estimate how much of the new rock armour would cover seabed that is already disturbed. For example, a 100 m pipeline that is currently surface laid and 100% rock armour covered would be recorded as disturbing the following seabed areas:

- 100 m x 10 m = 1,000 m^2 long-term disturbance due to presence of existing rock armour;
- 20 m x 10 m x 2 = 400 m^2 short-term disturbance due to pipeline end removal; and
- 10 m x 5 m x 2 = 100 m^2 long-term disturbance due protection of cut ends with new rock armour.

Where existing surface-laid and exposed pipeline sections are removed, this is likely to disturb a narrow corridor of seabed since no excavation will be required. The disturbance corridor in these instances is assumed to be 0.5 m, which covers the footprint of the surface-laid line. All such exposures that are proposed to be cut and recovered occur at the ends of the pipelines. Disturbance associated with the cutting of these exposures is therefore already covered in the estimates for cutting of the pipeline ends as described above.

Where surface-laid and mattress-covered pipeline / umbilical sections are removed, the disturbance associated with removal will occur wholly within the disturbance corridor already created by removal of the mattresses (recorded in Table 5.3). As such, no disturbance area for removal of these pipeline sections in recorded in Table 5.5.

Table 5.5: Disturbance Associated with Pipelines/Umbilicals/Cables to be Decommissioned *in-situ* with ends made safe

Pipeline number	Total length (m)	Current condition	Short term disturbance (cutting and removal of ends and exposures)	Long term disturbance (rock armour)
PL208	1,008	Surface laid and either rock covered (887 m) or exposed (121 m)	1 x 20 m x 20 m = 400 m^2 (end) 1 x 121 m x 0.5 m = 60.5 m^2 (exposure)	887 m x 10 m = 8,870 m^2 (existing) 2 x 10 m x 5 m = 100 m^2 (new on cut ends)
PL1316	1,182	Surface laid and either rock covered (1,123 m) or mattress covered (59 m)	2 x 20 m x 20 m = 800 m^2 (ends)	1,123 m x 10 m = 11,230 m^2 (existing) 2 x 10 m x 5 m = 100 m^2 (new on cut ends)
PLU4472/ N0878	290	Surface laid and either rock covered (177 m) mattress covered (93 m) or exposed (20 m)	1 x 93 m x 0.5 m = 46.5 m^2 (ends) 1 x 20 m x 0.5 m = 10 m^2 (exposure)	177 m x 10 m = 1,770 m^2 (existing) 2 x 10 m x 5 m = 100 m^2 (new on cut ends)
PLU4473/ N0879	1,404	Surface laid and either rock covered (1,362 m) or mattress covered (42 m)	2 x 20 m x 20 m = 800 m^2 (ends)	1,362 m x 10 m = 13,620 m^2 (existing) 2 x 10 m x 5 m = 100 m^2 (new on cut ends)
PL378	11,942	Trenched and buried (11,942 m)	2 x 20 m x 20 m = 800 m^2 (ends)	2 x 10 m x 5 m = 100 m^2 (new on cut ends)
PL2651	10,488	Trenched and buried (10,488 m) with 23 areas of rock dump (approx. 718 m total)	2 x 20 m x 20 m = 800 m^2 (ends)	718 m x 10 m = 7,180 m^2 (existing) 2 x 10 m x 5 m = 100 m^2 (new on cut ends)
PL63	2,200	Trenched and buried (946 m) and exposed (1,254 m)		1,254 m x 10 m = 12,540 m^2 (new on ends and exposures)
PL648	1,776	Trenched and buried (1,137 m) and exposed (639 m)		639 m x 10 m = 6,390 m^2 (new on ends and exposures)
PLU2652	10,950	Trenched and buried (10,950 m) with fourteen areas of rock dump (approx. 1,316 m total)	2 x 20 m x 20 m = 800 m^2 (ends)	1,316 m x 10 m = 13,160 m^2 (existing) 2 x 10 m x 5 m = 100 m^2 (new on cut ends)
PLU2653	11,070	Trenched and buried (11,070 m) with seventeen areas of rock dump (approx. 1,261 m total)	2 x 20 m x 20 m = 800 m^2 (ends)	1,261 m x 10 m = 12,610 m^2 (existing) 2 x 10 m x 5 m = 100 m^2 (new on cut ends)
PLU4471	12,560	Trenched and buried (11,930 m) and exposed (630 m)	1 x 20 m x 20 m = 400 m^2 (ends) 1 x 630 m x 0.5 m = 315 m^2 (exposure)	2 x 10 m x 5 m = 100 m^2 (new on cut ends)
		TOTAL	**6,032.0 m^2**	**Existing - 68,440.0 m^2 (94,000 Te) – estimated** **New - 19,830.0 m^2 (20,730 Te)** **Total - 88,270.0 m^2 (114,730.0 Te)**

5.1.2.5 Footprint of Seabed Disturbance from Overtrawl Surveys Post-Decommissioning

Once the decommissioning activities are complete, surveys will be conducted to check that the seabed has been left in a condition that does not present a hazard to other sea users – particularly the fishing industry. Surveys will use a variety of techniques, particularly acoustic tools such as sidescan sonar. However, as part of this, a fishing vessel may be required to carry out overtrawling of the seabed within the 500 m safety zones of platforms and subsea installations and within a 100 m corridor (50 m each side) of pipeline/umbilical/cable routes to verify that this has been achieved. Table 5.6 presents an estimate of the total potential seabed impact due to overtrawl surveys. This is a very approximate estimate based on the presence of safety exclusion zones at two surface installations (the Auk A and Fulmar A/AD centres) and the subsea field at Auk North, plus the total length of all pipelines/umbilicals/cables being decommissioned, including the SALM bases, multiplied by a width of 100 m. It is possible that the total area to be overtrawled will only focus on certain key areas (rather than the whole area subject to decommissioning activities). Because of this, and because of other unknowns such as turning circle of the vessel plus trawl system to be used, there is little point attempting to finely calculate the exact area to be overtrawled, e.g. by excluding the space occupied by the remaining Fulmar A footings, rock armour, or the length of pipeline within 500 m safety exclusion zones (to avoid over-inflating the trawled area estimate). Overall it is considered that the figure of 11.435 km^2 shown in Table 5.6 represents a reasonably pragmatic worst-case estimate of the total area potentially to be affected.

Table 5.6: Potential Direct Impact Area on Seabed as a Result of Overtrawl Surveys

Activity	Dimensions	Short-term disturbance (m^2)
Overtrawl surveys of pipelines/umbilicals/cables, platforms and subsea installations	Pipelines/umbilicals/cables – 82,930 m x 100 m Platforms and subsea installations – (2 platforms and 2 subsea manifolds) x 500 m radius	11,434,592
	TOTAL	**11,434,592**

5.1.2.6 Summary of Seabed Disturbance

Table 5.7 summarises the estimated short- and long-term disturbance associated with decommissioning activities.

Table 5.7: Summary of Short- and Long-Term Disturbance

Activity	Table	Short-term disturbance (m^2)	Long term disturbance (m^2)
Full removal of topsides	n/a		
Full removal of jackets	5.1	2,121	0
Presence of Fulmar A footings decommissioned *in-situ*	5.2	0	5,280
Removal of subsea structures including templates, manifolds, SALM bases, tees, spools and surface laid umbilicals, mattresses and grout bags	5.3	12,162.8	0
Pipeline full rock armour (if necessary)	5.4	0	**137,150**
Pipeline ends / exposures cut and made safe with rock armour, and existing rock armour remaining in place	5.5	6,032	88,270
Totals from decommissioning operations described above		**20,315.8.8**	**230,700**
Overtrawl surveys	5.6	11,434,592	0
Total from decommissioning operations above plus overtrawl surveys[1]		**11,434,592**	**230,700**

[1] The total short-term disturbance including overtrawls is equal to the overtrawl disturbance, since this will take place across the same areas that have already been disturbed by previous decommissioning activity.

5.1.3 Disturbance of Seabed Habitats During Decommissioning

5.1.3.1 Direct Benthic Disturbance and Habitat Loss Due to Removal of Jackets, Subsea Infrastructure and Overtrawl Surveys

The main mechanism of direct benthic disturbance will potentially come from overtrawling at the end of decommissioning activities, which is expected to affect up to 11.435 km^2 of seabed. Impacts from the overtrawling may include mortality and injury, arising from crushing, upending and burial of benthic and epibenthic fauna that cannot move away, as well as disturbance of motile fauna as they move away from the area of disturbance. The sediment structure, including burrows of any animals present, will be disturbed.

Upon completion of the subsea decommissioning activities, it is expected that a benthic community typical of the area will start to become re-established in the overturned and resettled sediment. This will occur through a combination of rehabilitation of some of the existing disturbed fauna working their way back to a new sediment surface **[Ref. 65]**, migration of animals from adjacent undisturbed seabed, and natural settlement by larvae and plankton **[Ref. 66]**.

In a series of large-scale field experiments, **[Ref.66]** investigated the recovery of benthic communities within a variety of sediment types (clean sand, silty sand, muddy sand and mud) to physical disturbance. Of the four sediment types investigated, the communities from muddy sands and mud showed the longest recovery rates. In low-energy areas of the North Sea subject to extensive dredging, another study showed that local fauna took approximately three years to recover to the original level of species abundance and diversity **[Ref. 67]**.

The recovery time for benthic communities following disturbance by beam-trawling in the southern North Sea and CNS was modelled **[Ref. 68]**, which indicated that mud habitats on average took longer to recover (approximately four years) than shallower high energy sand and gravel areas (approximately two years). Auk, Fulmar and Auk North are located in the CNS and the seabed is predominantly muddy sand and sandy mud, indicating a probable recovery time in the region of three to four years, i.e. a similar timescale to that found in the field studies of **[Ref. 66]** and **[Ref. 67]**.

The scale and duration of seabed disturbance impacts from the proposed decommissioning is small when compared to the other main subsea activity in the North Sea, commercial trawling. According to the Seafish Gear Database **[Ref. 69]**, beam trawls used in the North Sea for demersal fishing can be up to 12 m in width and may be towed at up to 7 knots (3 m/s). A commercial trawler with a 12 m wide chain mat type beam trawl trawling at 2 m/s would take approximately 132 hours to cover an area equivalent to the maximum overtrawl requirement in the Auk, Fulmar and Auk North fields (11.435 km^2). Maximum fishing effort in ICES rectangles 41F2 and 42F2 between 2014 and 2018 was 20 days, or 480 hours, per rectangle per year (not including disclosive data). In this context, the scale of the area of impact from the overtrawling activity is small. In addition, the overtrawling required as part of decommissioning will only take place once and will not be repeated.

The ocean quahog is included on the OSPAR list of threatened and declining habitats and species **[Ref. 37]** and is a qualifying species for several UK protected sites including the Fulmar MCZ. Seven adult ocean quahogs were identified from a total of 210 x 0.1 m^2 grab samples recovered in the Project area, equivalent to three animals per m^2. Ocean quahog adults are within the size range 3-15 cm and on the JNCC SACFOR scale, this amounts to an abundance rating of ‘common’ **[Ref. 70]**. The ocean quahog is considered to be moderately tolerant of smothering. It is a burrowing species that can switch between suspension and surface deposit feeding. It is thought to preferentially engage in suspension feeding, remaining buried in the sediment with its inhalant and exhalent siphons exposed. It periodically buries itself further in the sediment, respiring anaerobically often for one to seven days (although the longest recorded is 24 days) before returning to the surface **[Ref. 71]**. Another study **[Ref. 72]** also reported on the abilities of buried fauna to burrow back to the surface, and confirmed that bivalves are able to burrow back up through 20 – 50 cm of overburden depending on species and substrate.

On the basis of this published research, the similarity between the proposed overtrawling activity to the commercial trawling undertaken over the CNS as a whole, and as overtrawling is not expected to result in deep burial, any impact to ocean quahogs at a population level is not likely to be significant.

5.1.3.2 Impacts from Existing Infrastructure Decommissioned In-Situ – Habitat Change

The proposed decommissioning activities will result in approximately 0.231 km^2 of seabed surface being left covered with hard substrate. This will comprise the Fulmar A jacket footings, previously deposited rock armour and new rock armour deposited to protect cut pipeline ends and exposures, as well as new rock armour deposited to protected sections of pipeline exhibiting shallow burial status are summarised in Table 5.7.

Infrastructure left *in-situ* will take up a footprint that would otherwise be available for colonisation by soft-sediment fauna. It is likely that the newly deposited material will eventually support an epifaunal community typical of the anthropogenic and natural hard substrate already present in the area (which includes manifolds, surface-laid pipelines / umbilicals / cables and spools, mattresses, rock armour, shells and occasional stones). Fugro survey work **[Refs. 12, 13, 16, 17, 18, 19, 20]** has indicated that such communities are characterised by a mix of sessile and mobile forms such as the plumose anemone *Metridium dianthus*, the crab *Lithodes maja*, hermit crabs, various erect hydroids and bryozoans, common starfish and the sea urchins including *Gracilechinus acutus*.

The proposed introduction of new rock armour will not represent a substantial net increase in the artificial hard substrate on the seabed, due to the simultaneous removal of mattresses and removal or burial of surface laid pipelines / umbilicals / cables. The footprint of the existing and new material decommissioned *in-situ* on the seabed surface will be negligible compared to the available remaining soft-sediment habitat and no change is expected to the general community composition in the area. Pipelines that are decommissioned in-situ and buried beneath the seabed are expected to have no discernible impact on sediment infauna or epifauna, since they will be buried to a target depth of 0.6 m to top of pipe, which is deeper that the majority of infauna will burrow.

Overall impact due to habitat change from material decommissioned *in-situ* is expected to be minor.

5.1.3.3 Impacts from Existing Infrastructure Decommissioned In-Situ – Material Degradation

A further impact to the benthos may occur as the structures degrade. Structural degradation of pipelines and jacket footings will be a long-term process caused by corrosion leading to eventual collapse under their own weight. During this process, degradation products derived from the exterior and interior of the pipelines/umbilicals and jacket footings will breakdown and potentially become bioavailable to benthic fauna in the immediate vicinity.

On the basis that pipelines/umbilicals/cables will have been flushed and cleaned prior to decommissioning, the primary degradation products will originate from the following structural components:

- Pipeline contents (inhibited seawater is assumed and assessed as a worst-case, though it may be that untreated seawater is used for some or all of the pipelines);
- Pipeline scale containing naturally occurring radioactive material (NORM);
- Steel;
- Sacrificial anodes (zinc and aluminium);
- Concrete (e.g. pipeline coating or mattresses); and
- Plastic coatings.

Inhibited Seawater

As the structures corrode, any inhibited seawater contents will gradually become exposed to the overlying seawater and sediments through leak paths caused by corrosion and material breakdown over time. Contents release and mixing with ambient seawater, or sediments and pore-waters, will occur as a prolonged process involving small quantities at a time. The chemicals used in inhibited seawater will have been selected and permitted for use under the operational permitting system and will be very similar to those used through the life of the Auk, Fulmar and Auk North fields and also during the original installation and commissioning of the infrastructure. The following chemical types are generally present in inhibited seawater:

- Oxygen scavenger: these are typically classified as PLONOR[21] chemicals;
- Biocide: this would be the most toxic component which by the mode of action is designed to kill bacteria. By their mode of action biocides typically become deactivated (either within the pipeline or structure, or if released into the environment; **[Ref. 73]**;
- Scale Inhibitor: although not PLONOR-listed, scale inhibitors are typically low toxicity and present a low environmental risk; and
- Corrosion Inhibitor: these are typically surface-active chemicals (surfactants) which provide corrosion protection by forming a protective layer on the metal surface. This mechanism of action reduces the potential discharge to sea as it will preferentially remain on the metal surface.

The small scale localised and gradual nature of this type of release, and over a timescale in which the chemicals will have become degraded and ineffective (in terms of their original purpose) before any release occurs, will mean that any impacts to biota in the vicinity will be negligible.

NORM

NORM-contaminated scale may be present in oil production wells, associated flowlines and in topsides pipework and processing facilities. The quantity of NORM in the topsides (being returned to shore) is not precisely known and the amount present in the flowlines is currently unknown either for Auk **[Ref. 1]** or for Fulmar and Auk North **[Ref. 105]**. The most significant radioactive element in NORM scale and produced water is radium and in particular the stable isotope 226Ra which has a half-life of 1,620 years **[Ref.74]**. When scale precipitates from produced water, the radium naturally present in the water can become concentrated into the scale at concentrations higher than those originally present in the water **[Ref. 75]**. Marine organisms can potentially bioaccumulate radium from solution in seawater, from ingested seabed sediments or from their food. Studies of the impacts of 226Ra released into the North Sea via produced water and natural processes indicate that it is unlikely to cause effects on marine organisms **[Ref. 74]**.

NORM scale discharged from offshore installations is known to be insoluble in seawater and when produced water rich in barium and radium is discharged to sulphate-rich seawater, the radium precipitates rapidly as a complex of barium, radium and sulphate which is also insoluble. 226Ra therefore has a very low concentration in solution in seawater and has a low bio-availability to marine organisms. Dissolved cations in seawater, particularly calcium and magnesium, also inhibit the bioaccumulation of NORM **[Ref. 75]**. The quantities of this material are expected to be small and any release into the benthic environment would also be very gradual; available research indicates that the risk to the environment from such inputs is negligible **[Ref. 75]**, but that the number of studies from which to draw conclusions is limited.

Metals

It is expected that metals will be released into the sediments and water column during gradual breakdown of the steel footings, pipelines, and associated sacrificial anodes (zinc and aluminium). The total quantity of steel to be decommissioned *in-situ* is approximately 6,988 tonnes (excluding the Fulmar A footings, for which a figure is currently not available), together with 116 tonnes of copper and 91 tonnes of sacrificial anodes (mostly zinc and aluminium) **[Ref. 76]**. The concern is that metals have the potential to exert toxic effects in marine biota or to bioaccumulate through the food web **[Ref. 77]**. Metals can act as enzyme inhibitors, adversely affect cell membranes, damage

[21] Posing Little Or NO Risk to the environment

reproductive and nervous systems, cause changes in metabolic and respiratory efficiency, affect growth and behaviour or act as carcinogens in marine benthic organisms **[Refs. 78, 79]**.

In the CNS, seabed temperatures are consistently less than 10°C throughout the year, oxygen concentrations are fairly uniform, and salinity is in the order of 35‰. Under these conditions corrosion rates for unprotected steel range between 0.1 to 0.2 mm/year **[Ref. 80]**, although corrosion could be slowed by protective coatings, sacrificial anodes, marine growth or burial, to 0.02 to 0.05 mm/year. Corrosion rates can be increased on a localised basis if metal pitting occurs, or where conditions permit attack by sulphate-reducing bacteria, to as much as 0.5 to 2 mm/year. Early estimates anticipated that failure of pipelines due to through-wall degradation would begin to occur after many decades - of the order of 60 to 100 years **[Ref. 81]**. More recent estimates suggest longer periods for jacket footings, pipelines, umbilicals and cables of potentially hundreds of years **[Ref. 82]**. This ties in with studies carried out for the Ninian North Platform jacket footings, in which failure and collapse due to corrosion were estimated to take place after 300 to 400+ years **[Ref. 83]**.

In a study of the impacts of aluminium sacrificial anodes on the marine environment **[Ref. 84]**, it was noted that anodic dissolution does not significantly increase the concentration of Al in the water, but that both enrichment and an increase in the mobility of Al were evident in sediments in the immediate vicinity. Sacrificial anodes generally have a 20 to 25-year design life **[Ref. 82]** and their protection is maintained through replacement over the operational life of structures and pipelines. Such maintenance and protection will cease for infrastructure decommissioned *in-situ*, the effect of which will be that inputs of metals such as zinc and aluminium from these sources will cease shortly after decommissioning while there could be corresponding increase in the rate of steel corrosion.

The metals released by corrosion are likely to form bonds with the particulates and sediments, making them less bioavailable to marine organisms **[Ref. 85]**. Along buried pipeline corridors and around the footings there may be accumulations of iron and other metals in the sediments localised to within a few metres.

The toxicity of a given metal varies between marine organisms for several reasons, including their ability to take up, store, remove or detoxify these metals **[Refs. 77, 78]**. As outlined in Section 3.3, the recorded concentrations of most sediment metals within 200 m of both Auk and Fulmar A exceeded background values typical of the CNS, and also exceeded ERL values (where these are available) above which detectable adverse effects start to become apparent in toxicity assays or monitoring studies. This was not the case at Auk North however, where concentrations for most metals at all stations were below UKOOA mean concentrations for the CNS and also less than OSPAR ERL concentrations. The structures to be decommissioned in-situ have already been in place releasing metals for many years, and their degradation will continue slowly over decadal or centurial timescales **[Ref. 86]**. On this basis it is not expected that concentrations of metals in water and sediments will build or accumulate significantly. In addition, trace metals are regulated in marine organisms and few have been shown to bioaccumulate significantly **[Ref. 85]**.

Overall, the slow release of the metals associated with the pipeline and jacket footings is expected to have a negligible impact on the local environment.

Concrete

Pipelines PL1315 and PL38, proposed for decommissioning *in-situ* following trenching and burial, have concrete coatings. In addition, quantities of cement-based grout will be left below the seabed in foundation piles for subsea infrastructure that has been removed, together with the Auk, Fulmar A and Fulmar AD jacket piles. This is estimated to total 5,502 tonnes **[Ref. 76]**, excluding any concrete that may remain on the seabed if any mattresses cannot be retrieved safely. Any remaining concrete will degrade over centuries. The degradation products will be the aggregates (sand and gravel) used in the concrete and the reacted cement compounds, predominantly calcium carbonate. These degradation products are relatively chemically inert and are likely to result only in a slight increase in the coarse sediment present. Impacts on benthic fauna are likely to be negligible due to the small area impacted and reduce further over time as the coarse material is slowly covered by the fine sediment characteristic of the area.

Plastics

Some of the pipelines and umbilicals are likely to be coated with or incorporate plastic materials (such as polyethylene), estimated to total 607 tonnes **[Ref. 76]**. It is not possible to give an accurate timescale for the degradation of polymers used for umbilical/cable coating as they have not been in use in a seawater environment long enough for their complete degradation to be observed and recorded. In any case its degradation is expected to occur over many decades, or possibly centuries **[Ref. 87]**. Over time these materials are likely to gradually fragment and disperse as microplastics or even nanoplastics[22]. There is virtually no information on weathering of plastics at sea, especially those submerged in seawater or sediment beyond the direct influence of photo/ultraviolet degradation **[Ref. 88]**.

Plastics in general have been considered non-toxic in the marine environment e.g. **[Ref. 89]**. As no micro-organisms have evolved to utilise the chemically resistant polymer chains as a carbon source, plastics can be expected to persist in the environment for centuries **[Ref. 86]**. While there has been much reporting on the issue of plastics in the marine environment, particularly in recent years, very little is known about the fate and impacts of its breakdown products, **[e.g. Refs. 88, 90]**. Adverse effects of microplastics on marine organisms can potentially arise from physical effects, including the physical obstruction or damage of feeding appendages or digestive tract or other physical harm. In addition, microplastics can act as vectors for chemical transport into marine organisms causing chemical toxicity **[Ref. 88]**, although some recent studies appear to counter this hypothesis **[Ref. 91]**.

The plastics within the inventory being decommissioned *in-situ* will be either trenched and buried or buried underneath rock cover, so even once degradation becomes evident it is likely to be many decades or even centuries before dispersal of breakdown products into the wider marine environment occurs. Globally, at least 8 million tons of plastic end up in the marine environment every year **[Ref. 92]**. Much uncertainty remains about the impacts of plastics in the marine environment; however, against global levels of input, and recognising the relatively small and very gradual inputs over an extended time period from the breakdown of plastics decommissioned *in-situ* at Auk, Fulmar and Auk North, environmental impacts are expected to small and not significant.

5.1.3.4 Disturbance of Drill Cuttings

Physical disturbance of the Fulmar and Auk cuttings piles is likely to result in re-distribution of some of their contents onto the surrounding seabed, along with entrained contaminants. Such disturbance is likely to occur during removal of the Auk and Fulmar AD jackets. As outlined in Section 2.3.4, the cuttings pile at Auk occupies an area of 5,000 m^2 and is up to 1.2 m high at its highest point, while that at Fulmar is larger, at 11,000 m^2 and 6.9 m high.

The removal of the Auk A and Fulmar AD jackets will involve cutting through the jacket piles securing these installations to the seabed. Whilst it may be possible to cut the jacket piles using internal cutting techniques, which would involve no disturbance to the cuttings pile, it may be necessary to access these externally. Which method will be used cannot be determined until the detailed engineering phase. Therefore, in order to ensure the worst-case cuttings disturbance could be assessed, modelling was undertaken to predict the fate and effect of cuttings removal from around the installation legs for external pile cutting, should this be required.

Two reports have been produced considering the Best Available Technique (BAT) for disturbing the cuttings: a high-level BAT Assessment Overview for Repsol Sinopec Resources UK Limited's North Sea assets **[Ref. 103]**, and a BAT Assessment for the Fulmar AD cuttings pile **[Ref. 104]**. Both reports recommended jetting as the BAT for disturbing the cuttings pile, in the absence of the option to leave *in-situ*. An additional BAT Assessment for the Auk cuttings pile will be completed at a later date.

---

[22] Microplastics are sometimes defined as particles in the size range 1 µm to 5 mm, and nanoplastics as particles 1 nm to 1 µm.

Other potential sources of further disturbance to cuttings piles exist – first from the overtrawling that typically takes place following decommissioning as part of the assurance process to ensure a safe seabed for other sea users, and second from the eventual collapse of the Fulmar A jacket footings into the cuttings pile. These are discussed and assessed below.

Cuttings Disturbance as Part of Auk Jacket Removal

The fate and effects of discharges from dredging activities in cuttings piles, potentially necessary to cut and remove the jacket legs and parts of the pipeline infrastructure from the seabed at Auk, were modelled. Sintef's DREAM (Dose-related Risk and Effect Assessment Model) software was used, along with input data from recent sampling of the piles. The model predicts the fate of particulate materials discharged to the marine environment (their dispersion and physico-chemical composition over time) and it can also calculate an estimate of risk to the environment using a metric known as the Environmental Impact Factor (EIF) simultaneously in both the sediment and water column compartments. Full details of the modelling approach, inputs and results are provided in **[Ref. 93]**. The scenarios and key results are summarised below.

Two methods of cuttings removal were modelled: using a suction dredger and water jetting, as follows:

> Suction dredger – GTO Drillcut Dredge with a liquid to solid ratio of 10:1 and a flow rate of 60 te/h through a 150 mm hose which is relocated eight times along a 50 m radius arc to the south and east of the jacket. At each location, an eighth of the relocated cuttings volume is discharged.

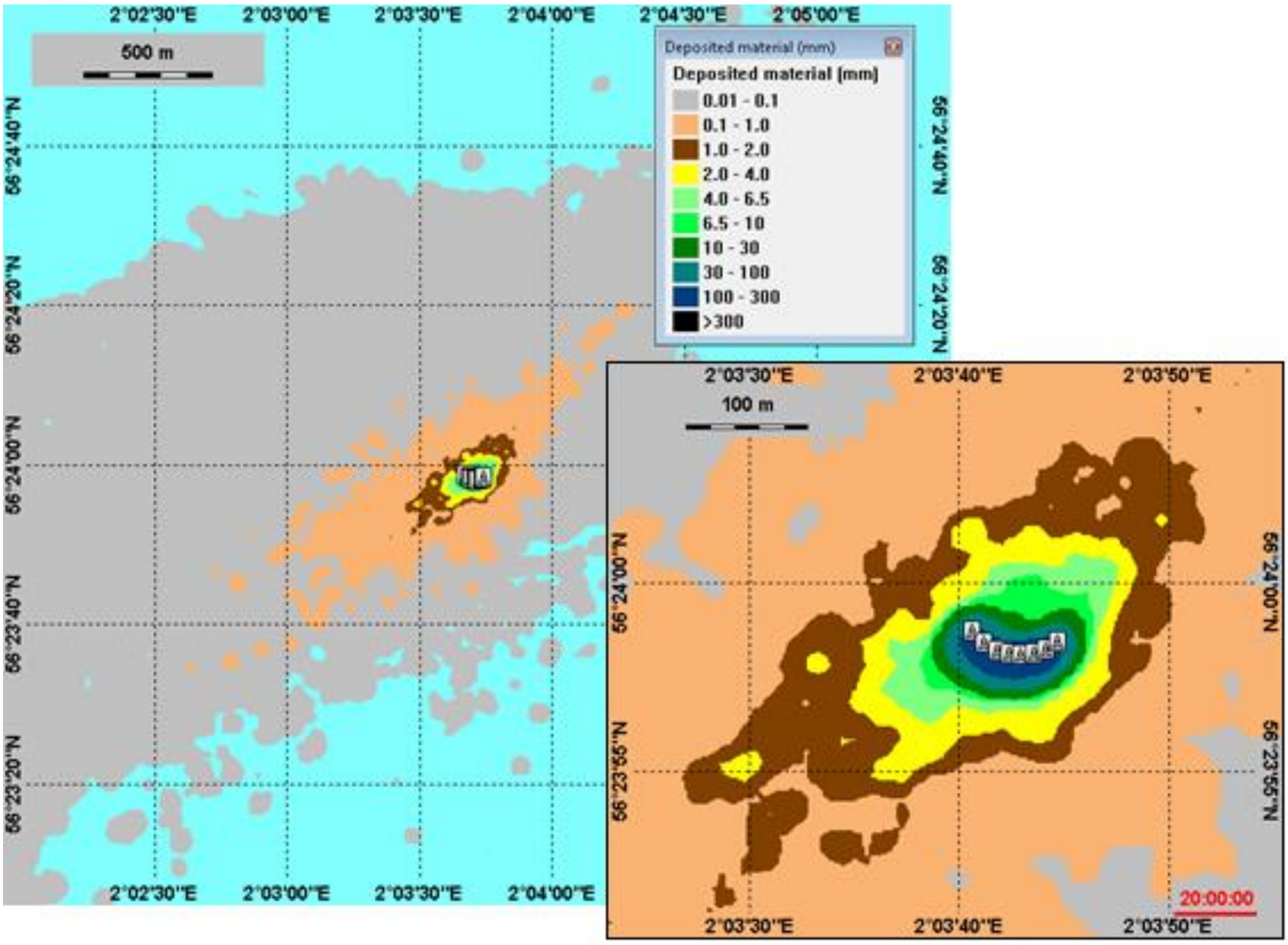
> Water jetting – using water jets to excavate the required quantity of material at each leg. Simulation of the jet plume carrying the excavated material away from each leg was based on the same liquid to solids ratio and flow rate as for suction dredging, but with a vertical discharge through a 50 mm diameter port at two locations for each leg.

These two modelling approaches were applied to a maximum excavation depth around each leg of -3.6 m, which would allow pile cutting to occur at down to -3.0 m depth below seabed level. The tidal current data files used in the modelling indicated that June 2013 was the least dispersive month for the Auk location, and this was therefore the data file used in the Auk study.

The results summarised here focus on the suction dredging, since these represent the worst case in terms of area affected. The results of modelling the sediment redistribution, in terms of the thickness of material deposited around the Auk platform, are summarised in Figure 5.1. Deposition is concentrated within an elongated oval pattern aligned with the main axis of tidal flow, extending up to 1.5 km from the discharge points although over most of this area thickness of deposition will be between 0.1 and 1 mm. Deposition thickness rapidly diminishes with distance; the maximum depositional thickness is predicted to fall from 0.3 m at each of the eight deposition points, to less than 1 mm within approximately 250 m to the north-east and south-west, and 100 m to the north-west and south-east. This amounts to an area of seabed affected of approximately 0.08 km^2. A large proportion of the finer elements of the mud will be transported out of the modelled area due to the fine particle sizes of the material involved and will contribute to background levels of suspended solids in the water column.

In the immediate vicinity of each discharge (within 10 to 30 m) changes in particle size distribution are predicted; however, beyond approximately 30 m, the percentage change in grain size is minimal. Regarding levels of contamination by oil, modelling indicates that no part of the relocated cuttings will have THC concentrations exceeding 50 $\mu g g^{-1}$.

Figure 5.1: Auk Cuttings Pile Sediment Redistribution from Cuttings Pile Excavation (Suction Pile Dredging) to -3.6 m at Each Leg



Risk to the seabed sediments[23] from toxicity, oxygen depletion, grain size change and burial thickness have been modelled and are presented in Figure 5.2, where the shape of the risk contours generally reflect the depositional pattern. Figure 5.2 also shows the recovery of the seabed over time, and the risk remaining after one year and ten years.

Immediately following the excavation discharges, the EIF for the sediment is predicted to be 5,167 and this represents an impact over an area that is approximately 11.5 km by 6 km. This sediment impact is predicted to decrease rapidly to an EIF of 223 after one year to an area of 4 km by 1.5 km and, to an EIF of 5.75 within an area of 1 km by 500 m by ten years. It is also predicted that the area affected by the core area within which the risk rating is >5% will shrink back to an area of 450 m by 100 m around the discharge point within 10 years. The largest contribution to the risk level (almost 100%) arises from the toxicity of oil-related components in the cuttings pile. It must be noted, however, that this impact is taking place within an area where the fauna has been subject to the same toxic impacts since drilling commenced in the 1970s and has been highly modified for four decades to date.

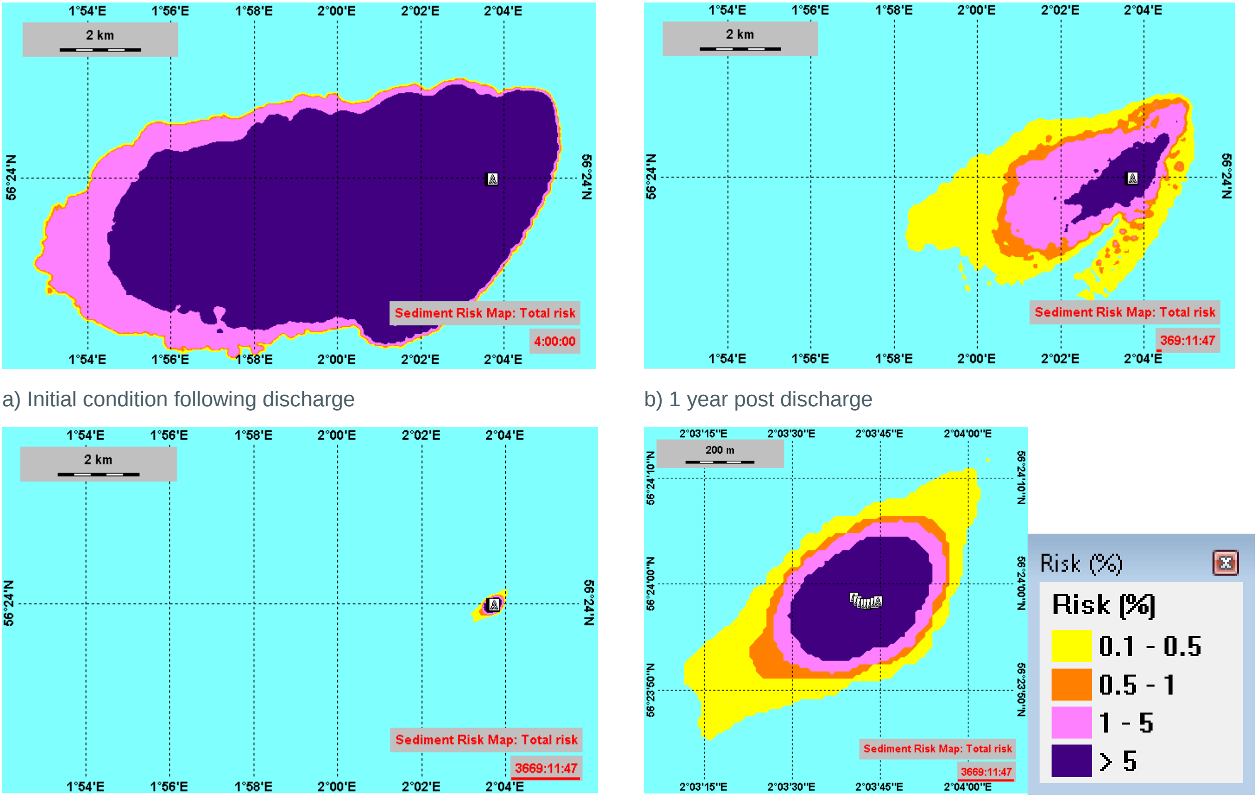
In the water column, the discharge plume is predicted to move around the discharge point with the currents. The water column risk of >5% extends to approximately 18 km from the modelled discharge point initially and is predicted to remain within 30 m of the seabed; i.e. the upper 50 m of the water column is not affected. The maximum water column EIF of 6,800 occurs after 3.75 days,

[23] In most consenting regimes, risks <5% as calculated by the DREAM model are considered acceptable, with limited effect and a high expectation of recovery, and changes in the ecosystem may in many cases be undetectable. Where the risk is >5%, risks are potentially significant and should be investigated and justified.

but risk levels reduce to <5% within 7.5 days of commencing dredging. The sources of risk to the water column are predicted to arise mostly from the fine suspended solids, with only 2% attributable to the toxicity of the oil components present. This ephemeral impact in the water column is typical of that from other short-term discharge activities offshore such as drilling and batch discharge of chemicals.

Essentially, these results indicate that most of the material mobilised by the dredging activities will resettle within the area already affected by the original cuttings discharges. Also, the presently existing pattern of oil contamination around Auk will continue to underlie the thin blanket of cuttings material redistributed by the suction dredging.

Figure 5.2: Auk - Time Sequence of Risk to the Seabed Posed by the Cuttings Excavation (Suction Dredging) Discharges to -3.6 m at Each Leg



a) Initial condition following discharge

b) 1 year post discharge

c) 10 years post discharge

d) 10 years post discharge (large scale)

Cuttings Disturbance as Part of Fulmar AD Jacket Removal

Similar modelling was conducted for the potential need to disturb the cuttings pile beneath Fulmar AD, based on identical disturbance mechanisms, suction dredging and jetting. Full details of the modelling approach, inputs and results are provided in **[Ref. 94]**. Key aspects of the scenarios modelled are summarised as follows.

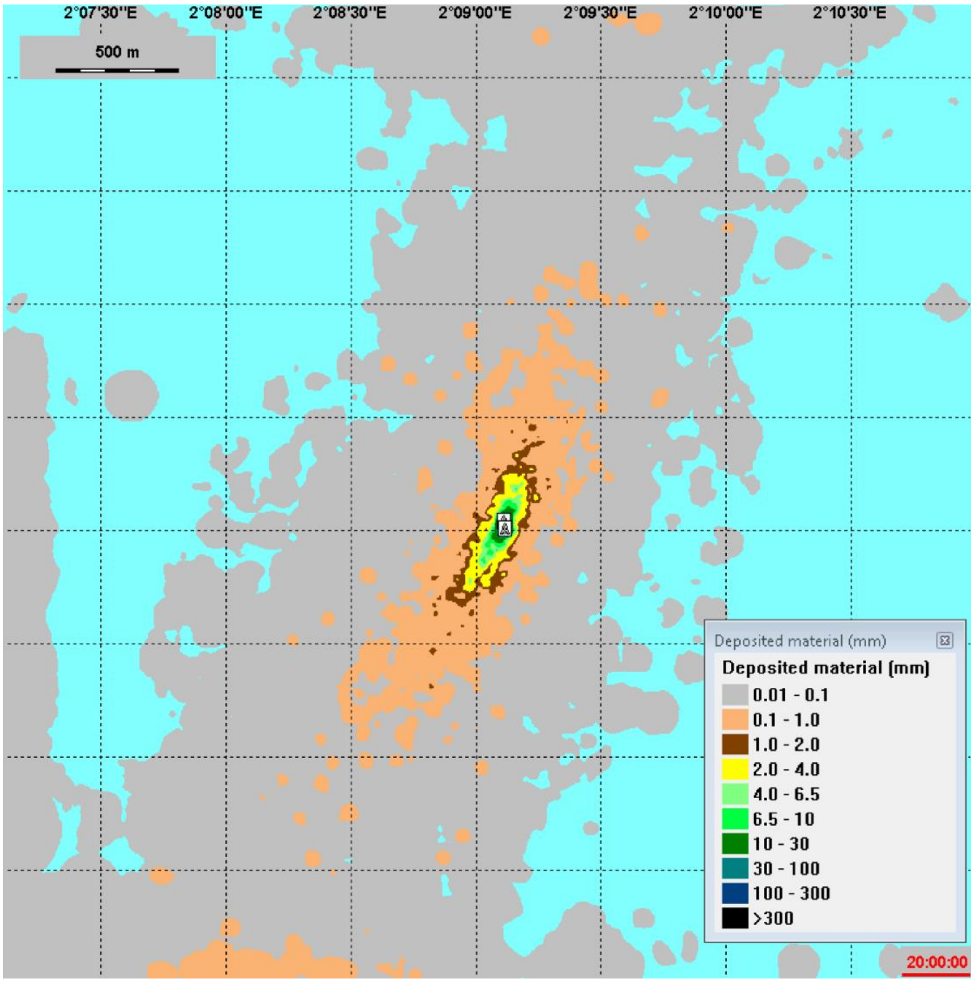
- Suction Dredger – GTO Drillcut Dredge with a liquid to solid ratio of 10:1 and a flow rate of 60 te/h through a 150 mm hose which is relocated to two locations on an arc of 150 m radius to the west of the jacket; the location was determined by the behaviour of the seabed currents. At each location, a twelfth of the relocated cuttings volume is discharged.
- Jetting of the same quantity of material at each leg. The same liquid to solids ratio and flow rate as the suction dredging were assumed except that the discharge was vertical through a 50 mm diameter port at two locations for each leg to simulate the jet plume.

As at Auk, a maximum excavation depth around each leg of -3.6 m was assumed for Fulmar AD, which would allow pile cutting to occur at down to -3.0 m depth below seabed level. The tidal current data files used in the modelling indicated that June 2012 was the least dispersive month for the Fulmar field location, and this was therefore the data file used in the Fulmar AD study. The results summarised here focus on the suction dredging, since these represent the worst case in terms of area affected.

The modelled thickness of material deposited around the Fulmar AD location, are summarised in Figure 5.3. Deposition is concentrated within an elongated oval pattern aligned with the main axis of tidal flow, extending up to 1.5 km from the discharge points although over most of this area thickness of deposition will be between 0.1 and 1 mm. Deposition thickness rapidly diminishes with distance; the maximum depositional thickness is predicted to fall from 1.9 m at each of the two deposition points, to less than 1 mm within approximately 350 m to the north-east and south-west, and 100 m to the north-west and south-east. This amounts to an area of seabed affected of approximately 0.1 km^2. A large proportion of the finer elements of the mud will be transported out of the modelled area due to the fine particle sizes of the material involved and will contribute to background levels of suspended solids in the water column.

In the immediate vicinity of each discharge (within 10 to 30 m) changes in particle size distribution are predicted; however, beyond approximately 30 m, the percentage change in grain size is minimal[24]. Regarding levels of contamination by oil, modelling indicates that following cessation of discharge no part of the relocated cuttings will have THC concentrations exceeding 50 μgg^{-1}.

Figure 5.3: Fulmar AD Cuttings Pile Sediment Redistribution from Cuttings Pile Excavation (Suction Pile Dredging) to -3.6 m at Each Leg

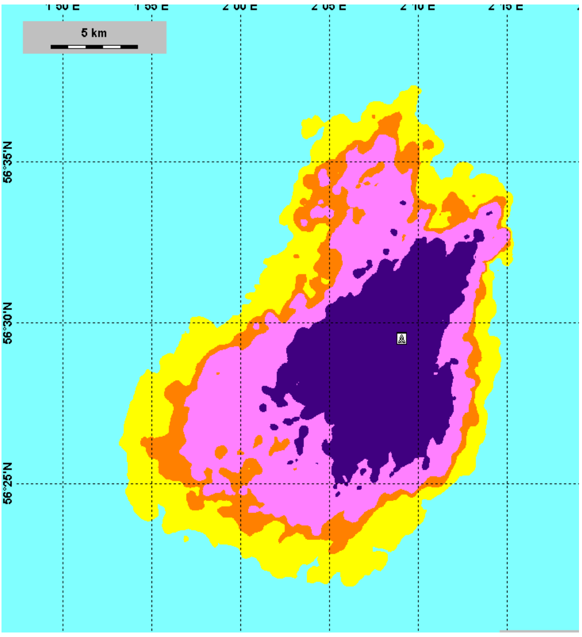


[24] It should be noted that some of the relocated cuttings pile will remain on the existing cuttings pile (extending over an area of 11,000 m^2 around the Fulmar A and AD jackets); therefore there will be minimal change in median grain size.

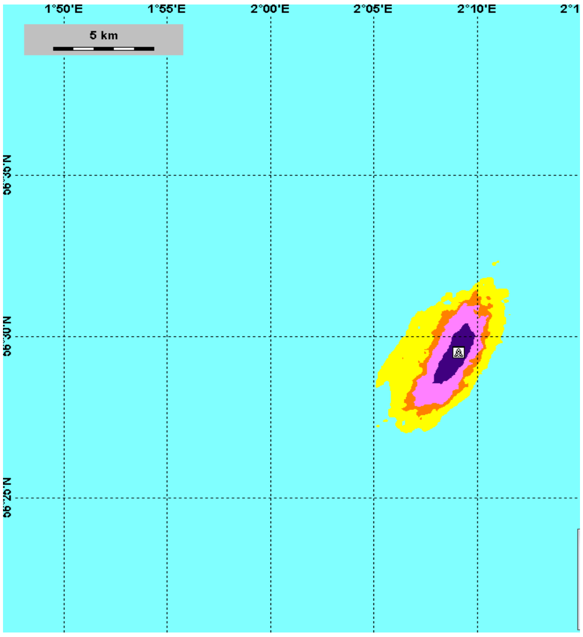
Risk to the seabed sediments from toxicity, oxygen depletion, grain size change and burial thickness have been modelled and are presented in Figure 5.4, where the shape of the risk contours generally reflect the depositional pattern. Figure 5.4 also shows the recovery of the seabed over time, and the risk remaining after one year and ten years.

Immediately following the excavation discharges, the EIF for the sediment is predicted to be 8,445 and this represents an impact over an area that is approximately 13 km by 9 km. This sediment impact is predicted to decrease rapidly to an EIF of 302 after one year over an area of 16 km by 10 km, and to an EIF of 5 within an area of 1 km by 750 m by ten years. It is also predicted that the area affected by the core area within which the risk rating is >5% will shrink back to an area of 625 m by 425 m around the discharge point within 10 years. The largest contribution to the risk level (almost 100%) arises from the toxicity of oil-related components in the cuttings pile. It must be noted, however, that this impact is taking place within an area where the fauna has been subject to the same toxic impacts since drilling commenced in the 1970s and has subsequently been highly modified for four decades.

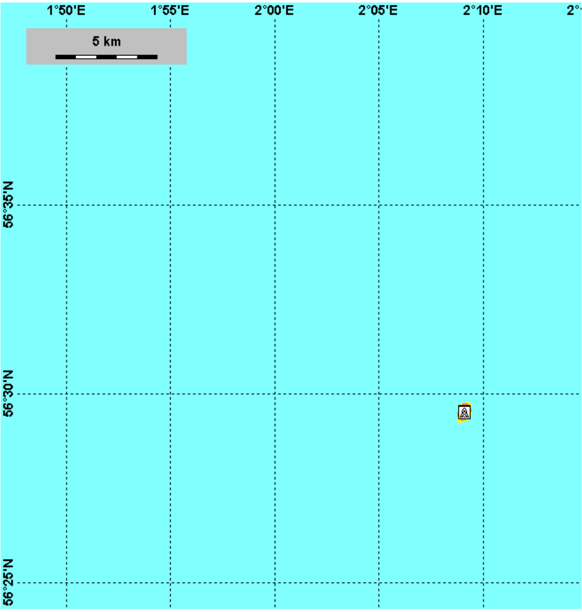
Figure 5.4: Fulmar AD - Time Sequence of Risk to the Seabed Posed by the Cuttings Excavation (Suction Dredging) Discharges to -3.6 m at Each Leg



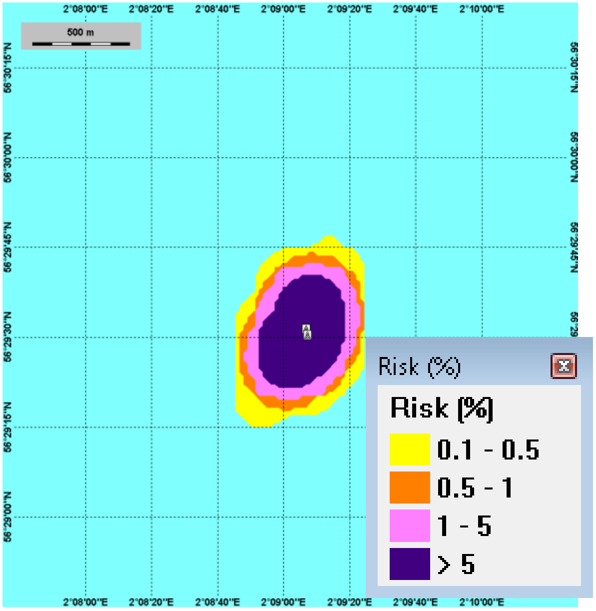
a) Initial condition following discharge



b) 1 year post discharge



c) 10 years post discharge



d) 10 years post discharge (large scale)

In the water column, the discharge plume is predicted to move around the discharge point with the currents. The water column risk of >5% extends to approximately 13 km from the modelled discharge point initially, and is predicted to remain within 18 m of the seabed; i.e. the upper 65 m of the water column is not affected. The maximum water column EIF of 3,546 occurs after 12.25 days, but risk levels reduce to <5% within 15.75 days of commencing dredging. The sources of risk to the water column are predicted to arise mostly from the fine suspended solids, with only 2% attributable to the toxicity of the oil components present. This ephemeral impact in the water column is typical of that from other short-term discharge activities offshore such as drilling and batch discharge of chemicals.

5.1.3.5 Conclusion from Cuttings Modelling

Essentially, these results indicate that most of the material mobilised by the dredging activities will resettle within the area already affected by the original cuttings discharges. Also, the presently existing pattern of oil contamination around Auk and Fulmar will continue to underlie the thin blanket of cuttings material redistributed by the suction dredging. Jetting results in a thinner more localised deposition of the disturbed material and as a result represents a marginally preferable environmental option to dredging.

A review of the observed impacts observed during actual cuttings pile dredging operations presented by OSPAR **[Ref. 95]** corroborates the modelling results and is summarised below:

- Dredging of the North West Hutton platform cuttings pile (which was approximately 30,000 m^3 and consisted of 48% rock, 45% seawater and 7% oil/other chemicals used during drilling operations) including repeated dredge back-flushes resulted in significant re-suspension of cuttings material, which showed:
    - Drifting of re-suspended material was low during operations.
    - Hydrocarbon concentrations on dredged cuttings were similar to those on undisturbed cuttings, and whilst levels of alkylphenol ethoxylates and barium were higher in the dredge-recovered water at the platform topsides, hydrocarbon levels in the water remained low, indicating that the majority of hydrocarbons remained bound to the cuttings and did not become free in the dredged water.
    - Corroborating the above, hydrocarbons were not increased significantly in the seawater samples from monitoring stations as a result of the dredging, and there was no detectable oil in the plumes generated during the trial.
    - There were no visible indications of an oil sheen at the surface, and little discernible effect was seen in the water column more than 100 m from the dredging operations.
- Use of high-pressure water jets to clear OBM cuttings from the Hutton Tension Leg platform, causing significant re-suspension of cuttings, had no major effect on the spatial distribution of cuttings contamination, or on biological communities outside 100 m from the original platform location.

The investigations at North West Hutton and the Hutton Tension Leg Platform suggest that seabed and water column impacts resulting from drill cuttings disturbance can be expected to be minimal, and the majority of hydrocarbons present would remain bound to the cuttings **[Ref. 96]**. On the basis of the DREAM modelling results and the observed cuttings disturbance exercises recorded in **[Ref. 94]**, the potential impact on receptor groups is expected to be low; this is described for the key groups in Table 5.8.

Table 5.8: Potential Impacts on Receptor Groups as a Result of Disturbance of the Drill Cuttings Piles

Receptor group and discussion of potential impact
Plankton
Industry research **[Ref. 96]** cites a number of sources indicating the impacts of drill cuttings discharge on plankton are negligible. Recorded deleterious effects on phytoplankton are generally attributed to light attenuation due to suspended solids. The majority of the disturbed material is expected to re-settle almost immediately, and material disturbed at the seabed (at least 80 m depth) is unlikely to interact with the photic zone. No significant impacts on plankton are expected.
Benthic fauna
Whilst activities causing disturbance of the Auk and Fulmar cuttings accumulations will cause spreading of contaminated material, modelling for such activities indicated that this spread will be largely confined to the area of seabed already affected by the original drilling discharges (Xodus, 2018c,d). The modelling also indicated little change to sediment hydrocarbon content, whilst also predicting toxic effects from the oil with a recovery period of more than 10 years. It should be noted that this impact will be taking place within an area that has been subject to similar impacts for four decades and where the fauna has long been highly modified and opportunistic in nature. Other published modelling studies have similarly concluded that physical disturbance to an oily cuttings pile (such as the Hutton Tension Leg Platform operations described above) have been found to have no major effect on the spatial distribution of cuttings contamination, or on biological communities located more than 100 m from the disturbance location **[Ref. 95]**. *Burying* Industry research **[Ref. 96]** reports a threshold drilling fluid/cuttings burial depth causing mortality of benthic organisms of 6.5 mm. Modelling of cuttings disturbance activities at Auk and Fulmar indicates that contaminated material will largely settle within the existing cuttings-affected areas, and that deposition of thicknesses exceeding 6.5 mm will be confined to the central part of the piles that supports an existing highly modified low diversity and opportunistic fauna. Significant adverse effects due to burial are therefore not expected. *Anoxia* In addition to toxicity and burial, drill cuttings can impact the benthos through anoxia caused by a combination of organic enrichment (which increases the biochemical oxygen demand) and through introduction of fine sediments (which restricts oxygen penetration into sediments). Drill cuttings material re-settling outside the existing accumulations is expected to be minimal. Any material that does settle is likely to be very fine, and unconsolidated (since coarser and/or consolidated material is unlikely to be re-suspended). It will settle gently and therefore there is likely to be oxygenated water in the pore spaces initially. It is not expected to form an effective barrier to oxygen penetration from the surrounding seawater. In addition, the act of re-suspension is likely to partially re-oxygenate the material. The material settling outside the existing cuttings accumulation is not likely to be thick enough to kill the infauna, which is expected to burrow back to the surface and assist in re-working the sediment. **[Ref. 95]** suggests that spreading of cuttings material will encourage aeration and degradation of cuttings material. Whilst there is potential for disturbance of the cuttings accumulations to promote organic enrichment in the surrounding sediments, the scale of this impact is expected to be limited and is not expected to cause anoxic conditions. The amount of material that will be re-distributed is unlikely to be sufficient to produce an effective oxygen barrier between the seabed and the surrounding seawater, or to prevent infauna from reaching the surface and re-working the sediment. In conclusion, the disturbance and re-settlement impacts (due to the small amount of material likely to be moved outside the existing cuttings accumulation area) will be confined to a benthic community already modified and habituated to similar conditions long-term, and the limited potential for smothering and anoxia suggest there will be no significant impacts on the benthos from disturbance of the cuttings accumulation.
Fish
The drilling fluid material may be toxic since many of the toxic components (such as aromatics) remain present at levels exceeding ERL concentrations. However, **[Ref. 95]** indicates that hydrocarbons are likely to remain bound to sediments rather than become free in the water column and therefore pathways for toxic components into fish are likely to be limited. The most likely effect on fish is interference with feeding behaviour due to increased sediment load in the water column. Increased sediment load as a result of the proposed activities is expected to be short-term and is insignificant when compared to the commercial trawling activity in the area. In addition, it is considered likely that fish would tend to avoid waters that are affected by transiently high levels of suspended material. For this assessment, shellfish are considered to be part of the benthic fauna and are included in the assessment above.
Seabirds
The most familiar effect of oil pollution on seabirds is the contamination of plumage, resulting in flightlessness and lack of insulation, compounded by ingestion of toxins through preening during attempts to remove contamination. The decommissioning of the Hutton Tension Leg Platform and the large-scale disturbance of the cuttings accumulation resulted in no visible surface sheen. It is therefore highly unlikely that decommissioning activities at the Fulmar and Auk cuttings accumulations, which are anticipated to cause less disturbance than the Hutton Tension Leg Platform operations, will result in any hydrocarbon contamination at the surface. It is anticipated that there will be no effect on seabirds from disturbance of the cuttings accumulation.
Marine mammals
There is little published data available on the impacts of synthetic-based fluids on marine mammals. Fugro survey **[Refs. 12, 13]** indicates toxic components of the drilling fluids used are still present at concentrations exceeding ERL. Since the majority of the drilling fluid disturbed by the proposed activities is however expected to remain bound to the drill cuttings particles, which are expected to re-settle close to the original cuttings accumulation, marine mammals in the area will experience minimal exposure.

Cuttings Disturbance as Part of Overtrawling Post-Decommissioning

Overtrawling of the seabed is likely to be conducted following decommissioning as part of activities to provide assurance of a clean seabed to other sea users. Whether overtrawling will be required over the full decommissioning footprint or a part of it is not known; similarly, it is not known to what extent, if any, trawling across cuttings piles might be necessary. The assessment here is based on the results of modelling the discharges from the dredging potentially required to remove the Auk and Fulmar AD jackets **[Refs. 93, 94]** as outlined above, together with other published studies.

Any overtrawling that might take place over all or part of the cuttings piles will involve a lesser degree of physical disturbance to that modelled and discussed above. At Fulmar, any overtrawling around the Fulmar A location would in any case be limited by the presence of the jacket footings decommissioned *in-situ*. Also, any overtrawling of the cuttings piles would potentially be occurring in the context of earlier dredging disturbance having recently taken place.

Modelling conducted by DNV and reported by OSPAR **[Ref. 95]**, undertaken as part of wider research on the potential impact of drill cuttings being left *in-situ*, estimated that trawling a medium sized oil-based cuttings pile would disturb only the top 20 cm of material. Of that disturbed sediment, 96.7% would immediately re-settle without becoming suspended in the water column. Some 3.3% of the top 20 cm of the drill cuttings would become suspended, with 2.47% re-settling within the existing accumulation area and only 0.83% of the top 20 cm re-settling outside of the existing accumulation area. Using these figures, it is possible to estimate the effects of overtrawling the Auk accumulation:

- The Auk cuttings accumulation has an area of approximately 5,000 m^2. Assuming as a worst case that the entire accumulation was trawled to a depth of 20 cm, a total volume of 1,000 m^3 of material would be disturbed;
- Of this, 958.3 m^3 would resettle immediately without becoming suspended and 33.3 m^3 would become suspended and re-settle within the existing cuttings accumulation; and
- Only 8.3 m^3 would become suspended and settle outside the existing cuttings accumulation boundaries.

Using the same DNV modelling results and assumptions, the effects of overtrawling the accumulation at Fulmar is estimated as follows:

- The Fulmar cuttings accumulation has an area of approximately 11,000 m^2, or 6,000 m^2 assuming the footings of Fulmar A (approximately 5,000 m^2) remain *in-situ*. Assuming that 6,000 m^2 of the accumulation remaining outside the footings was trawled to a depth of 20 cm, a total volume of 1,200 m^3 of material would be disturbed;
- Of this, 1,160.4 m^3 would resettle immediately without becoming suspended and 29.6 m^3 would become suspended and re-settle within the existing cuttings accumulation; and
- Only 10 m^3 would become suspended and settle outside the existing cuttings accumulation boundaries.

The modelling and observations reported by OSPAR **[Ref. 95]** suggest that release of hydrocarbons into the water column from disturbed drill cuttings is minimal, and that most of the hydrocarbon material present would remain bound to the cuttings. On this basis, the potential impact on receptor groups is likely to be minimal (as outlined in **[Ref. 95]**). It should be noted that although the emphasis here is on drill cuttings disturbance by overtrawls (since that activity, together with dredging or jetting, represents the greatest potential for interaction with the cuttings), the assessment is equally applicable to any other disturbance of the cuttings that may occur during the removal of the other Auk and Fulmar field infrastructure. It is also applicable to any disturbance to the cuttings piles that might take place following decommissioning.

Cuttings Disturbance as a Result of Fulmar A Footings Collapse

At some point following decommissioning, the Fulmar A jacket footings will fail and collapse due to corrosion, and there is the potential for this to result in disturbance to the cuttings pile beneath. As outlined in Section 5.1.3.3, there are no exact predictions for how long the Fulmar A jacket footings will remain standing, but estimates suggest collapse is likely after several hundred years.

Consideration also needs to be given to the likely persistence of the cuttings pile and status of oil based mud contamination at the time of footings collapse. The conclusion from the UKOOA JIP on cuttings piles longevity was that the presence of significant contamination is likely to be measured in decadal timescales, e.g. 10 to 50 years in water depths of around 70 m representative of the CNS, but at centennial timescales of 500 to 1,500 years for water depths of more than 120 m **[Ref. 97]**. Auk and Fulmar, both in the CNS at 85 m and 83 m respectively may be closer to the decadal timescales predicted, and the survey data available indicates that the area of contamination has shrunk at both Auk and Fulmar over the last decade (Section 2.3.4). On this basis, it is debatable whether any contamination will be present after the timescale for failure and collapse of the footings. However, combined with the evidence from monitoring and modelling studies conducted for physically larger levels of disturbance (as outlined above) significant impact is unlikely. It is likely therefore that cuttings pile disturbance from any dredging, jetting and overtrawling procedures, as assessed above, represent greater sources of concern.

5.1.4 Indirect Disturbance Due to Sediment Suspension and Re-settling

Direct disturbance of the seabed during decommissioning operations will cause sediment re-suspension. Sediments that are re-suspended will travel in the water column before re-settling. Most sediment is expected to re-settle within the direct disturbance area, but some may re-settle in adjacent areas not directly affected by decommissioning operations.

Increased suspended sediment load in the water column, and the subsequent re-settling of that sediment can negatively affect seabed habitats and species. The effect mechanisms are interference with feeding due to individuals inability to keep their feeding apparatus clear of sediment, and physical burial of individuals that are unable to recover to the surface through layers of newly deposited sediment **[Refs. 98, 99]**.

The potential area of direct seabed disturbance is 11.435 km^2 (Table 5.7). Most re-suspended sediment will re-settle within the initial disturbance area, but if it is assumed that some will land within an additional 100 m wide peripheral area around the margins of the direct disturbance areas (along the pipeline routes and around the 500 m safety exclusion zones). This would amount to an additional 9.7 km^2 of seabed indirectly impacted by sediment re-settlement.

Defra's Charting Progress for UK Seas report **[Ref. 100]** considers that impacts arising from sediment re-suspension are short-term (generally over a period of a few days to a few weeks). In addition, infaunal communities are naturally habituated to sediment transport processes and are therefore less susceptible to the direct impact of temporarily increased sedimentation rates.

These impacts on benthic habitats and species will be localised and are not expected to result in significant changes to the benthic community in the short or long-term.

5.1.5 Mitigation Measures

All rock placement will be carried out using a vessel with a flexible fall pipe, assisting with positional accuracy and controlling the spread of the material. No vessel anchoring is planned during decommissioning operations.

Disturbance of the cuttings piles during decommissioning operations could potentially occur during the removal of the Auk and Fulmar AD jackets (but could be minimised if it is possible to cut the piles internally) and from overtrawling for clean seabed surveys, but also to an undefined extent from future fishing activity. Repsol Sinopec Resources UK Limited will ensure that data are made available to enable the cuttings piles to be marked on Kingfisher charts and FishSAFE plotter files.

This will highlight the presence of the cuttings piles to fishermen and assist in reducing the frequency of trawling interactions (over which time the cuttings piles will continue to naturally degrade). It is likely that the activities potentially causing the most disturbance to the cuttings piles may assist recovery of the seabed in the longer term.

5.1.6 Cumulative Assessment

Other oil and gas surface installations in the vicinity of the Fulmar and Auk platforms, and also within the Fulmar MCZ, include Clyde (Figure 3.13). The Janice, James and Affleck fields have now been decommissioned. Other field developments in the vicinity within the Fulmar MCZ include Levin, Medwin, Nethan and Orion, all tied back to Clyde. A network of approximately 296 km of pipelines is associated with these or which pass through the MCZ. This does not include the small diameter methanol, chemical and hydraulic lines that are sometimes piggybacked or laid alongside the existing gas lines. The seabed areas, and the proportion of the MCZ area, affected by infrastructure removal at Auk, Fulmar and Auk North (Table 5.9) will mostly coincide with the areas that were disturbed during the construction, installation and operational phases of the developments. In addition, the decommissioning activities proposed will reduce the footprint of infrastructure on the seabed – both within the Auk, Fulmar and Auk North fields and in relation to the oil and gas industry seabed footprint in the region overall.

Janice, James and Affleck were decommissioned recently, so there is no likelihood of direct overlap between activities here and those planned for Auk, Fulmar and Auk North.

Commercial fishing is the main activity resulting in seabed disturbance near the Project area. As outlined in Section 5.1.3.1, seabed disturbance associated with decommissioning activities will be minor in comparison to the annual disturbance associated with demersal trawling, as a one-off event, decommissioning is not expected to significantly increase the seabed impact associated with commercial fishing.

Overall it is considered that decommissioning will result in a net reduction of impact to the seabed from the oil and gas industry in the region, the MCZ and the North Sea in additive terms.

Table 5.9: Seabed Impact Due to Auk, Fulmar and Auk North Decommissioning Activities Predicted Within the Fulmar MCZ

Impact	Area affected (km^2)	Percentage of Fulmar MCZ (%)
Short-term disturbance without overtrawl surveys	0.285	0.011
Short-term disturbance including overtrawl surveys	11.435	0.469
Long-term disturbance due to infrastructure decommissioned in-situ and rock armour	0.231	0.009
Long-term disturbance due to cuttings pile at Auk, including potential for spreading of contamination by dredging activities	0.134 (existing area where THC levels currently exceed 50 $\mu g g^{-1}$) This area is not predicted to increase if dredging/jetting is required for pile cutting (Section 5.1.3.4)	0.005
Long-term footprint due to cuttings pile at Fulmar, including potential for spreading of contamination by dredging activities	0.262 (existing area where THC levels currently exceed 50 $\mu g g^{-1}$) This area is not predicted to increase if dredging/jetting is required for pile cutting (Section 5.1.3.4)	0.011

5.1.7 Transboundary Impact

Decommissioning activities are located approximately 15 km west of the UK/Norway median line, at their closest point. Planned decommissioning activities are not anticipated to create any transboundary impacts with regards to disturbance of the seabed and cuttings piles.

5.1.8 Protected Sites

5.1.8.1 Fulmar MCZ

The potential impacts from the proposed decommissioning associated with Auk, Fulmar and Auk North activities within the Fulmar MCZ will cause a localised area of seabed disturbance to the MCZ due to suspension and resettlement of sediments potentially smothering sessile seabed organisms, including ocean quahog. The area at potential risk of being impacted is relatively small compared to the extent of the MCZ (2,439 km^2) and is summarised in Table 5.9.

Sediments that are redistributed and mobilised as a result of the proposed decommissioning activities will be transported by the seabed currents before settling out over adjacent seabed areas. Disturbance to the seabed will be mostly short-term, localised and largely confined to areas that have already been subject to disturbance through the installation and operational phases of the infrastructure (or that which is already subject to demersal trawling). Through the natural sediment movement processes in this relatively low-energy location, the muddy sands, sandy muds and mixed sediments and their typical benthic communities are expected to show good recovery within three or four years. Similar considerations apply to the ocean quahog, which is expected to be relatively tolerant of both serious smothering/overturning and lighter sedimentation.

The small proportion of the site that has been affected by cuttings piles at Auk and Fulmar is currently recovering, although complete recovery is expected over a decadal timescale.

Overall, the planned decommissioning activities including cumulative impact considerations are predicted not to have a significant adverse effect upon the integrity of the Fulmar MCZ and its protected features.

5.1.9 Residual Impact

The residual impact to seabed habitat and benthic communities due to the planned decommissioning activities is summaries in Table 5.10.

Table 5.10: Residual Impact to Seabed Habitat and Benthos

Impact	Sensitivity	Magnitude
Short-term direct and indirect disturbance due to removal of infrastructure / pipelines	Medium	Minor
Long-term disturbance due to decommissioning *in-situ* of hard substrate (habitat change)	Medium	Minor
Long-term effects due to degradation of structures decommissioned *in-situ*	Medium	Negligible
Long-term effects due to cuttings piles disturbance	Medium	Minor
Rationale		
Decommissioning activities at Auk, Fulmar and Auk North will cause a physical disturbance to the local seabed environment due to subsea infrastructure removal. Sessile and mobile organisms are predicted to have some tolerance to accommodate the seabed disturbance, the natural background communities will be able to recover relatively quickly, and any changes to the existing modified communities on the cuttings piles are unlikely to be discernible (thus medium sensitivity). The impact is not likely to affect long-term functioning of benthic communities, with the seabed impact being localised (thus low vulnerability). The benthic environment is part of the Fulmar MCZ (thus high value). Impacts to the seabed will be highly localised and largely temporary in nature with good recovery potential (thus minor magnitude). Combining these, the impact significance for the seabed and benthic communities is defined as Low and not significant. Most of the hard substrata being left *in-situ* has been in place for the life of the Auk, Fulmar and Auk North fields, including the footings of the Fulmar A jacket and most of the currently existing rock cover over pipelines. The proposed introduction of small additional rock placements will not add significantly to the artificial hard substrata already in place. In addition, it is not expected that this will result in any significant change to the species typically present on naturally occurring hard material in the area as a whole. The sensitivity of the benthic fauna and habitats present is medium, and the impact magnitude minor, resulting in the significance of habitat change impacts being rated low. Structural degradation of pipelines/umbilicals/cables and jacket footings left *in-situ* will be a long-term process leading to eventual collapse under their own weight. Degradation products from these items (or any materials contained) will be released. The small scale and gradual nature of these types of releases, over a timescale in which the chemicals or materials will have become degraded and ineffective (in terms of their original purpose) will mean that none will build up, bioaccumulate or reach levels that are intrinsically harmful		

to the marine environment. The sensitivity of the benthos receptor to these types of impact is considered medium, but the magnitude of impacts is likely to be negligible giving an overall impact significance level of low for materials degradation. Whilst potential disturbance of the Auk and Fulmar cuttings accumulations will cause redistribution of contaminated material, modelling for such activities at Auk and Fulmar AD indicated that this will be confined to the area of seabed already affected by the original drilling discharges. The modelling also indicated little change to sediment hydrocarbon content within the deposition area, whilst also predicting a recovery period of more than 10 years. It should be noted that this impact will be taking place within an area that has been subject to similar but continuous impact for four decades and where the fauna has long been highly modified and opportunistic in nature. It is therefore considered that the impact of potential dredging or jetting activities is not likely to significantly alter the state of the benthic environment at or around the cuttings piles in the longer term. Sensitivity is medium for the fauna present, and with an impact magnitude considered minor, the significance of drilling mud related impacts comes out at low. The resulting significance for all impacts to the benthic environment assessed is low.
Impact significance
Low

5.2 Other Sea Users

5.2.1 Introduction

The proposed decommissioning activities have the potential to affect other users of the sea. This may happen during the decommissioning activities themselves or after decommissioning should any infrastructure decommissioned *in-situ* interact with activities such as fishing. Through the EA process, the following issues were considered as potentially having a significant impact on other sea users:

- Physical presence of subsea infrastructure and Fulmar A jacket footings decommissioned *in-situ*; and
- Physical presence of cuttings piles at the Auk and Fulmar A.

5.2.2 Description and Quantification of Impact

5.2.2.1 Long-Term Physical Presence of Subsea Infrastructure Decommissioned in-situ

The long-term presence of subsea infrastructure decommissioned *in-situ* has the potential to interfere with other sea users, and includes the following items:

Pipelines/umbilicals/cables:

- Group 1, 24" concrete coated pipeline (PL1315)
- Group 2, 10" concrete coated pipeline, surface laid and exposed (PL38)
- Group 3, Pipelines and umbilicals (PL208, PL1316, PLU4472/N0878, PLU4473/N0879);
- Group 4, Pipelines (PL378, PL2651); and
- Group 6, Umbilicals and cables (PLU4471, PLU2652, PLU2653).

However, Group 1 PL1315 and Group 2 PL38 are being fully trenched and buried prior to being left *in-situ* as a base case, and/or may require elements of rock placement along part or all their lengths to ensure they are fully overtrawalable once decommissioned, Group 3 pipelines are already fully rock covered and overtrawlable, and Groups 4 and 6 are already fully trenched and buried. These will therefore not be exposed to other sea users including fishermen and fishing gear.

The exposed ends of all pipelines/umbilicals/cables being left *in-situ* will be cut into short sections for recovery onto a vessel for transfer to shore. The remaining cut ends will be made safe to mitigate snagging hazards for other users of the sea, for example by burial or adding rock cover.

Once all decommissioning activities are completed, debris clearance surveys will be undertaken to ensure a clear seabed has been left that is safe for other sea users. As part of the assurance process required, it is also likely that overtrawl surveys will be undertaken within the 500 m safety exclusion zones of platform and subsea installation locations and within a 100 m corridor (50 m each side) of pipeline/umbilical/cable decommissioned *in-situ*.

The physical presence of the subsea infrastructure decommissioned *in-situ* and localised rock placement will not result in any increase to the existing potential for interaction with fishing gear. However, the presence of the Fulmar A jacket footings with no topsides or 500 m safety exclusion zone will provide increased potential for interactions.

5.2.2.2 Long-Term Physical Presence of Fulmar A Jacket Footings

The base case decommissioning option for the Fulmar A platform is for the topsides and most of the jacket to be removed, leaving the footings *in-situ*. The footings will occupy an area of seabed of approximately 0.005 km^2 (Table 5.7). This would represent an ongoing snagging hazard to other sea users, particularly to vessels deploying subsea equipment such as fishing vessels, for the centuries timescale it may take for the steel structure to corrode, collapse and fragment.

Once decommissioning activities are complete, information will be made available to allow Admiralty Charts and the FishSAFE system to be updated and all changes to be notified to fishermen and other sea users.

5.2.2.3 Long-Term Physical Presence of Cuttings Piles

Removing the 500 m safety exclusion zones at Auk and Fulmar opens the area to other sea users and will enable fishing gear to interact with the Auk and Fulmar drill cuttings piles once decommissioning is complete. One effect of leaving the Fulmar A jacket footings in place is that these will provide a barrier to disturbance by fishing gear for a significant part of the cuttings pile. Nevertheless, the potential remains for demersal trawl interactions with contaminated cuttings around the former Auk Alpha and Fulmar AD locations.

As described in Section 2.3.4, survey data from the cuttings piles at Auk and Fulmar indicate that the contaminated areas have shrunk in size, particularly at Auk where the 50 $\mu g g^{-1}$ sediment hydrocarbon footprint has halved in area since 2008 (Table 2.5). The conclusion from the UKOOA JIP on cuttings piles with regard to longevity was that the presence of significant contamination is likely to be measured in decadal timescales, e.g. 10 to 50 years in water depths of around 70 m representative of the CNS, but at centennial timescales of 500 to 1,500 years for water depths of more than 120 m **[Ref. 97]**. Auk and Fulmar, both in the CNS at 85 m and 83 m respectively could have longevities measured in closer to the decadal timescales predicted, and this is supported by the survey data available showing the area of contamination to be shrinking **[Refs. 12, 13]**.

Discounting the possible disturbance resulting from footings collapse (see Section 5.1.5.5), two decommissioning-related activities have the potential to alter the cuttings piles. The first is the possible need to undertake clearance dredging or jetting of the cuttings pile around the Auk and Fulmar AD jacket legs to expose the steel piles for cutting. The second is the overtrawling activity potentially required in demonstration of a safe seabed, as outlined above. However, as outlined in Section 5.1.5, modelling studies conducted to investigate the impacts of cuttings disturbance by dredging or jetting **[Refs. 93, 94]**, together with the results earlier field trials and modelling studies conducted for fishing-related disturbance at several locations **[Ref. 95]** indicate that most of the material mobilised will resettle within the existing footprint of contamination by the original cuttings discharges. Neither activity should therefore increase the risk potential associated with trawl-cuttings pile interactions.

These studies indicate that any fishing interactions with the cuttings piles remaining should not result in significant environmental impact. Further, the survey and overtrawling work carried out by Repsol Sinopec Resources UK Limited following decommissioning will be designed to provide assurance of a safe seabed.

5.2.3 Mitigation

A number of mitigation measures will be employed to eliminate or minimise the impact on other sea users:

- The Auk, Fulmar and Auk North subsea infrastructure is currently shown on Admiralty charts and the FishSAFE system. Once decommissioning activities are complete, information will be made available to allow Admiralty Charts and the FishSAFE system to be updated and all changes to be notified to fishermen and other sea users;
- Surveys and debris searches will be conducted as part of a programme to ensure a safe seabed is left for other sea users. As part of the assurance for this, overtrawling will be conducted within the 500 m safety exclusion zones of former installation locations and within a 100 m corridor (50 m each side) of pipelines/umbilicals/cables decommissioned *in-situ* as required or as necessary;
- Independent verification of seabed clearance will be obtained;

- Repsol Sinopec Resources UK Limited recognises its commitment to monitor any structures decommissioned *in-situ* and will make arrangements to undertake post-decommissioning monitoring. The type and frequency of monitoring required will be determined through a risk-based approach and agreed with OPRED. During the period over which monitoring is required, the status of the infrastructure decommissioned *in-situ* would be reviewed and any necessary remedial action undertaken to ensure it does not pose a risk to other sea users; and
- Post-decommissioning monitoring will include benthic environmental survey work to review the recovery and ongoing condition of the cuttings piles. The scope, specification and frequency of this monitoring will be agreed with OPRED and stakeholders.

5.2.4 Cumulative Assessment

Most infrastructure is being removed or trenched and buried. Considered alongside the low levels of fishing and shipping activity in the vicinity of the Auk, Fulmar and Auk North fields, the wide expanse of offshore water available for navigation, and the surveys, debris clearance, and overtrawling assurance, it is not anticipated that there will be any significant cumulative impacts with respect to the long-term presence of decommissioned subsea infrastructure.

Following decommissioning, monitoring will be conducted in agreement with OPRED to ensure the subsea infrastructure decommissioned *in-situ* remains in a state that is safe for other sea users. In terms of the scale of the decommissioning activities with regards to other sea users, there are estimated to be 457 safety zones in the UKCS **[Ref. 101]**. The decommissioning of the Auk, Fulmar and Auk North fields will see the removal of effectively three of these, each approximately 0.8 km^2. This will reduce the area of the North Sea that is currently unavailable to other sea users and reduce the cumulative impact of oil and gas physical presence in the region. There are no negative cumulative impacts expected.

5.2.5 Transboundary Impact

As the Auk, Fulmar and Auk North area is beyond the UK's 12 NM limit, EU and non-EU vessels are also permitted to fish in the area, subject to management agreements including, for example, quota allocation and days at sea. Fishing activity in the area is low, and it was reported **[Ref. 59]** that the majority of fishing here is by UK demersal trawlers. With the median line between the UK and Norway some 30 km from Fulmar (and approximately 15 km from the eastern end of PL1315), there is no mechanism by which significant transboundary impacts to other sea users could occur in terms of the infrastructure that is decommissioned *in-situ*.

5.2.6 Residual Impact

The residual impact to other sea users due to the planned decommissioning activities is summarised in Table 5.11.

Table 5.11: Residual Impact to Other Sea Users

<table>
<tr><th>Receptor</th><th>Sensitivity</th><th>Magnitude</th></tr>
<tr><td>Other sea users, excluding fisheries</td><td>Low</td><td>Minor</td></tr>
<tr><td>Fisheries</td><td>Medium</td><td>Minor</td></tr>
<tr><td colspan="3">Rationale</td></tr>
<tr><td colspan="3">The information in the Environment Baseline (Section 3) has been used to assign the sensitivity of the receptors and the magnitude of the impact as follows. At this location, sea users other than fisheries mainly relates to shipping. In offshore deep waters, shipping is generally not sensitive or vulnerable to infrastructure being decommissioned in-situ at the seabed and makes limited use of the area (thus low sensitivity) and will experience only very localised effects including the beneficial returned availability of areas formerly occupied in the long-term by installations and safety exclusion zones (thus minor magnitude). On this basis, the consequence is negligible and the impact Low.

With prior consultation, the fishing industry is expected to be tolerant of short-term interference whilst decommissioning is underway; also, the removal of infrastructure and safety exclusion zones at Auk, Fulmar A and AD and Auk North means that fisheries will regain the use of sea areas from which they have been excluded long-term, which is considered a positive impact. Fishing effort in the area is low, as are recorded catch values; however, snagging risk will remain from the Fulmar A jacket footings decommissioned in-situ (thus medium sensitivity). Given the approach and design of decommissioning activities proposed, stakeholder consultation and information to be provided of changes to update Admiralty Charts and FishSAFE and other notifications to be made, the impact magnitude is considered Minor. The potential to retain a safety zone around the jacket footings is also being investigated.

Combining these, the impact consequence is defined as Low and not significant.</td></tr>
<tr><td colspan="2">Impact significance</td><td></td></tr>
<tr><td colspan="3">Low</td></tr>
</table>

6. CONCLUSIONS

Following a detailed review of the project activities, the environmental sensitivities of the decommissioning project area, industry experience of decommissioning activities and incorporating stakeholder concerns, it was determined that further assessment of the following issues was required in order to properly define the potential impact of the proposed decommissioning activities at Auk, Fulmar and Auk North:

> Seabed interaction, with disturbance to the seabed

> Seabed interaction, with disturbance to cuttings piles; and

> The physical presence of infrastructure decommissioned *in-situ* in relation to other sea users, both in terms of possible exclusion and risk of snagging.

A review of each of these potentially significant environmental interactions has been completed and, considering the mitigation measures that will be built into the project activities, there is expected to be no significant impact on receptors. As part of this review, cumulative and transboundary impacts were assessed and determined to be not significant.

Given the location of the decommissioning project activities, of key importance is the potential for impact to the Fulmar MCZ within which the Auk, Fulmar and Auk North fields are located. This site is designated for seabed features, namely subtidal sands, subtidal muds, subtidal mixed sediments, and the ocean quahog. Having reviewed the decommissioning project activities, there is not expected to be a significant impact on any of these features or the site's conservation objectives.

Finally, this EA has considered the Marine Policy Statement issued as the framework for preparing UK Marine Plans and taking decisions affecting the marine environment, until the North East Inshore and North East Offshore Marine Plans are developed and adopted. Repsol Sinopec Resources UK Limited considers that the proposed decommissioning activities are in broad alignment with such objectives and policies.

In summary, the proposed operations have been rigorously assessed through the ENVIDs, CA and EA for the Auk, Fulmar and Auk North assets, resulting in a set of selected decommissioning options which are thought to present the least risk of environmental impact whilst satisfying safety risk, technical feasibility, societal impacts and economic requirements. Based on the findings of this EA and the identification and subsequent application of the mitigation measures identified for each potentially significant environmental impact, it is concluded that the proposed Auk, Fulmar and Auk North Decommissioning activities will result in no significant environmental impact.

7. REFERENCES

1. Repsol Sinopec Resources UK Limited (2018). Preparation of CA, EIA and DP for Auk, Auk North & Fulmar. Auk Decommissioning Programme Second Draft. RP-DTAAUK001-DC-0065-02-C02 issued 05/04/2018.
2. Repsol Sinopec Resources UK Limited (2019a). Preparation of CA, EIA and DP for Auk, Auk North & Fulmar. Fulmar Sub-Structures Decommissioning Programme. Third pre-draft. RP-DTAFUL001-DC-0062-C01, pending issue.
3. OPRED (2018). Guidance Notes. Decommissioning of Offshore Oil and Gas Installations and Pipelines. Offshore Decommissioning Unit, Offshore Petroleum Regulator for Environment and Decommissioning, Department of Business, Energy and Industrial Strategy. December 2017.
4. HM Government (2011). UK Marine Policy Statement. HM Government Northern Ireland Executive Scottish Government Welsh Assembly Government. London: The Stationery Office, March 2011. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69322/pb3654-marine-policy-statement-110316.pdf.
5. Decom North Sea (2017). Environmental Appraisal Guidelines: Offshore Oil and Gas Decommissioning.
6. Xodus (2018) Preparation of CA, EIA and DP for Auk, Auk North & Fulmar; CA Recommendation Fulmar Jacket. Report to Repsol Sinopec Resources UK Ltd from Xodus Group. A302016-S00-REPT-002.
7. OGUK (2015). Guidelines for Comparative Assessment in Decommissioning Programmes. SKU: EN038.
8. Xodus (2018). Preparation of CA, EIA and DP for Auk, Auk North & Fulmar; CA Recommendation Subsea. Report to Repsol Sinopec Resources UK Ltd from Xodus Group. A302016-S00-REPT-001-R02 issued 23.02.2018.
9. OGUK (2015). Guidelines for the Abandonment of Wells, Issue 5, July 2015. SKU: OP071.
10. OSPAR (2006). OSPAR Recommendation 2006/5 on a Management Regime for Offshore Cuttings Piles.
11. ERT (2010). Assessment of cuttings distribution and extent of 50 mgkg-1 oil contamination at Talisman's Assets in compliance with Stage 1 OSPAR Recommendation 2006/5 (3.4.3), Environmental Monitoring Surveys, August 2008, Doc No: ERT 2002/R003.
12. Fugro (2018). Cuttings Pile Assessment Report Auk Pre-Decommissioning Survey, UKCS Block 30/16, Doc No: 170019-R-004(02).
13. Fugro (2018). Cuttings Pile Assessment Report Fulmar Pre-Decommissioning Survey, UKCS Block 30/16, Doc No: 170019-R-007(01).
14. UKOOA (2005). UKOOA JIP 2004 Drill Cuttings Initiative Phase III: final report. Report for submission to DTI. Report number 20132900, 26 January 2005.
15. DTI (2001). Report to the Department of Trade and Industry. Strategic Environmental Assessment of the Mature Areas of the Offshore North Sea 2. Consultation Document, September 2001.
16. Fugro (2017). Field Report, Auk, Auk North and Fulmar Pre-Decommissioning Survey, UKCS Block 30/16, Doc No: 170019-R-001(01).
17. Fugro (2017). Habitat Assessment, Auk, Auk North and Fulmar Pre-Decommissioning Survey, UKCS Block 30/16, Doc No: 170019-R-002(01).

18. Fugro (2018). Environmental Baseline Survey Report, Auk Pre-decommissioning Survey. 2017 Repsol Auk, Auk North and Fulmar Decommissioning, Doc No: 170019-R-003(03).
19. Fugro (2018). Environmental Baseline Report, Fulmar Pre-Decommissioning Survey. 2017 Repsol Auk, Auk North and Fulmar Decommissioning, Doc No: 170019-R-006(01).
20. Fugro (2018). Environmental Baseline Survey Report, Auk North Pre-Decommissioning Survey. 2017 Repsol Auk, Auk North and Fulmar Decommissioning, Doc No: 70019-R-005(02).
21. Fugro (2007). Rig site survey Auk prospect UKCS Block 30/16. Environmental Baseline and Habitat Survey. Report No. 9237.4V3.1. Volume 3.
22. Britsurvey (1997). Drill Cuttings Survey 1997 Fulmar.
23. ERT (1993). Shell Fulmar A Environmental Survey July 1992. Report No. ERT 92/151/R4.
24. Shell Group (1993). Assessment of the Toxicity of Sediments Collected During a Seabed Survey Around the North Sea Fulmar A Platform.
25. BGERS (1990). Shell Fulmar Alpha Drill Cutting Mound 3D Sonar Survey.
26. AUMS (1989). Shell North Fulmar field post-drilling environmental survey, June 1988. Department of Zoology, Aberdeen University Marine Studies Limited. pp. 89.
27. M-Scan (1986). A survey of seabed sediment hydrocarbon concentrations around the Auk and Vulcan fields. November 1985 Survey. M-Scan LTD. Ascot. (UE05/4-1986).
28. OPRU (1978). Biological Survey of the Auk Oil Field, May 1977. Report from the Oil Pollution Research Unit.
29. IOE (1978). Brent-Auk fields offshore environmental appraisal: hydrocarbon baseline study. Institute of Offshore Engineering. Heriot-Watt University, Edinburgh.
30. Hartley Anderson (2011). Summary of Seabed Mapping and Sampling around the Montrose/Arbroath and Auk/Fulmar Field Areas. Report to Talisman Energy (UK) Limited, May 2011.
31. JNCC (2010). UKSeaMap – Predictive mapping of seabed habitats. Online at http://jncc.defra.gov.uk/page-5534 [Accessed 02/12/2017].
32. Jones, L., Parry, M. & Wright, H. (2016). Community analysis of Fulmar MCZ, Offshore Brighton MCZ and Western Channel MCZ. JNCC Report No. 593. JNCC, Peterborough.
33. IOE (1985). Input of contaminants to the North Sea from the United Kingdom. Institute of Offshore Engineering. Heriot-Watt University, Edinburgh.
34. UKOOA (2001) An analysis of UK offshore oil and gas environmental surveys 1975 to 1995. A study carried out by Heriot-Watt University at the request of the United Kingdom Offshore Operators Association. pp. 132 and appendices.
35. OSPAR (2014) Levels and trends in marine contaminants and their biological effects – CEMP assessment report 2013. Monitoring and Assessment Series. OSPAR Commission London. Publication No. 631/2014.
36. Battelle (2007). Sediment toxicity of petroleum hydrocarbon fractions. Report prepared for Massachusetts Department of Environmental Protection by Battelle. September 2007.
37. OSPAR (2008). List of threatened and/or declining species & habitats. Online at https://www.ospar.org/work-areas/bdc/species-habitats/list-of-threatened-declining-species-habitats [Accessed 18/12/2017].
38. Irving, R. (2009). The Identification of the Main Characteristics of Stony Reef Habitats under the Habitats Directive. Joint Nature Conservation Committee. Available online at: http://jncc.defra.gov.uk/pdf/web432.pdf. [Accessed 15 December 2017].

39. Olsgard, F. and Gray, J.S. (1995). A comprehensive analysis of the effects of offshore oil and gas exploration and production on the benthic communities of the Norwegian continental shelf. Marine Ecology Progress Series. 122, pp. 277–306.

40. Hiscock, K., Langmead, O., Warwick, R. and Smith, A. (2005) Identification of seabed indicator species to support implementation of the EU Habitats and Water Framework Directives. Second edition. Report to the Joint Nature Conservation Committee and the Environment Agency from the Marine Biological Association. Plymouth: Marine Biological Association. JNCC Contract F90-01-705. 77 pp.

41. Fugro (unpublished). Beatrice Pre-Decommissioning Survey Habitat Assessment Report (161067_02rev3).

42. Coull, K.A., Johnstone, R. and Rogers, S.I. (1998). Fisheries Sensitivity Maps in British Waters. Published and distributed by UKOOA Ltd.

43. Ellis, J.R., Milligan, S., Readdy, L., South, A., Taylor, N. and Brown, M. (2012). Mapping the spawning and nursery grounds of selected fish for spatial planning. Report to the Department of Environment, Food and Rural Affairs from Cefas. Defra Contract No. MB5301.

44. Aires, C., Gonzlez-Irusta, J.M., Watret, R. (2014). Scottish Marine and Freshwater Science Report, Vol 5 No 10, Updating Fisheries Sensitivity Maps in British Waters'. Available online at http://www.scotland.gov.uk/Publications/2014/12/3334 with further details at http://www.scotland.gov.uk/Topics/marine/science/MSInteractive/Themes/fish-fisheries/fsm [Accessed 14/06/2016].

45. Webb, A., Elgie, M., Irwin, C., Pollock, C. and Barton, C. (2016). Sensitivity of offshore seabird concentrations to oil pollution around the United Kingdom: Report to Oil & Gas UK. Document No HP00061701.

46. Reid, J., Evans, P.G.H. and Northridge, S. (2003). An atlas of cetacean distribution on the northwest European Continental Shelf. Joint Nature Conservation Committee, Peterborough.

47. Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M.B., Scheidat, M., Teilmann, J., Vingada, J. and Øien, N. (2017). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. Online at https://synergy.st-andrews.ac.uk/scans3/files/2017/05/SCANS-III-design-based-estimates-2017-05-12-final-revised.pdf [Accessed 10/12/17].

48. Jones, E., McConnell, B., Sparling, C and Matthiopoulos, J. (2015). Marine Mammal Scientific Support Research Programme MMSS/001/11. At-sea usage and activity. Online at http://www.smru.st-andrews.ac.uk/files/2015/10/MR5-1_at-sea_usage_and_activity_VF2.pdf [Accessed 22/12/17].

49. Defra (2016) Fulmar Marine Conservation Zone: Factsheet. Available online at https://www.gov.uk/government/publications/marine-conservation-zones-fulmar [Accessed 09/08/2017].

50. Hamer, K. C., Phillips, R. A., Wanless, S., Harris, M. P., & Wood, A. G. (2000). Foraging ranges, diets and feeding locations of gannets *Morus bassanus* in the North Sea: evidence from satellite telemetry. *Marine Ecology Progress Series* **200**: 257-264.

51. JNCC (2018). Supplementary Advice on Conservation Objectives for Fulmar MCZ. Joint Nature Conservation Committee and Defra, February 2018.

52. Camphuysen, K., Scott, B. and Wanless, S. (2011). Distribution and foraging interactions of seabirds and marine mammals in the North Sea: a metapopulation analysis [online]. Available at: http://www.abdn.ac.uk/staffpages/uploads/nhi635/ZSLpaper-kees.pdf.

53. Jones, E., McConnell, B., Sparling, C. and Matthiopoulos, J. (2013). Grey and harbour seal density maps. Report from the Sea Mammal Research Unit to Marine Scotland [online]. Available: http://www.scotland.gov.uk/Resource/0041/00416981.pdf.

54. McConnell, B.J., Fedak, M. A., Lovell, P, and Hammond, P.S. (1999). Movements and foraging areas of grey seals in the North Sea. *Journal of Applied Ecology*, 36: 573-90.

55. Hammond, P.S., Berggren, P., Borchers, D.L., Collet, A., Heide Jorgensen, M.P., Heimlich, S., Hiby, A.R., Leopold, M.F. and Oien, N. (2002). Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. *Journal of Applied Ecology*, 39 (2): 361-376.

56. McLeod, E., Salm, R., Green A. and Almany, J. (2008). Designing marine protected area networks to address the impacts of climate change. *Frontiers in Ecology and the Environment*, **7**: 362-370.

57. Russell, D.J.F. and McConnell, B. (2014). Seal at-sea distribution, movement and behaviour. Report to DECC, URN D 14 [online]. Available at: www.gov.uk/government/uploads/system/uploads/attachment_data/file/346304/OESEA2_SMRU_Seal_distribution_and_behaviour.pdf.

58. Scottish Government (2019). Fishing Effort and Quantity and Value of Landings by ICES Rectangle. Scottish Government, Available online at https://www2.gov.scot/Topics/Statistics/Browse/Agriculture-Fisheries/RectangleData [Accessed 05/11/2019].

59. Anatec (2017). Auk, Auk North and Fulmar Subsea Infrastructure Decommissioning Fishing Analysis. November 2017. No. A4049-XG-RA-1.

60. DECC (2016). UK Offshore Energy Strategic Environmental Assessment 3. Appendix 1H: Other sea users. 2016. Available online at https://www.gov.uk/government/consultations/uk-offshore-energy-strategic-environmental-assessment-3-oesea3 [Accessed 09/08/2017].

61. IEEM (2010). Guidelines for Ecological Impact Assessment in Britain and Ireland - Marine and Coastal. Institute of Ecology and Environmental Management.

62. Morris, P. and Therivel, R. (2009). Methods of Environmental Impact Assessment. Natural and Built Environment Series. Routledge, third edition. 576 pages.

63. IEMA (2004). Guidelines for environmental impact assessment. Institute of Environmental Management and Assessment. Available online at: http://bailey.persona-pi.com/Public-Inquiries/Barking%20Riverside/B-Core%20Documents/Category%20D%20National,%20London%20and%20Local%20Policy%20and%20Guidanc%20Documents/D6%20-%20Evironmental%20Assessment%20Impact.pdf.

64. IPCC (2014). Climate Change 2014 Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

65. Neal, K.J. & Avant, P. (2008). *Owenia fusiformis* A tubeworm. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://192.171.193.68/species/detail/1703.

66. Dernie, K. M., Kaiser, M. J., and Warwick, R. M. (2003). Recovery rates of benthic communities following physical disturbance. *Journal of Animal Ecology*, **72** (6), 1043-1056.

67. Foden, J., Rogers, S.I. and Jones, A.P. (2009). Recovery rates of UK seabed habitats after cessation of aggregate extraction. *Marine Ecology Progress Series*, **390**, 15-26.

68. Hiddink, J., Jennings, S. and Kaiser, M.J. (2006). Indicators of the Ecological Impact of Bottom-Trawl Disturbance on Seabed Communities. *Ecosystems*, **9**(7), 1190 – 1199.

69. Seafish (2018). Seafish Gear Database. Online at http://www.seafish.org/geardb/gear/beam-trawl/.

70. JNCC (2017). SACFOR abundance scale used for both littoral and sublittoral taxa from 1990 onwards. Accessed at: http://jncc.defra.gov.uk/page-2684.

71. Tyler-Walters, H. and Sabatini, M. (2008). *Arctica islandica* Icelandic cyprine. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Online at http://www.marlin.ac.uk/species/detail/1519 [Accessed 27/01/2017].

72. Tillin, H.M. and Budd, G. (2016). Abra alba and Nucula nitidosa in circalittoral muddy sand or slightly mixed sediment. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Online at http://www.marlin.ac.uk/habitat/detail/62 [Accessed 26/12/2017].

73. Chervenack, M.C. (2000). The environmental fate of commonly used oxidizing and non-oxidizing biocides: Reactions of industrial water biocides within the system. International environmental conference & exhibit; Setting the environmental course for the 21st century; 2000; Denver, Colorado. 16 pages.

74. Hylland, K. and Erikson, D.O. (2013). Naturally occurring radioactive material in North Sea produced water: environmental consequences. Norsk Olje og Gass.

75. OGUK (2015). NORM Scale. Online at http://www.oilandgasuk.co.uk/knowledgecentre/normscale.cfm [Accessed 30/11/17].

76. Xodus (2017). Preparation of CA, EIA & DP for Auk, Auk North & Fulmar: Subsea Material Inventory Study Report. Report to Repsol Sinopec Resources UK Ltd from Xodus Group. RP-DTAAUK001-SS-0046 Rev C01 issued 20/12/2017.

77. Neff, J.M. (2002). Bioaccumulation in marine organisms. Effect of contaminants from oil well produced water. Elsevier, London.

78. Kennish, M. J. (1997). Pollution Impacts on Marine Biotic Communities. CRC Press LLC, USA, ISBN 0-8493-8428-1.

79. Ansari, T.M., Marr, I.L. and Tariq, N. (2004). Heavy Metals in Marine Pollution Perspective – A Mini Review. *Journal of Applied Sciences*, **4**: 1-20.

80. Roberge, P (1999). Handbook of Corrosion Engineering. McGraw-Hull Professional. 1072 pages.

81. HSE (1997). The abandonment of offshore pipelines: Methods and procedures for abandonment. Offshore technology report. HSE Books, Norwich. ISBN -7176-1421-2. Health and Safety Executive.

82. Xodus (2017). Qualitative Risk Assessment of Leaving Items In-Situ. Report to Repsol Sinopec Resources UK Ltd from Xodus Group. RP-DTAAUK001-HS-0058 Rev C01 issued 20/12/2017.

83. CNRI (2017). Ninian Northern Platform Late Life and Decommissioning Project. Report – Environmental Statement. P0005-BMT-EN-REP-00006, February 2017.

84. Gabelle, C. Baraud, F., Biree, L., Gouali, S., Hamdoun, H., Rousseau, C., van Veen, E. and Leleyter, L. (2012). The impact of aluminium sacrificial anodes on the marine environment: A case study. *Applied Geochemistry*, **27**, Issue 10, October 2012, Pages 2088-2095.

85. MPE (1999). The Final Disposal of Disused Pipelines and Cables. Summary of the Findings of a Norwegian Assessment Programme. Oslo, December, 1999. Ministry of Petroleum and Energy.

86. OGUK (2013). Long term Degradation of Offshore Structures and Pipelines Decommissioned and left in-situ, Oil and Gas UK. February 2013.

87. Shell UK (2017). Brent Field Pipelines Decommissioning Technical Document. Report no BDE-F-PIP-BA-5801-00001.

88. GESAMP (2015). Sources, fate and effects of microplastics in the marine environment: a global assessment (Kershaw, P.J., ed.). IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/

UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Rep. Stud. GESAMP No. 90, 96 p.

89. DNV (2006). Petroleum Safety Authority Norway (PSA), Material risk – aging offshore installations. Det Norske Veritas.

90. Law, K.L. (2017). Plastics in the Marine Environment. Annual Review of Marine Science, Vol. 9 pages 205-229. First published online as a Review in Advance on September 7, 2016. https://doi.org/10.1146/annurev-marine-010816-060409

91. Beiras, R. and Tato, T. (2019). Microplastics do not increase toxicity of a hydrophobic organic chemical to marine plankton. Marine Pollution Bulletin 138, 58–62

92. IUCN (2018). Marine Plastics. Issues Brief. International Union for the Conservation of Nature. May 2018.

93. Xodus (2018c). Preparation of CA, EIA and DP for Auk, Auk North & Fulmar; Drill Cuttings Disturbance Modelling - Auk. Report to Repsol Sinopec Resources UK Ltd from Xodus Group. RP-DTAAUK001-HS-0062 Rev R02 issued 21/05/2018.

94. Xodus (2018d). Preparation of CA, EIA and DP for Auk, Auk North & Fulmar; Drill Cuttings Disturbance Modelling - Fulmar. Report to Repsol Sinopec Resources UK Ltd from Xodus Group. RP-DTAFUL001-HS-0029 Rev C01.

95. OSPAR (2009b). Assessment of the possible effects of releases of oil and chemicals from any disturbance of cuttings piles. OSPAR Commission, London. Publication number 337/2009 (2009 update). Online at www.ospar.org/documents?d=7082 [Accessed 18/01/2018].

96. IOGP (2016). Environmental fates and effects of ocean discharge of drill cuttings and associated drilling fluids from offshore oil and gas operations. International Association of Oil and Gas Producers, Report 543, March 2016. IOGP, London, UK. 144 pp.

97. UKOOA (2002). Drill Cuttings JIP Task 6. Drill Cuttings Recovery Project. Final Report.

98. Gubbay, S. (2003). Marine aggregate extraction and biodiversity. Information, issues and gaps in understanding. Report to the Joint Marine Programme of the Wildlife Trusts and WWF-UK.

99. Rogers, C.S. (1990). Reponses of coral reefs and reef organisms to sedimentation. Marine Ecology Progress Series, 62, 185 – 202.

100. Defra (2010). Charting Progress 2, the State of UK Seas. Available online at http://chartingprogress.defra.gov.uk [Accessed 07/12/2017].

101. UKOilandGasData (2017). Online metadata covering UKCS offshore oil and gas wells, 2D and 3D seismic surveys, infrastructure, licences and fields. Available at: https://www.ukoilandgasdata.com [Accessed 29/01/2018].

102. Xodus (2017). Preparation of CA, EIA and DP for Auk, Auk North & Fulmar; Fulmar and Auk North Scoping Letter. TN-DTAAUK001-HS-0048-C01. 10 pages.

103. Xodus (2019). Preparation of CA, EIA & DP for Auk, Auk North & Fulmar: BAT Assessment Overview. Report to Repsol Sinopec Resources UK Ltd from Xodus Group. RP-DTAFUL001-HS-0031 Rev C02 issued 08/07/2019.

104. Xodus (2019). Preparation of CA, EIA & DP for Auk, Auk North & Fulmar: Fulmar AD Cuttings BAT Assessment. Report to Repsol Sinopec Resources UK Ltd from Xodus Group. TN-DTAFUL001-HS-0032 Rev C01 issued 17/06/2019.

105. Repsol Sinopec Resources UK Limited (2019b). Preparation of CA, EIA and DP for Auk, Auk North & Fulmar. Fulmar and Auk North Topsides and Subsea Facilities Decommissioning Programmes. Third pre-draft. RP-DTAFUL001-DC-0063-C01, pending issue.

APPENDIX A ENVID MATRIX

Aspect	Activity										Mitigation	Option Selection Notes to inform CA	Post-workshop decision for consideration in a streamlined EA	Support for EA position
	Reverse construction / prep work topsides / jacket	Subsea structure, pipeline/ umbilical and spools removal/ prep for leave *in situ*	Remove platform topsides and transfer to shore	Remove jackets and transfer to shore	Partial jacket removal (Fulmar footings) leave *in situ*	Nearshore jacket transfer/ dismantling	Onshore dismantling	Offshore debris clearance and overtrawl trials	Legacy	Planned/ Unplanned				
1 Energy use and emissions to air														
Gaseous emissions	*See sub-categories*													
i) Vessels and onshore transport	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	P	- Low sulphur diesel - RSRUK Contractor selection - maintenance programme - MARPOL compliance - Campaign, logistics, sharing vessels (across RSRUK portfolio) optimising vessels to minimise use - Energy and emissions assessment study to be carried out (inputs to EIA and CA evaluation) -Waste duty of care	Options with most emissions will be those involving most vessels and of longest duration - NOTE: Full removal option requires no legacy monitoring (2 legacy surveys for assessment assumed)	No	Project: Such emissions will occur in the context of stopping production and therefore stopping almost all future emissions (from operations, including vessels). RSRUK will review EU ETS data and compare estimates derived during the CA and previous study work to confirm that likely emissions are likely to be small relative to those during production. Industry: Review of previous decommissioning ESs shows atmospheric emissions have no significant impact and are almost always extremely small in the context of UKCS/global emissions. Compared to those previously arising from the assets through their operational phase, emissions from short term decommissioning activities are small.
ii) Power generation on offshore / onshore facilities (vessels covered above)	Yes	No	Yes	No	No	No	Yes	No	No	P	- RSRUK Contractor selection - maintenance programme, audits - Energy and emissions assessment study to be carried out - Fuel gas use will cease at CoP, with optimal power generation moving over to diesel use only.	- Power demand will differ depending on piece small, piece large and single lift of topsides (power use will shift between offshore and onshore) - Also consider the jacket (power use will shift between offshore and onshore).	No	As for Aspect 1 i).
iii) Material recycling and replacement	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	P	- Waste duty of care '- Waste management plans	As above	No	As for Aspect 1 i). Note: responsible handling of materials returned to shore dealt with under waste as outlined under Aspect 8.
2 Physical presence														
i) Physical presence of vessels in relation to other sea users	Yes	Yes	Yes	Yes	Yes	Yes	no	Yes	Yes	P	- Campaign, logistics, sharing vessels (across RSRUK portfolio) optimising vessels to minimise use. - UKHO standard communication channels including Kingfisher, Notice to Mariners and radio navigation warnings - Collision risk assessment - Stakeholder consultation - Logistics plan - Fisheries Liaison officer	Options with largest physical presence impacts will be those involving most vessels/largest vessels for longest duration - NOTE: where transfer to barge is required for topsides and/or jacket, this could have a larger than normal physical presence - albeit short-term	No	Project: Short term operations in the context of the life of the fields. Activity will occur using similar vessels to those currently deployed for oil and gas across the central North Sea. Vessels will generally be in use around existing infrastructure - they will not occupy 'new' areas. Other sea users will be notified in advance of activities occurring, meaning those stakeholders will have time to make any necessary alternative arrangements. Industry: The well known and practiced planning and notification measures mean that offshore activities such as these are not seen as a major issue in relation to shipping and other sea users - especially in an area such as this where shipping levels and presence of other sea users are low.
ii) Physical presence of infrastructure decommissioned in situ in relation to other sea users	no	Yes	no	no	Yes	no	no	no	no	P	- Stakeholder consultation, especially discussion of issues with SFF and NFFO - Notifications and notice to mariners	Options with largest physical presence impacts will be those for leaving infrastructure in place	Yes	Project: The decommissioning case emerging from the CA is to leave pipelines and mattresses in place rather than remove. As a potential perceived deviation from the 'clean seabed' notion, and as this is a ley issue with one of the main stakeholders, this will therefore require assessment in the EA. This issue may require balancing against the habitat disturbance associated with removing infrastructure. Industry: Key stakeholder concern and thus generally assessed in detail (albeit with conclusion of no significant impact).
3 Disturbance to the seabed and cuttings piles														
i) Disturbance to the seabed (including disturbance to the cuttings piles)	no	Yes	no	Yes	no	Yes	no	Yes	no	P	- Quantify footprints for options - Limit the footprint of the activities - Minimise disturbance of cuttings piles - Modelling study for cuttings disturbance - Optimise rock placement (e.g. use of FFPV, bags, grade etc.) - Review of survey data for distribution of sensitivities, especially of ocean quahogs - Aim to use DP in the MCZ - Stakeholder consultation in line with Stakeholder Engagement Plan	This type of impact relates directly to project footprint/size - options involving infrastructure removal will disturb seabed most in the short term Leaving infrastructure in place could have longer term impacts (perpetuating habitat change for example). May also generate stakeholder interest	Yes	Project: In this location, within the Fulmar MCZ, this will be a key issue with multiple stakeholders. Industry: ESs tend to conclude very small areas of seabed disturbed, and state no significant impact.

Aspect	Activity										Mitigation	Option Selection Notes to inform CA	Post-workshop decision for consideration in a streamlined EA	Support for EA position
	Reverse construction / prep work topsides / jacket	Subsea structure, pipeline/ umbilical and spools removal/ prep for leave *in situ*	Remove platform topsides and transfer to shore	Remove jackets and transfer to shore	Partial jacket removal (Fulmar footings) leave *in situ*	Nearshore jacket transfer/ dismantling	Onshore dismantling	Offshore debris clearance and overtrawl trials	Legacy	Planned/ Unplanned				
4 Discharges to sea														
i) Routine vessel (e.g. greywater, blackwater, ballast) and/or facilities discharges	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	P	- IMO Ballast Water Management Convention, including Ballast water plan and log book - Treatment to IMO/MARPOL standards - Compliance with company's marine assurance standards	Options with most discharges will be those involving most vessels and of longest duration, i.e. total removal (vs leave in place)	No	Project: Well controlled activities managed by all vessels on an ongoing basis. Industry: This is not considered to be a major oil and gas industry issue and is assessed with varying levels of detail in both decommissioning and development EIAs.
ii) Chemicals/hydrocarbon/NORM discharges	yes	Yes	no	yes	yes	yes	Yes	yes	yes	P	- Selection of chemicals with less potential for environmental impact - Environmental risk assessment through the MATs/SATs system - Decom yard management plans, selection, auditing - Predefined cleanliness achieved through hydrocarbon freeing (Drain Flush Purge Vent DFPV) - RSRUK HSE management system	Perhaps little to choose between options over the long term? -NOTE: piece small method could result in more discharges compared to single lift offshore.	No	Project: Likely to be limited volumes of relatively 'clean' fluids, or those that will be assessed in more detail in the MAT/SAT process. Industry: These discharges are typically Included in EIAs, but the permitting system is the more appropriate location for any specific risk assessment of discharges. As would be expected, significant impacts are not predicted.
5 Underwater noise														
i) Underwater noise from vessels (injury/disturbance to marine species)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	P	- Campaign, logistics, sharing vessels (across RSRUK portfolio) optimising vessels to minimise use. - Main potential impact likely to be from disturbance rather than injury - RSRUK contractor selection process	Options with most vessel noise will be those involving most vessels and of longest duration, i.e. total removal (vs leave in place)	No	Project: The project will not be using any new activities that have not previously been assessed as 'acceptable' through previous permit applications in the area. This project is not located within an area protected for marine mammals. Industry: With mitigation measures, EIAs for offshore oil and gas decommissioning typically show no injury, or significant disturbance. For projects outside of protected marine mammal habitats, this issue could be scoped out.
ii) Underwater noise from cutting noise / dredging / Mass Flow Excavation (MFE) (injury/disturbance to marine species) and rock placement	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	P	- Suitable technology for cutting will be selected to ensure the effectiveness of the cutting, minimising the duration, disturbance and risk of requiring the activity to be repeated - No explosives use planned.	Options with most cutting noise beneath the water column will have the most impact e.g. total removal (vs. leave in place)	No	As for Aspect 5 i) above.
6 Resource use (offshore and onshore)														
i) Use of raw materials and additives (including chemicals, rock cover and steel)	Yes	Yes	yes	Yes	Yes	Yes	Yes	No	yes	P	- Planning of activities will minimise use of materials (there is also a financial driver for this) - recycling as much as possible. - Investigate reuse of existing subsea protection materials ie mattresses and grout bags. (to minimise the use of rock placement).	- NOTE: considered as input data for CA process.	No	Project: Typical use of materials, limited in most cases. RSRUK will review use of materials in context of UK level use. Industry: Not usually an issue of concern in offshore oil and gas, but is often considered as a result of the current (soon to be replaced) DECC decommissioning guidelines. Where impacts are considered, significant impacts are not expected.
ii) Energy consumption (fuel use and power consumption by offshore and onshore plant/equipment)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	P	- Monitor fuel use - Energy and emissions assessment study to be carried out - Scheduling/design to optimise opportunities to use resources more efficiently (e.g. at same time)	Options with most power use will be those involving most vessels and of longest duration, i.e. total removal vs leave in place	No	Project: Emissions will occur in the context of stopping almost all future energy use associated with the development (apart from limited survey activity). Industry: Review of previous decommissioning ESs suggests energy use is predicted to have no significant impact in some cases, or is not mentioned at all in the remaining cases. Where impacts are considered, significant impacts are not expected.
iii) Use of landfill space	Yes	Yes	yes	yes	Yes	yes	Yes	Yes	no	P	- Maximise recycling opportunities - RSRUK Environmental Management System - follow RSRUK waste management strategy and project management plan.	Options with most impact will be those involving most material brought to shore, i.e. total removal (vs leave in place)	No	Project: Limited quantities of material returned will be returned to shore, and these will be mostly recycled. Industry: This is not usually an issue of concern in oil and gas activities, but has been raised as a typical stakeholder concern in decommissioning. Where impacts are considered, significant impacts are not expected.

Aspect	Activity										Mitigation	Option Selection Notes to inform CA	Post-workshop decision for consideration in a streamlined EA	Support for EA position
	Reverse construction / prep work topsides / jacket	Subsea structure, pipeline/ umbilical and spools removal/ prep for leave *in situ*	Remove platform topsides and transfer to shore	Remove jackets and transfer to shore	Partial jacket removal (Fulmar footings) leave *in situ*	Nearshore jacket transfer/ dismantling	Onshore dismantling	Offshore debris clearance and overtrawl trials	Legacy	Planned/ Unplanned				
7 Onshore Dismantling yard activities														
i) Airborne noise, including traffic movements at onshore sites	no	no	yes	yes	yes	Yes	Yes	no	no	P	- Environmental audit of dismantling yard (including site visit) - RSRUK contractor management / selection processes - Yard to engage with local communities - Review records of engagement with communities and close out of issues - Contract award should include recognition of social issues including noise	Options with most impact will be those involving most material brought to shore in largest lumps, i.e. total removal vs leave in place	No	Project: All onshore sites will deal with potential environmental issues as part of existing site management plans and there is anticipated to be no change in potential for impact. RSRUK procedures require suitably approved facilities, including site visits, review of permits and consideration of how new facility construction and design has been developed to minimise impact. Industry: For oil and gas EIA in general, onshore issues are not within scope. For decommissioning, onshore issues are variously covered, following the highlighting of a number of potential issues in the soon to be replaced DECC guidance. With the new guidance shortly to be issued, it is expected that there will be less Regulatory requirement to consider onshore impacts.
ii) Odour (onshore) (e.g. from marine growth)	No	No	No	No	No	Yes	Yes	No	No	P	- Environmental audit of dismantling yard - Selection of a yard that has procedures in place to dispose of marine growth in a manner that will avoid odour nuisance - Marine growth management plan or waste management plan	Options with most material left offshore will have the smallest impact here.	No	As for Aspect 7 i) above.
iii) Light - onshore	No	No	yes	yes	yes	Yes	Yes	No	No	P	- Environmental audit of dismantling yard - Yard to engage with local communities - Review records of engagement with communities and close out of issues - Stakeholder engagement	Options with most impact will be those involving largest vessels brought to shore, i.e. single lift vs piece small	No	As for Aspect 7 i) above.
iv) Dust	No	No	No	No	No	No	Yes	No	No	P	- Environmental audit of dismantling yard - Yard to engage with local communities - Review records of engagement with communities and close out of issues - Bid evaluation for onshore activities should consider economic, environment and social issues - Environmental management plan	Options with most impact will be those involving most material brought to shore, i.e. total removal (vs leave in place)	No	As for Aspect 7 i) above.
v) Visual aesthetics - Onshore	No	No	yes	yes	yes	yes	yes	No	No	P	- Environmental audit of dismantling yard - Yard to engage with local communities - Review records of engagement with communities and close out of issues	Options with most impact will be those involving most material brought to shore, i.e. total removal (vs leave in place)	No	As for Aspect 7 i) above.
8 Waste generation	*See sub-categories*													
i) Non-hazardous waste	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	no	P	- RSRUK Waste management strategy - Project waste management plan, use of licensed waste contractors/sites, waste transfer notes - Develop WMP prioritising reuse and recycling - Contractor to maintain a waste audit trail through to recycling or disposal facility - Contractor to report waste inventories - Audit of yard's/contractors waste management systems	Options with most impact will be those involving most material brought to shore, i.e. total removal (vs leave in place)	No	Project: Waste management is understood to be a key stakeholder interest in decommissioning, and RSRUK expects to detail measures in place to manage waste in the EA. This will be outlined briefly in a section that describes the overall RSRUK EMS and how this will be applied to manage the decommissioning programme. This section will not seek to replicate inventory data from the DP, or to quantify waste streams in detail, but instead discuss RSRUK expectations with regards appropriate handling. Regarding capacity, part of the waste tenderer's bid will need to include demonstration of capacity to handle expected volumes. Where a yard outside the UK is selected, RSRUK will ensure commitments regarding transfrontier shipments are met. Industry: It is waste management, not generation, that is the issue across DPs, with capacity to handle waste within the UK often cited as a stakeholder concern. Environmental documentation prepared to support DPs usually recognises this. How waste will be managed as per RSRUK standards and existing legislation and guidance will be outlined in the EA.
ii) Hazardous waste (including F-gases)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	P	- RSRUK Waste management strategy - Project waste management plan, use of licensed waste contractors/sites, waste transfer notes - Develop WMP prioritising reuse and recycling - Contractor to maintain a waste audit trail through to recycling or disposal facility - Contractor to report waste inventories - Audit of yard's/contractors waste management systems	Options with most impact will be those involving most material brought to shore, i.e. total removal (vs leave in place)	No	Project: Waste management is understood to be a key stakeholder interest in decommissioning, and RSRUK expects to detail measures in place to manage waste in the EA. This will be outlined briefly in a section that describes the overall RSRUK EMS and how this will be applied to manage the decommissioning programme. This section will not seek to replicate inventory data from the DP, or to quantify waste streams in detail, but instead discuss RSRUK expectations with regards appropriate handling. Regarding capacity, part of the waste tenderer's bid will need to include demonstration of capacity to handle expected volumes. Where a yard outside the UK is selected, RSRUK will ensure commitments regarding transfrontier shipments are met (including any potential return of hazardous materials). Industry: It is waste management, not generation, that is the issue across DPs, with capacity to handle waste within the UK often cited as a stakeholder concern. Environmental documentation prepared to support DPs usually recognises this. How waste will be managed as per RSRUK standards and existing legislation and guidance will be outlined in the EA.

Aspect	Activity										Mitigation	Option Selection Notes to inform CA	Post-workshop decision for consideration in a streamlined EA	Support for EA position
	Reverse construction / prep work topsides / jacket	Subsea structure, pipeline/ umbilical and spools removal/ prep for leave *in situ*	Remove platform topsides and transfer to shore	Remove jackets and transfer to shore	Partial jacket removal (Fulmar footings) leave *in situ*	Nearshore jacket transfer/ dismantling	Onshore dismantling	Offshore debris clearance and overtrawl trials	Legacy	Planned/ Unplanned				
iii) Radioactive waste (including naturally occurring radioactive material)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	P	- RSRUK Waste management strategy - Project waste management plan, use of licensed waste contractors/sites, waste transfer notes - Develop WMP prioritising reuse and recycling - Contractor to maintain a waste audit trail through to recycling or disposal facility - Contractor to report waste inventories - Audit of yard's/contractors waste management systems - Licensed facility capable of taking contaminated material under appropriate licence and disposing appropriately (e.g. incineration) - Company procedures during preparation to return radioactive material to shore	NOTE: no real difference between options overall	No	Project: Waste management is understood to be a key stakeholder interest in decommissioning, and RSRUK expects to detail measures in place to manage waste in the EA. This will be outlined briefly in a section that describes the overall RSRUK EMS and how this will be applied to manage the decommissioning programme. This section will not seek to replicate inventory data from the DP, or to quantify waste streams in detail, but instead discuss RSRUK expectations with regards appropriate handling. Regarding capacity, part of the waste tenderer's bid will need to include demonstration of capacity to handle expected volumes. Where a yard outside the UK is selected, RSRUK will ensure commitments regarding transfrontier shipments are met (including any potential return of radioactive materials). Industry: It is waste management, not generation, that is the issue across DPs, with capacity to handle waste within the UK often cited as a stakeholder concern. Environmental documentation prepared to support DPs usually recognises this. How waste will be managed as per RSRUK standards and existing legislation and guidance will be outlined in the EA.
iv) Marine growth	No	Yes	No	Yes	Yes	Yes	Yes	no	No	P	- Project waste management plan, use of licensed waste contractors/sites, waste transfer notes - Develop WMP - Contractor to maintain a waste audit trail through to recycling or disposal facility - Audit of yard's waste management - Consider jetting offshore - Marine growth management plan	Options with most impact will be those involving most material brought to shore, i.e. total removal (vs leave in place)	No	As for Aspect 8 i) above.
9 Others														
i) Light - offshore (particularly seabirds)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	P	- Lighting directed below the horizontal plane unless required for technical or safety reasons		No	Not a major issue for project (a few vessels present on site for short duration) nor industry.
ii) Aesthetics - Offshore	No	No	Yes	Yes	Yes	Yes	No	No	No	P	- Campaign planning to limit vessel days to minimum required - Project location located well offshore		No	As for Aspect 9 i) above.
iii) Livelihood / employment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	P	- Project to identify and share yard requirements, to allow yards to plan/bid		No	Project: The variable potential for impact from the decommissioning activities has not been identified as a differentiator in the CA. Whilst it is recognised that there could be a negative effect resulting from cessation of production, there will be a counter-benefit in the additional work required to effect the decommissioning. It is expected that the key socioeconomic effect would occur through potential interaction with fisheries. This will be covered as for Aspect 2 ii) above. Industry: Typically little detail, often as adhoc comment in other related assessments - certainly not considered to be a significant negative effect of decommissioning activity.
10 Unplanned events														
i) Accidental chemical/hydrocarbon release (inc. export pipelines, vessels, both offshore, nearshore and onshore)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	no	UP	- SOPEP, including modelling and appropriate response planning (for vessels over 400 gross register tonnage) - Collision risk assessment - Maintenance procedures - SIMOPs - Bulk handling procedures and personnel training - Vessels will be selected which comply with IMO/MCA codes for prevention of oil pollution - Preferred operational procedures to be in place onboard Vessels including use of drip trays under valves, use of pumps to decant lubricating oils, use of lockable valves on storage tanks and drums - Chemical storage areas contained to prevent accidental release of chemicals - Maintenance procedures - Pre-mobilisation audits will be carried out including a comprehensive review of spill prevention procedures - Arrangements in place to track spills - Third party management/engagement for pipeline crossings, adjacent work sites and associated decommissioning work - Wells P&A'd and topsides DFPV and isolated - Auk and Fulmar field OPEPs will be updated to include details of the HLV (if used) and adhered to within the 500 m safety exclusion zones around the platforms	Options with most risk of impact will be those involving with most vessels and of longest duration, i.e. total removal (vs leave in place)	No	Project: Well plugging and abandonment is outside of the scope of the EA, as it is not reliant on DP approval. The possibility of a well blowout therefore does not require consideration in the EA. Pipelines will have been flushed and cleaned outside of the scope of the DP also, and they will therefore be 'clean' at the point the EA scope begins. Release of a live hydrocarbon and chemical inventory is therefore also out of scope. RSRUK expects that the heavy lift vessel potentially to be used in jacket decommissioning will have the largest fuel inventory of any vessel involved in the Project activities. This amounts to 18,846 m^3 in total, predominantly heavy fuel oil. This quantity is less than the worst case crude oil spill from loss of well containment modelled and assessed in the Fulmar field OPEP, and approximately equivalent to the volume modelled and assessed for a similar incident type in the Auk field OPEP. In addition the vessel's fuel inventory is split between 11 separate tanks. Therefore, the potential impact from fuel inventory release will be at worst equivalent to that already assessed and mitigated for the operational phase of these fields. Industry: There are a variety of approaches to accidental hydrocarbon and chemical release in decommissioning EIA. Some focus on modelling and some on a more qualitative assessment. As with development EIA, the potential for impact on protected sites and shores is recognised, but typically assessed as being not significant as a result of the low probability together with routinely applied mitigation measures.

Aspect	Activity: Reverse construction / prep work topsides / jacket	Subsea structure, pipeline/ umbilical and spools removal/ prep for leave *in situ*	Remove platform topsides and transfer to shore	Remove jackets and transfer to shore	Partial jacket removal (Fulmar footings) leave *in situ*	Nearshore jacket transfer/ dismantling	Onshore dismantling	Offshore debris clearance and overtrawl trials	Legacy	Planned/ Unplanned	Mitigation	Option Selection Notes to inform CA	Post-workshop decision for consideration in a streamlined EA	Support for EA position
ii) Snagging of fishing gear	No	No	No	No	Yes	Yes	No	Yes	Yes	UP	- Overtrawlability trials following activities - Stakeholder consultation - Remediation activities (spans) - Significant snag risks notified on fishsafe	Options with most risk of impact will be those leaving most infrastructure in situ, i.e. leave in place, vs total removal	Yes	Project: In pure environmental terms, the pipelines will be 'clean' and there is no risk resulting from snagging. However, this issue will be considered as part of the in situ decommissioning impact on fisheries, as for Aspect 2 ii) above, as it is considered to be a socioeconomic issue. Industry: Variable consideration of such issues - in some cases not considered, in others simply socio-economic, and in others both socio-economic and safety. With appropriate post-decommissioning survey monitoring (and commitment to remediation if deemed necessary), this issue is considered to be not significant.
iii) Dropped objects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	no	UP	- Procedures will be in place to reduce the potential for dropped objects - Subsea structures will not be removed until after the flowlines and pipelines have been flushed and cleaned - Training and awareness of contractors will be required - Lift planning will be undertaken to manage risks during lifting activities, including the consideration of prevailing environmental conditions and the use of specialist equipment where appropriate - All lifting equipment will be tested and certified - Procedures will be put in place to make sure that the location of any lost material is recorded and that significant objects are recovered where practicable - Debris clearance surveys will be carried out - DROPS survey to be caried out (dropped object and make safe survey) (topside only)	Options with most risk of impact will be those involving with most vessels and of longest duration, and those involving most lifts	No	Project: As the methodology for topsides/jacket removal to shore has not been defined, there exists the possibility that jackets and/or topsides could be transported by a vessel using a crane. Where these would be suspended over the side of the vessel for the transfer, the possibility of dropping onto a live pipeline cannot be ruled out. However, dropped object procedures are industry-standard and there is only a very remote probability of any interaction with any live infrastructure. Industry: Dropped object assessments range from scoping the issue out completely, to assessment of the impact on seabed, hydrocarbon release probability and snagging by fisheries. Given the industry standard mitigation used, assessments quickly conclude no significant impact.

Repsol Sinopec Resources UK
163 Holburn Street, Aberdeen AB10 6BZ, UK

Tel: +44 (0) 1224 352500
www.repsolsinopecuk.com