Schooner and Ketch Decommissioning Environmental Appraisal Report

Consultation Version

December 2018

Acronyms

API	American Petroleum Institute
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practicable
BEIS	Department for Business, Energy and Industrial Strategy
cSAC	Candidate Special Area of Conservation
CA	Comparative Assessment
CEFAS	Centre for
CMS	Caister Murdoch System
COP	Cessation of Production
DECC	Department of Energy and Climate Change (now BEIS)
DP	Decommissioning Programme
DSV	Diving Support Vessel
E	Easting (coordinate)
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EMS	Environmental Management System
ENVID	Environmental Impact Identification
ERL	Effect Range Low
ERM	Effect Range Median
ESDV	Emergency Shut Down Valve
Faroe	Faroe Petroleum (ROGB) Limited
FLO	Fishing Liaison Officer
FPSO	Floating Production, Storage and Offloading System
HLV	Heavy Lift Vessel
HRA	Habitat Regulations Assessment
HSE	Health and Safety Executive
ICC	Installation Control Centre
JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservation Committee
km	Kilometre

KP	Kilometre Point
LAT	Lowest Astronomical Tide
LSA	Low Specific Activity
m	Metres
MAH	Major Accident Hazard
MAT	Master Application Template
rMCZ	Recommended Marine Conservation Zone
MCZ	Marine Conservation Zone
MeOH	Methanol
MEI	Major Environmental Incident
MMO	Marine Mammal Observer
MPA	Marine Protected Area
MODU	Mobile Offshore Drilling Unit
MoD	Ministry of Defence
MS	Marine Scotland
N	Northing (coordinate)
NE	North East
NMI	Normally Manned Installation
NW	North West
NFFO	National Federation of Fishermen’s Organisations
NIFPO	Northern Ireland Fish Producers Organisation
NMI	Normally Manned Installation
NNR	National Nature Reserve
NORM	Naturally Occurring Radioactive Material
N/A	Not Applicable
NUI	Normally Unmanned Installation
OGA	Oil & Gas Authority
O & G UK	Oil & Gas UK
OPEP	Oil Pollution Emergency Plan
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSRL	Oil Spill Response Limited
OSPAR	Oslo and Paris Convention

PAM	Passive Acoustic Monitoring
P & A	Plug and Abandonment
PL	Pipe Line
POB	Personnel on Board
PON	Petroleum Operations Notice
SAC	Special Area of Conservation
SAT	Subsidiary Application Template
SCANS	Small Cetaceans in Europe Atlantic waters and the North Sea Survey
SCI	Site of Community Importance
SOPEP	Shipboard Oil Pollution Emergency Plan
SLV	Sheer Leg Vessels
SNS	Southern North Sea
SSCV	Semi-submersible Crane Vessel
SFF	Scottish Fishermen’s Federation
TBC	To Be Confirmed
Te	Tonnes
TGT	Theddlethorpe Gas Terminal
UK	United Kingdom
UKCS	United Kingdom Continental Shelf

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Executive Summary

1 Background and Overview of the Project

On the United Kingdom Continental Shelf (UKCS), the decommissioning of offshore oil and gas installations and pipelines is controlled through the Petroleum Act 1998, as amended by the Energy Act 2008. Under the Petroleum Act 1998, owners of an offshore installation or pipeline must obtain approval of a 'Decommissioning Programme'(DP)[1] from the Department for Business, Energy and Industrial Strategy (BEIS) before they can proceed with its decommissioning. Faroe will submit two DPs to BEIS for their approval, one to cover the Ketch field and one to cover the Schooner field. The scope of the DPs will be for the facilities for which Faroe have liability to decommission under the Petroleum Act 1998.

Faroe plan to decommission the Schooner field facilities and Ketch field facilities in tandem between 2018 and 2025. The Schooner and Ketch Normally Unmanned Installations (NUIs) are located in Block 44/26a and Block 44/28b of the southern North Sea (SNS), approximately 130 kilometres and 162 kilometres, respectively, from the nearest landfall at Easington on the East Ridings of Yorkshire coastline. Both the Schooner and Ketch platforms and the NW Schooner wellhead and integral protection structure will be completely removed and recovered to onshore. The Comparative Assessment (CA) for both Schooner and Ketch pipelines concluded that only the section of pipelines, mattresses and grout bags that form the Caister pipeline's crossing adjacent to the Murdoch platform (the final 80m of the Schooner pipelines and the final 100m of the Ketch pipelines, before the Murdoch platform) will be removed and transported to onshore (Faroe, 2018d and Faroe, 2018e), with the remainder of both pipelines being decommissioned in-situ. The entire Ketch pipeline will be trenched and buried prior to being decommissioned *in-situ*. The two mattresses that are scheduled to remain are buried beneath the rock dump that covers the Caister umbilical which crosses the Schooner pipelines, it is therefore impractical to remove these 2 mattresses. The 14 concrete mattresses associated with the Schooner end of the Schooner pipelines will be removed and transported to onshore. The 52 concrete mattresses along the length of the Ketch pipeline and all mattresses at the Ketch platform will be removed and transported to shore. If problems are encountered during operations to remove the mattresses, BEIS will be consulted and agree on an alternative approach before any other options are executed. Trenching of the entire length of the Ketch pipelines should be sufficient that the cut ends do not need to be stabilised by addition of material. As a contingency grout bags will be used to stabilise the cut pipeline ends. Decommissioning of items *in-situ* will be subject to the results of an over-trawl assessment to ensure they do not present a snagging hazard.

The Environmental Appraisal (EA) report supports the Decommissioning Programmes along with the CA and documents the results of the EA process undertaken to consider the impact of the planned

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[1] The Petroleum Act 1998 refers to an 'abandonment programme' however the preferred and generally accepted term is a 'decommissioning programme'.

activities and possible accidental events associated with the decommissioning of the Schooner field facilities and Ketch field facilities.

Table 1 presents a summary of the planned activities and the aspects from those activities that have the potential to interact with the environment and are included within the scope of the EA. Where more than one method could be used to undertake the activity, that which presents the worst case potential environmental impact has been presented and assessed.

Table 1. Planned Decommissioning Activities

Activities[2]	**Aspect**
General support	Vessels for surveying, deploying tools and ROVs, removal of facilities, transportation of removed items to onshore. Positioning of vessels using dynamic positioning systems.
Removal and recovery of NW Schooner wellhead and integral protection structure	Local excavation to allow access for lifting equipment to remove wellhead and integral protection structure from the seabed for recovery to shore for onshore disposal. Cutting of well conductors for recovery to shore for onshore disposal. Any fluids from the well abandonment activities are likely to either be cleaned to below 30 mg/l oil in water and discharged to sea or shipped to shore for appropriate treatment. These operations will be undertaken as part of the well P&A activities. No vessels will be required to support their operations.
Removal and recovery of topsides	Prior to removal the topsides will have been cleaned of process fluids, fuels and lubricants via flushing and draining. The likely fate of the topsides flush fluids will be transfer to tote tanks for transport by vessel and appropriate treatment and disposal onshore. Best endeavours will be made to clean the topsides pipework to below 30 mg/l oil in water. Vessel anchoring on location at the installations and possible ballast water discharge. Cutting of topsides equipment into smaller components for removal (piece-small removal). Topsides will be disposed of onshore as per the waste hierarchy.
Removal and recovery of jackets	Vessel anchoring on location at the installations and possible ballast water discharge. Potential use of explosives to sever piles (charges will be placed internally within jacket leg necessitating the removal of soil plugs to access piles). Jackets will be disposed of onshore as per the waste hierarchy.

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[2] Activities associated with the plug and abandonment of wells will include the use of a jack-up drilling unit positioned alongside each platform. The use of a jack-up drilling unit has been included in the assessment for topsides lifting preparation and hydrocarbon free activities, which would be undertaken first and plug and abandonment of wells would follow.

Activities[2]	Aspect
Decommissioning Schooner pipelines *in situ*	Local excavation to allow access for cutting shears and lifting equipment to remove cut pipeline ends for onshore disposal as per the waste treatment hierarchy. A discharge of residual hydrocarbons and/or chemicals on disconnection is possible, however the pipelines will all be cleaned and flushed prior to cutting to achieve a minimum of 30 mg/l oil in water. Placement of biodegradable grout bags on pipelines' cut ends. Permanent presence of the buried pipelines in the seabed. Recovery of pipelines' cut end sections and mattresses for onshore disposal as per the waste hierarchy.
Decommissioning Ketch pipelines *in situ*	Local excavation to allow access for cutting shears and lifting equipment to remove cut pipeline ends for onshore disposal as per the waste treatment hierarchy. A discharge of residual hydrocarbons and/or chemicals on disconnection is possible, however the pipelines will all be cleaned and flushed prior to cutting to achieve a minimum of 30 mg/l oil in water. Deployment of jet trenching tool to bury ~~sections of exposed~~ the entire pipeline. Permanent presence of the buried pipelines in the seabed. Recovery of pipelines' cut end sections and mattresses for onshore disposal as per the waste hierarchy.
Seabed over-trawl assessment	Fishing gear will be used to establish that the seabed in the platform areas and along the pipeline corridors is free from snagging hazards.
Onshore processing of removed infrastructure	The onshore transport and processing of removed facilities (cleaning, cutting etc.) at a shore based waste processing facility. In preparation for transport to an appropriately licenced facility for their recycling or disposal to landfill.

2 Environmental Baseline

2.1 Physical Environment

The project area is predominantly influenced by the SNS current (borne from the Scottish coastal water), that takes water through a south-east and north-west flow. The project area where tidal ranges increase southwards, as the water reaches the coast.

2.1.1 Seabed Sediments

Silty sand was the dominant seabed habitat being represented across the majority of the Ketch survey area. Coarser mixed sediment (i.e. gravelly sand / shelly fragments and pebbles) were occasionally present in the troughs between sand ripples in patches along the Ketch export pipeline route, in particular at KPL_06, as well as in some areas within the Ketch field where boulders and mixed sediments were identified on the side scan sonar data (Geo XYZ and Benthic Solutions, 2018a). The whole of the Schooner platform survey area was defined as silty sand with the presence of ripples and scattered ripples (Geo XYZ and Benthic Solutions, 2018b). The sedimentology of the southern section of the Schooner export pipeline route was defined as silty sand. The sedimentology of the middle section of the Schooner export pipeline route comprised mainly silty sand with some areas of detrital sediments and fine sand with shell debris. Regarding the sedimentology of the northern part of the Schooner export pipeline route, three areas can be defined. The first one on the South is 2.5km long and is composed of silty sand with patches of detrital sediments and fine sand with shell debris. The second area is around 4km long and is only defined as a silty sand. The last area is around 1km and is defined as a silty sand with patches of detrital sediments. (Geo XYZ and Benthic Solutions, 2018b).

2.1.2 Heavy and Trace Metal Concentrations

The analysis of total concentrations of heavy and trace metals from the Schooner and Ketch stations found that cadmium and mercury were undetectable. Concentrations of chromium, iron, nickel, lead and vanadium were lower than average background levels for the Southern North Sea. A majority of stations showed a correlation with the percentage fines reflecting a clear fines trend across the survey area that included barium and barium related metals. Overall, metal concentrations were consistent with uncontaminated baseline sediments and/or within typically expected background levels for the Southern North Sea.

2.2 Biological Environment

2.2.1 Benthic Communities

The benthos describes the organisms that live in (infauna) and on the seabed (epifauna). Activities that result in physical or chemical disruption of the seabed can affect the fauna.

Macrofaunal taxonomy of all recovered fauna from the Schooner sample sites identified a total of 8,042 individuals (infauna and solitary epifauna) from the 36 samples analysed. Of the 219 species recorded, 216 were infaunal (including solitary epifauna), consisting of 95 annelid species accounting for 38.5% of the total individuals. The crustaceans were represented by 64 species (20.6% of total individuals), the molluscs by 39 species (20.1% of total individuals) and the echinoderms by seven species (10.5% of total individuals). Solitary epifauna were represented by four species (1% of total individuals) whilst all other groups (Nemertea, Nematoda, Platyhelminthes, Sipuncula, Chaetognatha, Enteropneusta and Osteichthyes) accounted for the remaining 9.2% of individuals, or seven species.

Macrofaunal taxonomy of all recovered fauna from the Ketch sample sites identified a total of 7,308 individuals (infauna and solitary epifauna) from the 36 samples analysed. Of the 211 species recorded, 206 were infaunal (including solitary epifauna), consisting of 87 annelid species accounting for 31.7% of the total individuals. The crustaceans were represented by 61 species (17.7% of total individuals), the molluscs by 39 species (23.21% of total individuals) and the echinoderms by seven species (12.1% of total individuals). Solitary epifauna were represented by three species (0.3% of total individuals) whilst all other groups (Nemertea, Nematoda, Platyhelminthes, Sipuncula, Chaetognatha, Enteropneusta and Osteichthyes) accounted for the remaining 15.0% of individuals, or nine species.

Annelids, crustaceans and molluscs were found to dominate the infauna at almost all of the survey stations.

2.2.2 Habitats

Three main habitats were identified during the Ketch and Schooner surveys: Fine-medium sand, muddy sand, and rippled sand with sporadic shell and pebble fragments (Geo XYZ and Benthic Solutions, 2018a and Geo XYZ and Benthic Solutions, 2018b).
Circalittoral fine sand habitat is characterised by medium to fine sand with less than 5% silt or clay composition. Muddy sand is characterised by high silt/clay content, the silt content typically ranging from 5% to 20%, although some stations within the Ketch field and all 12 stations within the Schooner field exhibited a higher percentage of fines (>25%) for this habitat type. Rippled sand with sporadic shelly fragments and occasional pebbles habitat is a mixed substratum in the form of sand with varying levels of shell fragments, pebbles and cobbles. The major delineated area of mixed sediment was located in the northern area of the Ketch pipeline, closest to the Murdoch platform and along the Schooner export pipeline route from the central region to the northern half of the pipeline survey area.

2.2.1 Plankton

Plankton consists of the plants (phytoplankton) and animals (zooplankton) which live freely in the water column and drift with the water currents. Plankton forms a fundamental link in the food chain and is vulnerable to discharges to the sea and accidental chemical or hydrocarbon spills.

The distribution and abundance of plankton is heavily influenced by water depth, tidal mixing and thermal stratification within the water column (Edwards *et al*., 2010). The shallow water depths of the SNS create well mixed waters, which undergo large seasonal temperature variations (JNCC, 2004). The waters also undergo considerable tidal mixing due to the shallow water column and faster currents in the general area compared to other areas of the North Sea. There is therefore relatively little seasonal stratification throughout the year and is a consistent replenishment of nutrients. Opportunistic planktonic species, such as diatoms, are therefore particularly successful (Leterme *et al*., 2006).

Diatoms comprise a greater proportion of the phytoplankton community than dinoflagellates from November to May, when mixing is at its greatest (McQuatters-Gollop *et al.,* 2007). The phytoplankton community is dominated by the dinoflagellate genus Ceratium (*C. fusus, C. furca, C. lineatum*), along with higher numbers of the diatom, Chaetoceros (subgenera Hyalochaete and Phaeoceros) than are typically found in the northern North Sea (*DECC, 2009*). Zooplankton in the SNS is mainly comprised of small copepod species including Para-Pseudocalanus spp., with the second most abundant species being echinoderm larvae (DECC OESEA2, 2011).

2.2.1 Fish

Fish species known to use the project area for spawning and nursery are summarised in Table 2 (Ellis *et al*., 2012; Coull *et al*., 1998). It should be noted that, although potential spawning areas for fish species have been mapped, these areas are not fixed and are highly likely to vary spatially over time as fish populations naturally move through surrounding areas. Additionally, fish species may spawn earlier or later in response to seasonal variations in environmental conditions (Coull *et al*., 1998). Fish that lay their eggs on the seabed (bottom spawners) are more susceptible to disturbances to the seabed than fish that release their eggs into the water column (pelagic spawners). The following bottom spawning species are known to use the project area for spawning: sandeels, herring, whiting, cod, ling, plaice and European Hake. None of the species indicated in Table 2 are listed under Annex V of the OSPAR list of threatened and/or declining species and habitats, by CITES (Convention on International Trade in Endangered Species), an international agreement between governments to regulate international trade in wild animals and plants. Spurdog and tope are listed on the IUCN (International Union for the Conservation of Nature) Red List of Threatened Species as vulnerable. In the North East Atlantic, spurdog is listed as critically endangered.

Table 2. Fish Spawning and Nursery Durations in the Project Area (Coull *et al*, 1998, Ellis *et al*., 2012)

Species	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Mackerel					🟦	🟦 **N**	🟦 **N**	🟩 **N**	**N**	**N**		
Plaice	🟦	🟦	🟩									🟦
Herring	🟩 **N**	**N**	**N**								🟩	🟩
Sole			🟩	🟦	🟩							
Sprat					🟦	🟦	🟩 **N**	🟩 **N**	**N**	**N**		
Nephrops	🟩 **N**	🟩 **N**	🟩 **N**	🟩 **N**	🟩 **N**	🟩 **N**	🟩 **N**	🟩 **N**	🟩 **N**	🟩 **N**	🟩 **N**	🟩 **N**
Whiting		🟩	🟩	🟩 **N**	🟩 **N**	🟩 **N**	**N**	**N**				
Spurdog	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
Tope	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
Cod	🟩	🟦	🟦 **N**	🟩 **N**	**N**	**N**						
Blue Whiting						**N**	**N**	**N**				
Ling			**N**	**N**	**N**	**N**						
European Hake			**N**	**N**	**N**	**N**	**N**	**N**				
Anglerfish			**N**	**N**	**N**	**N**	**N**	**N**				
Sandeel	🟩 **N**	🟩 **N**	**N**	**N**							🟩	🟩

🟦 **Peak Spawning** 🟩 **Spawning** **N** **Nursery**

2.2.1.1 Elasmobranchs

In a survey conducted by CEFAS, twenty-six species were identified and recorded throughout the North Sea and surrounding waters. Of these, only the spurdog (*Squalus acanthias*), tope shark (*Galeorhinus galeus*), starry smooth hound (*Mustelus asterias*), and starry ray (*Amblyraja radiata*) may be present within the general vicinity of the Schooner and Ketch NUIs (Ellis *et al.,* 2004).

2.2.2 Seabirds

Seabird distribution and abundance in the SNS varies throughout the year, with offshore areas in general, containing peak numbers of birds following the breeding season and through winter (DECC, 2016). Only a small number of the seabird species breeding in the UK are not listed in Mitchell *et al*. (2004) as breeding within Regional Sea 2 where the project is located (for example Manx Shearwater, Storm Petrel, Leach's Storm Petrel, Arctic Skua, Great Skua and Black Guillemot). The North Norfolk Coast SPA site, located approximately 160 km south west from the project area qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex I of the Directive during the breeding season: for the presence of Common

Tern (*Sterna hirundo*), Little Tern (*Sterna albifrons*), Mediterranean Gull (*Larus melanocephalus*), Roseate Tern (*Sterna dougallii*) and Sandwich Tern (*Sterna sandvicensis*) (JNCC, 2001). The species listed on Annex I of the Directive during the breeding season at the North Norfolk Coast SPA site have shown a level or general upwards trend in numbers at sites across England over the last five years except for little tern whose numbers have shown a downward trend (BTO, 2018).

Seabird vulnerability to oil is considered extremely high during July for all Blocks and during December for Block 44/21 and Block 44/26 within the project area (Certain et al., 2015).

2.2.3 Marine Mammals

2.2.3.1 Cetaceans

There is potential for decommissioning activities to impact the movement and feeding behaviour of cetaceans, primarily through underwater noise. Table 3 identifies species of cetaceans previously sighted within the project area (Reid *et al.,* 2003) which include Atlantic white-sided dolphin (*Lagenorhynchus acutus*) (ICUN conservation status: Least Concern), harbour porpoise (*Phocoena phocoena*) (ICUN conservation status: Least Concern) and minke whale (*Balaenoptera acutorostrata*) (ICUN conservation status: Least Concern).

Best available animal density information for the proposed project area has been taken from the Small Cetacean Abundance in the European Atlantic and North Sea – II (SCANS-III) 2016 survey (Hammond *et al,* 2017). Density data for the species identified by Reid *et al.,* (2003) as being present within the vicinity of the project area are available from the SCANS-III data for all species (Table 4). The proposed decommissioning activities fall across SCANS-III survey area block O.

Table 3. Summary Accounts of Cetacean Species Anticipated to be in the Vicinity of the Project Area

Species	Summary
Atlantic white-sided dolphin	Odontocete (Toothed whale). Atlantic white-sided dolphin is very gregarious, with observed group sizes frequently numbering in tens to hundreds. It is superficially rather similar to the white-beaked dolphin. The two species may form mixed herds that are sometimes very large. White-sided dolphins live mainly in cool waters (7-12º C), particularly seaward or along the edges of continental shelves (typically in depths of 100-500 metres). Mainly occurs north and north west of Britain (Scotland), and is rare in the central and north-eastern North Sea.
Harbour porpoise	Odontocete (Toothed whale). Adult length ranges from 1.4 to 1.9 metres. New-borns may be between 67 cm to 85 cm. Harbour porpoise generally stay below the surface of the water. However, they are occasionally spotted when resting at the surface. It is the most numerous marine mammal in north-west European shelf waters.

Species	Summary
Minke whale	Mysticete (Baleen whale). Adult minke whales measure between 8 and 10 metres in length. They regularly occur in small groups of 2-3 animals and are often described as an inquisitive animal as a result of many sightings being made close to vessels. The species occurs mainly on the continental shelf in water depths of 200 metres or less; for example, in the northern and central North Sea.

Table 4. Estimated Marine Mammal Density within the Vicinity of the Project Area from SCANS-III Data (Hammond *et al*, 2017)

Species	Density (animals per square kilometre) per SCANS III survey area
	Block O
Atlantic white-sided dolphin	No data
Harbour porpoise	0.888
Minke whale	0.010

Harbour porpoise abundance was comparable between the 1994 and 2005 SCANS survey results and the population has been assessed (as part of 3rd Report by UK under article 17 on the implementation of the Habitat Directive) to be in favourable condition with a total abundance in UK waters of 177,567 animals (CV=0.15) (DECC, 2016). The abundance of white-sided dolphins across the entire CGNS MU was estimated at 69,293 (95% CI= 34,339-139,828) with the UK component estimated at 46,249 animals (95% CI =26,993-79,243) (DECC,2016). The abundance of minke whales across the entire CGNS MU is 23,528 (95% CI= 13,989-39,572), with the UK component estimated at 12,295 animals (95% CI =7,176-21,066) (DECC,2016).

2.2.3.2 Pinnipeds

Grey seal (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*) are both resident in UK waters and are listed under Annex II of the EU Habitats Directive. Harbour seal pupping and moulting occurs from May to August, occasionally extending into September. Pupping occurs on land from June to July. During this time harbour seals are generally restricted to nearshore coastal areas. Harbour seals are not normally found foraging more than 60 kilometres from shore (*DECC OESEA2, 2011*). Grey seal pupping generally occurs in October, with moulting occurring between February and March (*DECC OESEA2, 2011*). During this period, grey seals will be found either onshore or on foraging trips in the vicinity of their haul-out site. At this time the offshore density of grey seals will be lower.

The project area is located approximately 130 kilometres from the coast so it is highly unlikely that these species may be encountered in the vicinity of the decommissioning operations.

2.2.4 Habitat and Species Conservation

The northernmost part of the project area, where the export pipelines join the Murdoch Platform, is included within the Dogger Bank SAC and MPA which is located approximately 24.3 kilometres northwest of the Ketch NUI. Most of the decommissioning work will be undertaken just outside of the Dogger Bank SAC/SCI and MPA but remedial and disconnection work on both gas export pipelines at the approach to the Murdoch platform and the removal of the Caister pipeline crossing will encroach into the area.

The Southern North Sea cSAC and MPA, located approximately 12 kilometres north of the Schooner NUI, falls within the decommissioning project area due to the presence of the export pipelines at the Murdoch platform end which just encroach on the site.

Furthermore, the recommended conservation zone 'Markham's Triangle' is located 24 kilometres southwest of the Ketch NUI whilst North Norfolk Sandbanks and Saturn Reef cSAC/SCI and MPA are located approximately 42 kilometres south-west of the Ketch NUI.

A large number of nationally designated sites are also present along this section of the coast and include SSSIs selected for geological interest or presence of special plants, terrestrial invertebrates, breeding seabirds or breeding waterfowl and National Nature Reserves (NNRs) which contain examples of some of the most important ecosystems in Britain, including sand dune, shingle, saltmarsh, mudflat and wet grassland.

2.2.5 Potential Annex I Habitats and Annex II Species

Special Areas of Conservation (SACs) were established under the EC Habitats Directive, to protect marine habitats and species of European importance. SACs are identified for the habitats and species listed in the EC Habitats Directive. These include sandbanks, reefs, submarine structures made by leaking gasses, harbour porpoise and bottlenose dolphin.

The Dogger Bank SAC/SCI and MPA (situated 24.5 kilometres northeast of the Schooner NUI) is designated due to the vast expanse of Annex I shallow sandbank habitat in less than 20 metres water depth (*JNCC, 2015a*). The shallow water, sandy sediments and year-round productivity of the Dogger Bank make it an ideal spawning ground for sandeels (Ammodytes spp.). Sandeels are a major food source for several seabird species, seals and harbour porpoise (Annex II species) and consequently the Dogger Bank area is utilised as a foraging ground for several species (*JNCC, 2015a*). The conservation objectives for this site are (*JNCC, 2018a*):

- For the feature to be in favourable condition thus ensuring site integrity in the long term and contribution to Favourable Conservation Status of Annex I Sandbanks which are slightly covered by seawater all the time. This contribution would be achieved by maintaining or restoring, subject to natural change:
    - The extent and distribution of the qualifying habitat in the site;
    - The structure and function of the qualifying habitat in the site; and
    - The supporting processes on which the qualifying habitat relies.

The North Norfolk Sandbanks and Saturn Reef SAC/SCI and MPA is designated dues to the presence of Annex I shallow sandbank habitat, typical marine fauna which inhabit sandbanks are; polychaete worms, amphipods and small clams which burrow within the sediment and hermit crabs, seastar, brittlestars and flatfish (plaice and sole) on the seabed (*JNCC, 2015a*) and also due to the presence of the Saturn Reef (also an Annex I habitat). Saturn Reef is an example of a biogenic *Sabellaria spinulosa* reef which is formed through the production of tube structures within which the Ross worm (*S. spinulosa*) resides (*JNCC, 2010*). This biogenic reef seabed provides a more complex habitat for a greater diversity of species compared to the sandy habitat surrounding the area. The conservation objectives of the site are (JNCC, 2017b):

- For the features to be in favourable condition thus ensuring site integrity in the long term and contribution to Favourable Conservation Status of Annex I Sandbanks which are slightly covered by sea water all of the time and Annex I Reefs. This contribution would be achieved by maintaining or restoring, subject to natural change:
    - The extent and distribution of the qualifying habitats in the site;
    - The structure and function of the qualifying habitats in the site; and
    - The supporting processes on which the qualifying habitats rely

The Southern North Sea cSAC and MPA has been identified as an area of importance for the Annex II species, harbour porpoise (ICUN conservation status: Least Concern) and has been put forward to the EU for formal designation. The site extends to 36,958km^2 extending down the North Sea from the River Tyne south to the Thames, and includes habitats such as sandbanks and gravel beds. The water depths within the site range between 10 metres and 75 metres. The conservation objectives of the site are (*JNCC, 2016*):

- To avoid deterioration of the habitats of the harbour porpoise or significant disturbance to the harbour porpoise, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to maintaining Favourable Conservation Status (FCS) for the UK harbour porpoise.
- To ensure for harbour porpoise that, subject to natural change, the following attributes are maintained or restored in the long term:
    - The species is a viable component of the site.
    - There is no significant disturbance of the species.
    - The supporting habitats and processes relevant to harbour porpoises and their prey are maintained.

Review of the geophysical data at the Schooner NUI site (*Senergy S&G, 2012*) indicates a uniform seabed with low sonar reflectivity, interpreted using BGS information to comprise clayey sand. The absence of any apparent areas of high reflectivity suggests an absence of EC Habitats Directive 92/43/EEC Annex I habitats that can often be associated with such features, including stony and biogenic reefs (*Senergy S&G, 2012*).

There was no evidence from the seabed imagery across the Murdoch hub survey area of any Annex I habitats protected under the Habitats Directive (1992), priority habitats or species in England, listed under Section 41 of the NERC Act (2006) that were deemed to require action in the UK Biodiversity Action Plan and continue to be regarded as conservation priorities in the subsequent UK Post-2010 Biodiversity Framework (*JNCC and Defra, 2012*) (*Gardline, 2016*). There was also no indication of species or habitats on the OSPAR (2008) list of threatened and/or declining species and habitats or any species on the IUCN Global Red List of threatened species (*IUCN, 2014*).

A review of the ground-truthing data from the Ketch field and pipeline route survey and the Schooner field and pipeline route survey (Geo XYZ and Benthic Solutions, 2018c and Geo XYZ and Benthic Solutions, 2018d) indicated the presence of several potentially sensitive habitats and species:

- ‘Sandbanks which are slightly covered by sea water all the time’ - EC Habitats Directive Annex I habitat (see discussion above);
- Burrowing megafauna communities - UK BAP habitat;
- Sandeel habitat - UK BAP priority marine species;
- The ocean quahog (*Arctica islandica)*.

2.2.5.1 Burrowing megafauna communities

In order to determine whether the habitats recorded during the Ketch and Schooner surveys should be classified as the UK Habitat Feature of Conservation Importance (FOCI) of ‘mud habitats in deep water’ (also a UK BAP Habitat), a combination of environmental factors and faunal information are considered, as outlined in (JNCC, 2014). The UKBAP definition of ‘mud habitats in deep water’ is as follows:

“Mud habitats in deep water (circalittoral muds) occur below 20-30m in many areas of the UK's marine environment, including marine inlets such as sealochs. The relatively stable conditions associated with deep mud habitats often lead to the establishment of communities of burrowing megafaunal species where bathyal species may occur with coastal species. The burrowing megafaunal species include burrowing crustaceans such as Nephrops norvegicus and Callianassa subterranea. The mud habitats in deep water can also support seapen populations and communities with Amphiura spp.” (UKBAP, 2008).

No seapens were recorded in the Ketch or the Schooner survey area, however their absence does not preclude the classification as ‘mud habitat in deep water’, as while burrowing megafauna is an essential element of the habitat, seapens may, and by extension may not, be present (JNCC, 2014). The environmental conditions described by the UKBAP are comparable with those recorded in both survey areas, although the sediment is dominated by sand rather than mud. However, it is likely that this difference will not preclude classification of ‘mud habitats in deep water’ as the key aim of this classification is the conservation of the burrowing megafauna.

2.2.5.2 Sandeel habitat - UK BAP priority marine species

Sandbanks and other sandy substrates may be important habitats for sandeels (Ellis *et al*., 2010), which are small, thin eel-like fish that form large shoals and live most of their life buried in the seabed. Part of the project area falls within the spawning ground for sandeels (see Table 2). Sandeel distribution is primarily driven by the availability of suitable substrates for settlement and burrowing and are known to avoid areas with >4% of silt/clay and absent where silt/clay or very fine sand content is greater >10% (Wright *et al*., 2000; Holland *et al*., 2005). A review of the particle size composition of the sediments within the survey area was undertaken in order to further evaluate the potential of the survey area as sandeel habitat. All stations within the Ketch field and Schooner field (including pipeline station SPL_01 (closest to the Schooner field)), except for station K11 revealed a silt content >10%, with the lowest proportion of sediment fines found at K05 (10.4%) and S_07 (25.5%), theoretically making these sampled stations unsuitable sandeel habitats. Review of the underwater footage confirmed the absence of sandeels within those stations. However, the remaining stations located on both pipeline routes (KPL_04 to KPL_06 and SPL_09 and SPL_02 to SPL_06) showed evidence of sandeel occurrence which was clearly recorded in the underwater footage and most likely due to reduced sediment fines within the Dogger Sandbank at the Ketch pipeline stations. A further two video transects were carried out along the Schooner export pipeline route (SPL_09 and SPL_10) and confirmed the presence of sandeels at these locations.

2.2.5.3 Ocean Quahog (*Arctica islandica*)

A single ocean quahog individual was noted in one of the grab samples at station S11 but there was no evidence of distinct *A. islandica* siphons at the seabed on any of the Schooner survey area video footage or still photographs. The bivalve species is afforded status under the OSPAR Commission, and is included in the OSPAR List of Threatened and/or Declining Species in the Greater North Sea area as a priority (OSPAR, 2008; 2009). This species is also listed as a Marine Conservation Zone Feature of Conservation Importance (MCZ FOCI) for both inshore and offshore protection (JNCC and Natural England, 2016).While previous surveys of marine protected areas (MPA) designated for the protection of *A. islandica* populations have shown only sparse populations (O'Connor, 2016; 13 individuals from 156 Hamon grab samples), it is highly unlikely that the single individual noted on the Schooner survey would be considered to be of any conservation importance. No evidence was found for the occurrence of ocean quahogs within the Ketch field or along the Ketch export pipeline.

2.2.6 Coastal Protected Areas

There are several coastal protected areas along the eastern English coastline to the west of the project area including SSSIs, SPAs and Important Bird Areas (IBAs). The SPAs to the west of the project area regularly support wildfowl and waders and gulls. The eastern coast of England and the North Norfolk coast provide some of the most important wetlands, cliffs and bays in Europe which provide significant haul-out and breeding areas for seals and seabirds. The Humber Estuary is designated as an SAC due to its coastal lagoons, sand dunes, grey seals, migrating birds and river/sea lamprey features. The coast is approximately 130 kilometres from the project area and therefore is unlikely to be impacted by an oil spill.

2.2.7 Marine Conservation Zones Project

There are two recommended MCZ areas in the vicinity of the project area; Net Gain 7: Markham's Triangle (approximately 20 kilometres south-east of Block 44/26a) and Net Gain 9: Holderness Offshore (80 kilometres south-west of Block 44/26a). Net Gain 7: Markham's Triangle is an area composed of two broad-scale habitats (moderate energy circalittoral rock and subtidal missed sediment), subtidal sands and gravels and an important habitat are for European eel (*Anguilla Anguilla*). Net Gain 9: Holderness Offshore is an area composed of a broad-scale subtidal sand habitat and areas of subtidal sands and gravels and Ross worm reefs as habitat areas of conservation importance (*Net Gain, 2011*).

Although these sites have been identified as possessing features, habitats and/or species warranting further protection and as fulfilling the criteria for creating a network of protected areas, no official protected status imposing any restrictions upon commercial activities such as fisheries oil, gas and renewables development, has been formally implemented.

2.2.8 Marine Plan Areas

This region of the SNS lies within the East Offshore Marine Plan area which sets the framework for future development from Flamborough Head to Felixstowe, and covers approximately 49,000 square kilometres of sea from 12 nautical miles out to the maritime borders with the Netherlands, Belgium, and France (*DEFRA, 2014*). Marine plans, together with the National Marine Policy Statement, underpin the planning system for England’s seas. In accordance with the policies within the East Offshore Marine Plan, relevant economic, environmental and social aspects in the region of the project area have been considered simultaneously, and using the best available evidence.

Faroe understand the principles behind the East Offshore Marine Plan, for example, policy ECO1 which relates to the pressures cumulative impacts can place on the ecosystem. Faroe aims to minimise these pressures in the vicinity of the project area via operational and environmental management controls. Collision risk assessments have been carried out for both the Schooner and Ketch NUIs; however, risks associated with the decommissioning project would also be assessed in line with policy ECO2 which relates to the risk of release of hazardous substances as a secondary effect due to increased collision risk. Policies such as BIO1 are considered throughout Faroe’s current and future operations taking into account the best available evidence of protected habitats, species and conservation status within the area.

2.3 Socio-Economic Baseline

2.3.1 Commercial Fisheries

Commercial fishing activity within the vicinity of the project area is generally low with peak moderate activity in August and September; however, data was undisclosed from December to April (*Scottish Government, 2018*). The project area lies with ICES rectangle 37F2. Landings during the years 2014 to 2016 were predominantly demersal species making up 53.03 per cent of the live weight catches in 2016, followed by shellfish (46.93 per cent) and pelagic making up approximately 0.04 per cent of catches in 2016 (*Scottish Government, 2018*).

ICES Rectangle 37F2 has a fishing effort of 429.4 effort days per 100 square kilometres per year which is relatively moderate but consistent with fishing efforts for large areas of the SNS. The highest fishing efforts in this region are located in more inward waters adjacent to the stretch of coast between

Bridlington and Hartlepool. The number of fishing tracks along the Schooner and Ketch pipelines is fairly low (between 12 to 42 tracks) for the northern halves of the pipelines from Murdoch. Moving south along the pipelines towards the Schooner and Ketch installations the number of fishing tracks increases to a maximum of 244 to 296 tracks (Ketch pipeline) and a maximum of 406 and 479 tracks (Schooner pipeline) before decreasing again on approach to the installations and their 500 m safety exclusion zones.

Industrial fisheries target the sandeel populations of the southern and central North Sea. The fishery is focused on the Dogger Bank and takes place mainly during the summer months (*Rogers & Stocks, 2001*). Pelagic fisheries in the SNS mainly target herring, sprat and horse mackerel. Purse seiners and pelagic trawls are usually used in the herring fishery, with the greatest landings in the summer months (*Rogers & Stocks, 2001*).

The Preliminary Environmental Information Report (Poseidon Aquatic Resource Management Ltd, 2017) produced for the Hornsea Project 3 windfarm presented commercial fisheries data for a 'regional commercial fisheries study area' which covered ICES rectangles: 37F0 to F3, 36F0 to F3, 35F0 to F3 and 34F0 to F3. Surveillance data for UK and non-UK vessels of all sizes indicate that the predominant gear types across the regional commercial fisheries study area include demersal otter trawlers and beam trawlers in the offshore areas (outside 12 nm) and potters/whelkers and shrimpers (targeting shellfish) within inshore areas (inside 12 nm); clusters of other gears are also noted in a few locations including scallop dredgers.

2.3.2 Shipping and Ports

The density of shipping traffic within the SNS is relatively high, due to the presence of a number of international ports (Hull and Grimsby) within the region. Data shows that shipping densities in the project area are moderate, with highest activity in the summer months (*DECC, 2009* and *Oil and Gas Authority, 2016*).

2.3.3 Wind Farms

A number of wind farm sites are located near to the project area (see Figure 3.7). The Hornsea 1 wind farm site is the closest site, under construction, to the project, located approximately 11.5 km from the Schooner platform. Based on the proposed decommissioning project offshore operations period (2018 to 2024) the offshore construction of the following windfarm developments may overlap with the project operations: Hornsea Project 1, Hornsea Project 2 , Hornsea Project 3 , Triton Knoll, Dogger Bank Creyke Beck A and B and Teesside A and B.

2.3.4 Oil and Gas Activity

Oil and gas activity within the project area is moderate compared to other blocks to the north east. The project area contains the Schooner and Ketch gas fields, and sections of the Topaz to Schooner, Schooner to Murdoch, Ketch to Murdoch export pipelines.

In the vicinity of the project area several oil and gas developments have commenced decommissioning of assets and have an approved DP, whilst others are in the decommissioning planning phase and/or have a draft DP under consideration. The closest approved decommissioning project to the Schooner and Ketch decommissioning project is Spirit Energy's Markham ST-1, located approximately 30 km to the south east of the Ketch installation (see Figure 3.8). Faroe are also aware that Conoco Phillips are planning to decommission the Caister Murdoch System (CMS) through which the Schooner and Ketch produced gas and condensate is processed (see Figure 3.7). Based on the proposed decommissioning project offshore operations period (2018 to 2025) there is the potential for the temporal overlap of the approved decommissioning programmes with the project operations.

2.3.5 Tourism and Leisure

The tourism industry is not likely be impacted by normal offshore oil and gas operations but leisure activities could be threatened in the event of a major accidental spill approaching the coast, however this is unlikely given the coast is approximately 130 kilometres from the project area and minimal beaching of hydrocarbons is expected.

2.3.6 Military Exercise Areas

Blocks 44/26, 44/27 and 44/28 all overlap with a military exercise area (Oil & Gas Authority, 2017). As a result, these blocks are considered to be an area of concern to the Ministry of Defence (Oil & Gas Authority, 2017).

2.3.7 Archaeology

There are three charted wrecks in the project area, the closest lying approximately 1 kilometre to the northwest of the Schooner NUI (Hydrographer of the Navy, 2008).

2.3.8 Submarine Cables

There are no proposed cables in the vicinity of the project and one existing communications cable (NORSEA COMMS) located approximately 5km west of the Ketch pipeline at the nearest point (see Figure 3.7).

2.3.9 Aggregate Dredging Activity

To the south of the proposed decommissioning project there are a number of marine aggregate production areas and one marine aggregate application area (see Figure 3.7).

3 Environmental Impact Assessment

The EA process began with an Environmental Impact Identification (ENVID) Workshop. The purpose of the ENVID workshop was to identify any environmental hazards associated with the decommissioning project activities and to document the associated environmental risks. Each potential Environmental impact identified was categorised using the Faroe Schooner and Ketch Decommissioning Project 5x5 Risk Assessment Matrix (RAM), to establish its Environmental significance. Significance was established by combining the likelihood and consequence scores. The majority of potential impacts identified were rated as Low (green) environmental risk following standard mitigation and there were no potential impacts rated as High (red) environmental risk. The impacts rated as Low environmental risk were not assessed further. The activities evaluated in the ENVID as having a potential for medium environmental risk (orange) that required further assessment were:

- **Severance of jacket piles using explosives**
- **Use of jet trencher and/or plough trencher to bury Ketch pipelines**
- **Schooner and Ketch pipelines remaining *in-situ***

The potential environmental risk associated with loss of containment of the entire inventory of diesel from a vessel utilised in the decommissioning was identified as needing further assessment as, at the time of the ENVID, up to date oil spill modelling was not available to inform the initial assessment.

The potential impacts associated with the three planned activities that were identified as medium environmental risk requiring further assessment were disturbance to the seabed and disturbance and/or injury to noise sensitive species from underwater noise.

Table 5 summarises the findings of the EA process. The key hazards, environmental effects, control and mitigation measures proposed by Faroe to mitigate those effects are also presented in Table 5.

Table 5. Key hazards, environmental effects, control and mitigation measures proposed for the Schooner and Ketch decommissioning project

Source of Impact	Key Environmental Receptors	Effects	Control and Mitigation Measures	Impact Significance
Section 4.2: Discharges to Sea and Small Unplanned Releases				
Planned discharges to sea will occur from the use of vessels and small releases of the pipeline contents to sea during cutting of the pipelines. Additionally, the potential exists for ballast water to be discharged dependent upon the vessel type engaged in the decommissioning activities.	Water quality, Benthic communities, Plankton, Fish/Shellfish, Marine mammals, Fishing	Releases have the potential to cause localised toxic effects on marine fauna and flora and localised pollution, which may impact local marine wildlife.	• The use of any chemicals for cleaning and flushing or for any other decommissioning activities will be permitted under the Offshore Chemical Regulations 2002 (as amended) • The discharge of any residual hydrocarbons from pipeline and riser disconnections and cutting activities will be permitted under The Offshore Petroleum Activities (Oil Pollution Prevention and Control (OPPC)) Regulations 2005 (as amended). • Vessel activities such as the release of drainage water and grey water will be subject to separate regulatory requirements. • Any ballast water discharges will be in line with the International Maritime Organisation ballast water management convention and guidelines.	Due to the control measures that Faroe will have in place to manage planned discharges and the short duration of activities, the environmental risk of these aspects is considered low and the potential impacts are considered not significant
Small unplanned releases of fuel, hydraulic oil,	Water quality, Benthic communities,	Releases have the potential to cause localised toxic effects	• Small unplanned releases will be managed under the existing Schooner and Ketch Field Oil Pollution Emergency Plan (OPEP)	Due to the control measures that Faroe will have in place to reduce the occurrence of

Source of Impact	Key Environmental Receptors	Effects	Control and Mitigation Measures	Impact Significance
lubricants or chemicals may occur during decommissioning activities.	Plankton, Fish/Shellfish, Marine mammals, Fishing	on marine fauna and flora and localised pollution, which may impact local marine wildlife.	(Petrofac/Faroe, 2016) and the vessel Shipboard Oil Pollution Emergency Plans (SOPEPs)	the most frequent type of spill, the environmental risk of these aspects is considered low and the potential impacts are considered not significant
Section 4.3: Atmospheric Emissions and Energy Use				
Emissions from power generation and energy use by vessels, preparatory works for removal of the topsides and the onshore transport and processing of materials and waste.	Air quality	Emissions have the potential to contribute to the pool of greenhouse gasses in the atmosphere (CH_4, CO_2), acid effects (SOx, NOx) and a short term localised impact on air quality.	• Low sulphur diesel fuel will be used if this is available; • Maintenance of vessel combustion equipment and certification, adherence to company standards. • The number of vessel and helicopter movements will be optimised through efficient planning. • Materials and waste will be treated at appropriately licenced onshore facilities and the process of obtaining these licences will have included an assessment of the impacts from energy use and atmospheric emissions at the facility.	Time spent by vessels in the field will be limited through optimisation of the decommissioning schedule and elevated concentrations of atmospheric gases from vessel activities will be localised, short-lived and will hardly be detectable beyond a short distance from the vessels due to the dispersive nature of the offshore environment.
Section 4.4: Physical Presence				
The pipelines that will be decommissioned *in-situ* may	Fishing.	Potential for interference with fishing activities through loss of nets if	• Marking pipelines on admiralty charts and addition to FISHSAFE. • Trenching and burial of Ketch pipelines.	The pipelines are anticipated to remain buried and monitoring will be performed (at a frequency to be agreed

Source of Impact	Key Environmental Receptors	Effects	Control and Mitigation Measures	Impact Significance
present a snagging hazard to fishing activity should they become exposed.		they become snagged on pipelines. Potential for emergency situation due to snagging.	• Over trawl survey performed to confirm over trawlability.	with OPRED) to confirm the pipelines decommissioned in-situ remain stable and buried. The pipelines will undergo and overtrawl assessment to confirm over trawlability. The measures outlined above will ensure that fishing operations are at a low risk from snagging. Given the control measures that Faroe will have in place to reduce the occurrence of snagging, the environmental risk of these aspects is considered low and the potential impacts are considered not significant
Vessels on transit to the Schooner and Ketch facilities and on location.	Shipping and Fishing	Exclusion of fishing activities and associated economic impact. Physical obstruction in the sea and an associated navigational hazard and increased risk of collision with third-party vessels.	• 500 m safety exclusion zone around NUIs already in place. • Notice to Mariners prior to operations commencing. • Kingfisher Bulletins issued prior to operations commencing. • Collision Risk Management Plan developed and implemented. • Patrol of safety zone by ERRV.	Other vessel masters will have sufficient time to plan their intended routes so that they can avoid the 500 m safety exclusion zone and ensure the potential for collisions with the vessels are significantly reduced. The measures outlined above will ensure that all shipping traffic is aware of the presence of the

Source of Impact	Key Environmental Receptors	Effects	Control and Mitigation Measures	Impact Significance
			• ERRV will have Automatic Radar Plotting Aid (ARPA) in place. • Consent to Locate approved and in place prior to operations commencing. Any necessary variations to the existing Schooner and Ketch Platforms Consent to Locates will be in place to cover all phases of the decommissioning operations. • Vessel communication systems. • Fishsafe bulletins.	vessels throughout operations. Although shipping and fishing activity in the area is moderate, the measures undertaken to alert vessels to the presence of the decommissioning activity in advance means the risk of these aspects can be considered as low and the potential impacts are considered not significant.
Vessels anchoring on location	Fishing	The potential exists for vessel anchors and anchor chains to snag fishing gear.	• Notice to Mariners prior to operations commencing. • Liaison with regional fishing groups. • Consent to Locate approved and in place prior to operations commencing. • Kingfisher Bulletins issued prior to operations commencing. • Anchor management plan in operation • Patrol of safety zone by ERRV. • ERRV will have Automatic Radar Plotting Aid (ARPA) in place. • Vessel communication systems.	The presence of anchors and anchor chain does present a snagging risk however given the short durations of anchoring needed and the control measures that Faroe will have in place to reduce the occurrence of snagging, the environmental risk of these aspects is considered low and the potential impacts are considered not significant.

Source of Impact	Key Environmental Receptors	Effects	Control and Mitigation Measures	Impact Significance
			- Fishsafe bulletins.	
Section 5: Seabed Disturbance				
Anchoring of vessel for topsides removal and recovery	Sediments, benthic communities, protected/sensitive areas.	Temporary disturbance of a small area of seabed, sediment and any associated macrofauna. Potential for disturbance of sensitive species that may be present.	- If anchored vessels are required to be used an anchor management plan will be implemented.	Given the small footprint (0.03824 km^2) of disturbance, absence of sensitive species in the vicinity and the expected recovery from temporary disturbance caused by anchoring the significance of the impact is considered 'low'.
Removal and recovery of NW Schooner wellhead and integral protection structure using jack-up MODU. Topsides preparation using jack-up MODU at both platforms		Temporary disturbance of a small area of seabed, sediment and any associated macrofauna. Potential for disturbance of sensitive species that may be present.	- The removal and recovery of items will be planned and carefully executed. - Positioning of the jack-up MODU legs will be planned and carefully executed.	Given the disturbance will be temporary, the absence of sensitive species and habitats has been confirmed at both platforms and recovery to the seabed and sediment is expected the significance of the impact is considered 'low'.

Source of Impact	Key Environmental Receptors	Effects	Control and Mitigation Measures	Impact Significance
Over-trawl assessment survey following decommissioning operations		Temporary disturbance of a small area of seabed, sediment and any associated macrofauna. Potential for disturbance of sensitive species that may be present.	• In order to minimise disturbance to the seabed from the over-trawl assessment the area that requires assessment will be optimised through liaison with fishing organisations and the regulator.	Given the small footprint (4. 3308 km^2) of disturbance relative to the size of the Schooner and Ketch licence blocks (400 km^2), absence of sensitive species in the vicinity and the expected recovery from temporary disturbance caused by the over-trawl assessment the significance of the impact is considered 'low'.
Cutting of pipeline ends			• The removal and recovery of items will be planned and carefully executed. • The vessels involved will position themselves directly over each item before lifting so that the item can be lifted vertically as far as possible, to avoid dragging on the seabed and therefore minimise the area of seabed disturbed.	Given the small footprint (0.0007 km^2) of disturbance, absence of sensitive species in the vicinity and the expected recovery from temporary disturbance caused by the movement of sediment to either side of the pipeline for cutting access the significance of the impact is considered 'low'. The use of cutting shears is considered to have a negligible impact on the seabed as the tool is rigged from the vessel and sits vertically above the pipeline

Source of Impact	Key Environmental Receptors	Effects	Control and Mitigation Measures	Impact Significance
				with minimal contact to seabed
Cutting Jacket piles to free legs from seabed			• Cutting operations will be planned and carefully executed.	Internal cutting is the preferred method and only if this fails will external cutting be necessary. Disturbance to the seabed will be temporary and it is expected that any suspended sediment will drop out of the water column, settling back on the seabed within a short duration. In addition, no sensitive species or habitats were recorded in the vicinity of the platforms. Given the above the significance of the impact is considered 'low'.
Trench and burial of Ketch pipelines to decommission *in situ*			• Trenching and burial operations will be planned and carefully executed.	Trenching and burial of the exposed Ketch pipeline sections that lie within the Dogger Bank SAC/SCI and MPA will be necessary. No sediment will be removed and any suspended sediment will drop out of the water column, settling back on the seabed

Source of Impact	Key Environmental Receptors	Effects	Control and Mitigation Measures	Impact Significance
				within a short distance and duration. Given the above the significance of the impact is considered 'low'.
Recovery of grout bags at Schooner and Ketch pipelines and Caister pipeline crossing.			- The removal and recovery of items will be planned and carefully executed. - The vessels involved will position themselves directly over each item before lifting so that the item can be lifted vertically as far as possible, to avoid dragging on the seabed and therefore minimise the area of seabed disturbed.	Removal of grout bags may cause temporary disturbance to the seabed and benthos however by the removal of the grout bags, a hard substrate, the seabed will be allowed to return to its natural soft substrate environment allowing species typical of this environment to colonise the new areas. Given the above the significance of the impact is considered 'low'.
Decommissioning of mattresses and pipelines *in situ*		There is the potential for the slow release of degradation products from the pipelines decommissioned in-situ as they degrade over time. Degradation products of the pipeline, NORM scale and any entrained	- Pipelines will have undergone a series of flushing and cleaning during the preparation for decommissioning.	The release of degradation products is expected to occur slowly, and rapidly disperse within the water column, therefore the impact on the environment is expected to be minimal. Given the above the significance of the impact is considered 'low'.

Source of Impact	Key Environmental Receptors	Effects	Control and Mitigation Measures	Impact Significance
		heavy metals and any hydrocarbons or heavy metals associated with residual solids will break down and could potentially become bioavailable to benthic fauna in the immediate vicinity.		
Section 6.0: Underwater Noise				
Underwater noise from decommissioning operations (vessels, trenchers)	Plankton, Fish/Shellfish, Marine Mammals, Protected/Sensitive Areas	Potential disturbance to marine mammal and fish. Potential behavioural changes in fish and marine mammals due to increase in background underwater noise levels.	• Decommissioning operations inevitably give rise to noise. The vessels and MODU will be on location for the minimum period of time required to successfully and safely conduct the decommissioning operations, thus minimising the duration of potential noise impacts as far as practicable.	The mitigation ensures that the impact remains as predicted and that any impacts are short term. The noise modelling shows that instantaneous injury to marine mammals and fish is unlikely to occur for any of the continuous noise sources (MODU/JUB, HLV, Cargo Barge, Supply Boat, DSV/ROV Support Vessel, Trawler Vessel, Jet Trencher / Plough Trencher) therefore the significance of the impact is considered ‘low’.

Source of Impact	Key Environmental Receptors	Effects	Control and Mitigation Measures	Impact Significance
Underwater noise from the use of explosives to sever the jacket piles	Plankton, Fish/Shellfish, Marine Mammals, Protected/Sensitive Areas	Potential disturbance and or injury to marine mammal and fish. Potential behavioural changes in fish and marine mammals due to increase in background underwater noise levels.	• The measures presented in the JNCC guidelines for minimising the risk of injury to marine mammals from using explosives including MMOs, a PAM system, pre-detonation search and the inclusion of a ten minute 'soft start' procedure will be adhered to.	The use of explosives is a contingency option if both internal and external cutting of the piles fails. There is a likely risk of permanent injury to cetaceans, pinnipeds and fish resulting from the pile severance explosions. MMOs, a PAM system and the inclusion of a ten minute 'soft start' procedure, will reduce the potential injury ranges considerably for marine mammals. The use of explosives will be for a relatively short duration and the mitigation measures will reduce the potential impact, therefore the significance of the impact to fish and marine mammals is considered 'low'.
Section 7: Accidental Events				
Dropped Objects	Sediments, Benthic communities, Fishing	Dropped objects have the potential to cause disturbance to the seabed and benthic faunal communities.	• All items will be securely stowed. • Lifting operations will be planned to manage the risk, meet requirements of Lifting Operations and Lifting Equipment Regulations (LOLER) 1998	The mitigation measures will reduce the severity of the potential impact, particularly for fisheries, as recovery of dropped objects, particularly

Source of Impact	Key Environmental Receptors	Effects	Control and Mitigation Measures	Impact Significance
		They also pose a potential risk of snagging gear to fisheries.	and will use the correct lifting equipment that is tested and certified. • Recovery of dropped objects will take place where practicable. • Dropped object reporting as per PON2 requirements. Dropped Object sweep of seabed. Incident log/register.	those of significant size, will take place where this is practicable. The recovery of dropped objects helps to avoid snagging of fishing gear. Therefore, the risk of these aspects can be considered as low and the potential impacts are considered not significant.
An emergency incident (e.g. vessel collision), leading to potential unintentional releases	Water quality, Plankton, Fish/Shellfish, Offshore seabirds, Coastal seabirds, Marine mammals, Shipping, Fishing, Tourism/leisure, Coastal populations	Potential total loss of containment of entire inventories of diesel, utility fuels and chemicals from vessels potentially causing significant hydrocarbon and chemical pollution. Potential impacts on water quality and marine wildlife in the affected area.	• All mitigation measures as defined above for unintentional releases during day to day operations. • All contracted vessels will have a ship-board oil pollution emergency plan (SOPEP) in place. • An Emergency response plan (ERP) in place prior to operations commencing. • A contract with an oil spill response organisation will be in place to ensure a timely and efficient mobilisation of oil spill response resources and competent response personnel. • The ERRV will have 5 cubic metres of dispersant on board.	Oil spill modelling has shown that in the event of a worst-case hydrocarbon release (inventory loss from the decommissioning vessel), the diesel would weather offshore in the waters immediately surrounding the well location. Diesel is not predicted to beach in any scenario. Significant impacts on fish and seabird species are not expected. The impact on offshore designated sites is expected to be low given the very low probability of surface oiling (0-10% range) over the clear majority of the sites and the fact that most protected

Source of Impact	Key Environmental Receptors	Effects	Control and Mitigation Measures	Impact Significance
				features are on the seabed where minimal impacts are expected from a surface oil spill. The impact on offshore protected species (harbour porpoise – associated with the Southern North Sea cSAC and MPA) is also expected to be low given the avoidance behaviour that marine mammals in general show towards oil spills. Based on the modelling the controls and mitigation measures in place by Faroe are sufficient to manage any unintentional releases and therefore the significance of the impact is considered 'low'.

4 Conclusions

Following the initial assessment and further assessment undertaken during the EA process, including an oil spill modelling study, and implementation of additional control and mitigation measures where necessary, the level of environmental risk from the planned and unplanned decommissioning operations including disturbance to the seabed, underwater noise and accidental events from a large spill was determined to be ‘low’. In addition, the cumulative impact from physical presence, seabed disturbance and underwater noise was assessed and determined to be ‘low’.

1 Introduction

1.1 Background

Faroe Petroleum (ROGB) Limited, hereafter referred to as Faroe have prepared this Environmental Appraisal (EA) report to support the Decommissioning Programmes (Faroe, 2018) that are required by the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) (part of the Energy and Security Directorate in the Department of Business, Energy and Industrial Strategy (BEIS)) for the decommissioning of the Schooner and Ketch fields.

The purpose of the EA is to document the Environmental Impact Assessment (EIA) process that has been undertaken to evaluate the potential environmental impact of the proposed decommissioning projects on the marine environment and identify any remedial works or mitigation that may be required to reduce the level of any potential impacts and risks to ‘As Low As Reasonably Practicable’ (ALARP).

Faroe have considered several technical and commercial solutions in order to prolong the field life of both Schooner and Ketch; either as a standalone field or in conjunction with other fields in the area; however, none of them have been considered to be economic. Faroe is now seeking consent for the Cessation of Production (CoP) at both the Ketch and Schooner fields in line with the Theddlethorpe Gas Terminal (TGT) cessation of operations in 2018.

The facilities at the Schooner and Ketch fields are under the operatorship of Faroe who have a 60% interest in the fields with Tullow Oil SK Limited having the remaining 40% interest. First gas production was achieved at Schooner and Ketch in 1996 and 1999 respectively, with Faroe assuming the role of operator at both facilities in 2014.

1.2 Location of the Fields

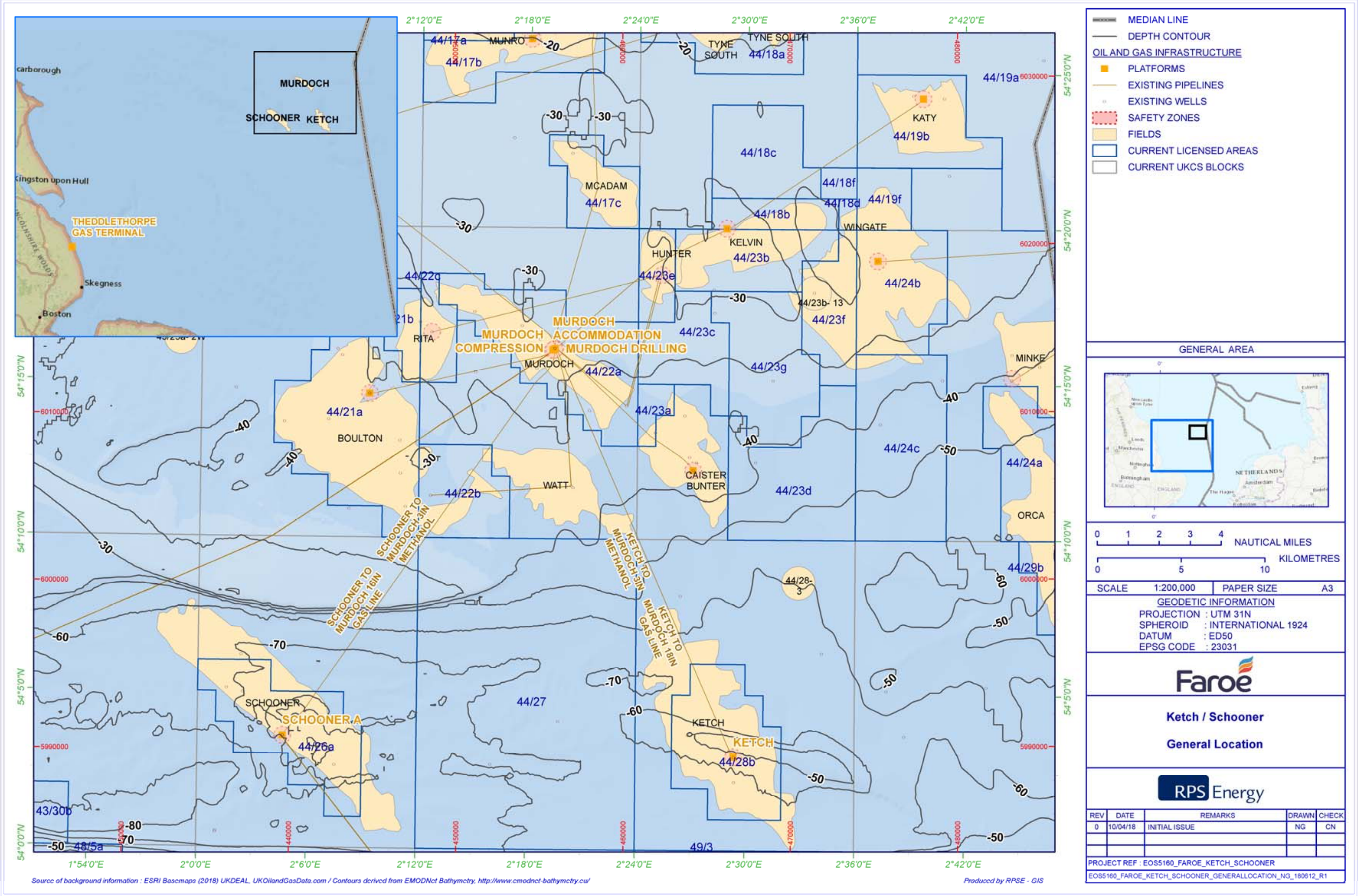
The Schooner and Ketch Normally Unmanned Installations (NUI’s) are located in Block 44/26a and Block 44/28b of the southern North Sea (SNS) (Figure 1.1).

The Schooner NUI is located at latitude 54° 03’ 35.30” North and longitude 02° 04’ 40.10" East, approximately 130 kilometres (km) from the nearest landfall at Easington on the East Ridings of Yorkshire coastline. The nearest international boundary to the development is the UK/Netherlands median line approximately 49 km to the east. The water depth at this location is approximately 70 metres (m).

The Ketch NUI is located at latitude 54° 03’ 00” North and longitude 02° 29’ 23” East, approximately 162 km from the nearest landfall at Easington on the East Ridings of Yorkshire coastline. The nearest international boundary to the development is the UK/Netherlands median line approximately 18 km to the east. The water depth at this location is approximately 57 m.

1.3 Overview of the Schooner and Ketch Fields

Produced gas and condensate from both the Schooner and Ketch installations is exported via the Murdoch Normally Manned Installation (NMI) (in Block 44/22a) which acts as the Installation Control Centre (ICC) operated by Conoco, to the TGT (see Figure 1.2). Produced gas and condensate from Ketch is exported via an 18-inch pipeline and produced gas and condensate from Schooner is exported via a 16-inch pipeline, with all produced gas and condensate being separated and compressed at the Murdoch NMI before transportation via the Caster Murdoch System (CMS) infrastructure to the TGT.



Source of background information : ESRI Basemaps (2018) UKDEAL, UKOilandGasData.com / Contours derived from EMODNet Bathymetry, http://www.emodnet-bathymetry.eu/

Produced by RPSE - GIS

Figure 1.1 Location of the Schooner and Ketch NUIs

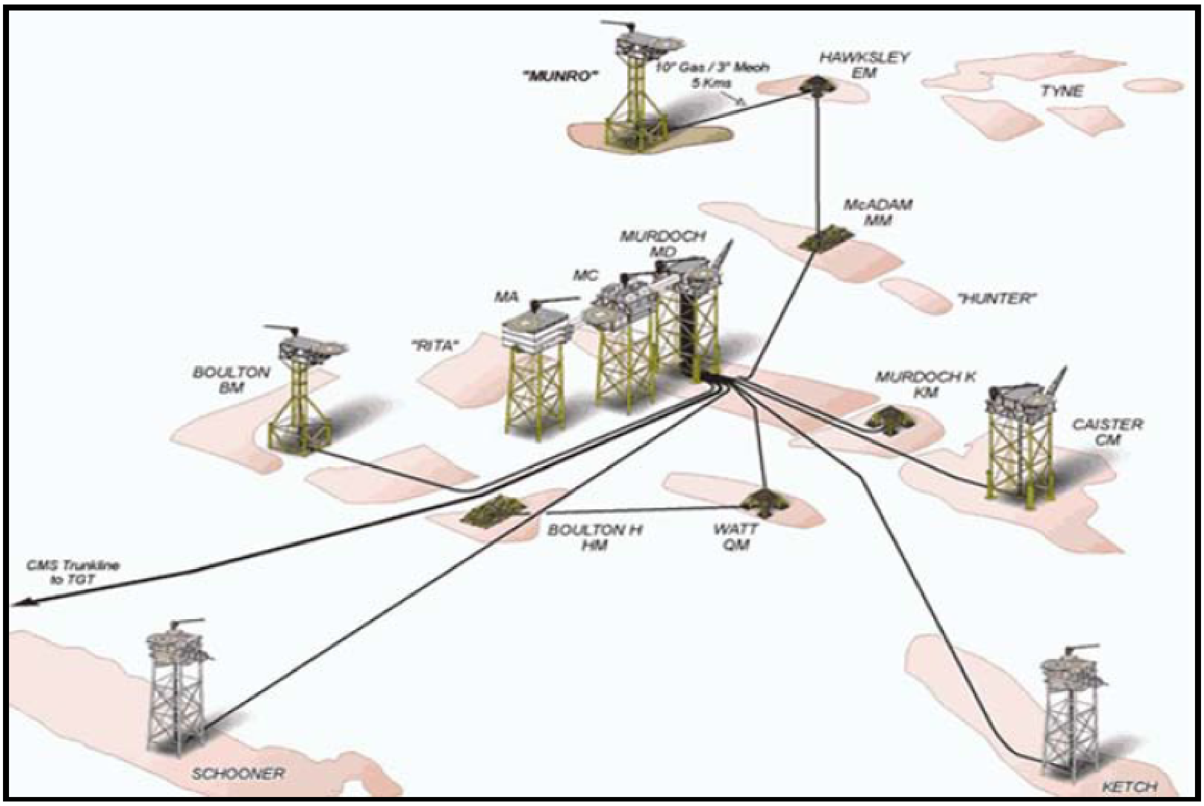


Figure 1.2 Schematic Showing Schooner and Ketch Fields tied back to Murdoch

1.4 EA Scope

The scope of the EA is aligned with the scope of the Decommissioning Programmes (Faroe, 2018a). The scope covers the following:

- The Schooner and Ketch NUI comprising a Jacket (a conventional 4-leg skirt piled steel structure) and topside (a conventional carbon steel structure of four decks plus a helideck); and
- The associated pipelines comprising the Ketch 18-inch export pipeline (PL1612) and the Schooner 16-inch export pipeline (PL1222), their associated 3-inch methanol lines (PL1613 and PL1223) and stabilisation materials.

The decommissioning of the Schooner and Ketch wells is not included in the scope of the EA and instead the potential environmental impacts associated with this activity will be assessed by the Well Intervention Master Application Template (MAT) process through the BEIS online UK Energy Portal. Likewise, the discharges relating to the flushing and cleaning of pipelines and topside systems cleaning will be assessed by submission of Chemical Permit and Oil Term Permit Subsidiary Application Templates (SAT) and are therefore excluded from the scope of the EA. The management of waste has been discussed in Section 2.5 of the EA and for the purpose of transparency from a waste management perspective the waste from the wells to be abandoned is included in this section. High level details of the wells to be abandoned are included in Section 2.1. The assessment of potential environmental impacts associated with the onshore cleaning, dismantling and disposal of any facilities brought onshore is not included in the scope of the EA as Faroe will use appropriately licenced onshore facilities and therefore any potential onshore environmental effects will be managed and mitigated in accordance with the terms of the relevant environmental permits.

1.5 Regulatory Context

On the United Kingdom Continental Shelf (UKCS), the decommissioning of offshore oil and gas installations and pipelines is controlled through the Petroleum Act 1998, as amended by the Energy Act 2008. Under the Petroleum Act 1998, owners of an offshore installation or pipeline must obtain approval of a 'Decommissioning Programme'(DP)1 from the BEIS before they can proceed with its decommissioning. Faroe will submit two DPs, one each for the Ketch and Schooner fields.

There is no statutory requirement to undertake an Environmental Impact Assessment (EIA) that satisfies the EIA Directive (Directive 2011/92/EU as amended by Directive 2014/52/EU) to support a DP, however OPRED requires that each offshore Decommissioning DP submitted for approval must be accompanied by an EA, as set out in the Decommissioning Guidance Notes (BEIS, 2017a).

Faroe's existing Environmental Management System (EMS) was audited in March 2017 and was granted verification as meeting the requirements of an EMS in relation to OSPAR Recommendation 2003/5. Faroe will ensure that the decommissioning activities will be integrated into and carried out in accordance with the company EMS.

1.6 Stakeholder Engagement and Consultation

Engagement with stakeholders is an important part of the decommissioning process because it enables the issues and concerns of stakeholders to be incorporated into the projects mitigation measures where applicable.

1.6.1 Initial Consultation

Faroe has held initial meetings and dialogue with OPRED on the proposed decommissioning strategy. In addition, a high-level EA scoping report was sent to BEIS, Marine Scotland (MS), Joint Nature Conservation Committee (JNCC), the Scottish Fishermen's Federation (SFF), the National Federation of Fishermen's Organisations (NFFO) and the Ministry of Defence (MoD) on the proposed decommissioning strategy for comment. Informal responses received to date from stakeholders in response to the high-level EA scoping report have been captured and considered in detail by Faroe and addressed, where appropriate, in the EA (Table 1.1).

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1 The Petroleum Act 1998 refers to an 'abandonment programme' however the preferred and generally accepted term is a 'decommissioning programme'.

Table 1.1 Responses from stakeholders on the proposed Schooner and Ketch Decommissioning Project

Organisation	Responses received	Comments to responses received
JNCC	Habitats of nature conservation concern We would welcome further discussion concerning protected habitats to ensure that the correct information is provided within the EA to allow assessment of whether habitats of conservation importance are, or are not, present and whether proposed activities may adversely affect habitats of conservation importance.	Additional content has been added to Section 3.3.6. conservation objectives have been added for SACs and cSACS. The impact of seabed disturbance on the Dogger Bank SAC/SCI and MPA has been assessed in Section 5.
	Marine Protected Sites We recommend Faroe check the status of all sites discussed in the EA prior to submission and refer to them accordingly; further information can be found on the JNCC web page (http://jncc.defra.gov.uk/offshoreMPAs).	MPA status has been added to the descriptions of the relevant protected sites.
	Project scope - Seabed disturbance Seabed disturbance can occur during sediment excavation, vessel positioning (e.g. mobile offshore drilling unit (MODU)), over-trawl assessment, removal of materials, temporary placement of objects of the seabed, and anchor placement. We recommend best practices are followed when planning the project to ensure, where possible, the smallest possible footprint of operations to reduce potential seabed disturbance. We also recommend that, where practical, deposition of stabilisation materials (e.g. rock dump to stabilise MODU) are kept to a minimum and that infrastructure is not placed on seabed features or habitats of conservation importance.	Noted. Mitigation measures to reduce seabed disturbance are presented in Section 5.5.
	Environmental survey data We note that site-specific surveys were commissioned in March 2018 and the results, once analysed, will be used to inform the EA. We highlight: • The environmental description should focus on that of the actual area to be decommissioned and not just provide a generic description of the local environment. Evidence should be presented within the EA confirming that any older data presented are still relevant.	Figures of the survey areas are presented in Section 3.1. A summary of survey results is presented in Sections 3.2.1, 3.3.1 and 3.3.2. Noted, Faroe will provide JNCC with copies of the survey reports.

	• Any gaps or limitations in environmental information should be acknowledged with, where appropriate, strategies to address these gaps or limitations. • Survey data should provide adequate evidence that habitats and species of nature conservation concern, including Annex I habitats, are or are not present. • It is good practice to include a diagram indicating the surveyed area in the context of the proposed activities and to identify any sample points or the location of photographic evidence. Data provided should also include high resolution acoustic data, video and / or still images. We also recommend that Faroe supply JNCC with copies of relevant survey reports (in addition to the EA), to help us better understand the site and provide future advice regarding the proposed decommissioning.	
	Environmental Baseline - Marine mammals When considering the marine mammal environmental baseline within the EA, we highlight that results from the third Small Cetaceans in Europe Atlantic waters and the North Sea survey (SCANS III) are now available[2]. The report summarises design-based estimates of abundance for a number of marine mammal species including harbour porpoise, white-beaked dolphins and minke whales. We also highlight that data associated with the revised Phase III report of the Joint Cetacean Protocol (JCP) is now available[3] The JCP III density surfaces have been scaled to the SCANS III abundance estimates for the marine mammal management units[4]. JNCC recommends that the guidance in Appendix 7 of this report is considered before using these data.	Reference to the latest studies as indicated is included in Section 3.3.5.
	Environmental Baseline - Seabirds We note the inclusion of seabird vulnerability information within the scoping report. We believe this data is from the Seabird Oil Sensitivity Index (SOSI), although it is not	See section 3.3.4 for correct reference to SOSI and information on seabird species in the project area from Kober et al., 2015.

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[2] https://synergy.st-andrews.ac.uk/scans3/

[3] http://jncc.defra.gov.uk/page-7201

[4] http://jncc.defra.gov.uk/pdf/Report_547_webv2.pdf

	labelled as such in the report. We recommend the information is referred to correctly in the EA. We also highlight this index is not intended to inform environmental baselines on seabird populations. We recommend consideration of other data sources when describing the baseline biological environment in the EA, e.g. Kober et al., 2010[5]. The purpose of the SOSI is to identify areas where seabirds are likely to be most sensitive to oil pollution by considering factors that make a species more or less sensitive to oil-related impacts. Therefore, when assessing the impacts of accidental events on seabird populations, inclusion of this information is appropriate.	
	Environmental Impact Assessment - Worst case scenario JNCC considers it best practice to consider the full worst-case scenario in order to enable a meaningful assessment of the full environmental impacts of a project. JNCC appreciates that final DPs are still subject to change and that subsequent stages are often contingent on the outcome of earlier activities. However, every effort should be made to predict the worst-case scenario and carry out impact assessment on that basis, so that all elements have been assessed and presented in an EA.	As stated in section 2.7 the activities that present the worst case potential environmental impact have been presented and assessed. Where assumptions have been made throughout the assessment these are presented at the start of each assessment section.
	Environmental Impact Assessment - Noise disturbance We note that jacket piles will be severed using cutting tools and there is no reference to the use of explosives. When considering potential impacts from noise disturbance, we highlight injury thresholds for marine mammals published in 2016 (NOAA, 2016)[6]. It is considered these new thresholds reflect the most comprehensive and up to date scientific knowledge relating to the risk of auditory injury to marine mammals; we therefore consider the new thresholds should be used for any marine mammal noise assessments	As a very last resort, if internal cutting and external cutting fails, explosives will be used to sever the jacket piles. The noise assessment presented in Section 6 has considered the use of explosives as a worst case potential environmental impact and uses the injury thresholds for marine mammals published in 2016 (NOAA, 2016).
	Cumulative/in-combination impacts JNCC suggests that the proposed activities are assessed alongside other approved	Assessment of potential cumulative impacts from the decommissioning activities with other users in the

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[5] http://jncc.defra.gov.uk/page-5622

[6] http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm

	decommissioning activities, 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.	vicinity is presented in Section 8.
BEIS	The environmental baseline needs to show trends when it is presented in the appraisal, for example has a population level stayed the same or declined or is a species on or off the IUCN list, i.e. has a receptor become more sensitive to a likely impact.	This information has been included in Sections 3.3.3 and 3.3.4.
	The distances to European protected sites should be incorporated into the appraisal and which infrastructure is located in any protected sites as well as MCZ's. Maps are very useful.	Distances to protected sites are included within Section 3.3.6. Decommissioning activities for infrastructure within protected sites are presented in Figure 3.3.
	Faroe Petroleum may find the MMO's interactive marine planning tool useful with regard to other development around the proposed decommissioning area and the Planning Inspectorate website – national infrastructure projects, provides details of which projects have been formally submitted for consideration under that regime.	This tool has been used to inform the assessment of potential cumulative impacts from the decommissioning activities with other users in the vicinity. The cumulative impact assessment is presented in Section 8.
	S5 Key Environmental Sensitivities Noting shell fishing figures have increased, we assume they are located mostly towards the coast. Are there any species on the IUCN list as endangered?	Potters/whelkers and shrimpers all target shellfish within inshore areas (inside 12nm). See Section 3.4.1. Spurdog (*Squalus acanthias)* may use the project area as a nursery and are on the IUCN list as endangered.
	S6 Potential Environmental Impacts Might there be species or habitat loss as well as disturbance associated with decommissioning activities. The section should consider cumulative impacts. In addition, what is the nature of any decommissioning located in Dogger Bank SAC and could it contribute to any cumulative impact with other activities in that area. For accidental events, Faroe Petroleum may also consider the Safety Case which references the OPEP and presents information to consider the potential for a major environmental incident and consequence assessment. The	Sections 5 and 6 of the EA report consider the loss of species and habitat associated with decommissioning activities. Assessment of potential cumulative impacts from the decommissioning activities is presented in Section 8. The nature of decommissioning located within the Dogger Bank SAC/SCI and MPA is related to the Schooner and Ketch export pipelines burial and disconnection activities. The extent of the pipelines located within the Dogger Bank SAC/SCI and MPA is presented in Section 3, Figure 3.3. Noted.

	Safety Case is likely to change to a Dismantlement Safety Case as decommissioning risks change. (See relevant guidance).	
	Details about the type of information required in the Environmental Appraisal include: A non-technical summary Introduction Policy and regulatory context Stakeholder consultation Decommissioning activities – each part of programme, duration, timing, spatial context etc Environmental Issues Identification (ENVID) Environmental Baseline including site specific data from the surveys and documenting any gaps in information Environmental Assessment with methodology, including modelling of impacts where relevant, the significance of impacts including decommissioning in Dogger Bank SAC should also be considered and information provided for HRA purposes. Conclusions References Appendix	Noted and EA is structured to include the information.
	If there is no chosen option at Comparative Assessment stage then the EA should assess the preferred option or option with worse case environmental impact. We may ask for further information to support the pipeline decommissioning option which is selected.	The EA has been written based on the preferred decommissioning option for the pipelines following the CA stage. As stated in Section 2.7 the activities that present the worst case potential environmental impact have been presented and assessed. Where assumptions have been made throughout the assessment these are presented at the start of each assessment section.
	Collision risk – there may be a change in risk to other users of the sea during decommissioning including snag hazard. The Environmental Appraisal must consider the continuity of maintaining the Standard Offshore Marking Schedule up to platform removal and also subsea hazards. We may request a Vessel Traffic Survey or Navigational Risk Assessment. The operator should consider if the Consent to	The safety zones for the Schooner and Ketch platforms and the NW Schooner well will remain in place until the platforms are removed. The Consent to Locate currently in place for the platforms will be varied as necessary during the decommissioning process to ensure compliance.

	Locate the platforms may need varying during the process up to platform removal and now continuity in markings will be maintained.	
	Debris surveys and clearance This will need to be discussed with OPRED noting how the schedule of this decommissioning proposal is timed with the proposed decommissioning of Caister Murdoch.	Noted – See Section 2.3.2
	Post decommissioning monitoring and pipeline monitoring This may be requested depending on survey findings, what is presented in the Environmental Appraisal and what is proposed.	Noted
	Can Faroe confirm if other stakeholders have been engaged early in the process?	Responded by e-mail to BEIS on 4th May 2018 to state that the scoping report had been sent to JNCC, SFF, NFFO, MoD and Marine Scotland.

1.6.2 Future Consultation

The formal consultation process will begin with the submission of the draft DPs, supported by this EA, to OPRED. The consultation process will include the DPs being placed on the Faroe external website to make the documents publicly available.

1.7 Environmental Appraisal Process

In order to evaluate the potential environmental impact of the proposed Decommissioning Programmes on the environment the EA process must be executed. This EA documents the results of the EA process and is used to communicate the process. An overview of the EA process is provided in Figure 1.3.

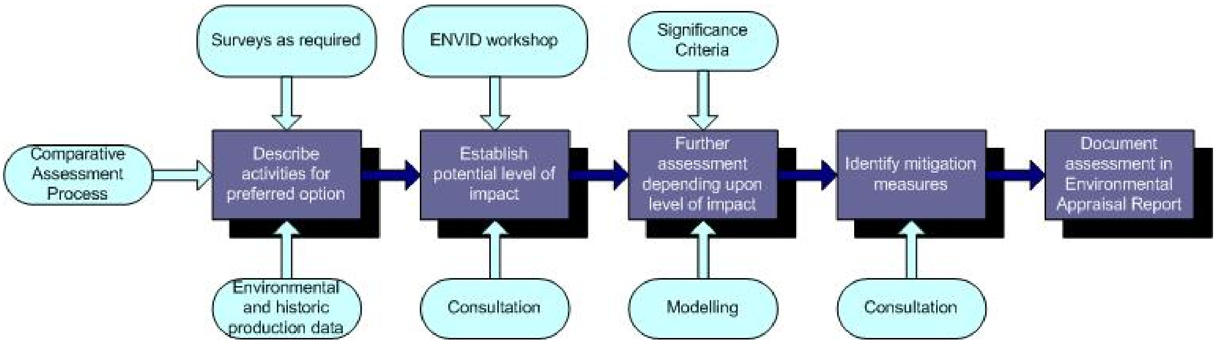

Figure 1.3. Principal stages in the EA process

2 Proposed Decommissioning Project

This section presents the preferred decommissioning solution, hereafter referred to as the 'decommissioning project', as presented in Section 3 of the Decommissioning Programmes (Faroe, 2018a and Faroe 2018b).

The preferred decommissioning solution involves:

- The complete removal and onshore disposal of the Schooner and Ketch topsides and jackets;
- *In-Situ* decommissioning of the Schooner pipelines (PL1222 and PL1223) and associated concrete mattresses; and
- *In-Situ* decommissioning of the Ketch pipelines (PL1612 and PL1613) following trenching and burial of entire pipeline.

There are currently two options under consideration for the decommissioning of the Ketch and Schooner platforms. The topsides and jackets of both platforms will be rendered hydrocarbon free. They will then either:

- Be completely removed and re-used or recycled (default option) or;
- Remain *in situ* and be converted to an offshore windfarm support facility.

At the time of writing discussions between Faroe and an offshore wind farm company regarding the feasibility of the platforms being converted to offshore windfarm facilities are at an early stage. A decision regarding the reuse / disposal of the platforms will be made in 2019. For the purposes of assessing the potential worst case environmental impact, the EA report has been written based on the default option of the Ketch and Schooner platforms being completely removed.

2.1 Infrastructure to be Decommissioned

A full inventory of the items to be decommissioned during the decommissioning project is provided in Section 2 of the Decommissioning Programmes (Faroe, 2018a and Faroe 2018b). A high-level overview of the items to be decommissioned is provided in this section to inform the reader of the items in relation to the decommissioning project activities.

The Schooner and Ketch installations and pipelines covered under the Decommissioning Programmes (Faroe, 2018a and Faroe 2018b) are presented in Table 2.1, Table 2.2 and Table 2.3. The Schooner and Ketch wells are presented here for information (Table 2.4 and Table 2.5) however they are out with the scope of the EA (see Section 1.4).

There is only one subsea installation to be decommissioned at the Schooner field. This is a subsea well consisting of a wellhead protection structure with a debris cap weighing 10 tonnes, a well tree weighing 40 tonnes, with an integral protection frame weighing 20 tonnes.

Table 2.1. Surface Facilities

Item	Weight (Te)
Schooner Topsides	2,375
Schooner Jacket	2,021
Schooner Jacket piles	694
Ketch Topsides	2,179
Ketch Jacket	1,550
Ketch Jacket piles	690

Table 2.2. Pipelines

Item	Diameter (inches)	Length (km)	Construction materials	Product Conveyed	From – To End Points	Burial Status
Schooner export pipeline PL1222	16	28.5	Steel with a polypropylene coating	Gas and Condensate	Schooner to Murdoch	Trenched and Buried
Schooner piggyback line PL1223	3	28.5	Steel with a polypropylene coating	Methanol	Schooner to Murdoch	Trenched and Buried
Ketch export pipeline PL1612	18	26.6	Steel with a polypropylene coating	Gas and Condensate	Ketch to Murdoch	Laid on seabed, partially buried
Ketch piggyback line PL1613	3	26.6	Steel with a polypropylene coating	Methanol	Ketch to Murdoch	Laid on seabed, partially buried

Table 2.3. Subsea Pipeline Stabilisation Features

Stabilisation Feature	Total Number	Weight (Te)	Location(s)	Exposed/Buried/Condition
Schooner Field				
Mattress on Caister / Schooner pipeline crossing	8	22.24	KP 0.00 – 0.50	Exposed/partially buried
Schooner platform mattresses	14	170.88	KP 0.007 – 0.109	Buried / partially buried
Murdoch Platform mattresses	13	189.04	KP 0.00 – 0.50	Buried / partially buried
Grout bags	Approximately 400	Approximately 26	KP 0.00 – 0.50	Exposed/partially buried
Ketch Field				
Concrete Mattresses (Murdoch approach & Caister Crossing)	21	13	KP 0.00 – 0.50	Exposed
Mattress along Ketch pipeline subsea route	52	421	KP 0.50 – 26.147	partially buried/exposed
Grout bags (at Caister pipeline Crossing)	Approximately 32	Approximately 17	KP 0.00 – 0.50	Exposed

Table 2.4. Schooner Wells

Well Name	Well Type	Status
SA01 - 44/26a-A1	Gas Production	Completed Operating
SA02 - 44/26a-A2	Gas Production	Completed Operating
SA03 - 44/26a-A3	Gas Production	Completed Operating
SA04 - 44/26a-A4	Gas Production	Completed Operating
SA05 - 44/26a-A5	Gas Production	Shut in
SA06 - 44/26a-A6Y	Gas Production	Shut in
SA07 - 44/26a-A7	Gas Production	Suspended AB1
SA08 - 44/26a-A8Z	Gas Production	Completed Operating
SA09 - 44/26a-A9Z	Gas Production	Shut in
SA10 - 44/26a-A10Z	Gas Production	Completed Operating
SA11 - 44/26a-A11	Gas Production	Completed Operating
Subsea Wells		
NW Schooner - 44/26a-7	Gas Production	Suspended

Table 2.5. Ketch Wells

Well Name	Well Type	Status
KA01 – 44/28b-K1	Gas Production	Completed Operating
KA03- 44/28b-K3X	Gas Production	Shut in
KA04 – 44/28b-K4Z	Gas Production	Completed, plugged
KA05 – 44/28b-K5	Gas Production	Shut in
KA06 – 44/28b-K6Y	Gas Production	Shut in
KA07 – 44/28b-K7	Gas Production	Completed Operating
KA08 – 44/28b-K8Z	Gas Production	Completed Operating
KA09 – 44/28b-K9Y	Gas Production	Completed Operating
KA10 – 44/28b – K10Y	Gas Production	Shut on the tree
Subsea Wells		
44/28b-1	Exploration	Abandoned AB3
44/28b-2	Exploration	Abandoned AB3
44/28b-3	Appraisal	Abandoned AB3
44/28b-4	Appraisal	Abandoned AB3

2.1.1 Drill Cuttings

All drill cuttings generated during drilling activity were skipped and shipped to shore and therefore no drill cuttings are expected to be located in the vicinity of the project area, this was confirmed during the pre-decommissioning environmental survey (GEOXYZ and Benthic Solutions, 2018a and GEOXYZ and Benthic Solutions, 2018b).

2.2 Decommissioning Project Activities

At the time of writing this EA the detailed engineering studies required to define the methods for decommissioning have not been completed. Where more than one method could be used, that which presents the worst case potential environmental impact has been assessed.

2.2.1 Well Abandonment

Both the Schooner and Ketch platform wells and the Schooner subsea well will be plugged and abandoned (P&A) as per the Oil and Gas UK Guidelines for Abandonment of Wells (O&G UK, 2015). The potential environmental impacts associated with the well P&A campaign will be considered under the Well Intervention and Marine Licence applications submitted on the Portal Environmental Tracking System (PETS) and are therefore excluded from the scope of the EA. The well abandonment operations will occur out with the boundaries of any nearby European protected sites. For the purpose of transparency from a waste management perspective the weight of the well conductors from the wells to be abandoned is presented in Table 2.9, Section 2.5, however it is planned that the well conductors will be removed as part of the well plug and abandonment campaign subject to no technical difficulties being experienced.

2.2.2 Topsides

Prior to removal the topsides will have been cleaned of process fluids, fuels and lubricants via flushing and draining. Pipeline flushing and cleaning operations will take place prior to topsides disconnections (See section 2.2.5). The likely fate of the topsides flush fluids will be transfer to tote tanks for transport by vessel and appropriate treatment and disposal onshore. Best endeavours will be made to clean the topsides pipework to below 30 mg/l oil in water. It is anticipated that both the Schooner and Ketch topsides will be removed using the reverse installation method, a single lift and taken onshore for cleaning and disposal. Removal using a single lift is the preferred option for the topsides however there are several removal methods that could be used as presented in Table 2.6. Prior to removal of the topsides generators will be used during platform visits whilst solar panels, with battery storage will power navigation equipment.

Table 2.6. Possible Topsides Removal Methods

Method	Description
Onshore disposal using Heavy Lift Vessel (HLV), or Shear Leg Vessel (SLV)	Removal of topsides as complete unit in a single lift and transportation to shore for re-use of selected equipment, recycling, break up and/or disposal. Single lift dependant on vessel availability.
Modular removal and re-use/recycle by HLV	Removal of parts/modules of topsides for transportation and reuse in alternate location(s) and/or recycling/disposal
Offshore removal 'piece small' for onshore reuse/disposal	Removal of topsides by breaking up offshore and transporting to shore using work barge. Items will then be sorted for re-use, recycling or disposal.

2.2.3 Jacket

It is anticipated that both the Schooner and Ketch jackets will be removed using the reverse installation method, by a single lift or two lifts and taken onshore for cleaning and disposal. Removal by a single lift or two lifts is the preferred option for the jackets however there are several removal methods that could be used as presented in Table 2.7.

Table 2.7. Possible Jacket Removal Methods

Method	Description
Onshore disposal using Heavy Lift Vessel (HLV), Monohull crane vessel or Shear Leg Vessel (SLV)	Removal of the jacket in a single lift, or two lifts and transport ashore for break up and recycling of steel.
Onshore disposal using 'piece small'	Remove jacket in several pieces using attendant work barge and transport to onshore yard.
Onshore disposal using a pull-on barge	A pull-on barge removal method based on a submersible barge which is submerged on one end to the seabed. The jacket will then be pulled on to the barge/vessel by winch.

The jackets are held by a single pile at each of the four legs, these piles will need to be cut to remove the jacket. The pile cuts will be made below the seabed level at such a depth to ensure that any remains are unlikely to become uncovered. There are three methods that could be employed to cut the piles in order to remove the jacket, these are (in the order of preference to use):

- The piles will be cut internally most likely using an abrasive water jet cutter or some form of mechanical cutter. This will involve the soil plug from within the piles to be removed to 3.5 m below the seabed;
- In case the internal cutting fails due to technical reasons then the contingency option is to cut the piles externally with a diamond wire cutter mounted on an ROV. This will involve the establishment of a trench with shallow sides around the jacket leg to allow the diamond wire cutter to access the piles below the seabed.
- If both of the above methods fail, which is highly unlikely, then explosives would need to be used to sever the piles.

The exact cutting points and jacket removal method will be determined following a detailed engineering study and the outcome of commercial tendering.

2.2.4 Subsea Installations and Stabilisation Features

The NW Schooner wellhead and integral protection structure will be completely removed from the seabed and transported to shore for onshore disposal as part of the Mobile Offshore Drilling Unit (MODU) campaign to plug and abandon the well. In order to remove the wellhead and integral protection structure it may be necessary to excavate an area of seabed around the structure.

2.2.5 Pipelines

The export pipelines will be cleaned and flushed prior to any decommissioning related activity, the likely fate of the products associated with the cleaning and flushing will be reinjection into a redundant well(s) at the Murdoch platform. The methodology for cleaning the pipelines and the locations of the disposal wells will be developed during detailed design and agreed with OPRED using the environmental permitting process, however it is thought at this stage it will consist of launching a pig cleaning train into each pipeline from the respective platform. The cleaning train is likely to consist of multiple pigs separating cleaning chemicals and treated seawater followed by filtered untreated seawater. The pipelines will be cleaned and flushed to achieve a minimum of 30 mg/l oil in water. It is likely that a combination of pigging and flushing will be used on the gas export lines (PL1222 and PL1612). The methanol piggyback pipelines (PL1223 and PL1613) will be flushed only with untreated seawater, the likely fate of methanol and seawater will be reinjection into a redundant well(s) at the Murdoch platform. The pipeline cleaning and flushing phase may be supported by a Walk to Work vessel alongside the platforms.

The pipeline decommissioning options for both fields were assessed using a Comparative Assessment process (Faroe, 2018d and Faroe, 2018e). The decommissioning option that scored most favourably for each pipeline is presented in Table 2.8.

Table 2.8. Pipeline Decommissioning Preferred Option

Pipeline	Option	Method
Schooner export pipeline PL1222	Leave *in situ* with removal of exposed ends to onshore.	Pipeline is significantly buried and will be safe to leave *in situ.* End sections will be cut using sheers at the point at which they are sufficiently buried, lifted using grappling tools and ~~recovered~~ removed for onshore disposal as per the waste treatment hierarchy.
Schooner piggyback line PL1223	Leave *in situ* with removal of exposed ends to onshore.	Pipeline is significantly buried and will be safe to leave *in situ.* End sections will be cut using sheers at the point at which they are sufficiently buried, lifted using grappling tools and ~~recovered~~ removed for onshore disposal as per the waste treatment hierarchy.
Ketch export pipeline PL1612	Leave *in situ* and bury by trenching and backfilling with natural deposits.	End sections will be cut using shears, removed for onshore disposal as per the waste treatment hierarchy and ends covered as required (this includes the stabilisation features that form the Caister pipeline crossing). Entire pipeline will be trenched and buried.
Ketch piggyback line PL1613	Leave *in situ* and bury by trenching and backfilling with natural deposits.	End sections will be cut using shears, removed for onshore disposal as per the waste treatment hierarchy and ends covered as required (this includes the stabilisation features that form the Caister pipeline crossing). Entire pipeline will be trenched and buried with natural deposits.

Both pipelines will be *left in situ* except for:

- the sections of pipelines and mattresses that form the Caister pipeline’s crossing adjacent to the Murdoch platform (the final 90m of the pipelines before the Murdoch platform) will be removed and transported to onshore, and
- the mattresses and section of pipeline that they cover on the approach to the Schooner riser and the connection point and spool piece at Murdoch, which will be removed and transported to onshore.

Minimal local excavation will be carried out at the crossing and each end, but enough to allow access for cutting and the attachment of lifting equipment for the safe removal of the exposed ends of pipeline and the pipeline associated with the Caister pipeline’s crossing.

The Schooner pipelines are significantly buried (see burial profile for pipelines in Appendix 1 of the Schooner DP) and will be safe to leave in-situ. The Ketch pipelines were subject to an inspection survey in December 2017, one of the objectives of the survey being to establish the state and depth of pipeline burial (Fugro, 2018). The burial profile for the Ketch pipelines is presented in Appendix 2 of the Ketch DP. The Ketch export pipeline is exposed over a length of 16,768.5 metres (64 % of the total pipeline length) (Fugro, 2018). The preferred decommissioning option for the Ketch pipelines will be to leave them *in situ* and trench and bury the entire pipeline using a jet trencher (Figure 2.1) to a minimum depth of 0.6 m from the top of the pipeline or deeper if equipment allows.

Past pipeline surveys indicate that both pipelines are stable and that the Schooner pipelines will remain buried. The Ketch pipeline is anticipated to remain buried following the trenching and burial of the entire pipeline.

Figure 2.1 Burial of Pipeline using Jet Trenching

2.2.6 Pipeline Stabilisation Features

The Comparative Assessment for both Schooner and Ketch pipelines concluded that the sections of pipelines and mattresses that form the Caister pipeline’s crossing adjacent to the Murdoch platform (the final 80m of the Schooner pipelines and the final 100m of the Ketch pipelines, before the Murdoch platform) will be removed and transported to onshore (Faroe, 2018d and Faroe, 2018e). The 8 mattresses that form the Schooner / Caister pipeline crossing and 11 of the 13 mattresses that cover the Schooner pipelines closest to the Murdoch Platform will be removed and transported to onshore. The two mattresses that are scheduled to remain are buried beneath the rock dump that covers the Caister umbilical which crosses the Schooner pipelines, it is therefore impractical to remove these 2 mattresses. The 14 concrete mattresses associated with the Schooner end of the Schooner pipelines (see Table 2.3) will be removed and transported to onshore. The 52 concrete mattresses along the length of the Ketch pipeline and all mattresses at the Ketch platform (see Table 2.3) will be removed and transported to shore. If problems are encountered during operations to remove the mattresses, BEIS will be consulted and agree on an alternative approach before any other options are executed. Trenching of the entire length of the Ketch pipelines should be sufficient that the cut ends do not need to be stabilised by addition of material. As a contingency grout bags will be used to stabilised the cut pipeline ends.

The grout bags (approximately 32) associated with the Ketch pipelines crossing of the Caister pipeline and the grout bags (approximately 400) associated with the Schooner pipelines and Caister pipeline crossing will be removed and transported to onshore. A summary of the preferred decommissioning options for the pipeline stabilisation features is presented in Table 2.9.

Table 2.9. Pipeline Stabilisation Feature Decommissioning Preferred Option

Feature	Option	Method
Schooner Field		
Mattresses on Caister / Schooner pipeline crossing and at Schooner platform	Completely remove	Minimal local excavation will be carried out, but enough to allow access for the attachment of lifting equipment for the safe diverless removal of mattresses.
2 x mattresses below Caister crossing umbilical rock dump	Leave *in situ*	The mattresses are partially or completely buried below rock dump and are deemed not to present a snagging risk. An overtrawl survey will be undertaken to confirm the mattresses do not represent a snagging hazard.
Grout bags (at Caister pipeline Crossing)	Completely remove	Minimal local excavation will be carried out at the crossing, but enough to allow access for the safe diverless removal of grout bags.
Ketch Field		
Concrete Mattresses at Murdoch approach, Caister Crossing and at the Ketch platform	Completely remove	Minimal local excavation will be carried out, but enough to allow access for the attachment of lifting equipment for the safe diverless removal of mattresses.
Mattresses along Ketch pipelines subsea route	Completely remove	Minimal local excavation will be carried out, but enough to allow access for the attachment of lifting equipment for the safe diverless removal of mattresses.
Grout bags (at Caister pipeline Crossing)	Completely remove	Minimal local excavation will be carried out at the crossing, but enough to allow access for the safe diverless removal of grout bags.

2.3 Surveys

2.3.1 Pre-decommissioning Environmental Survey

A pre-decommissioning environmental survey was undertaken in March 2018 (see Section 3.1) to inform the DPs, Environmental Appraisal, various licences, permits and consents, and provide a baseline against which the results of any post-decommissioning environmental surveys can be referenced.

2.3.2 Execute Phase and Legacy Surveys

On completion of the decommissioning project a site survey will be carried out in the 500m radius of both installation sites. Oil and gas seabed debris will be removed for onshore disposal or recycling in line with existing disposal methods. Independent verification of seabed state will be obtained by trawling (over trawl survey) the platform areas and pipeline corridors. The option of using a side scan sonar survey to verify a clear seabed will be explored at the time. This will be followed by a statement of clearance to all relevant governmental departments and non-governmental organisations. The timing of these surveys will be co-ordinated where possible with the post- decommissioning surveys to be undertaken at the Murdoch field.

Monitoring will be performed to confirm pipelines decommissioned in-situ remain stable and buried at a frequency to be agreed with OPRED.

2.4 Vessel Use

Vessels will be used offshore at the Schooner and Ketch platform locations, along the Ketch pipeline route and at the connection point at the spool pieces with Murdoch. Various types of vessel will be required for different periods of time throughout the decommissioning project. The pipeline cleaning and flushing phase may be supported by a Walk to Work vessel alongside the platforms. The topsides will be prepared for lifting and made hydrocarbon free supported by a Mobile Offshore Drilling Unit (MODU) following well plug and abandonment activities. The Jacket and topsides will be removed and transported to shore by means of either a heavy lift vessel (HLV), Monohull crane vessel or Sheer Leg Vessel (SLV). Other supporting vessels such as tugs and cargo barges may also be required to support. A Dive Support Vessel (DSV) or Construction Support Vessel (CSV) is likely to be used for the decommissioning of the pipelines *in situ*. No stabilisation material will be required for the MODU or SLV. The exact vessel types and vessel schedule are unknown at the time of writing the EA. A high level and worst-case vessel schedule has been used along with the fuel consumption rate of generic vessel types to calculate the estimated fuel usage for the decommissioning project (Table 2.10).

Table 2.10. Estimated Fuel Usage by Vessels required for Decommissioning Project

Vessel Type	Duration (Days)	Fuel Usage per Day(Te)	Fuel Usage (Te)
MODU[1]	276	10	2760
Heavy Lift Vessel (Dynamically positioned)	24	20	480
Large Barge[2]	24	30	720
Two Tugs (for barge)[3]	24	25 per tug	1200
Dive Support Vessel or Construction Support Vessel	8	18	144
Trenching Vessel [4]	10	18	180
Supply Vessel (working)	68	5	340
Emergency Response and Rescue Vessel (ERRV) [5]	118	4	83
Survey Vessel (post environmental survey)[4]	6	18	108
Fishing trawler (over trawl survey)[6]	8	4	32
Walk to Work Vessel (Dynamically positioned)[7]	20	6.6	132
Total	**586**		**6,568**

Notes: Topsides and pipelines cleaning and flushing will be undertaken from the Schooner and Ketch Installations, the walk to work vessel may support these operations alongside the platforms. Estimated fuel use per vessel type is based on The Institute of Petroleum Guidelines (IoP) (2000) unless stated otherwise.

[1] Fuel consumption of a Jack-Up MODU estimated at 10 tonnes per day. 220 days of the total MODU duration and 2200 tonnes of the total fuel is for the plug and abandonment of all Ketch and Schooner Wells.

[2] Estimated fuel use based on SSCV 100kT no propulsion (working)

[3] Estimated fuel use based on cargo barge tug (50-100t BP) (working)

[4] Estimated fuel use based on IoP (2000) values for Dive Support Vessel.

[5] Estimated fuel use based on standby vessel (1000-1500 HP) (working)

[6] Estimated fuel use based on IoP (2000) values for safety vessel (working)

[7] Estimated fuel use based on Nor Valiant vessel.

2.5 Waste Management

All material removed from offshore will be returned to onshore for treatment at a waste management site that has the appropriate permits and licences in place to handle and treat all expected waste streams.

Non-hazardous materials, such as scrap metal, concrete, and plastics not contaminated with hazardous waste, will be removed and, where possible, re-used or recycled (except for the pipelines remaining *in situ*). Other non-hazardous waste which cannot be reused or recycled will be disposed of to a landfill site. Where necessary, hazardous waste will be pre-treated to reduce hazardous properties or, in some cases, render it non-hazardous prior to recycling or landfilling. Under the Landfill Directive, pre-treatment will be necessary for most hazardous wastes which are destined to be disposed of to a landfill site. The likely fate of the flush fluids from topsides cleaning is shipping by tote tanks for appropriate treatment and disposal onshore (see Section 2.2.2) and the likely fate of pipeline flush fluids is reinjection into redundant wells at the Murdoch platform (see Section 2.2.5). The fate of well abandonment fluids is not known at present but these are likely to either be cleaned to below 30 mg/l oil in water or shipped to shore for appropriate treatment. Table 2.11 presents an estimate of the mass and proposed fate of the Schooner and Ketch infrastructure. The estimated mass of the well conductors and trees associated with the well abandonment operations have been included under the respective Schooner and Ketch installation columns of Table 2.11. The majority of waste material from the Schooner and Ketch fields consists of steel.

A Waste Management Plan for the decommissioning programmes will be prepared and implemented in line with the Waste Framework Directive. The waste management plan will be a live document that specifies where all waste will be sent from offshore and includes:

- Faroe's intentions for the active management of offshore waste;
- A process of advising the waste stream regulator if a waste stream/volume location changes;
- Identification and categorisation of the generic waste streams and the generic end point of these waste streams; and
- An inventory of waste in accordance with the Waste Framework/Waste Hierarchy, Waste Inventory, waste categorisation and waste management obligations.

Table 2.11. Estimated Mass and Proposed Fate of the Schooner and Ketch Fields Infrastructure

	Infrastructure Item/Fate	**Schooner Installations**[1]	**Ketch Installation2**	**Schooner Pipelines**	**Ketch Pipelines**	**Schooner Subsea Installation**	**Grout Bags**	**Mattresses**
Weight (Te)		5,160.0	4,419.0	6,838.3	9,169.0	70.0	43.0	807.16
Percentages of total inventory	Steel	93.9	92.9	92.1	82.5	98	0	0
	Concrete/ cement	2.9	3.4	5.6	16.0	1.0	100	99
	Plastic/other	1.5	1.7	1.8	1.3	1.0	0	1
	Non-Ferrous Metals	1.7	2.0	0.5	0.2	0	0	0
Recovered onshore (Te)	Total	5,160.0	3,936.0	66.0	200.0	70.0	43.0	787.0
	Recycle	4,546.0	3,892.0	65.3	198.0	69.0	43.0	0
	Landfill	93.0	44.0	0.7	2.0	1.00	0	0
Decommissioned *in situ* (Te)		521.0 (Piles)	483.0 (Piles)	6,772.0	8,969.0	0	0	20.16

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1 Includes the estimated weight of the well conductors and trees (1,100 tonnes) associated with the abandonment of all Schooner platform wells. Estimated weight of marine growth on the jacket, which is estimated to be 141 tonnes, is not included in the above weights.

2 Includes the estimated weight of the well conductors and trees (900 tonnes) associated with the abandonment of all Ketch platform wells. Estimated weight of marine growth on the jacket, which is estimated to be 141 109 tonnes, is not included in the above weights.

2.6 Decommissioning Project Proposed Schedule

A proposed schedule for the decommissioning project is provided in Figure 2.2. The bars on the Gantt chart show windows for each decommissioning activity from the earliest anticipated start date to the latest anticipated end date. Decommissioning activities are expected to be performed in tandem for the Schooner and Ketch field facilities.

Figure 2.2. Gantt Chart of Proposed Project Schedule

2.7 Summary of Decommissioning Activities

Table 2.12 presents a summary of the planned activities and the aspects from those activities that have the potential to interact with the environment and are included within the scope of the EA. Where more than one method could be used to undertake the activity, that which presents the worst case potential environmental impact has been presented and assessed.

Table 2.12 Planned Decommissioning Activities

Activities[3]	Aspect
General support	Vessels for surveying, deploying tools and ROVs, removal of facilities, transportation of removed items to onshore. Positioning of vessels using dynamic positioning systems.
Removal and recovery of NW Schooner wellhead and integral protection structure	Local excavation to allow access for lifting equipment to remove wellhead and integral protection structure from the seabed for recovery to shore for onshore disposal. Cutting of well conductors for recovery to shore for onshore disposal. Any fluids from the well abandonment activities are likely to either be cleaned to below 30 mg/l oil in water and discharged to sea or shipped to shore for appropriate treatment. These operations will be undertaken as part of the well P&A activities. No vessels will

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[3] Activities associated with the plug and abandonment of wells will include the use of a jack-up drilling unit positioned alongside each platform. The use of a jack-up drilling unit has been included in the assessment for topsides lifting preparation and hydrocarbon free activities, which would be undertaken first and plug and abandonment of wells would follow.

Activities[3]	Aspect
	be required to support there operations.
Removal and recovery of topsides	Prior to removal the topsides will have been cleaned of process fluids, fuels and lubricants via flushing and draining. The likely fate of the topsides flush fluids will be transfer to tote tanks for transport by vessel and appropriate treatment and disposal onshore. Best endeavours will be made to clean the topsides pipework to below 30 mg/l oil in water. Vessel anchoring on location at the installations and possible ballast water discharge. Cutting of topsides equipment into smaller components for removal (piece-small removal). Topsides will be disposed of onshore as per the waste hierarchy.
Removal and recovery of jackets	Vessel anchoring on location at the installations and possible ballast water discharge. Potential use of explosives to sever piles (charges will be placed internally within jacket leg necessitating the removal of soil plugs to access piles). Jackets will be disposed of onshore as per the waste hierarchy.
Decommissioning Schooner pipelines *in situ*	Local excavation to allow access for cutting shears and lifting equipment to remove cut pipeline ends for onshore disposal as per the waste treatment hierarchy. A discharge of residual hydrocarbons and/or chemicals on disconnection is possible, however the pipelines will all be cleaned and flushed prior to cutting to achieve a minimum of 30 mg/l oil in water. Placement of biodegradable grout bags on pipelines' cut ends. Permanent presence of the buried pipelines in the seabed. Recovery of pipelines' cut end sections and mattresses for onshore disposal as per the waste hierarchy.
Decommissioning Ketch pipelines *in situ*	Local excavation to allow access for cutting shears and lifting equipment to remove cut pipeline ends for onshore disposal as per the waste treatment hierarchy. A discharge of residual hydrocarbons and/or chemicals on disconnection is possible, however the pipelines will all be cleaned and flushed prior to cutting to achieve a minimum of 30 mg/l oil in water. Deployment of jet trenching tool to bury the entire pipeline. Permanent presence of the buried pipelines in the seabed. Recovery of pipelines' cut end sections and mattresses for onshore disposal as per the waste hierarchy.
Seabed over-trawl assessment	Fishing gear will be used to establish that the seabed in the platform areas and along the pipeline corridors is free from snagging hazards.
Onshore processing of removed infrastructure	The onshore transport and processing of removed facilities (cleaning, cutting etc.) at a shore based waste processing facility. In preparation for transport to an appropriately licenced facility for their recycling or disposal to landfill.

3 Environmental Baseline

This section of the EA report summarises the main features and sensitivities of the environmental baseline in the project area. Only features and sensitivities which are of relevance to the EA report, as identified in the ENVID and scoping stage have been presented here. Where the ENVID/scoping stage identified no potential for interaction between the project activities and certain environmental receptors, no description of those receptors has been provided.

3.1 Environmental Baseline Surveys

Faroe Petroleum commissioned a pre-decommissioning Environmental Baseline survey (EBS) in March 2018 to confirm the absence of drill cuttings at the Ketch and Schooner NUIs and the North-West Schooner well, to establish the environmental baseline conditions in the project area. Seabed video and photography was used to verify the absence of Annex 1 or other sensitive habitats at locations of interest identified in geophysical data and at EBS stations. In addition, grab sampling for faunal and sediment analysis (e.g. hydrocarbons, metals) was performed at several environmental stations. Seabed video and photography acquisition was undertaken prior to seabed sampling to ground-truth the sediments throughout the survey area and minimise the potential for damage to sensitive habitats by grab sampling. High resolution video footage and still images were acquired at each station with the addition of four grab samples per station. One (Ketch) and four (Schooner) stations were added for camera operations only. The location of environmental sample stations for the Ketch and Schooner survey areas are presented in Figures 3.1 and 3.2 respectively. The results from the Schooner to Murdoch export pipelines survey is described by dividing the pipeline into three parts: the northern part closest to the Murdoch platform, the middle part and the southern part closest to the Schooner platform.

Figure 3.1 Ketch Environmental Survey Sample Locations (Geo XYZ and Benthic Solutions, 2018a)

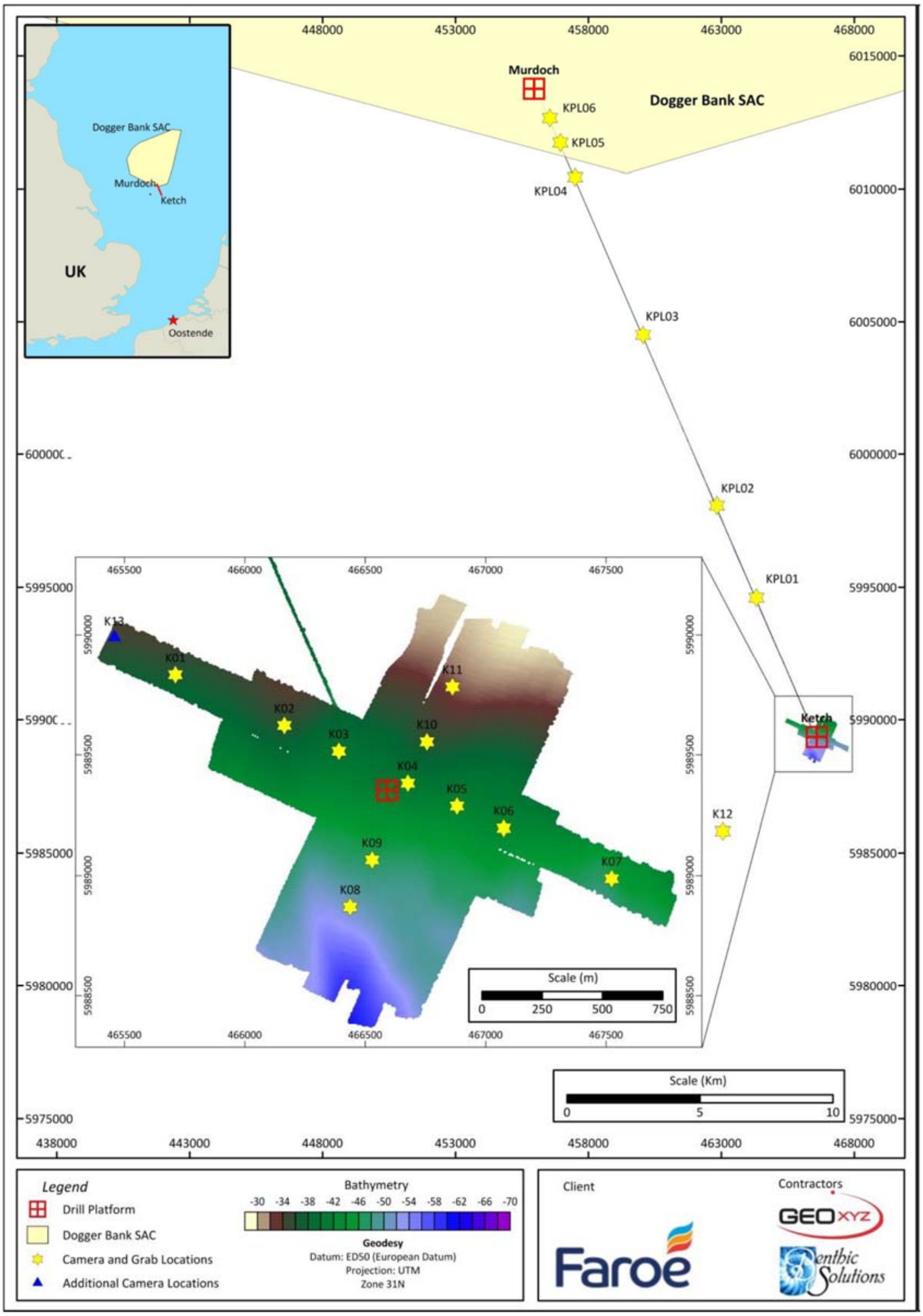
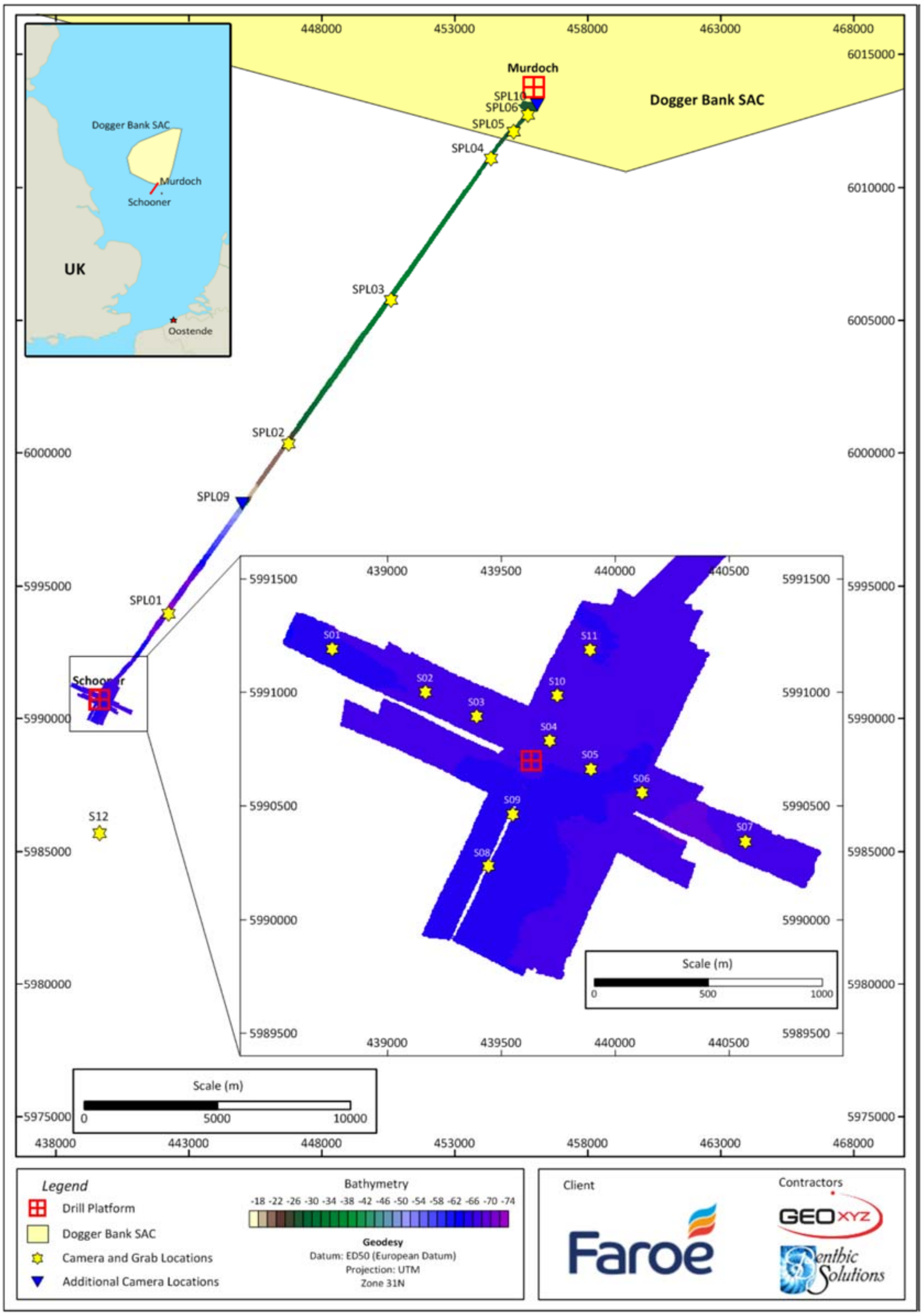


Figure 3.2 Schooner Environmental Survey Sample Locations (Geo XYZ and Benthic Solutions, 2018b)



3.2 Physical Environment

Within the SNS, water depth tends to decrease in a southerly direction, especially in a series of shoals that lie parallel to the Norfolk coast.

The project area is predominantly influenced by the SNS current (borne from the Scottish coastal water), that takes water through a south-east and north-west flow. Residual (non-tidal) currents tend to flow in a south-east direction. Tidal current speeds are between 0.5 $m.s^{-1}$ and 2 $m.s^{-1}$. The north – south or reverse orientation of ripples on the sandy seabed observed during the Schooner survey indicates a west to east or east to west current direction (Geo XYZ and Benthic Solutions, 2018b).

The project area where tidal ranges increase southwards, as the water reaches the coast. The mean spring tidal range is approximately 2 metres within the project area but may increase by up to 30% in gales. Wave heights in the area are shown in the table below (Table 3.1). There is considerable variation in wave height throughout the year, for example in the autumn and winter months waves exceeding 4 metres have been recorded for about 15% of observations, whilst summer waves generally exceed 4 metres for about 2% of observations (*UKDMAP, 1998*). The tides in Block 44/26a are 1.4 and 0.8 meters per second respectively for spring and neap tides (Hydrographer of the Navy, 1999).

Table 3.1. Yearly significant wave height in the vicinity of Block 44/26a (UKDMap, 1998)

10% Exceedance	25% Exceedance	50% Exceedance	75% Exceedance
2.5 - 3.0 metres	1.5 - 2.0 metres	1.0 - 1.5 metres	0.5 - 1.0 metres

Prevailing wind directions vary seasonally in the project area, but on average westerly winds predominate. In December and January wind speeds can reach 14 to 16.5 m/s, which on the Beaufort scale is between force 6 and 7 (strong breeze to moderate gales). The calmest months are from May to August.

3.2.1 Seabed Sediments

Silty sand was the dominant seabed habitat being represented across the majority of the Ketch survey area. Coarser mixed sediment (i.e. gravelly sand / shelly fragments and pebbles) were occasionally present in the troughs between sand ripples in patches along the Ketch export pipeline route, in particular at KPL_06, as well as in some areas within the Ketch field where boulders and mixed sediments were identified on the side scan sonar data (Geo XYZ and Benthic Solutions, 2018a). The whole of the Schooner platform survey area was defined as silty sand with the presence of ripples and scattered ripples (Geo XYZ and Benthic Solutions, 2018b). The sedimentology of the southern section of the Schooner export pipeline route was defined as silty sand. The sedimentology of the middle section of the Schooner export pipeline route comprised mainly silty sand with some areas of detrital sediments and fine sand with shell debris. Regarding the sedimentology of the northern part of the Schooner export pipeline route, three areas can be defined. The first one on the South is 2.5km long and is composed of silty sand with patches of detrital sediments and fine sand with shell debris. The second area is around 4km long and is only defined as a silty sand. The last area is around 1km and is defined as a silty sand with patches of detrital sediments. (Geo XYZ and Benthic Solutions, 2018b).

Particle size analysis indicated that the seabed within the Ketch field was predominantly composed of muddy sand (10 out of 12 stations), with varying but low levels of gravel and shell fragments. Stations along the Ketch export pipeline revealed some minor variations, ranging from muddy sand at the first three pipeline stations (KPL_01 to KPL_03) to a slightly gravelly muddy sand at station KPL_06 (Geo XYZ and Benthic Solutions, 2018a). The average (mean) sediment composition at the Ketch stations was as follows:

- Fines: mean 22.39% ± 15.57SD (standard deviation),
- Sand: mean 77.38% ± 15.38SD,
- Gravel: mean 0.23% ± 0.46SD.

Particle size analysis indicated that the seabed within the Schooner Field was predominantly composed of muddy sand, with varying but low levels of gravel and shell fragments, whereas stations along the Schooner export pipeline revealed sandy sediments with a sand proportion of greater than 90%. The sediment type with a high proportion of sand was evident at five of the six pipeline stations, with the exception of deepest (~74m) pipeline station SPL_01 located closest to the Schooner Field, which was characterised by muddy sand sediment comparable to that of the Schooner field. The average (mean) sediment composition was as follows:

- Fines: mean 26.10% ± 17.62SD (standard deviation).
- Sand: mean 73.39% ± 17.69SD.
- Gravel: mean 0.51% ± 0.62SD.

3.2.1.1 Heavy and Trace Metal Concentrations

Results for heavy and trace metal analysis are presented in Table 3.2 and Table 3.3. Total metal concentrations are widely used for offshore surveys and can provide a useful context as indicators of comparative contamination. Metals are generally not harmful to organisms at concentrations normally found in marine sediments and some, like zinc, may be essential for normal metabolism although can become toxic above a critical threshold (Geo XYZ and Benthic Solutions, 2018c). In order to assign a level of context for toxicity, an approach used by Long, *et al.* (1995) to characterise contamination in sediments was applied to the metal analysis. Long *et al.* reviewed field and laboratory studies and identified nine metals that were observed to have ecological or biological effects on organisms. They defined "effect range low" (ERL) values as the lowest concentration of a metal that produced adverse effects in 10% of the data reviewed, whilst "effect range median" (ERM) values designate the level at which half of the studies reported harmful effects. Consequently, metal concentrations recorded below the ERL value are not expected to elicit adverse effects, while levels above the ERM value are likely to be toxic to some marine life. All metal concentrations recorded at the Schooner and Ketch stations were below the ERL values and are therefore not expected to elicit adverse effects on marine life. Of particular relevance to the offshore oil and gas industry are metals associated with drilling related discharges. Solid barites are often discharged during the drilling process and also contain measurable concentrations of heavy metals as impurities, including cadmium, chromium, copper, lead, mercury, and zinc (NRC, 1983). Heavy metals, either as impurities or additives are also present in other mud components. Barium levels were homogenous in nature across the Ketch survey area with no obvious pattern of distribution in relation to the Ketch Platform. Higher concentrations were recorded at the Ketch reference station and close to the Schooner wells (S_04 and S_05), the latter reflecting a potential for contamination from the historical discharge of drilling muds. However these concentrations recorded within the current survey are not particularly high, with contaminated stations frequently showing concentrations in thousands or tens of thousands of mg.kg^{-1}.

The analysis of total concentrations of heavy and trace metals from the Schooner and Ketch stations found that cadmium and mercury were undetectable. Concentrations of chromium, iron, nickel, lead and vanadium were lower than average background levels for the Southern North Sea. A majority of stations showed a correlation with the percentage fines reflecting a clear fines trend across the survey area that included barium and barium related metals. Overall, metal concentrations were consistent with uncontaminated baseline sediments and/or within typically expected background levels for the Southern North Sea.

Table 3.2. Heavy and Trace Metal Concentrations (mg/kg (dry weight)) at Ketch Survey Stations (Geo XYZ and Benthic Solutions, 2018c)

Section	Station	Aluminium	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Nickel	Vanadium	Zinc
Ketch Field	K_01	2070	13.9	38.1	<0.1	11	6.1	8000	10.9	<0.1	8.2	34.4	20.6
	K_02	4800	11.4	63.5	<0.1	14.9	8.3	11600	11.9	<0.1	12.9	30.7	26.7
	K_03	1610	8.5	115	<0.1	6.9	3.4	7560	6.1	<0.1	4.8	22.7	13.2
	K_04	1750	7.5	166	<0.1	7.7	4.7	7410	6.7	<0.1	5.3	22	15.9
	K_05	624	6	38.8	<0.1	5.6	12.9	3390	4.6	<0.1	3.8	17.8	13.1
	K_06	1850	6.9	48.6	<0.1	7.7	4.3	7270	5.6	<0.1	5.3	21.4	13.6
	K_07	2620	5.7	52.1	<0.1	9.6	4	7270	5.8	<0.1	6.5	19.4	15.3
	K_08	2910	5.2	52.1	<0.1	12.1	5.2	7330	7.1	<0.1	8.4	21.6	19
	K_09	2740	4.6	75.7	<0.1	10.2	3.9	7220	6.1	<0.1	7	19.2	16.5
	K_10	2820	13.2	59.6	<0.1	12.3	5.8	9460	9.7	<0.1	8.4	35.6	21.3
	K_11	1450	13.5	15.1	<0.1	6.8	3	8370	7.4	<0.1	4.7	29	11.5
	K_12	4900	8	44.2	<0.1	15.6	9	10100	9.7	0.11	19.9	20.3	24.6
Ketch Pipeline	KPL_01	2940	3.1	31.6	<0.1	8.5	5.1	5500	5.8	<0.1	9.3	11.4	15.6
	KPL_02	4510	4.3	48.9	<0.1	12.8	5.9	7930	7.5	<0.1	16	16.9	18.8
	KPL_03	2580	3.1	32.5	<0.1	8.9	3.4	5280	4.6	<0.1	5.3	12.6	11.3
	KPL_04	1290	3.7	35.2	<0.1	8.3	4.3	4810	3.6	<0.1	4.5	15.3	10.6
	KPL_05	1680	4.8	27	<0.1	7.2	3.8	5290	3.7	<0.1	8.1	14	8.9
	KPL_06	1030	4.7	26	<0.1	5.3	3.6	4750	2.8	<0.1	3.6	13.2	7.5
Mean		2454.11	7.12	271.22	0.50*	9.52	5.37	7,141.11	6.64	0.48*	7.89	20.97	15.78
SD		1,247.96	3.61	35.85	0.00*	3.03	2.49	2,058.17	2.54	0.09*	4.39	7.25	5.26
CV (%)		50.85	50.70	66.52	0.00*	31.82	46.33	28.82	38.30	19.22*	55.59	34.57	33.35
ERL		-	8.2	-	1.2	-	34	-	47	0.1	-	21	150
UKOOA 95th percentile		-	-	272.40	0.72	44.77	13.86	18555.00	21.03	0.05	21.45	35.76	35.80

**Note: where levels were below the detection limit, a value of half the detection limit was applied in the calculations.*

Table 3.3. Heavy and Trace Metal Concentrations (mg/kg (dry weight)) Schooner Survey Stations (Geo XYZ and Benthic Solutions, 2018d)

Section	Station	Aluminium	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Nickel	Vanadium	Zinc
Schooner Field	S_01	3260	5.2	112	<0.1	11.9	11.1	8750	7.2	<0.1	8.3	21.3	17.9
	S_02	2640	5.7	111	<0.1	11.6	10.9	7990	6.1	<0.1	7.1	23.2	16.3
	S_03	3260	5.5	209	<0.1	13.1	13.3	8430	7.1	<0.1	7.9	22.6	18.7
	S_04	2450	6.4	263	<0.1	10.4	13.9	7800	5.9	<0.1	7.5	19.6	17.3
	S_05	2730	4.1	485	<0.1	7.6	10.5	8220	5.5	<0.1	5.3	14.5	15.8
	S_06	3330	5	221	<0.1	12.5	15	8720	7.3	<0.1	8.1	20.3	36
	S_07	2900	5.8	76.3	<0.1	10.3	9.6	8840	5.7	<0.1	7	20.7	15.7
	S_08	3570	5	97.2	<0.1	9.9	9.7	9330	5.6	<0.1	7.1	18.8	13.8
	S_09	2510	5.1	109	<0.1	10.9	10.6	7730	6.7	<0.1	6.8	20.8	18.5
	S_10	2630	5.8	74.8	<0.1	13.3	12.4	7340	6.9	<0.1	7.9	24.7	21.6
	S_11	3360	5.1	72.3	<0.1	12.2	10.7	8080	6.6	<0.1	7.1	21.6	18.4
	S_12	3590	5.3	35.8	<0.1	15.4	13.5	7220	9	<0.1	9.9	23	23.5
Schooner pipeline	SPL_01	3180	3.9	48.8	<0.1	11.1	9.5	6830	7.8	<0.1	7.9	15.4	17.9
	SPL_02	638	3.4	23.1	<0.1	4.9	8.1	3340	2.2	<0.1	2.9	10.8	8.8
	SPL_03	901	13.6	20.9	<0.1	9.5	9.7	5400	5.8	<0.1	6.3	32.4	15.7
	SPL_04	1060	7	16	<0.1	8	9.7	5220	4.4	<0.1	4.5	20.7	13.3
	SPL_05	1200	6.4	19.3	<0.1	5.9	8.9	5920	4.1	<0.1	3.9	15.8	10.6
	SPL_06	854	4.3	17.3	<0.1	5.6	11.6	4680	2.6	<0.1	3.2	12.8	10.2
Mean		2,447.94	5.70	111.77	0.05	10.23	11.04	7,213.33	5.92	0.05	6.59	19.94	17.22
SD		1,031.25	2.17	118.93	0.00	2.87	1.89	1,658.04	1.73	0.00	1.90	4.94	6.02
CV (%)		42.13	38.13	106.41	0.00	28.10	17.14	22.99	29.23	0.00	28.86	24.77	34.95
ERL		-	8.2	-	1.2	-	34	-	47	0.1	-	21	150
UKOOA 95th percentile		-	-	272.40	0.72	44.77	13.86	18,555.0	21.03	0.05	21.45	35.76	35.80

**Note: where levels were below the detection limit, a value of half the detection limit was applied in the calculations.*

3.2.1.2 Sediment Hydrocarbons

Results for hydrocarbon analyses are summarised and tabulated as total hydrocarbon concentrations, total polycyclic aromatic hydrocarbons (PAH), and total n-alkane and homologue ratios in Table 3.4 and Table 3.5.

The majority of the stations across the Ketch Field and the Ketch-to-Murdoch pipeline can be considered to reflect uncontaminated baseline sediments, exhibiting concentrations of total hydrocarbon content lower than published 95th percentile for background sediments in the Southern North Sea (11.39mg.kg-1; UKOOA 95th percentile, 2001). However, five stations were found to exceed the 95th percentile level; K_02 (29.8mg.kg^{-1}), K_08 (26.1mg.kg^{-1}), K_12 (16.0mg.kg^{-1}), KPL_01 (12.9mg.kg^{-1}) and KPL_02 (11.80mg.kg^{-1}). Four of the five aforementioned stations (excluding K_08) were found to coincide with the highest sediment fine proportions across the survey area, resulting in high TOC and THC levels. It is worth noting that stations K_02 and K_08 had THC levels that were twice as high compared to the next nearest station, suggesting an increased input of hydrocarbons at these two stations which may be a signature of historical contamination.

The majority of the stations across the Schooner survey field and the Schooner-to-Murdoch pipeline can be considered to reflect uncontaminated baseline sediments, exhibiting concentrations lower than published 95th percentile for background sediments in the Southern North Sea (11.39mg.kg+; UKOOA, 2001). However, four stations were found to exceed the 95th percentile level; S_01 (13.5mg.kg^{-1}), S_06 (16.5mg.kg^{-1}), S_12 (20.5mg.kg^{-1}), and SPL_01 (17.9mg.kg^{-1}). Three of the four aforementioned stations (excluding S_12) were found to coincide with the highest sediment fine proportions across the survey area, resulting in high TOC and THC levels. It is worth noting that station S_12 was located at a particular deep depth for the Southern North Sea, which is likely the reason for the atypically high THC recorded at this station.

Table 3.4. Summary of Hydrocarbon Concentrations at Ketch Survey Stations (Geo XYZ and Benthic Solutions, 2018c)

Section	Station	THC (mg.kg-1)	Total n-alkanes (ng.g-1)	Carbon Preference Index	Pristane/ Phytane Ratio	Proportion of Alkanes (%)	Total PAHs (ng.g-1)	Proportion of NPD (%)
Ketch Field	K_01	4.07	199	1.90	1.1	4.89	175	33.26
	K_02	29.80	844	1.85	2.6	2.83	690	33.48
	K_03	2.27	101	1.68	-	4.45	70.1	30.39
	K_04	7.98	282	1.88	2.1	3.53	213	31.41
	K_05	2.78	137	1.51	3.5	4.93	85.4	33.96
	K_06	4.67	216	2.14	1.9	4.63	216	32.78
	K_07	8.06	297	1.72	1.6	3.68	276	30.33
	K_08	26.1	485	2.12	2.2	1.86	415	33.98
	K_09	7.01	441	1.66	2.1	6.29	349	34.67
	K_10	4.27	164	1.50	1.0	3.84	156	31.03
	K_11	1.52	52	1.76	-	3.39	21.9	34.89
	K_12	16.0	997	1.70	3.2	6.23	799	35.92
Ketch Pipeline	KPL_01	12.9	655	1.95	2.0	5.08	596	31.04
	KPL_02	11.8	362	1.98	3.1	3.07	270	30.63
	KPL_03	8.24	183	2.81	2.0	2.22	104	34.23
	KPL_04	5.10	180	2.91	1.2	3.53	52.3	44.93
	KPL_05	8.10	252	2.74	3.0	3.11	71.0	41.97
	KPL_06	4.69	197	2.00	2.4	4.20	47.3	49.89
	Mean	9.19	335.75	1.99	2.19	3.99	255.94	34.93
	SD	7.83	259.83	0.42	0.75	1.22	231.90	5.37
	CV (%)	85.26	77.39	21.28	34.39	30.65	90.60	15.36
	UKOOA 95th Percentile	11.39	780.0	2.12	-	6.84	336	-

Table 3.5. Summary of Hydrocarbon Concentrations at Schooner Survey Stations (Geo XYZ and Benthic Solutions, 2018d)

	Station	THC (mg.kg-1)	Total n-alkanes (ng.g-1)	Carbon Preference Index	Pristane / Phytane Ratio	Proportion of Alkanes (%)	Total PAHs (ng.g-1)	Proportion of NPD (%)
Schooner Field	S_01	13.5	590	1.79	3.4	4.37	444	32.21
	S_02	9.32	378	2.02	2.3	4.06	222	32.25
	S_03	9.20	423	2.07	3.1	4.60	303	31.35
	S_04	9.86	198	1.96	2.1	2.01	160	29.56
	S_05	7.63	256	2.29	1.7	3.35	197	29.85
	S_06	16.5	684	2.27	3.5	4.14	493	31.24
	S_07	7.07	206	2.40	1.8	2.92	159	30.44
	S_08	6.74	199	2.01	2.0	2.96	189	34.13
	S_09	7.82	181	2.23	2.1	2.31	175	29.94
	S_10	9.96	319	2.46	3.6	3.21	228	31.67
	S_11	11.0	326	2.22	3.2	2.96	262	30.27
	S_12	20.5	806	2.15	3.7	3.93	642	35.36
Schooner Pipeline	SPL_01	17.9	645	2.03	2.9	3.60	483	31.88
	SPL_02	1.45	18	NC*	-	1.26	<35	-
	SPL_03	1.88	81	1.76	-	4.32	<35	-
	SPL_04	2.73	63	5.83	-	2.30	<35	-
	SPL_05	4.19	159	2.76	-	3.80	55.1	36.84
	SPL_06	2.08	53	NC*	-	2.57	<35	-
	Mean	8.85	310.4	2.39	2.71	3.26	286.6	31.93
	SD	5.55	234.6	0.95	0.73	0.93	165.6	2.16
	CV (%)	62.7	75.6	39.8	27.0	28.4	57.8	6.8
	UKOOA 95th Percentile	11.39	780	2.12	-	6.84	336	-

3.3 Biological Environment

3.3.1 Benthic Communities

The benthos describes the organisms that live in (infauna) and on the seabed (epifauna). Activities that result in physical or chemical disruption of the seabed can affect the fauna. Surveys of the SNS *(DECC OESEA2, 2011*) show that the general benthic fauna is characterized by thermal stability over time, water depth and seabed granulometry.

Results from the macrofaunal analysis of sediment samples collected during the pre-decommissioning EBS conducted by Faroe in March 2018 are presented in the EBS reports (Geo XYZ and Benthic Solutions, 2018c and Geo XYZ and Benthic Solutions, 2018d) and summarised in this section.

Macrofaunal analysis was carried out on 36 sediment sample replicates obtained at 18 stations sampled within the Schooner survey area and 36 sediment sample replicates obtained at 18 stations sampled within the Ketch survey area. Macrofaunal samples were processed in the field over a 500µm mesh sieve.

For the purpose of the assessment epifaunal species were separated into two categories; solitary epifauna and colonial epifauna. Solitary epifauna include specimens that, although epifaunal in nature, are recorded in low counts. Interactions of solitary epifauna with marine benthos can ensure they are of ecological importance in some regions; for the Schooner EBS they include three anemones, Actiniaria, *Cerianthus lloydii* and Edwardsiidae*,* as well as Phoronidae. Colonial epifauna are inclusive of encrusting epifauna which are generally recorded in high counts or as presence/absence. For the Schooner survey they were only represented by the cnidaria species, *Clytia hemisphaerica* and *Anthoathecata*, and the bryozoan *Triticella flava*. For the Ketch EBS they include three anemones, Actiniaria, *Cerianthus lloydii* and Edwardsiidae. Colonial epifauna were only represented by the cnidarian species, *Clytia hemisphaerica*, Anthoathecata, Astrohiza, and *Lovenella clausa*. Within these analyses solitary epifauna have been included with infaunal species, however colonial/encrusting epifauna have been included when discussing richness.

Macrofaunal taxonomy of all recovered fauna from the Schooner sample sites identified a total of 8,042 individuals (infauna and solitary epifauna) from the 36 samples analysed. Of the 219 species recorded, 216 were infaunal (including solitary epifauna), consisting of 95 annelid species accounting for 38.5% of the total individuals. The crustaceans were represented by 64 species (20.6% of total individuals), the molluscs by 39 species (20.1% of total individuals) and the echinoderms by seven species (10.5% of total individuals). Solitary epifauna were represented by four species (1% of total individuals) whilst all other groups (Nemertea, Nematoda, Platyhelminthes, Sipuncula, Chaetognatha, Enteropneusta and Osteichthyes) accounted for the remaining 9.2% of individuals, or seven species.

Macrofaunal taxonomy of all recovered fauna from the Ketch sample sites identified a total of 7,308 individuals (infauna and solitary epifauna) from the 36 samples analysed. Of the 211 species recorded, 206 were infaunal (including solitary epifauna), consisting of 87 annelid species accounting for 31.7% of the total individuals. The crustaceans were represented by 61 species (17.7% of total individuals), the molluscs by 39 species (23.21% of total individuals) and the echinoderms by seven species (12.1% of total individuals). Solitary epifauna were represented by three species (0.3% of total individuals) whilst all other groups (Nemertea, Nematoda, Platyhelminthes, Sipuncula, Chaetognatha, Enteropneusta and Osteichthyes) accounted for the remaining 15.0% of individuals, or nine species.

3.3.1.1 Infaunal trends

The macrofauna throughout the Schooner and Ketch survey areas was variable in terms of abundance, richness and species composition, as would be expected given the large distance covered and variation in sediment type. Annelids, crustaceans and molluscs were found to dominate the infauna at almost all of the Schooner stations. This dominance can also be seen in the overall species rank, with three annelids, three molluscs and two amphipods recorded in the top ten ranked species. In overall rank order, the top 10 dominant species within the Schooner survey area were the brittle star *Amphiura filiformis* followed by the polychaetes *Lumbrineris cingulata* and *Pholoe baltica*. The Nematoda phylum were ranked fourth, with the bivalves *Kurtiella bidentata* and *Phaxas pellucidus* ranked 5th and 6th, the amphipods *Harpinia antennaria* and *Ampelisca tenuicornis* followed in 7th and 8th with the bivalve *Fabulina fabula* and polychaete *Spiophanes bombyx* ranked 9th and 10th, respectively. In total 45 taxa were present with an average density of more than one individual per sample (0.1m^2), whereas 67 of the 216 infaunal taxa recorded were represented by only a single specimen throughout the entire survey. Due to the difference in sediment type and benthic community between the Schooner field stations and the pipeline stations, no species were recorded in every replicate, although Nematoda was present in 30 of the 36 replicates sampled.

Annelids, crustaceans and molluscs were found to dominate the infauna at almost all of the Ketch stations. This dominance can also be seen in the overall species rank, with three molluscs, three crustaceans and two annelids recorded in the top ten ranked species. In overall rank order, the top 10 dominant species within the Ketch survey area were the brittle star *Amphiura filiformis* followed by the polychaete *Pholoe baltica*. The Nematoda phylum were ranked third, with the bivalve *Kurtiella bidentata* and the polychaete *Lumbrineris cingulate* ranked 4th and 5th respectively, the crustacean *Callianassa subterranean* in 6th place and the two molluscs *Corbula gibba* and *Phaxas pellucidus* ranking 7th and 8th. Two amphipods, *Ampelisca tenuicornis* and *Harpinia antennaria* were ranked 9th and 10th, respectively. In total 39 taxa were present with an average density of more than one individual per sample (0.1m2), additionally 39 of the 206 infaunal taxa recorded were represented by only a single specimen throughout the entire survey. Due to the difference in sediment type and benthic community between the Ketch and the pipeline stations, no species were recorded in every replicate, with the bivalve, *Corbula gibba* and ophiuroid, *Amphiura filiformis* present in 34 of the 36 replicates sampled, with specimens recorded at every station.

Example photographs of some macro-invertebrate specimens recorded during both surveys are presented in Figure 3.3.

3.3.1.2 Epifaunal groups

Epifaunal groups were recorded at 28 of the 36 replicates sampled which were not statistically assessed within the infauna (recorded as colonial epifauna). Analysis of the infaunal and epifaunal communities indicates that infauna was dominant throughout the survey area, with epifauna making up a small but nevertheless consistent and important part of the community. Solitary epifauna was represented by four species, with colonial epifauna represented by three species; the general low dominance of epifauna in the survey is due to the lack or coarse sediment recorded.

Figure 3.3 Example of macro-invertebrate specimens recorded during the Schooner and Ketch surveys

3.3.1.3 Murdoch survey

Seabed surveys conducted by Gardline during 2015 at the Murdoch platform recorded visible fauna in homogenous sandy areas consisting of Annelida (Polychaeta); Arthropoda (Brachyura, Cirripedia, Paguridae); Chordata (*Limanda limanda, Platichthys flesus, Soleidae*); Cnidaria (Hydrozoa); Echinodermata (Asteroidea including *Asterias rubens*, Echinoidea); Mollusca (Bivalvia, Pharida, Scaphopoda) and Porifera (*Gardline, 2016*).

3.3.2 Habitats

One of the objectives of the pre-decommissioning EBS commissioned by Faroe was to assess the habitat in the project area. Habitat descriptions have been interpreted from the side scan sonar and bathymetric data, in conjunction with additional information on seabed sediment types and faunal communities from particle size analysis and underwater seabed photography data, respectively. Particle size analysis was performed using wet sieving techniques and laser diffraction on sediment samples acquired with a 0.1 m^2 BSL Double grab ((Geo XYZ and Benthic Solutions, 2018a and Geo XYZ and Benthic Solutions, 2018b).

Three main habitats were identified during the Ketch and Schooner surveys: Fine-medium sand, muddy sand, and rippled sand with sporadic shell and pebble fragments, which are described in further detail in the following sections (Geo XYZ and Benthic Solutions, 2018a and Geo XYZ and Benthic Solutions, 2018b).

3.3.2.1 Fine Medium Sand

Three of the Ketch stations (stations K11, KPL_04, and KPL_05) and four of the Schooner stations (stations SPL_03, SPL_04, SPL_05 and SPL_06) were characterised as fine-medium sand on the video and still data. This sediment type falls within the EUNIS classification of A5.25 'Circalittoral Fine Sand' (JNCC habitat code SS.SSa.CFiSa). Circalittoral fine sand habitat is characterised by medium to fine sand with less than 5% silt or clay composition.

3.3.2.2 Muddy Sand

High silt/clay content sediments in the form of muddy sand were dominant across the Ketch and Schooner fields. This sediment type most resembles the EUNIS classification of A5.26 'Circalittoral Muddy Sand' (JNCC habitat code SS.SMu.CMuSa). The silt content of this habitat typically ranges from 5% to 20%, although some stations within the Ketch field and all 12 stations within the Schooner field exhibited a higher percentage of fines (>25%) for this habitat type. Observed fauna within the Ketch and Schooner survey areas included: Annelida (*Ophiodromus flexuosus* and *Aphrodita acueleata*), Chordata (*Callionymus lyra and* Gadiformes sp.), and Arthropoda (Paguridae sp.). Burrowing megafauna are a common feature of this habitat and were clearly visible at most locations within the Ketch and Schooner fields.

3.3.2.3 Rippled Sand with Sporadic Shelly Fragments and Occasional Pebbles

A mixed substratum in the form of sand with varying levels of shell fragments, pebbles and cobbles was present at one Ketch export pipeline station; KPL_06 and present in patches along the Schooner export pipeline route. This was especially evident at the beginning of video transect KPL_06 where these areas were assigned to the EUNIS A5.44 'Circalittoral Mixed Sediment' habitat (JNCC habitat code SS.SMx.CMx). The major delineated area of mixed sediment was located in the northern area of the Ketch pipeline, closest to the Murdoch platform and along the Schooner export pipeline route from the central region to the northern half of the pipeline survey area. In both survey areas, associated fauna within the areas of mixed sediment also included: Sand eels (Ammodytidae sp.), Echinodermata (*Astropecten irregularis*), Arthropoda (*Liocarcinus depurator*), Annelida (Serpulidae sp.) and Cnidaria (*Alcyonium digitatum*) (Only present in the Schooner survey area). The project area is located approximately 24 kilometres south of the Dogger Bank[1]: an area of shallow sandy sediment which is less than 20 metres in depth in some places. Dogger Bank is of special ecological value and contains

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[1] *Please note that this reference is to the Dogger Bank itself, not the Dogger Bank SAC and MPA which covers a significantly larger area.*

species including *Echinocardium cordatum*, *Fabulina fabula* and a range of worms including the sand mason *Lanice conchilega* and *Owenia fusiformis* (DECC OESEA2, 2011).

3.3.3 Plankton

Plankton consists of the plants (phytoplankton) and animals (zooplankton) which live freely in the water column and drift with the water currents. Plankton forms a fundamental link in the food chain and is vulnerable to discharges to the sea and accidental chemical or hydrocarbon spills.

The distribution and abundance of plankton is heavily influenced by water depth, tidal mixing and thermal stratification within the water column (Edwards *et al*., 2010). The majority of the plankton occurs in the photic zone i.e. the upper 20 m of the sea which receives enough light for photosynthesis (Johns and Reid, 2001). Natural seasonality and high small-scale variability, both in species composition and abundance, is an important feature of planktonic communities.

The shallow water depths of the SNS create well mixed waters, which undergo large seasonal temperature variations (JNCC, 2004). The waters also undergo considerable tidal mixing due to the shallow water column and faster currents in the general area compared to other areas of the North Sea. There is therefore relatively little seasonal stratification throughout the year and is a consistent replenishment of nutrients. Opportunistic planktonic species, such as diatoms, are therefore particularly successful (Leterme *et al*., 2006).

Diatoms comprise a greater proportion of the phytoplankton community than dinoflagellates from November to May, when mixing is at its greatest (McQuatters-Gollop *et al.,* 2007). The phytoplankton community is dominated by the dinoflagellate genus Ceratium (*C. fusus, C. furca, C. lineatum*), along with higher numbers of the diatom, Chaetoceros (subgenera Hyalochaete and Phaeoceros) than are typically found in the northern North Sea (*DECC, 2009*). Zooplankton in the SNS is mainly comprised of small copepod species including Para-Pseudocalanus spp., with the second most abundant species being echinoderm larvae (DECC OESEA2, 2011).

3.3.4 Fish

Fish species known to use the project area for spawning and nursery are summarised in Table 3.6 (Ellis *et al*., 2012; Coull *et al*., 1998). It should be noted that, although potential spawning areas for fish species have been mapped, these areas are not fixed and are highly likely to vary spatially over time as fish populations naturally move through surrounding areas. Additionally, fish species may spawn earlier or later in response to seasonal variations in environmental conditions (Coull *et al*., 1998). Fish that lay their eggs on the seabed (bottom spawners) are more susceptible to disturbances to the seabed than fish that release their eggs into the water column (pelagic spawners). The following bottom spawning species are known to use the project area for spawning: sandeels, herring, whiting, cod, ling, plaice and European Hake. None of the species indicated in Table 3.6 are listed under Annex V of the OSPAR list of threatened and/or declining species and habitats, by CITES (Convention on International Trade in Endangered Species), an international agreement between governments to regulate international trade in wild animals and plants. Spurdog and tope are listed on the IUCN

(International Union for the Conservation of Nature) Red List of Threatened Species as vulnerable. In the North East Atlantic, spurdog is listed as critically endangered. Sandeels have specific habitat requirements relating to sediment particle size and could therefore be considered to be at greater risk of disturbance. Declining recruitment in sandeel populations in UK waters has been linked to an increase in water temperatures and fishing pressures (DECC, 2016a).

Table 3.6. Fish Spawning and Nursery Durations in the Project Area (Coull *et al*, 1998, Ellis *et al*., 2012)

Species	J	F	M	A	M	J	J	A	S	O	N	D
Mackerel					🟦	🟦 N	🟦 N	🟩 N	N	N		
Plaice	🟦	🟦	🟩									🟦
Herring	🟩 N	N	N								🟩	🟩
Sole			🟩	🟦	🟩							
Sprat					🟦	🟦	🟩 N	🟩 N	N	N		
Nephrops	🟩 N	🟩 N	🟩 N	🟩 N	🟩 N	🟩 N	🟩 N	🟩 N	🟩 N	🟩 N	🟩 N	🟩 N
Whiting		🟩	🟩	🟩 N	🟩 N	🟩 N	N	N				
Spurdog	N	N	N	N	N	N	N	N	N	N	N	N
Tope	N	N	N	N	N	N	N	N	N	N	N	N
Cod	🟩	🟦	🟦 N	🟩 N	N	N						
Blue Whiting						N	N	N				
Ling			N	N	N	N						
European Hake			N	N	N	N	N	N				
Anglerfish			N	N	N	N	N	N				
Sandeel	🟩 N	🟩 N	N	N							🟩	🟩

🟦 **Peak Spawning** 🟩 **Spawning** N **Nursery**

3.3.4.1 Elasmobranchs

In a survey conducted by CEFAS, twenty-six species were identified and recorded throughout the North Sea and surrounding waters. Of these, only the spurdog (*Squalus acanthias*), tope shark (*Galeorhinus galeus*), starry smooth hound (*Mustelus asterias*), and starry ray (*Amblyraja radiata*) may be present within the general vicinity of the Schooner and Ketch NUIs (Ellis *et al.,* 2004).

3.3.5 Seabirds

Seabird distribution and abundance in the SNS varies throughout the year, with offshore areas in general, containing peak numbers of birds following the breeding season and through winter (DECC, 2016). Only a small number of the seabird species breeding in the UK are not listed in Mitchell *et al*. (2004) as breeding within Regional Sea 2 where the project is located (for example Manx Shearwater, Storm Petrel, Leach's Storm Petrel, Arctic Skua, Great Skua and Black Guillemot). The North Norfolk Coast SPA site, located approximately 160 km south west from the project area qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex I of the Directive during the breeding season: for the presence of Common Tern (*Sterna hirundo*), Little Tern (*Sterna albifrons*), Mediterranean Gull (*Larus melanocephalus*), Roseate Tern (*Sterna dougallii*) and Sandwich Tern (*Sterna sandvicensis*) (JNCC, 2001). The species listed on Annex I of the Directive during the breeding season at the North Norfolk Coast SPA site have shown a level or general upwards trend in numbers at sites across England over the last five years except for little tern whose numbers have shown a downward trend (BTO, 2018).

Predicted maximum monthly abundance of seabirds in the Schooner and Ketch project area is based on an analysis of the European Seabirds at Sea (ESAS) data collected over 30 years (Kober et al., 2010). Continuous seabird density surface maps were generated using the spatial interpolation technique 'Poisson kriging' and fifty-seven seabird density surface maps were created to show particular species distribution in specific areas. Data from the relevant maps has been summarised for the Schooner and Ketch project area in Table 3.7.

Distribution and abundance of these bird species vary seasonally and annually. Seabird densities such as black-legged kittiwake are generally higher in the breeding season (May to September), whereas other species such as the common guillemot have higher densities in the winter season (October to April).

Table 3.7. Predicted seabird surface density (maximum number of individuals/km2 (Kober *et al.*, 2010).

SPECIES	SEASON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Northern gannet	Breeding					░	░	░	░	░			
	Winter	░	░	░	░						░	░	░
Great skua	Breeding					░	░	░	░				
	Winter	░	░	░	░					░	░	░	░
Northern fulmar	Breeding			▒	▒	▒	▒	▒					
	Winter	▓	▓						▓	▓	▓	▓	▓
Little auk	Winter	░	░	░								░	░
Arctic skua	Breeding					░	░	░	░				
Lesser black-backed gull	Breeding					░	░	░	░				
	Winter	▒	▒	▒	▒					▒	▒	▒	▒
Black-legged kittiwake	Breeding					█	█	█	█	█			
	Winter	▓	▓	▓	▓						▓	▓	▓
Common gull	Breeding					░	░	░	░				
	Winter	░	░	░	░					░	░	░	░
Great black-backed gull	Breeding				░	░	░	░	░				
	Winter	▒	▒	▒						▒	▒	▒	▒
Razorbill	Breeding					░	░						
	Winter	░	░	░	░						░	░	░
	Additional								▒	▒			
Herring gull	Winter	▒	▒	▒						▒	▒	▒	▒
Manx shearwater	Breeding					▒	▒	▒	▒	▒			
Common guillemot	Breeding					▒	▒						
	Additional								▒	▒			
	Winter	█	█	█	█						█	█	█
Atlantic puffin	Breeding				▒	▒	▒	▒					
	Winter	░	░	░					░	░	░	░	░
All species combined	Breeding				▓	▓	▓	▓	▓	▓			
	Summer							▓	▓				
	Winter	█	█	█								█	█

KEY	**Not recorded**	░ **≤ 1.0**	▒ **1.0 – 5.0**	▓ **5.0 – 10.0**	█ **10.0 - 15.0**	■ **15.0 - >20.0**

Table 3.8 presents the Seabird Oil Sensitivity index data for the project area and the surrounding area. Seabird vulnerability to oil is considered extremely high during July for all Blocks and during December for Block 44/21 and Block 44/26 within the project area.

Table 3.8. Seabird Oil Sensitivity Index (Certain *et al*., 2015)

Block	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
44/21	N	N	□	N	N	🔵	⬛	🟦	▨	N	N	⬛
44/22	N	N	□	N	N	▨	⬛	🔵	□	N	N	🔵
44/23	N	N	□	N	N	▨	⬛	□	□	N	N	🔵
44/26	N	N	□	N	N	🟦	⬛	🔵	□	□ 1	N	⬛
44/27	N	N	□	N	N	🔵	⬛	▨	▨	N	N	🔵
44/28	N	N	□	N	N	🔵	⬛	□	□	□ 1	N	🔵

KEY:	⬛	Extremely High	🟦	Very High	🔵	High	▨	Medium	□	Low
									N	No Data

1: These Blocks have no data coverage, however, data from adjoining months for the same Block have been used to fill the data gap (Step 1 method – JNCC, 2017a).
N: These Blocks have no data coverage and neither Step 1 nor Step 2 methods – (JNCC, 2017a) were able to address the data gap.

3.3.6 Marine Mammals

3.3.6.1 Cetaceans

There is potential for decommissioning activities to impact the movement and feeding behaviour of cetaceans, primarily through underwater noise. Table 3.9 identifies species of cetaceans previously sighted within the project area (Reid *et al.,* 2003) which include Atlantic white-sided dolphin (*Lagenorhynchus acutus*) (ICUN conservation status: Least Concern), harbour porpoise (*Phocoena phocoena*) (ICUN conservation status: Least Concern) and minke whale (*Balaenoptera acutorostrata*) (ICUN conservation status: Least Concern). Seasonal occurrence and abundance of cetaceans in the vicinity of the project area are summarised in Table 3.9. The limitations of sightings data should be realised and therefore cetacean species have the potential to be present at any time of year within the project area for feeding, with variations dependent upon the seasonal availability of food supplies. There is, however, limited information on the feeding ecology of cetaceans in UK waters (*DECC, 2016b*).

Best available animal density information for the proposed project area has been taken from the Small Cetacean Abundance in the European Atlantic and North Sea – II (SCANS-III) 2016 survey (Hammond *et al,* 2017). Density data for the species identified by Reid *et al.,* (2003) as being present within the vicinity of the project area are available from the SCANS-III data for all species (Table 3.10). The proposed decommissioning activities fall across SCANS-III survey area block O.

Table 3.9. Summary Accounts of Cetacean Species Anticipated to be in the Vicinity of the Project Area

Species	Summary
Atlantic white-sided dolphin	Odontocete (Toothed whale). Atlantic white-sided dolphin is very gregarious, with observed group sizes frequently numbering in tens to hundreds. It is superficially rather similar to the white-beaked dolphin. The two species may form mixed herds that are sometimes very large. White-sided dolphins live mainly in cool waters (7-12º C), particularly seaward or along the edges of continental shelves (typically in depths of 100-500 metres). Mainly occurs north and north west of Britain (Scotland), and is rare in the central and north-eastern North Sea.
Harbour porpoise	Odontocete (Toothed whale). Adult length ranges from 1.4 to 1.9 metres. New-borns may be between 67 cm to 85 cm. Harbour porpoise generally stay below the surface of the water. However, they are occasionally spotted when resting at the surface. It is the most numerous marine mammal in north-west European shelf waters.
Minke whale	Mysticete (Baleen whale). Adult minke whales measure between 8 and 10 metres in length. They regularly occur in small groups of 2-3 animals and are often described as an inquisitive animal as a result of many sightings being made close to vessels. The species occurs mainly on the continental shelf in water depths of 200 metres or less; for example, in the northern and central North Sea.

Table 3.10. Estimated Marine Mammal Density within the Vicinity of the Project Area from SCANS-III Data (Hammond *et al*, 2017)

Species	Density (animals per square kilometre) per SCANS III survey area
	Block O
Atlantic white-sided dolphin	No data
Harbour porpoise	0.888
Minke whale	0.010

Harbour porpoise abundance was comparable between the 1994 and 2005 SCANS survey results and the population has been assessed (as part of 3rd Report by UK under article 17 on the implementation of the Habitat Directive) to be in favourable condition with a total abundance in UK waters of 177,567 animals (CV=0.15) (DECC, 2016b). Following advice by SMRU and ICES, management units (MUs) for seven of the more common regularly occurring cetacean species have been agreed by the UK Statutory

Nature Conservation Bodies (SNCBs). The Celtic & Greater North Seas Management Unit (CGNS MU) was deemed appropriate for the management and conservation of both the Atlantic white-sided dolphin and minke whale (IAMMWG 2015). The abundance of white-sided dolphins across the entire CGNS MU was estimated at 69,293 (95% CI= 34,339-139,828) with the UK component estimated at 46,249 animals (95% CI =26,993-79,243) (DECC,2016b). The abundance of minke whales across the entire CGNS MU is 23,528 (95% CI= 13,989-39,572), with the UK component estimated at 12,295 animals (95% CI =7,176-21,066) (DECC,2016b).

There has been considerable information, using both controlled exposure experiments and opportunistic observations of anthropogenic noise source operations, on the behavioural responses of particularly sensitive marine mammals, including harbour porpoises (Kastelein *et al.,* 2008a,b; Gilles *et al.,* 2009) and beaked whales (Caretta *et al.,* 2008; McCarthy *et al*., 2011; Southall *et al.,* 2011; Tyack *et al.,* 2011). These studies amplify the conclusions of Southall *et al.,* (2007) that these are particularly sensitive species.

3.3.6.2 Pinnipeds

Grey seal (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*) are both resident in UK waters and are listed under Annex II of the EU Habitats Directive. Harbour seal pupping and moulting occurs from May to August, occasionally extending into September. Pupping occurs on land from June to July. During this time harbour seals are generally restricted to nearshore coastal areas. Harbour seals are not normally found foraging more than 60 kilometres from shore (*DECC OESEA2, 2011*). Grey seal pupping generally occurs in October, with moulting occurring between February and March (*DECC OESEA2, 2011*). During this period, grey seals will be found either onshore or on foraging trips in the vicinity of their haul-out site. At this time the offshore density of grey seals will be lower.

The project area is located 130 kilometres from the coast so it is highly unlikely that these species may be encountered in the vicinity of the decommissioning operations.

3.3.7 Habitat and Species Conservation

The northernmost part of the project area, where the export pipelines join the Murdoch Platform, is included within the Dogger Bank SAC and MPA which is located approximately 24.3 kilometres northwest of the Ketch NUI (See Figure 3.4). Most of the decommissioning work will be undertaken just outside of the Dogger Bank SAC/SCI and MPA but remedial and disconnection work on both gas export pipelines at the approach to the Murdoch platform and the removal of the Caister pipeline crossing will encroach into the Dogger Bank SAC and MPA.

The Southern North Sea cSAC and MPA, located approximately 12 kilometres north of the Schooner NUI, falls within the decommissioning project area due to the presence of the export pipelines at the Murdoch platform end which just encroach on the site. Figure 3.4 presents the length of both the Schooner and Ketch pipelines that fall within the Southern North Sea cSAC and MPA.

Furthermore, the recommended conservation zone ‘Markham’s Triangle’ is located 24 kilometres southwest of the Ketch NUI whilst North Norfolk Sandbanks and Saturn Reef cSAC/SCI and MPA are located approximately 42 kilometres south-west of the Ketch NUI.

A large number of nationally designated sites are also present along this section of the coast and include SSSIs selected for geological interest or presence of special plants, terrestrial invertebrates, breeding seabirds or breeding waterfowl and National Nature Reserves (NNRs) which contain examples of some of the most important ecosystems in Britain, including sand dune, shingle, saltmarsh, mudflat and wet grassland.

3.3.8 Potential Annex I Habitats and Annex II Species

Special Areas of Conservation (SACs) were established under the EC Habitats Directive, to protect marine habitats and species of European importance. SACs are identified for the habitats and species listed in the EC Habitats Directive. These include sandbanks, reefs, submarine structures made by leaking gasses, harbour porpoise and bottlenose dolphin.

The Dogger Bank SAC/SCI and MPA (situated 24.5 kilometres northeast of the Schooner NUI) is designated due to the vast expanse of Annex I shallow sandbank habitat in less than 20 metres water depth (*JNCC, 2015a*). The shallow water, sandy sediments and year-round productivity of the Dogger Bank make it an ideal spawning ground for sandeels (Ammodytes spp.). Sandeels are a major food source for several seabird species, seals and harbour porpoise (Annex II species) and consequently the Dogger Bank area is utilised as a foraging ground for several species (*JNCC, 2015a*). The conservation objectives for this site are (*JNCC, 2018a*):

- For the feature to be in favourable condition thus ensuring site integrity in the long term and contribution to Favourable Conservation Status of Annex I Sandbanks which are slightly covered by seawater all the time. This contribution would be achieved by maintaining or restoring, subject to natural change:
    - The extent and distribution of the qualifying habitat in the site;
    - The structure and function of the qualifying habitat in the site; and
    - The supporting processes on which the qualifying habitat relies.

The North Norfolk Sandbanks and Saturn Reef SAC/SCI and MPA is designated dues to the presence of Annex I shallow sandbank habitat, typical marine fauna which inhabit sandbanks are; polychaete worms, amphipods and small clams which burrow within the sediment and hermit crabs, seastar, brittlestars and flatfish (plaice and sole) on the seabed (*JNCC, 2015a*) and also due to the presence of the Saturn Reef (also an Annex I habitat). Saturn Reef is an example of a biogenic *Sabellaria spinulosa* reef which is formed through the production of tube structures within which the Ross worm (*S. spinulosa*) resides (*JNCC, 2010*). This biogenic reef seabed provides a more complex habitat for a greater diversity of species compared to the sandy habitat surrounding the area. The conservation objectives of the site are (JNCC, 2017b):

- For the features to be in favourable condition thus ensuring site integrity in the long term and contribution to Favourable Conservation Status of Annex I Sandbanks which are slightly covered by sea water all of the time and Annex I Reefs. This contribution would be achieved by maintaining or restoring, subject to natural change:
    - The extent and distribution of the qualifying habitats in the site;
    - The structure and function of the qualifying habitats in the site; and
    - The supporting processes on which the qualifying habitats rely

The Southern North Sea cSAC and MPA has been identified as an area of importance for the Annex II species, harbour porpoise (ICUN conservation status: Least Concern) and has been put forward to the EU for formal designation. The site extends to 36,958km^2 extending down the North Sea from the River Tyne south to the Thames, and includes habitats such as sandbanks and gravel beds. The water depths within the site range between 10 metres and 75 metres. The conservation objectives of the site are (*JNCC, 2016*):

- To avoid deterioration of the habitats of the harbour porpoise or significant disturbance to the harbour porpoise, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to maintaining Favourable Conservation Status (FCS) for the UK harbour porpoise.
- To ensure for harbour porpoise that, subject to natural change, the following attributes are maintained or restored in the long term:
    - The species is a viable component of the site.
    - There is no significant disturbance of the species.
    - The supporting habitats and processes relevant to harbour porpoises and their prey are maintained.

Review of the geophysical data at the Schooner NUI site (*Senergy S&G, 2012*) indicates a uniform seabed with low sonar reflectivity, interpreted using BGS information to comprise clayey sand. The absence of any apparent areas of high reflectivity suggests an absence of EC Habitats Directive 92/43/EEC Annex I habitats that can often be associated with such features, including stony and biogenic reefs (*Senergy S&G, 2012*).

There was no evidence from the seabed imagery across the Murdoch hub survey area of any Annex I habitats protected under the Habitats Directive (1992), priority habitats or species in England, listed under Section 41 of the NERC Act (2006) that were deemed to require action in the UK Biodiversity Action Plan and continue to be regarded as conservation priorities in the subsequent UK Post-2010 Biodiversity Framework (*JNCC and Defra, 2012*) (*Gardline, 2016*). There was also no indication of species or habitats on the OSPAR (2008) list of threatened and/or declining species and habitats or any species on the IUCN Global Red List of threatened species (*IUCN, 2014*).

A review of the ground-truthing data from the Ketch field and pipeline route survey and the Schooner field and pipeline route survey indicated the presence of several potentially sensitive habitats and species:

- 'Sandbanks which are slightly covered by sea water all the time' - EC Habitats Directive Annex I habitat (see discussion above);
- Burrowing megafauna communities - UK BAP habitat;
- Sandeel habitat - UK BAP priority marine species;
- The ocean quahog (*Arctica islandica)*.

3.3.8.1 Burrowing megafauna communities

In order to determine whether the habitats recorded during the Ketch and Schooner surveys should be classified as the UK Habitat Feature of Conservation Importance (FOCI) of 'mud habitats in deep water' (also a UK BAP Habitat), a combination of environmental factors and faunal information are considered, as outlined in (JNCC, 2014). The UKBAP definition of 'mud habitats in deep water' is as follows:

"Mud habitats in deep water (circalittoral muds) occur below 20-30m in many areas of the UK's marine environment, including marine inlets such as sealochs. The relatively stable conditions associated with deep mud habitats often lead to the establishment of communities of burrowing megafaunal species where bathyal species may occur with coastal species. The burrowing megafaunal species include burrowing crustaceans such as Nephrops norvegicus and Callianassa subterranea. The mud habitats in deep water can also support seapen populations and communities with Amphiura spp." (UKBAP, 2008).

No seapens were recorded in the Ketch or the Schooner survey area, however their absence does not preclude the classification as 'mud habitat in deep water', as while burrowing megafauna is an essential element of the habitat, seapens may, and by extension may not, be present (JNCC, 2014). The environmental conditions described by the UKBAP are comparable with those recorded in both survey areas, although the sediment is dominated by sand rather than mud. However, it is likely that this difference will not preclude classification of 'mud habitats in deep water' as the key aim of this classification is the conservation of the burrowing megafauna.

3.3.8.2 Sandeel habitat - UK BAP priority marine species

Sandbanks and other sandy substrates may be important habitats for sandeels (Ellis *et al*., 2010), which are small, thin eel-like fish that form large shoals and live most of their life buried in the seabed. Part of the project area falls within the spawning ground for sandeels (see Table 3.6). Sandeel distribution is primarily driven by the availability of suitable substrates for settlement and burrowing and are known to avoid areas with >4% of silt/clay and absent where silt/clay or very fine sand content is greater >10% (Wright *et al*., 2000; Holland *et al*., 2005). A review of the particle size composition of the sediments within the survey area was undertaken in order to further evaluate the potential of the survey area as sandeel habitat. All stations within the Ketch field and Schooner field (including pipeline station SPL_01 (closest to the Schooner field)), except for station K11 revealed a silt content >10%, with the lowest proportion of sediment fines found at K05 (10.4%) and S_07 (25.5%), theoretically making these sampled stations unsuitable sandeel habitats. Review of the underwater footage confirmed the absence of sandeels within those stations. However, the remaining stations located on both pipeline routes (KPL_04 to KPL_06 and SPL_09 and SPL_02 to SPL_06) showed evidence of sandeel occurrence which was clearly recorded in the underwater footage and most likely due to reduced sediment fines within the Dogger Sandbank at the Ketch pipeline stations. A further two video transects were carried out along the Schooner export pipeline route (SPL_09 and SPL_10) and confirmed the presence of sandeels at these locations.

3.3.8.3 Ocean Quahog (*Arctica islandica*)

A single ocean quahog individual was noted in one of the grab samples at station S11 but there was no evidence of distinct *A. islandica* siphons at the seabed on any of the Schooner survey area video footage or still photographs. The bivalve species is afforded status under the OSPAR Commission, and is included in the OSPAR List of Threatened and/or Declining Species in the Greater North Sea area as a priority (OSPAR, 2008; 2009). This species is also listed as a Marine Conservation Zone Feature of Conservation Importance (MCZ FOCI) for both inshore and offshore protection (JNCC and Natural England, 2016).While previous surveys of marine protected areas (MPA) designated for the protection of *A. islandica* populations have shown only sparse populations (O'Connor, 2016; 13 individuals from 156 Hamon grab samples), it is highly unlikely that the single individual noted on the Schooner survey would be considered to be of any conservation importance. No evidence was found for the occurrence of ocean quahogs within the Ketch field or along the Ketch export pipeline.

3.3.9 Coastal Protected Areas

There are several coastal protected areas along the eastern English coastline to the west of the project area including SSSIs, SPAs and Important Bird Areas (IBAs). The SPAs to the west of the project area regularly support wildfowl and waders and gulls. The eastern coast of England and the North Norfolk coast provide some of the most important wetlands, cliffs and bays in Europe which provide significant haul-out and breeding areas for seals and seabirds. The Humber Estuary is designated as an SAC due to its coastal lagoons, sand dunes, grey seals, migrating birds and river/sea lamprey features. The coast is approximately 130 kilometres from the project area and therefore is unlikely to be impacted by an oil spill.

3.3.10 Marine Conservation Zones Project

There are two recommended MCZ areas in the vicinity of the project area; Net Gain 7: Markham's Triangle (approximately 20 kilometres south-east of Block 44/26a) and Net Gain 9: Holderness Offshore (80 kilometres south-west of Block 44/26a). Net Gain 7: Markham's Triangle is an area composed of two broad-scale habitats (moderate energy circalittoral rock and subtidal missed sediment), subtidal sands and gravels and an important habitat are for European eel (*Anguilla Anguilla*). Net Gain 9: Holderness Offshore is an area composed of a broad-scale subtidal sand habitat and areas of subtidal sands and gravels and Ross worm reefs as habitat areas of conservation importance (*Net Gain, 2011*).

Although these sites have been identified as possessing features, habitats and/or species warranting further protection and as fulfilling the criteria for creating a network of protected areas, no official protected status imposing any restrictions upon commercial activities such as fisheries oil, gas and renewables development, has been formally implemented. Defra have indicated that although there is enough evidence to support designation of Markham's Triangle for subtidal sand habitat, more evidence is required on other aspects of the habitat and the implications of the designation of both sites on recreation and commercial impacts before Defra formally designate.

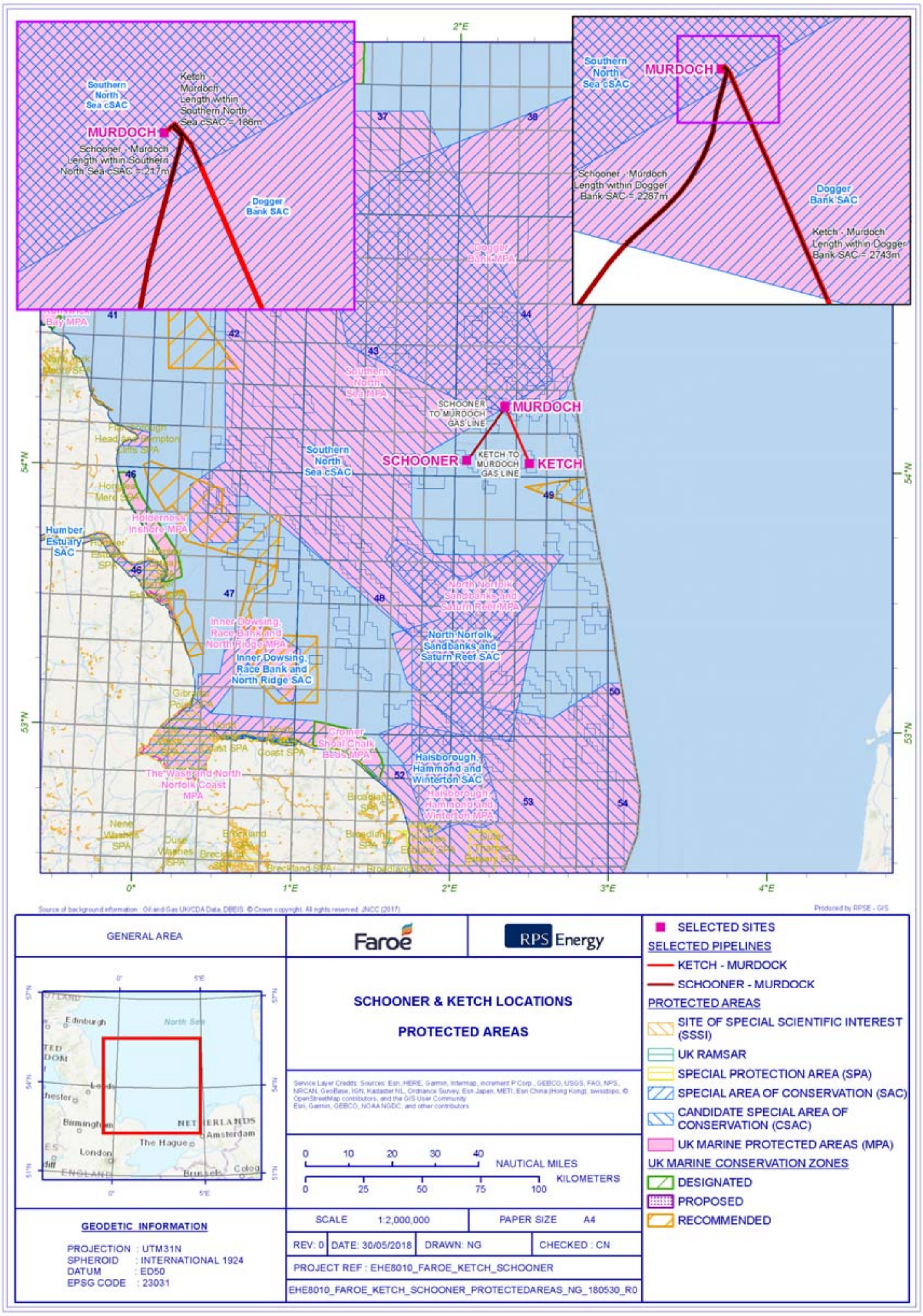
The Crown Estate report observes that offshore extraction of oil and gas is a substantial industry that makes a very important contribution to the UK economy (*Net Gain, 2010*). In identifying and classifying MCZs, the purpose is to maintain the ecological contribution made by the original sites whilst also seeking to reduce any potential impacts of the designation of a site on other commercial and recreational users of the sea in the area.

3.3.11 Marine Plan Areas

This region of the SNS lies within the East Offshore Marine Plan area which sets the framework for future development from Flamborough Head to Felixstowe and covers approximately 49,000 square kilometres of sea from 12 nautical miles out to the maritime borders with the Netherlands, Belgium, and France (*DEFRA, 2014*). Marine plans, together with the National Marine Policy Statement, underpin the planning system for England's seas. In accordance with the policies within the East Offshore Marine Plan, relevant economic, environmental and social aspects in the region of the project area have been considered simultaneously and using the best available evidence.

Faroe understand the principles behind the East Offshore Marine Plan, for example, policy ECO1 which relates to the pressures cumulative impacts can place on the ecosystem. Faroe aims to minimise these pressures in the vicinity of the project area via operational and environmental management controls. Collision risk assessments have been carried out for both the Schooner and Ketch NUIs; however, risks associated with the decommissioning project would also be assessed in line with policy ECO2 which relates to the risk of release of hazardous substances as a secondary effect due to increased collision risk. Policies such as BIO1 are considered throughout Faroe's current and future operations taking into account the best available evidence of protected habitats, species and conservation status within the area.

Figure 3.4 Environmentally Sensitive Areas



3.4 Socio-Economic Baseline

3.4.1 Commercial Fisheries

Commercial fishing activity within the vicinity of the project area is generally low with peak moderate activity in August and September; however, data was undisclosed from December to April (*Scottish Government, 2018*). The project area lies with ICES rectangle 37F2. Landings during the years 2014 to 2016 were predominantly demersal species making up 53.03 per cent of the live weight catches in 2016, followed by shellfish (46.93 per cent) and pelagic making up approximately 0.04 per cent of catches in 2016 (*Scottish Government, 2018*). Table 3.11 presents the live weight and first sale value of fish and shellfish landings into Scotland from 37F2 during the years 2014 to 2016 (*Scottish Government, 2018*).

Table 3.11. Live weight and value of fish and shellfish taken from ICES rectangle 37F2, 2014 – 2016 (Scottish Government, 2018)

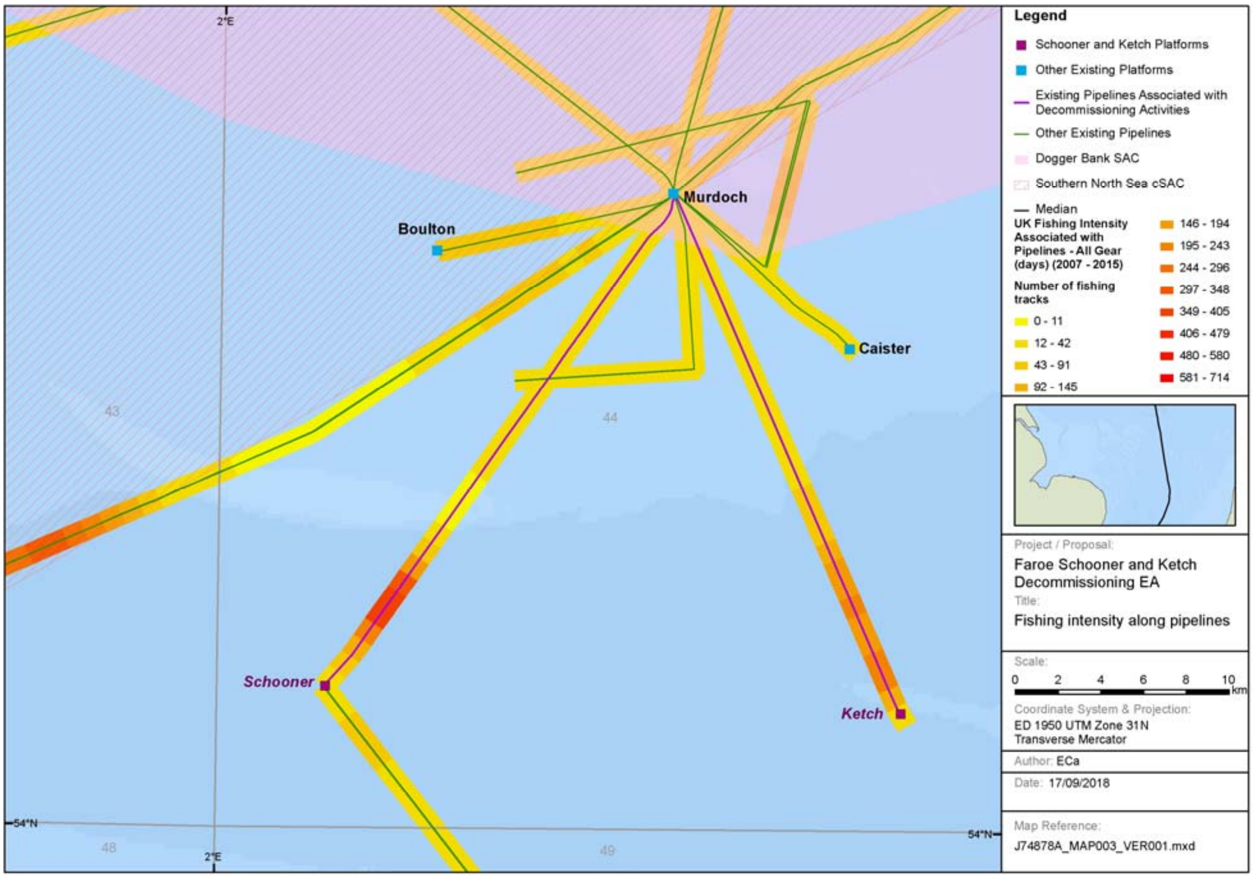
Fishery	2014 data		2015 data		2016 data	
	Live-weight (tonnes)	Value (£)	Live-weight (tonnes)	Value (£)	Live-weight (tonnes)	Value (£)
Demersal	1152	1,571,286	1048	1,527,656	938	1,380,839
Pelagic	1	2812.08	0	46	1	724
Shellfish	340	1,035,890	403	986,788	831	2,140,475
Total	**1,493**	**2,609,989**	**1,451**	**2,514,490**	**1,770**	**3,522,309**

The most common gear types observed in the region were trawls. Data relating to seine nets and gill nets was undisclosed. ICES Rectangle 37F2 has a fishing effort of 429.4 effort days per 100 square kilometres per year which is relatively moderate but consistent with fishing efforts for large areas of the SNS. The highest fishing efforts in this region are located in more inward waters adjacent to the stretch of coast between Bridlington and Hartlepool.

Figure 3.5 presents the intensity of mobile fishing associated with the Schooner and Ketch pipelines between 2007 and 2015 (*Scottish Government, 2018a*). The data layers were created following the methodology of Rouse et al. (2017). VMS position data were filtered by speed to distinguish fishing from steaming points. Fishing points were interpolated into tracks, accounting for the speed and heading of the vessel, to obtain a greater spatial resolution of fishing activity. Each pipeline was divided into 1 km sections. The total number of fishing tracks, extending 500 m either side of the pipeline, was calculated for each 1 km section according to four gear categories: dredging, nephrops (otter and pair trawls), demersal (otter, pair and beam trawls), and all mobile demersal gear. The number of fishing tracks along the Schooner and Ketch pipelines is fairly low (between 12 to 42 tracks) for the northern halves of the pipelines from Murdoch. Moving south along the pipelines towards the Schooner and Ketch installations the number of fishing tracks increases to a maximum of 244 to 296 tracks (Ketch pipeline) and a maximum of 406 and 479 tracks (Schooner pipeline) before decreasing again on approach to the installations and their 500 m safety exclusion zones.

Industrial fisheries target the sandeel populations of the southern and central North Sea. The fishery is focused on the Dogger Bank and takes place mainly during the summer months (*Rogers & Stocks, 2001*). Pelagic fisheries in the SNS mainly target herring, sprat and horse mackerel. Purse seiners and pelagic trawls are usually used in the herring fishery, with the greatest landings in the summer months (*Rogers & Stocks, 2001*).

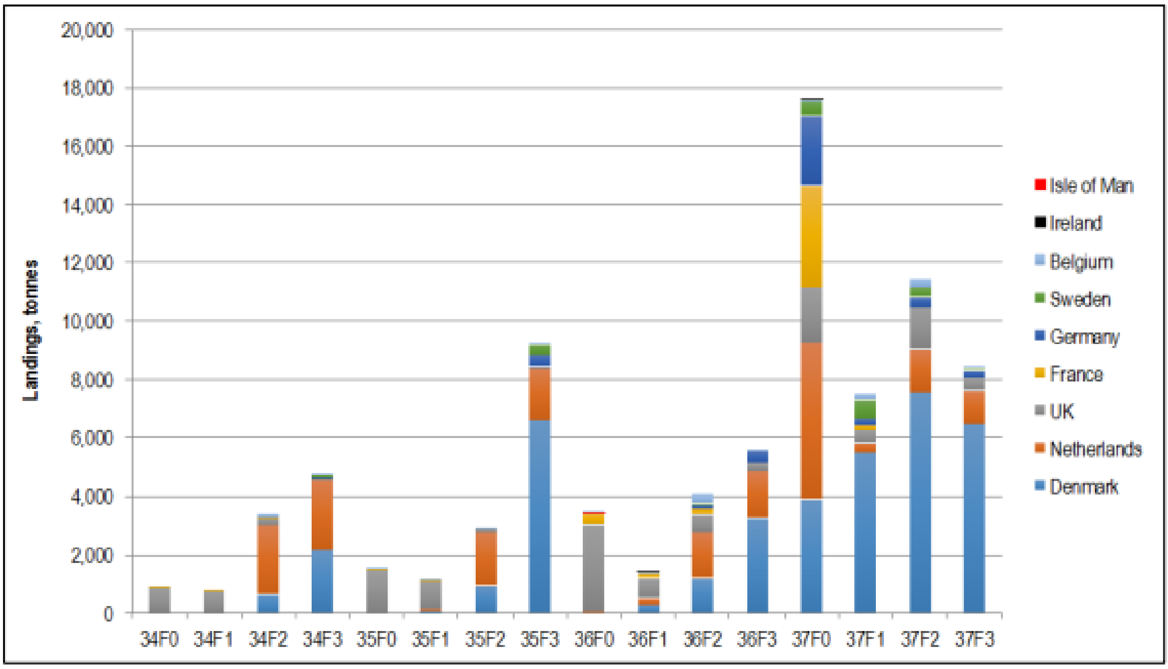
Figure 3.5: Fishing Intensity along the Schooner and Ketch Pipelines



The Preliminary Environmental Information Report (Poseidon Aquatic Resource Management Ltd, 2017) produced for the Hornsea Project 3 windfarm presented commercial fisheries data for a 'regional commercial fisheries study area' which covered ICES rectangles: 37F0 to F3, 36F0 to F3, 35F0 to F3 and 34F0 to F3. Surveillance data for UK and non-UK vessels of all sizes indicate that the predominant gear types across the regional commercial fisheries study area include demersal otter trawlers and beam trawlers in the offshore areas (outside 12 nm) and potters/whelkers and shrimpers (targeting shellfish) within inshore areas (inside 12 nm); clusters of other gears are also noted in a few locations including scallop dredgers.

The average annual landings across the regional commercial fisheries study area (Figure 3.6) show the highest quantity of catch (tonnes) to be taken from ICES rectangles 37F0 to F3 which includes the project area and 35F3. In the project area (37F2) the highest quantity of catch (tonnes) is taken by Danish registered vessels, followed by Dutch registered vessels, and UK registered vessels with smaller amounts by French, German, Swedish and Belgian vessels (negligible amounts are landed by Irish and Isle of Man registered vessels). Norwegian landing statistics are not available, but this fleet is understood to only sporadically target the regional commercial fisheries study area.

Figure 3.6: Average Annual Landed Weight, tonnes, of all Species landed by all EU Member States from the Regional Commercial Fisheries Study Area Indicating ICES Rectangles and Vessel Registered Country (based on five-years' data from 2011 to 2015) (data source: EU DCF database, 2017, cited in Poseidon Aquatic Resource Management Ltd, 2017)).



3.4.2 Shipping and Ports

The density of shipping traffic within the SNS is relatively high, due to the presence of a number of international ports within the region. Major ports within this region include Hull (a commercial and passenger port, with ro-ro ferry services to Belgium and the Netherlands) and Grimsby (the main port on the Humber, particularly important for commercial fishing landings). Data shows that shipping densities in the project area are moderate, with highest activity in the summer months (*DECC, 2009* and *Oil and Gas Authority, 2016*).

3.4.3 Wind Farms

A number of wind farm sites are located near to the project area (see Figure 3.7). The Hornsea 1 wind farm site is the closest site, under construction, to the project, located approximately 11.5 km from the Schooner platform. Based on the proposed decommissioning project offshore operations period (2018 to 2025) the offshore construction of the following windfarm developments may overlap with the project operations:

- **Hornsea Project 1** (offshore construction began in 2018 and anticipated to take up to four years).
- **Hornsea Project 2** (consented in 2016 and work on the project must start no later than Sept 2021).
- **Hornsea Project 3** (Project is at the pre-planning application stage).
- **Triton Knoll** (offshore construction works are estimated to take up to 5 years and work must start no later than July 2020).
- **Dogger Bank Creyke Beck A and B** (offshore construction start date not currently known but construction is to start no later than March 2020)
- **Teesside A and B** (offshore construction start date for either development is currently unknown. However, work on the projects must start no later than August 2022. The minimum construction period is three years and the maximum is six years).

3.4.4 Oil and Gas Activity

Oil and gas activity within the project area is moderate compared to other blocks to the north east. The project area contains the Schooner and Ketch gas fields, and sections of the Topaz to Schooner, Schooner to Murdoch, Ketch to Murdoch export pipelines.

Block 44/21 contains 19 previously drilled wells; 13 of which have been plugged and abandoned, 4 of which have been completed, and 2 of which have been suspended (Oil and Gas Data, 2018).

Block 44/22 contains 33 previously drilled wells; 21 of which have been plugged and abandoned and 12 of which have been completed (Oil and Gas Data, 2018).

Block 44/23 contains 25 previously drilled wells; 13 of which have been plugged and abandoned, 9 of which have been completed, and 3 of which have been suspended (Oil and Gas Data, 2018).

Block 44/26 contains 23 previously drilled wells; 11 of which have been plugged and abandoned, 10 of which have been completed, and 2 of which have been suspended (Oil and Gas Data, 2018).

Block 44/27 contains 2 previously drilled wells; 2 of which have been plugged and abandoned (Oil and Gas Data, 2018).

Block 44/28 contains 27 previously drilled wells; 16 of which have been plugged and abandoned, 10 of which have been completed, and 1 of which have been suspended (Oil and Gas Data, 2018).

In the vicinity of the project area several oil and gas developments have commenced decommissioning of assets and have an approved DP (Table 3.12), whilst others are in the decommissioning planning phase. The closest approved decommissioning project to the Schooner and Ketch decommissioning project is Spirit Energy's Markham ST-1, located approximately 30 km to the south east of the Ketch installation (see Figure 3.8).

Table 3.12. Oil and gas developments with an approved DP (OPRED, 2018)

DP Name	Location (Block/s)	Closest distance from project (km)	Proposed schedule	Potential temporal overlap with project
Spirit Energy Ann and Alison	48/10a, 49/6a, 49/11a	38	2017 to 2024	Yes
Spirit Energy Saturn (Annabel)	48/10	38	2018 to 2022	Yes
Spirit Energy Audrey	48/15	55	2017 to 2024	Yes
Spirit Energy Markham ST-1	49/5a and 49/10b	30	2017 to 2021	Yes
Conoco Phillips Viking Platforms	49/12a,49/16a, 49/17a, 49/18a and 49/12a	38	2014 to 2018	No
Conoco Phillips Viking Satellites CD, DD, ED,GD, HD Infield Pipelines	49/11d, 49/12a,49/16a, 49/17a and 49/12a	38	2016 to 2019	Yes
LOGGS	49/21a, 48/25b and 49/16	45	2016 to 2021	Yes

In addition, there are also several draft DPs under consideration in the vicinity of the project: Conoco Phillip's Viking VDP2 (operations scheduled between 2016 and 2021, Conoco Phillip's Viking VDP3 (operations scheduled between 2016 and 2024) and Perenco's Tyne South Installations (operations scheduled between 2016 and 2022). The closest of which is Perenco's Tyne south Installations located in Block 44/18a, approximately 44 km to the north of the Ketch installation.

Faroe are also aware that Conoco Phillips are planning to decommission the Caister Murdoch System (CMS) through which the Schooner and Ketch produced gas and condensate is processed (see Figure 3.7), hence the reason for the decommissioning of the Schooner and Ketch installations. The CMS comprises the Murdoch NMI (in Block 44/22a) which acts as the ICC for the export of produced fluids to the TGT. The CMS lies 17 km north of the Ketch installation at the closest point, from the Caister installation. Currently there is no draft or approved DP for the decommissioning of the Conoco CMS and therefore the proposed schedule of operations is unknown.

Based on the proposed decommissioning project offshore operations period (2018 to 2025) there is the potential for the temporal overlap of the approved decommissioning programmes with the project operations. The potential cumulative and in combination impacts from the proposed decommissioning project and the approved decommissioning programmes is presented in Section 8.

3.4.5 Tourism and Leisure

The tourism industry is not likely be impacted by normal offshore oil and gas operations but leisure activities could be threatened in the event of a major accidental spill approaching the coast, however this is unlikely given the coast is approximately 130 kilometres from the project area and minimal beaching of hydrocarbons is expected (Section 7). Leisure based and tourist activities are fairly widespread along the east coast of England. Popular seaside resorts along this stretch of the coast opposite the Blocks of interest include Whitby, Filey and Scarborough which are all popular for their bathing beaches, however it is unlikely a hydrocarbon spill would beach at these locations (Section 7) (*DECC, 2009*).

3.4.6 Military Exercise Areas

Blocks 44/26, 44/27 and 44/28 all overlap with a military exercise area (Oil & Gas Authority, 2017). As a result, these blocks are considered to be an area of concern to the Ministry of Defence (Oil & Gas Authority, 2017).

3.4.7 Archaeology

There are three charted wrecks in the project area, the closest lying approximately 1 kilometre to the northwest of the Schooner NUI (*Hydrographer of the Navy, 2008*).

3.4.8 Submarine Cables

There are no proposed cables in the vicinity of the project and one existing communications cable (NORSEA COMMS) located approximately 5km west of the Ketch pipeline at the nearest point (see Figure 3.7).

3.4.9 Aggregate Dredging Activity

To the south of the proposed decommissioning project there are a number of marine aggregate production areas and one marine aggregate application area (see Figure 3.7).

Figure 3.7: Offshore wind and marine aggregate activity in relation to the proposed decommissioning project location

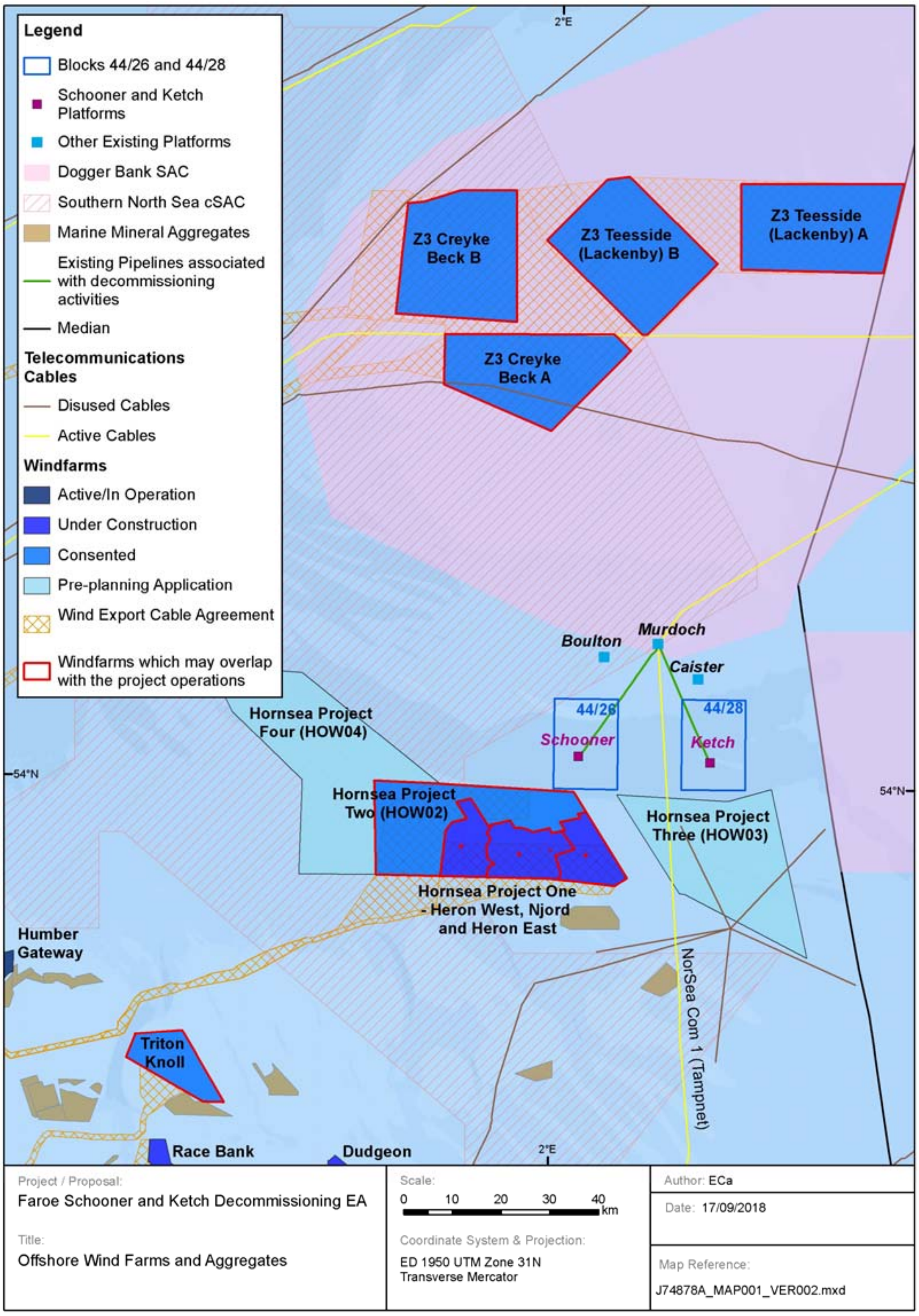
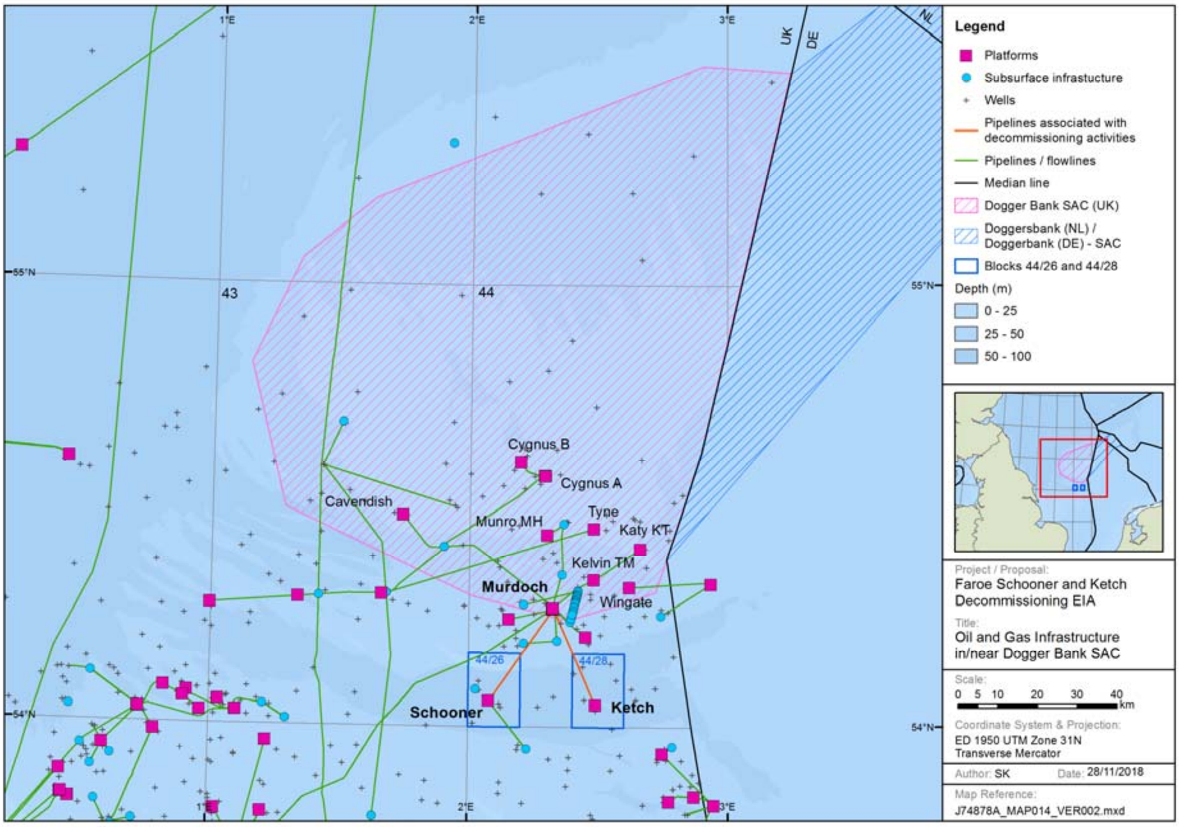


Figure 3.8. Offshore oil and gas infrastructure in relation to the proposed decommissioning project



4 Initial Environmental Impact Assessment

4.1 Environmental Impact Identification (ENVID) Workshop

The first phase of the EA process for the Schooner and Ketch Decommissioning Project was an Environmental Impact Identification (ENVID) Workshop held on the 26th March 2018 at Faroe's office in Aberdeen. The ENVID workshop was undertaken before the Comparative Assessment workshop and therefore considered several pipeline decommissioning options.

4.1.1 Objectives

The purpose of the ENVID workshop was to identify any environmental hazards associated with the decommissioning project and to document the associated environmental risks. The objectives of the workshop were to:

- Ensure all potential environmental risks have been identified;
- Assist in the understanding of the causes, consequences (impacts) and significance of environmental impacts;
- Establish the priority potential environmental risk areas for discussion and further assessment in the Environmental Appraisal;
- Identify effective controls and determine if these can be achieved for the management of the environmental aspects;
- Provide a process for evaluation, which is transparent and can be reviewed and understood by the regulator and stakeholders if necessary.

4.1.2 Process

The ENVID process involved:

- Assembling an appropriate team to encompass expertise in all of the key project functions to ensure a valid ENVID process.
- Explaining the use of the risk matrix to provide a qualitative assessment of environmental risk. Discussing and agreeing assessment criteria to ensure they are fit for purpose.
- Defining the consequences of identified environmental issues.
- Identifying controls required to either minimise or mitigate against the environmental risks associated with the identified issues.
- Describing the action required to achieve minimisation/mitigation.
- Assessing the environmental risks that remain (residual risk) after identified controls have been implemented.

- Recording summaries of issues, consequences, initial risk ratings, control and mitigation measures, actions (i.e. requires further assessment using underwater noise modelling) and residual risk on the ENVID Register.

4.1.3 Environmental Significance

Each Environmental Aspect identified was categorised using the Faroe Schooner and Ketch Decommissioning Project 5x5 Risk Assessment Matrix (RAM), presented in Figure 4.2 below, to establish its Environmental significance. The significance of any potential impact was determined through the use of a standard risk assessment methodology which employs the risk philosophy shown in Figure 4.1.

Severity of potential impact (consequence)
X
Likelihood
=
Risk (Impact)

Figure 4.1. Standard Risk Assessment Approach

4.1.4 Consequence of Potential Impact

The consequence of each impact was given a score between one and five as shown in Table A1, Appendix A and involves the consideration of two key drivers:

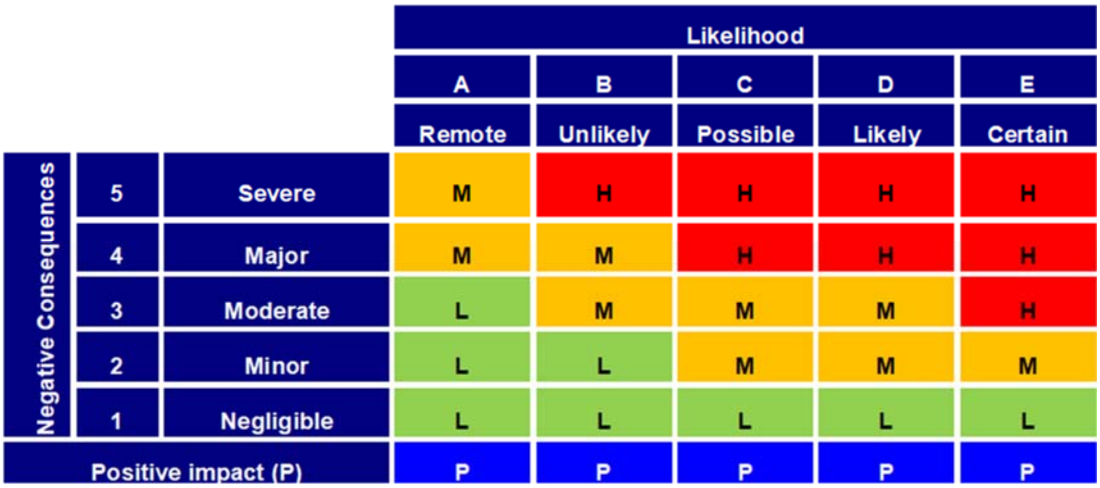
- **Environmental Receptors:** Consideration of the potential environmental sensitivities and receptors and published scientific evidence on the potential environmental impacts. This includes consideration of the geographical area over which an impact could occur.
- **Social Receptors:** Consideration of potential impacts on other users of the sea (potential conflict / concern resolution), interest groups and the general public and perceived potential impacts. This includes consideration of impacts that may result in negative feedback from the local community, from the regulator and from NGOs.

4.1.5 Likelihood

In order to assess the significance of a potential impact, the overall consequence was combined with the likelihood of the potential impact occurring. The likelihood of an aspect resulting in a potential impact is based around the frequency of occurrence within the proposed project timeframe and is scored as shown in Appendix B.

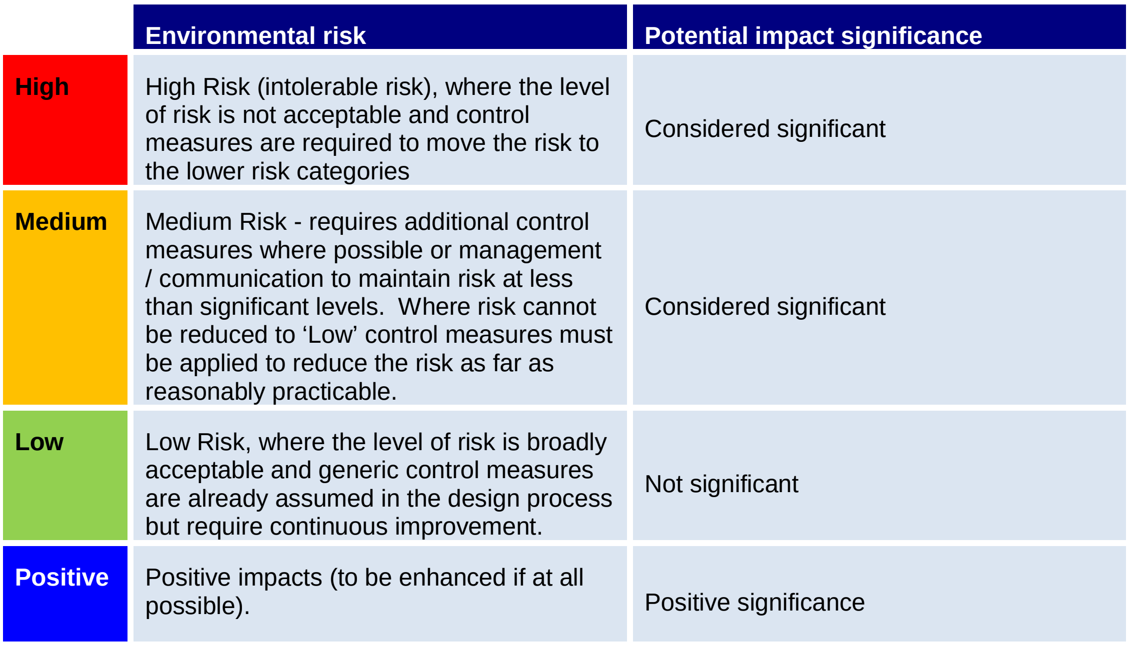
4.1.6 Combining Likelihood and Consequence to Establish Significance

Significance of potential impacts was assessed by combining the likelihood and consequence scores as per the Environmental Risk Matrix presented in Figure 4.2. The resulting scores were recorded in the ENVID Register. Interpretation of the overall risk in terms of potential impact significance could then be undertaken (Figure 4.3). Where potentially significant impacts were identified after standard control and mitigation measures were taken into consideration, the impacts were identified for further assessment.



			Likelihood				
			A	B	C	D	E
			Remote	Unlikely	Possible	Likely	Certain
Negative Consequences	5	Severe	M	H	H	H	H
	4	Major	M	M	H	H	H
	3	Moderate	L	M	M	M	H
	2	Minor	L	L	M	M	M
	1	Negligible	L	L	L	L	L
Positive impact (P)			P	P	P	P	P

Figure 4.2. Environmental Risk Matrix



	Environmental risk	Potential impact significance
High	High Risk (intolerable risk), where the level of risk is not acceptable and control measures are required to move the risk to the lower risk categories	Considered significant
Medium	Medium Risk - requires additional control measures where possible or management / communication to maintain risk at less than significant levels. Where risk cannot be reduced to ‘Low’ control measures must be applied to reduce the risk as far as reasonably practicable.	Considered significant
Low	Low Risk, where the level of risk is broadly acceptable and generic control measures are already assumed in the design process but require continuous improvement.	Not significant
Positive	Positive impacts (to be enhanced if at all possible).	Positive significance

Figure 4.3. Potential Environmental Risk and Significance

4.1.7 Summary of findings

The ENVID workshop results were presented in the ENVID report (Faroe, 2018b) and are summarised here. The ENVID workshop identified and assessed the potential environmental impacts of the potential decommissioning project activities. The majority of potential activities identified were rated as Low (green) environmental risk following standard mitigation and there were no potential activities rated as High (red) environmental risk. The aspects rated as Low environmental risk do not require detailed assessment and are therefore only discussed at a high level in Sections 4.2 to 4.5.

The activities evaluated in the ENVID as having a potential medium environmental risk (orange) have been selected for further assessment and are presented in Table 4.1 and discussed in Sections 5 to 8.

The potential environmental risk associated with loss of containment of the entire inventory of diesel from a vessel utilised in the decommissioning is further assessed as, at the time of the ENVID, up to date oil spill modelling was not available to inform the initial assessment.

The resulting environmental risk scores following the ENVID assessment and further assessment are presented in the Aspect Register in Appendix C. The project activities and associated assessment scores have been updated as necessary following the ENVID to reflect the current understanding of the project at the time of writing the EA.

Table 4.1. Interactions between the project operations and receptors rated as medium environmental risk

Activity	Physical			Biological								Socio-economic						
	Marine Water Quality	Air Quality	Sediments	Terrestrial Communities	Benthic Communities	Plankton	Fish / Shellfish	Offshore Seabirds	Coastal Seabirds	Marine Mammals	Protected / Sensitive Areas	Shipping	Fishing	Oil and Gas Activity	Pipelines / Cables	Tourism / Leisure	Resource Use/ Energy Use	Coastal Populations
Severance of jacket piles using explosives					🟦		🟦			🟦	🟦		🟦					
Use of jet trencher and/or plough trencher to bury Ketch pipelines			🟦		🟦						🟦							
Schooner and Ketch pipelines remaining in-situ													🟦					

4.2 Discharges to Sea and Small Unplanned Releases.

Planned discharges to sea will occur from the use of vessels and small releases of the pipeline contents to sea during cutting of the pipelines. Additionally, the potential exists for ballast water to be discharged dependent upon the vessel type engaged in the decommissioning activities. Small unplanned releases of fuel, hydraulic oil, lubricants or chemicals may occur during decommissioning activities.

The pipelines will have been cleaned and flushed prior to any cutting activity and the methanol will have been flushed from the piggybacked umbilical lines. The use of any chemicals for cleaning and flushing or for any other decommissioning activities will be permitted under the Offshore Chemical Regulations 2002 (as amended) and the discharge of any residual hydrocarbons from pipeline and riser disconnections and cutting activities will be permitted under The Offshore Petroleum Activities (Oil Pollution Prevention and Control (OPPC)) Regulations 2005 (as amended). Any ballast water discharges will be in line with the International Maritime Organisation ballast water management convention and guidelines. Vessel activities such as the release of drainage water and grey water will be relatively short in duration and will be subject to separate regulatory requirements.

Small unplanned releases will be managed under the existing Schooner and Ketch Field Oil Pollution Emergency Plan (OPEP) (Petrofac/Faroe, 2016) and the vessel Shipboard Oil Pollution Emergency Plans (SOPEPs).

There is the potential for the slow release of degradation products from pipelines and mattresses decommissioned in situ as they degrade over time. Structural degradation of the pipelines will be a long-term process caused by corrosion and eventual collapse of the pipelines under their own weight and that of the overlying mattresses, coating material and sediment. During this process, degradation products of the mattresses, pipelines and any entrained heavy metals will break down and could potentially become bioavailable to benthic fauna in the immediate vicinity. Contaminants could reach potential environmental receptors via the interstitial spaces in seabed sediments, overlying rock placement where applicable and the water column. The release of degradation products is expected to occur slowly and therefore the impact on the environment is expected to be minimal.

Based on the above, the environmental risk of these aspects is considered low and the potential impacts are considered not significant.

4.3 Atmospheric Emissions and Energy Use

The principal sources of atmospheric emissions and energy use are associated with the use of vessels, preparatory works for removal of the topsides and the onshore transport and processing of materials and waste.

Vessel activities will be conducted over relatively short periods. Total CO_2 emissions were calculated using the total fuel usage presented in Table 2.10 and the emissions factor of 3.2 tonnes of CO_2 per tonne of fuel. Carbon dioxide (CO2) emissions of approximately 21,018 tonnes could be emitted to the atmosphere (7,040 tonnes of which are from well plug and abandonment activities), which can be considered a small amount (0.21%) when compared to the 13,232,726 tonnes of CO_2 emitted in 2015 from UK offshore oil and gas installations (Oil & Gas UK, 2016). Also, the decommissioning activities are likely to be phased and therefore atmospheric emissions are likely to be spread over a number of years. Time spent by vessels in the field will be limited through optimisation of the decommissioning schedule and elevated concentrations of atmospheric gases from vessel activities will be localised, short-lived and will hardly be detectable beyond a short distance from the vessels due to the dispersive nature of the offshore environment. Vessel design dictates that offshore personnel will not be in the immediate vicinity of atmospheric emissions.

A relatively small volume of materials will be disposed of onshore (Table 2.11). As stated in Section 1.4 appropriately licenced onshore facilities will be used and the process of obtaining these licences will have included an assessment of the impacts from energy use and atmospheric emissions at the facility therefore any potential onshore environmental effects will be managed and mitigated in accordance with the terms of the relevant environmental permits and any further assessment of potential environmental impacts is not required in the EA process.

Based on the above, the environmental risk of these aspects is considered low and the potential impacts are considered not significant.

4.4 Physical Presence

The pipelines that will be decommissioned in situ may present a snagging hazard to fishing activity should they become exposed. The Schooner pipelines are significantly buried and will be safe to leave in-situ. The Ketch pipelines are exposed (Faroe define exposed pipelines as any length of pipeline not covered completely by natural deposits) over a length of 16,768.5 metres (64 % of the total pipeline length) (Fugro, 2018). The preferred decommissioning option for the Ketch pipelines will be to leave in situ and trench and bury the entire pipelines using a jet trencher followed by a plough to bury the pipelines to a minimum of 0.6 m below the seabed to the top of the pipeline. Past pipeline surveys indicate that both pipelines are stable and that the Schooner pipelines will remain buried. The Ketch pipelines are anticipated to remain buried following the trenching and burial of the entire pipelines. Trenching and burial of a 2,743 m length of the Ketch pipelines will be inside the Dogger Bank SAC (see Table 5.4, Section 5.4). On completion of the pipeline decommissioning activities, an over trawl survey will be performed to confirm over-trawlability. Monitoring will be performed to confirm pipelines decommissioned *in-situ* remain stable and buried at a frequency to be agreed with OPRED. Pipelines will be marked on admiralty charts and added to the FISHSAFE database.

Vessels on transit to the Schooner and Ketch facilities and on location present a physical obstruction in the sea and an associated navigational hazard and increased risk of collision with third-party vessels.

Vessel collision due to the presence of these activities is considered remote however the potential impact is considered moderate due to the potential for damage to other vessels or assets, resulting in concerns being raised by stakeholders or regional groups affected, such as fishing communities. Such an event could also potentially lead to elevated impacts such as injury/loss of life to vessel crew members or an unintentional release of hydrocarbons. The potential impact related to the release of hydrocarbons is addressed in Section 7.

Shipping densities in the area are moderate (see Section 3.4.2) however a number of mitigation measures will be in place to minimise the risk of collision including; issuing a notice to mariners prior to operations commencing to give vessels advance warning of the decommissioning operations, kingfisher bulletins issued prior to operations commencing and a collision risk management plan will be developed and implemented during operations. Additionally, vessels decommissioning the topsides and jacket are likely to be working within the platforms 500 metre safety exclusion zone which will be patrolled and enforced by an emergency response rescue vessel which will be equipped with automatic radar plotting aid (ARPA) which can create tracks of nearby vessels and calculate the tracked objects course thereby reducing the likelihood of collision. The trench and burial operations will be undertaken by a dynamically positioned vessel that will not need to anchor thereby reducing the risk of collision to other users of the sea.

Dependent upon final vessels selection it may be necessary for some vessels involved in the topsides and jacket decommissioning to be anchored on location. The presence of anchors and chains presents a potential snagging risk although the implementation of an anchor management plan, liaison with regional fishing groups and the same mitigation measures mentioned previously will minimise the risk of snagging. Prior to bringing an anchored vessel alongside the installations and NW Schooner subsea well a Collision Risk Assessment and Vessel Traffic Survey will be undertaken to inform the Consent to Locate application.

Based on the above, the environmental risk of these aspects is considered low and the potential impacts are considered not significant.

4.5 Transboundary

The Schooner and Ketch facilities are located approximately 49 kilometres and 18 kilometres, respectively, to the west of the nearest international boundary; the UK/Netherlands median line.

Any vessel discharges to sea will be localised in nature and will dissipate to negligible levels within a short distance from their source, before trans-boundary water quality deterioration is a factor.

The maximum injury ranges and disturbance zones estimated through use of underwater noise modelling for fish and marine mammals (see Section 6) are all less than the distance to the nearest international boundary and therefore any underwater noise generated by decommissioning activities will be localised in nature and will dissipate to background levels before trans-boundary impacts are a factor.

The atmospheric emissions from the decommissioning project will result in a minor deterioration of air quality over the local area and will dissipate to negligible levels within a short distance from their source, before trans-boundary air quality deterioration is a factor. Therefore, trans-boundary impacts upon air quality are not expected.

The waste arising from the decommissioning project is likely to be managed and processed entirely by contractors within the UK. The onshore locations for waste reception are unknown at the time of writing. There is possibility that some of the waste could may be shipped outside of the UK depending upon the type of waste and availability of UK facilities at the time of decommissioning. If waste is shipped internationally, the Schooner and Ketch Waste Management Plan will present the responsibilities Faroe has under the 'Duty of Care' legislation and identify appropriately licenced international onshore facilities where the waste can be treated. Therefore, no significant trans-boundary impacts from waste arising from the decommissioning project are expected.

Based on the above, the environmental risk of these aspects is considered low and the potential impacts are considered not significant. The trans-boundary impact from a large hydrocarbon release is discussed in Section 7.

5 Seabed Disturbance

5.1 Introduction

This section presents the further environmental assessment, undertaken by identifying and assessing the temporary and permanent environmental impacts from the various sources of seabed disturbance associated with the planned decommissioning activities. This section assesses both the potential for environmental impacts and outlines mitigation measures to minimise these impacts. To allow an assessment of the cumulative impact to the seabed (see Section 8), all activities that could disturb the seabed have been assessed.

5.2 Assumptions

At the time of writing this EA the detailed engineering studies required to define the methods for decommissioning have not been completed. Where more than one method could be used, that which presents the worst case potential environmental impact to the seabed has been assessed. The assumptions made on the methods that will be utilised for each activity to assess a worst-case seabed disturbance are presented in Table 5.1. The potential impact from stabilisation material has not been considered as the seabed conditions at present are stable and past rig visits to the platforms have not required stabilisation material therefore it is not anticipated that stabilisation material will be required to support the decommissioning activities.

Table 5.1 Activity Methodology Assumptions

Activity	Methodology Assumptions
Removal and recovery of NW Schooner wellhead and integral protection structure	Local excavation of seabed around the wellhead and integral protection structure to allow access for lifting equipment for removal. Assumption that less than a 1 metre zone around the structure could be affected. Placement of a jack up MODU to P&A and remove the wellhead protection structure.
Removal and recovery of topsides	Topsides will be prepared for lifting and made hydrocarbon free supported by a jack-up MODU. Topsides will be removed using an SLV which will be anchored to the seabed at each platform using eight anchors.
Removal and recovery of jackets	Jacket will be removed using an SLV which will be anchored to the seabed at each platform using eight anchors. Jacket piles will be cut using external cutting tool whereby excavation of a trench with shallow sides around the leg will be required.

Activity	Methodology Assumptions
Decommissioning Schooner pipelines *in situ*	Local excavation to allow access for cutting shears and lifting equipment to remove cut pipeline ends (both at the Schooner installation and Murdoch installation). Placement of biodegradable grout bags on pipeline cut ends. Permanent presence of the buried pipelines under the seabed. Recovery of pipelines' sections and mattresses for onshore disposal as per the waste hierarchy.
Decommissioning Ketch pipelines *in situ*	Local excavation to allow access for cutting shears and lifting equipment to remove cut pipeline ends (both at the Ketch installation and Murdoch installation). Deployment of jet trenching tool to bury the entire pipeline. Permanent presence of the buried pipelines under the seabed. Recovery of pipelines' sections and mattresses for onshore disposal as per the waste hierarchy.
Seabed over-trawl assessment	Fishing gear will be used to establish the seabed in the platform areas and pipeline corridors is free from snagging hazards.
Onshore processing of recovered infrastructure	The onshore transport and processing of facilities (cleaning, cutting etc.) at a shore based in preparation for transport to an appropriately licenced facility for their recycling or disposal to landfill.

Note: The pipeline cleaning and flushing phase will be undertaken from the installations but may be supported by a Walk to Work vessel alongside the platforms, however this will be a DP vessel and therefore no disturbance to the seabed is expected.

5.3 Sources of Seabed Disturbance

The ENVID identified potential temporary and permanent environmental impacts to the seabed from a number of decommissioning activities.

The decommissioning activities that may result in temporary seabed disturbance are movement of mattresses and grout bags to allow disconnection of pipelines, removal of the Schooner and Ketch pipelines and mattresses where they cross the Caister pipeline, anchoring of Mobile offshore drilling unit and sheerleg vessels, cutting of jacket piles for jacket removal; cutting of pipeline ends for removal, removal, discharge of cutting debris and recovery of NW Schooner wellhead and integral protection structure, trenching and burial of the entire Ketch pipeline and seabed over-trawl assessment. The pipeline cleaning and flushing phase will be undertaken from the installations but may be supported by a Walk to Work vessel alongside the platforms, however this will be a DP vessel and therefore no disturbance to the seabed is expected.

The decommissioning activity that may result in permanent seabed disturbance is the decommissioning of the Schooner and Ketch pipelines, mattresses and grout bags *in situ*.

Decommissioning of the Schooner and Ketch infrastructure will require activities taking place on or near the seabed that will result in disturbance to the seabed sediments and/or the water column. The sources of temporary seabed disturbance are presented in Table 5.2. The sources of permanent seabed disturbance are presented in Table 5.3.

5.3.1 Temporary disturbance

Short term potential environmental impacts associated with seabed disturbance can include direct mortality or physical injury to benthic species, and mobilisation and re-suspension of sediment.

Table 5.2 Estimate of the area of temporary seabed disturbance

Source of Temporary Seabed Disturbance	Assumptions made	Estimated area of direct impact (km^2)
Removal and recovery of NW Schooner wellhead and integral protection structure	Preparation undertaken by a jack up MODU with 3 jack-up legs. Assumes an area of seabed disturbance of 154 m^2 at each spud can (assuming a rig spud can diameter of 14.02 metres. Additional 1 m added to all sides of the wellhead protection structure (4.65 m x 4.10 m) to allow for disturbance including localised excavation.	0.000462 0.0000288
Topsides preparation using jack-up MODU at both platforms[1]	Preparation undertaken by a jack up MODU with 3 jack-up legs. Assumes an area of seabed disturbance of 154m^2 at each spud can (assuming a rig spud can diameter of 14.02 m).	0.000926
Topsides removal and recovery	SLV held in position by an eight-anchor mooring. Each anchor will directly cover an area of 30m^2; 8 anchor chains, each abrading an area of seabed assumed to be ≤ 5 m on either side of a chain which is in contact with the seabed over a worst-case length of 470 m per chain for all eight chains.	0.000240 0.038
Cutting Jacket piles to free legs from seabed	Assume that internal cutting fails due to technical reasons on two of the four piles at each platform. Therefore, piles cut externally using a diamond wire cutter mounted on an ROV. Removal of seabed around each of the piles to approx. 3.5m below natural seabed level. Assumption that the amount of seabed to be removed at each pile location will be 690 m^3.	0.00000276 km^3
Cutting and recovery of Schooner pipeline end at Murdoch platform	The area of seabed disturbance was assumed to be a corridor width of 10m, allowing sediment to be moved from its current location and deposited either side of the 90m long sections that are being removed. The use of shears is considered to have a negligible impact on the seabed as the tool is rigged from the vessel and sits vertically above the pipeline with minimal contact	0.0009

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[1] Well plug and abandonment activities would be undertaken by the jack-up MODU after the topsides preparation if this method is used instead of a walk to work vessel. Flushing of pipelines will be undertaken from the installations. During well plug and abandonment it may be necessary to place well conductors on the seabed temporarily before removing them to onshore. The impact from this will be assessed by the Well Intervention MAT process through the BEIS online UK Energy Portal

Source of Temporary Seabed Disturbance	Assumptions made	Estimated area of direct impact (km^2)
	to seabed. 10 m corridor area includes disturbed seabed due to recovery of 11 mattresses at the pipeline end and 8 mattresses associated with the Caister pipeline crossing.	
Cutting of Schooner pipeline end at Schooner platform	The area of seabed disturbance was assumed to be a corridor width of 10 m, allowing sediment to be moved from its current location and deposited either side of the 80m long section that are being removed.	0.0008
Cutting and recovery of Ketch pipeline end at Murdoch platform	The area of seabed disturbance was assumed to be a corridor width of 10 m, allowing sediment to be moved from its current location and deposited either side of the 100 m long sections that are being removed. The use of shears is considered to have a negligible impact on the seabed as the tool is rigged from the vessel and sits vertically above the pipeline with minimal contact to seabed. 10 m corridor area includes disturbed seabed due to recovery of 19 mattresses and approximately 32 grout bags.	0.0010
Cutting of Ketch pipeline end at Ketch platform	The area of seabed disturbance was assumed to be a corridor width of 10m, allowing sediment to be moved from its current location and deposited either side of the 10m long sections that are being removed.	0.0001
Trench and burial of Ketch pipelines to decommission in situ	The area of seabed disturbance was assumed to be a corridor width of 5 m, allowing the sediment to be deposited either side of the pipeline. The full length (26,600 m) of pipeline requires to be trenched and buried.	0.133
Recovery of grout bags at Schooner pipelines and Caister pipeline crossing.	Approximately 400 grout bags. Impacted area of 0.25 m x 0.25 m per grout bag.	0.000025
Recovery of grout bags at Ketch pipelines and Caister pipeline crossing.	Approximately 32 grout bags. Impacted area of 0.25 m x 0.25 m per grout bag.	0.0000020
Seabed over-trawl assessment	An assessment corridor of 100 m for Ketch pipelines for the entire length of 26,600 m. An assessment corridor of 100 m for those lengths of Schooner pipeline where exposures have been recorded (1.0 km). An assessment of 500 m safety zone at NW Schooner An assessment of 500 m safety zone at Ketch and Schooner.	2.66 0.10 0.7854 0.7854
Total (Km^2)		**4.51**
Total (Km^3)		**0.00000276**

Notes:

The assessment of the estimated disturbed seabed area from anchoring constitutes a worst-case scenario whereby it is assumed that the anchors from the sheerleg vessel would anchor in a different position to the MODU which

Source of Temporary Seabed Disturbance	Assumptions made	Estimated area of direct impact (km^2)
would anchor first alongside each platform.		

5.3.2 Permanent disturbance

Changes to the burial status of the pipelines, mattresses and grout bags decommissioned *in situ* are considered to cause permanent disturbance to the seabed. The type and amount of disturbance will be related to the dimensions and burial status of the items decommissioned *in situ*. All items to be decommissioned *in situ* are buried and based on historical survey data are stable and, once buried, are likely to remain so, therefore the degree of permanent seabed disturbance is anticipated to be minimal.

Table 5.3 Estimate of the area of permanent seabed disturbance

Source of Permanent Seabed Disturbance	Assumptions made	Estimated area of direct impact (km^2)
Decommissioning of 2 mattresses *in situ*	2 mattresses at Schooner field. Impacted area of 6 m x 3 m per mattress.	0.000018
Decommissioning Schooner pipelines *in situ*	Area is calculated based on 28.5 km for the length and 0.41 m for the width of the pipeline.	0.01169
Decommissioning Ketch pipelines *in situ*	Area is calculated based on 26.6 km length and 0.46 m for the width of the pipeline.	0.01224
Total		**0.02395**

5.4 Impacts on Sensitive Environmental Receptors

5.4.1 Temporary Disturbance

The total area of seabed that could potentially be temporarily disturbed from decommissioning activities is estimated at a maximum area of 4.51 km^2 (Table 5.2). Direct impacts from these activities can cause mortality or displacement of benthic species in the impacted area, whilst indirect impacts could arise from the increased amount of suspended sediment in the water column in the nearby vicinity. The potential impacts to the seabed from decommissioning activities, however, are influenced by the nature of the seabed sediments, the prevailing sediment transport system and the total area of seabed in contact with items. It is expected that any suspended sediment would be rapidly dispersed and drop out of the water column, settling back on the seabed within a short period given the prevailing tidal and current conditions in the area. Therefore, any disturbance from suspended sediment is expected to be short-term in nature.

5.4.1.1 Impacts on Designated Sites

The Dogger Bank SAC/SCI and MPA is located approximately 24.3 kilometres northwest of the Ketch NUI (See Figure 3.3, Section 3). The majority of the decommissioning activities will be undertaken outside of the Dogger Bank SAC/SCI and MPA but the pipeline activities at the Murdoch platform end will be within the Dogger Bank SAC/SCI and MPA. The Southern North Sea cSAC is located approximately 12 kilometres north of the Schooner NUI (See Figure 3.3, Section 3).

The Dogger Bank SAC/SCI and MPA is designated due to the vast expanse of Annex I shallow sandbank habitat in less than 20 metres water depth (*JNCC, 2015a*). The Southern North Sea cSAC has been identified as an area of importance for the Annex II species, harbour porpoise. The assessment of seabed disturbance on the Dogger Bank SAC/SCI and MPA has been presented here as the conservation feature 'harbour porpoise' is not considered to be impacted directly by seabed disturbance. Indirect impacts are also unlikely given the extent of the site and the ability of this feature to move within the site during activities.

Approximately 2.287 km of the length of the Schooner to Murdoch pipelines lie within the Dogger Bank SAC/SCI and MPA and approximately 2.743 km of the length of the Ketch to Murdoch pipelines lie (See Figure 3.1, Section 3). Table 5.4 presents the sources of temporary seabed disturbance that will occur within the Dogger Bank SAC/SCI and MPA and the estimated area of direct impact to the seabed.

Table 5.4 Estimate of the area of seabed disturbance within the Dogger Bank SAC/SCI and MPA

Source of Temporary Seabed Disturbance	**Assumptions made**	**Estimated area of direct impact (km^2)**
Cutting and recovery of Schooner pipeline end at Murdoch platform	See Table 5.2.	0.0009
Cutting and recovery of Ketch pipeline end at Murdoch platform	See Table 5.2.	0.0010
Trench and burial of Ketch pipelines to decommission in situ	The area of seabed disturbance was assumed to be a corridor width of 5m, allowing the sediment to be deposited either side of the pipeline. The full length (2,743 m) of pipelines within the designated sites requires to be trenched and buried.	0.0137
Recovery of grout bags at Schooner pipelines. Recovery of grout bags at Ketch pipelines.	See Table 5.2.	0.000025 0.0000020

Seabed over-trawl assessment	An assessment corridor of 100 m for Ketch pipelines for the entire length within the designated sites (2,743 m). An assessment corridor of 100 m for Schooner pipelines for the entire length within the designated sites (2,287 m).	0.274 0.228
Total (Km^2)		**0.51763**
Source of Permanent Seabed Disturbance	**Assumptions made**	**Estimated area of direct impact (km^2)**
Decommissioning of mattresses *in situ*	2 mattresses at Schooner. Impacted area of 6m x 3m per mattress.	0.00018
Decommissioning Schooner pipelines *in situ*	Area is calculated based on the length and 0.41m for the width of the pipeline.	0.00094
Decommissioning Ketch pipelines *in situ*	Area is calculated based on the length and 0.46m for the width of the pipeline.	0.0013
Total (Km^2)		**0.00242**

The estimated area of seabed disturbed temporarily and permanently within the designated site is 0.51763 km^2 and 0.00242 km^2 respectively.

The Dogger Bank SAC/SCI and MPA is designated for the feature Annex I sandbanks which are slightly covered by sea water all the time and the site covers an area of 12,331 km^2 (JNCC, 2015a). The estimated area of direct impact from temporary sources and permanent sources of seabed disturbance represents an area of 0.0042% and 0.00002% of the site respectively.

The assessment of the potential impact from seabed disturbance on the Dogger Bank SAC/SCI and MPA has been undertaken using the JNCC formal conservation advice package (JNCC, 2018a) for the Dogger Bank SAC/SCI and MPA to enable a decision to be reached as to whether the planned sources of seabed disturbance will have an impact on the qualifying feature of the Dogger Bank SAC/SCI and MPA. The operations advice on oil and gas decommissioning activities has identified the possible pressures that the seabed disturbance activities (see Table 5.2 and Table 5.3) may cause harm to the Dogger Bank SAC/SCI and MPA qualifying feature. The identified pressures and a discussion on how these pressures could be influenced by the decommissioning sources of seabed disturbance is presented in Table 5.5.

Table 5.5 Dogger Bank SAC/SCI and MPA assessment of identified seabed disturbance related pressures associated with oil and gas decommissioning activities

Identified Pressures	Assessment Discussion
Abrasion/disturbance of the substrate on the surface of the seabed	The trenching and burial operations of the Ketch pipelines and the Seabed over-trawl assessment have the potential to cause physical disturbance or abrasion at the surface of the substratum. The estimated worst case area of seabed potentially disturbed by these activities is small (4.4638 km^2) relative to the area covered by the site.
Changes in suspended solids (water clarity)	All activities identified as being a potential source of temporary seabed disturbance could cause sediment to mobilise into the water column. Sandy and gravel sediments should drop out of suspension quickly, and in the immediate area.
Hydrocarbon and PAH contamination	Pipelines will have undergone a flushing and cleaning regime prior to cutting and disconnection activities. Any residual hydrocarbons within the pipelines will be minimal and rapidly dispersed within the water column to undetectable levels. The survey results indicate that existing levels of hydrocarbons and PAH at the Schooner and Ketch pipeline locations within the Dogger Bank SAC/SCI and MPA are on average with the wider Southern North Sea (Geo XYZ and Benthic Solutions, 2018c and Geo XYZ and Benthic Solutions, 2018d) and are not contaminated.
Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion	The trenching and burial operations for the Ketch pipelines have the potential to cause physical disturbance or abrasion at the surface of the substratum. The estimated area of seabed disturbed by these activities is small (0.0137km^2) relative the area covered by the site. This pressure will be temporary in nature and recolonisation of the area would be expected to occur (see discussion in Section 5.4.1.2).
Siltation rate changes (low), including smothering (depth of vertical sediment overburden)	All activities identified as being a potential source of temporary seabed disturbance could cause sediment to mobilise into the water column. Sandy and gravel sediments should drop out of suspension quickly, and in the immediate area. Depth of burial surveys have found the pipelines to be very stable therefore suggesting limited sediment movement in the vicinity. The impact of the in situ decommissioning of the pipelines on sand movement is considered negligible given the stable nature of the seabed.

At the time of writing, JNCC considers the Dogger Bank SAC/SCI and MPA conservation features to be in unfavourable condition, however the potential pressures identified on the site related to decommissioning activities are likely to be temporary, over a small area relative to the size of the site and recovery expected in the short term. It is therefore concluded that the impact from seabed disturbance to the conservation features of the Dogger Bank SAC/SCI and MPA is considered to be low.

5.4.1.2 Impacts on Benthic Communities

The seabed habitat types and associated communities are widespread over adjacent areas of the southern North Sea. The most abundant macrofaunal species in the Schooner and Ketch project area are consistent with the faunal community type typical of sandy sediments in the wider SNS area. These species are widely distributed and are typically short lived and would be expected to rapidly recolonise disturbed sediment.

Given that the direct impacts from temporary seabed disturbance sources are purely physical through natural disturbance and smothering, and that the sediments will not have been contaminated, it is anticipated that the impacted sediment communities will begin to recover as soon as activities are completed. Re-colonisation of the impacted area can take place in a number of ways, including mobile species moving in from the edges of the area (immigration), juvenile recruitment from the plankton or from burrowing species digging back to the surface.

Although recovery times for this type of soft sediment faunal communities are difficult to predict, van Dalfsen *et al.* (2000) showed that the recovery of benthic communities following sand extraction at sites in the North Sea off the coasts of Denmark and the Netherlands occurred within two to four years. The effects on the benthic community appeared to be related to the physical impact on the sea floor, with small-scale disturbances in seabed morphology and sediment composition resulting in relatively short-term and localised effects. Rees *et al.* (1992) also showed that newly deposited sediment (at dredged material disposal sites) was rapidly colonised by opportunistic macrofauna.

Further, Collie *et al.* (2000) examined impacts on benthic communities from bottom towed fishing gear and concluded that in general, sandy sediment communities were able to recover rapidly, although this was dependent upon the spatial scale of the impact. It was estimated that recovery from a small-scale impact, such as a fishing trawl could occur within about 100 days. In this sort of impact, it was assumed that re-colonisation was through immigration into the disturbed area rather than from settlement or reproduction within the area. It was also noted that whilst the recovery rate of small bodied taxa, such as the polychaetes, which tend to dominate the data set, could be accurately predicted, sandy sediment communities often contain one or two long lived and therefore vulnerable species, the recovery of which is far harder to predict.

In a series of large scale field experiments Dernie *et al*. (2003) investigated the response to physical disturbance of marine benthic communities within a variety of sediment types (clean sand, silty sand, muddy sand and mud). Of the four sediment types investigated, the communities from clean sands had the most rapid recovery rate following disturbance and mud the slowest. The sandy sediment observed at the Schooner and Ketch project area can therefore be expected to recover at a comparatively fast rate.

There is not anticipated to be a significant long-term impact on the benthic communities from the temporary decommissioning activities, especially given the relatively small footprint (4.58 km^2) and absence of potential Annex I habitats from the site survey results (Section 3.3.7 and Geo XYZ and Benthic Solutions, 2018c and Geo XYZ and Benthic Solutions, 2018d), therefore the impact from seabed disturbance to benthic communities is considered to be low.

5.4.1.3 Impacts on Fish and Shellfish

A number of species of fish, including plaice and sole are known to spawn within the project area, whilst others use the area as a nursery and a smaller number of species use the area for both life cycle phases (see Table 3.6, Section 3). Seabed disturbance including the deposition of sediment is more likely to affect those species that lay their eggs on the seabed (demersal spawning) as opposed to species that release their eggs and sperm into the water column (broadcast spawning) after which they are carried by the currents and widely distributed. The Schooner and Ketch pre-decommissioning environmental survey identified the potential for sandeel spawning grounds and nursery grounds to overlap with the project area and the Dogger Bank SAC/SCI and MPA. Sandeel are a UK BAP priority marine species and are an important prey source for a variety of fish, seabirds and cetacean. Sandeel distribution is primarily driven by the availability of suitable substrates for settlement and burrowing, with areas of >4% of silt/clay being avoided and absence of the species in areas where silt/clay or very fine sand content is greater >10% (Wright *et al*., 2000; Holland *et al*., 2005). On review of the particle size composition of the sediments within the Ketch field survey area, all stations, except for station K11 revealed a silt content >10%, theoretically making these sampled stations unsuitable sandeel habitats. In addition, a review of the underwater footage confirmed the absence of sandeels within those field stations. However, the remaining stations on the pipeline route that fall within the Dogger Bank SAC/SCI and MPA (KPL_04 to KPL_06) showed evidence of sandeel occurrence on the underwater footage which is most likely related to the reduced sediment fines within the Dogger Sandbank. Given the estimated area of direct impact from temporary sources and permanent sources of seabed disturbance represents an area of 0.0042% and 0.00002% of the site respectively. The Schooner and Ketch area does not present a unique spawning or nursery area for species when compared to the wider SNS and the wider Dogger Bank SAC/SCI and MPA and the potential disturbance area is considered to be relatively small therefore the impact from seabed disturbance to fish species is considered to be low.

5.4.1.4 Impacts on Sediments

Sediments at the Schooner and Ketch fields were classified as predominantly muddy sand, and coarser sediment closer towards the Murdoch platform. The decommissioning activities are likely to result in a proportion of the sediments becoming suspended in the bottom few metres of the water column. Sandy and gravel sediments should drop out of suspension quickly, and in the immediate area, however, some of the finer silts may remain in the water column for some time and could be transported away from the immediate area on the prevailing currents, potentially giving rise to indirect impacts on other areas of seabed when they finally settle out of the water column. The sediment type, however, would tend to suggest that settlement of suspended material will occur in the vicinity of the activities with limited further afield sediment transport occurring. This also indicates that any smothering effects on seabed fauna will be localised.

5.4.2 Permanent Disturbance

The total area of seabed that could potentially be permanently disturbed from decommissioning activities is estimated at a maximum area of 0.02395 km^2 (Table 5.3). The decommissioning of pipelines *in-situ* could lead to long-term impacts to the benthic fauna. There is no evidence of scour at the mattress or pipeline locations and both pipelines have remained stable. Schooner is expected to remain buried and once trenched and buried Ketch is also expected to remain buried given the similarities of the pipeline, seabed sediments and seabed dynamics.

5.4.2.1 Impacts on Benthic Species

There is the potential for the slow release of residual hydrocarbons and degradation products from the pipelines decommissioned in-situ as they degrade over time. Structural degradation of the pipelines will be a long-term process caused by corrosion and eventual collapse of the pipelines under their own weight and that of the overlying sediment. During this process, degradation products of the pipeline, NORM scale and any entrained heavy metals and any hydrocarbons or heavy metals associated with residual solids will break down and could potentially become bioavailable to benthic fauna in the immediate vicinity. Contaminants could reach potential benthic environmental receptors via the interstitial spaces in seabed sediments and the water column. The release of degradation products is expected to occur slowly, and rapidly disperse within the water column, therefore the impact on the environment is expected to be minimal. There is the potential for residual hydrocarbons in the pipelines to be released on cutting the pipeline ends. These discharges have the potential to cause short-term toxicity or bioaccumulate within the benthic fauna in the immediate vicinity. Given the depth and current speed, it is likely that any discharges of residual hydrocarbons will dilute to levels that are too low to cause harm to benthic organisms.

5.5 Mitigation and Control Measures

In order to minimise disturbance to the seabed from the removal and recovery of items the operations will be planned and carefully executed. Vessel synergies e.g. the potential to share the ERRV with Conoco Phillips will be looked at during the tendering and contract award process. The vessels involved will position themselves directly over each item before lifting so that the item can be lifted vertically as far as possible, to avoid dragging on the seabed and therefore minimise the area of seabed disturbed. If an anchored vessel is required for the removal of the platforms then an anchor management plan will be implemented. In order to minimise disturbance to the seabed from the over-trawl assessment the area that requires assessment will be optimised through liaison with fishing organisations and the regulator. In addition, the possibility of using a side-scan sonar survey instead of an over-trawl assessment will be investigated at the time of the survey.

Best practices will be followed when planning the decommissioning project to ensure, where possible, the smallest possible footprint of operations to reduce potential seabed disturbance.

5.6 Conclusions

When put into context with the size of the Schooner and Ketch licence blocks (400 km^2) the estimated total area of seabed that could be temporarily disturbed forms 1.13 % of the total licence blocks area and the estimated total area of seabed that could be permanently disturbed forms a smaller 0.006% of the total licence blocks area. The decommissioning activities discussed above have the potential to cause short term, localised modification to the benthic fauna, sediments and fish and shellfish species. These impacts will be mitigated through careful planning of removal and recovery procedures, anchor management plans, incorporation of results of the pre-decommissioning EBS into plans and procedures and equipment selection. Based on the relatively small area, and the expected recovery from temporary disturbance the significance of the impact is considered ‘low’. All pipelines are expected to remain buried following decommissioning *in-situ* and any release of degradation products is expected to occur slowly, with rapid dispersion therefore the significance of any permanent impact is considered ‘low’.

6 Underwater Noise

6.1 Introduction

This section presents the findings of the Schooner and Ketch Decommissioning Project noise assessment that was undertaken as part of the further environmental assessment to provide guidance as to exclusion zone radii which should be observed in order to reduce the likelihood of physiological damage or behavioural change in marine mammals. The results of the assessment have also been used to inform the assessment of decommissioning project noise on marine mammals and fish. The Noise modelling methodology, presented in Appendix D, presents the further environmental assessment, undertaken by identifying and assessing the environmental impacts from the various sources of underwater noise associated with the planned decommissioning activities. This section assesses both the potential for environmental impacts and outlines mitigation measures to minimise these impacts. To allow an assessment of the cumulative impact of underwater noise (see Section 8), all activities that emit underwater noise have been assessed.

Noise will be generated both above and below the sea surface. Underwater noise has the potential to impact fauna in the area, particularly fish and cetacean species, potentially modifying their behaviour patterns (changes in swimming and breathing patterns and the masking of communication between marine mammals). More significantly and in extreme cases, the pressure waves associated with noise can inflict physical harm and possibly be lethal.

6.2 Acoustic Concepts and Terminology

The following section comprises a brief introduction to some key concepts relating to underwater sound and the ways it is described, classified and quantified: root-mean-square (rms), peak (pk), peak-to-peak (pk-pk) and sound exposure level (SEL) sound pressure levels.

Sound travels through the water as vibrations of the fluid particles in a series of pressure waves. The waves comprise a series of alternating compressions (positive pressure variations) and rarefactions (negative pressure fluctuations). Because sound consists of variations in pressure, the unit for measuring sound is usually referenced to a unit of pressure, the Pascal (Pa). The unit usually used to describe sound is the decibel (dB) and, in the case of underwater sound, the reference unit is taken as 1 µPa, whereas airborne sound is usually reference to a pressure of 20 µPa. To convert from a sound pressure level reference to 20 µPa to one referenced 1 µPa, a factor of 20 log (20/1) i.e. 26 dB has to be added to the former quantity. Thus 60 dB re 20 µPa is the same as 86 dB re 1 µPa, although difference in sound speed and densities mean that the difference in sound intensity is much more from air to water. All underwater sound pressure levels in this report are described in dB re 1 µPa. In water the ‘strength’ of a sound source is usually described by its sound pressure level in dB re 1 µPa, referenced back to a representative distance of 1 m from an assumed (infinitesimally small) point source. This allows calculation of sound levels in the far-field. For large distributed sources, the actual sound pressure level in the near-field will be lower than predicted.

There are several descriptors used to characterise a sound wave. The difference between the lowest pressure variation (rarefaction) and the highest pressure variation (compression) is the peak to peak (or pk-pk) sound pressure level. The difference between the highest variation (either positive or negative) and the mean pressure is called the peak pressure level. Lastly, the rms sound pressure level is used as a description of the average amplitude of the variations in pressure over a specific time window. These descriptions are shown graphically in Figure 6.1.

The rms sound pressure level (SPL) is defined as follows:

$$SPL_{rms} = 10log_{10}\left(\frac{1}{T}\int_{0}^{T}\left(\frac{p^2}{p_{ref}^2}\right)dt\right)$$

The magnitude of the rms sound pressure level for an impulsive sound (such as that from a seismic source array) will depend upon the integration time, T, used for the calculation (Madsen, 2005). It has become customary to utilise the T90 time period for calculation and reporting rms sound pressure levels. This is the interval over which the cumulative energy curve rises from 5% to 95% of the total energy and therefore contains 90% of the sound energy.

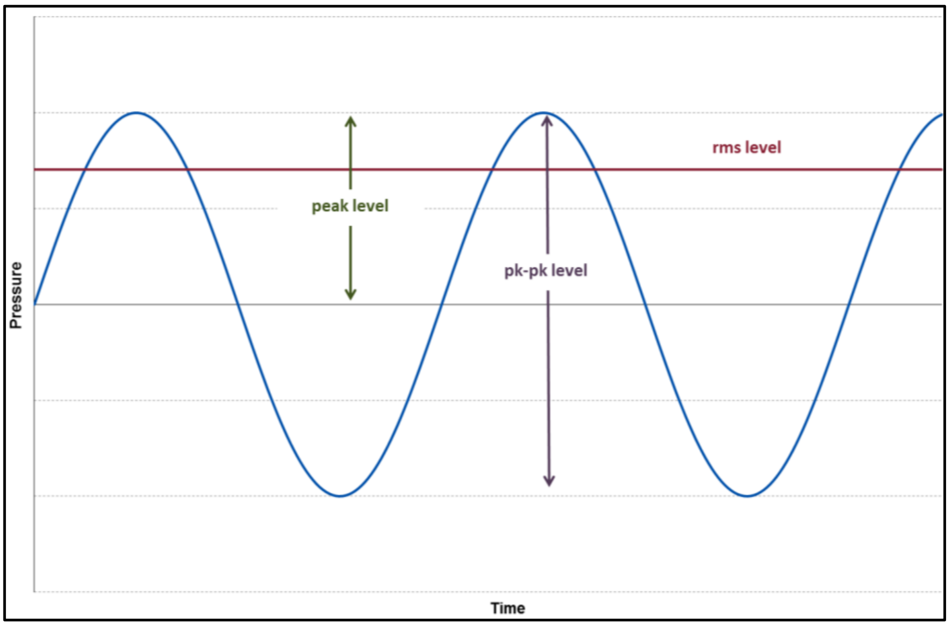

Figure 6.1 Graphical representation of acoustic wave descriptors

Another useful measure of sound used in underwater acoustics is the Sound Exposure Level, or SEL. This descriptor is used as a measure of the total sound energy of an event or a number of events (e.g. over the course of a day) and is normalised to one second. This allows the total acoustic energy contained in events lasting a different amount of time to be compared on a like for like basis[1]. The SEL is define as follows:

$$SEL = 10log_{10}\left(\int_{0}^{T}\left(\frac{p^2(t)}{p_{ref}^2 t_{ref}}\right)\right)$$

The frequency, or pitch, or the sound is the rate at which these oscillations occur and is measure in cycles per second, or Hertz (Hz). When sound is measured in a way which approximates to how a human would perceive it using an A-weighting filter on a sound level meter, the resulting level is described in values of dBA. However, the hearing faculty of marine mammals is not the same as humans, with marine mammals hearing over a wider range of frequencies and with a different sensitivity. It is therefore important to understand how an animal's hearing varies over the entire frequency range in order to assess the effects of sound on marine mammals. Consequently, use can be made of frequency weighting scales to determine the level of the sound in comparison between the typical hearing response curves for fish, humans and marine mammals is shown in Figure 6.2. (It is worth noting that hearing thresholds are sometimes shown as audiograms with sound level on the y axis rather than sensitivity, resulting in the graph shape being the inverse of the graph shown.)

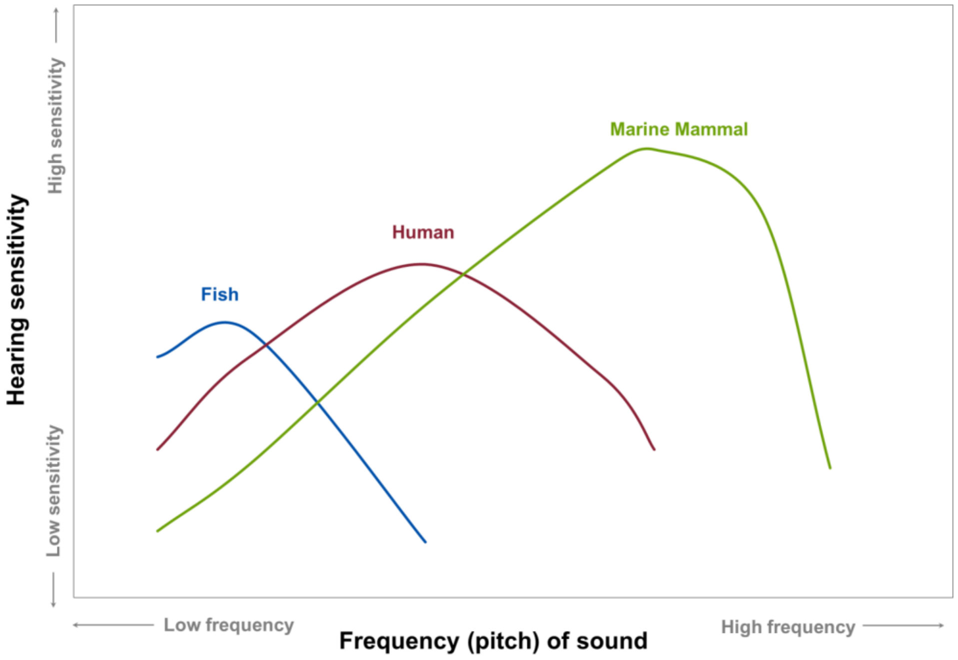

Figure 6.2 Comparison between hearing thresholds of different animals

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[1] Historically, use was primarily made of rms and peak sound pressure level metrics for assessing the potential effects of sound on marine life. However, the SEL is increasingly being used as it allows exposure duration and the effect of exposure to multiple events to be taken into account.

6.3 Noise Sources

The potential underwater noise sources associated with the decommissioning project activities considered in the noise modelling assessment are summarised below:

- dynamically positioned (DP) semi-submersible crane vessel / heavy lifting vessel (HLV);
- MODU for topside preparation (MODU will remain at installations for well plug and abandonment and cutting of well conductors);
- dive support vessels (DSVs);
- remotely operated vehicle (ROV) support vessels;
- cargo barge (towed by tugs);
- supply and safety vessels;
- dredging;
- underwater mechanical cutting (subsea shears);
- underwater cutting (abrasive water jet and / or diamond wire); and
- pile severance explosions.

6.4 Assumptions

As well as these individual noise sources, it has been assumed that various operating scenarios will exist, combining several of these individual noise sources. Subsequently, the following operating scenarios are also considered:

- **Phase 1: Topsides Preparation, Removal and Disposal** – DP vessels (HLV / JUB), MODU (Assumption the MODU will be used for both topside preparation and plug and abandonment of installation wells and cutting of well conductors), cargo barge (towed by tugs) and supply vessel.
- **Phase 2: Jacket and Piles Removal and Disposal** – DP vessels (HLV), DSV / ROV support vessel, cargo barge (towed by tugs), supply vessel, trawler vessel, abrasive jet cutting and pile severance explosions.
- **Phase 3: Pipeline Decommissioning** – DSV / ROV support vessel, cargo barge (towed by tugs), trawler vessel and jet trencher / plough trencher.
- **Phase 4: Post Decommissioning Verification Surveys** – Trawler vessel.

Because impulsive noise (pile severance explosions) and continuous noise (e.g. vessels and underwater cutting noise) are assessed using different criteria, it is not practical to combine them for the purposes of modelling scenarios involving both types of noise. Consequently, for scenarios where both types of noise are generated concurrently, a worst-case assessment should be approached, where exclusion zones are based on the activity which is potentially most injurious.

Noise source data has been taken from a combination of publicly available noise data for other similar developments, empirical calculations and theoretical predictions. It should be noted that even where specific noise measurement data is available, these data are often not in a suitable form for assessing the impacts of noise on wildlife. Consequently, it is often necessary to apply empirical corrections to convert from, for example, rms sound pressure levels to SEL or peak pressure levels.

Furthermore, due to the different types of noise sources (impulsive noise and continuous noise), separate noise modelling methodologies have been used (see Appendix D).

6.5 Summary of Noise Levels Used in Modelling

The source noise levels, sources of data and subsequent assumptions are given in Table 6.1.

Table 6.1 Noise source data used in noise modelling

Source / Activity	**Description / Assumptions**	**Data source**	**Source sound pressure level at 1m**		
			rms, dB re 1 µPa	***Peak, dB re 1 µPa***	***SEL (24h), dB re 1 $\mu Pa^2 s$***
MODU / JUB	Drilling rig used as proxy	Hannay *et al.* (2004) - 1/3 octaves measured for drilling rig (Wyatt 2008)	163	166	212
HLV (dynamically positioned)	Drilling rig with thrusters used as proxy	McCauley (1998)	183	186	232
Cargo Barge (towed by tugs)	Tug used as proxy	Richardson (1995)	172	175	221
Supply boat	Tug used as proxy	Richardson (1995)	172	175	221
Underwater abrasive jet cutting*	Generic data for jet cutting	Andre *et al.* (2009)	195	*	240
DSV / ROV Support Vessel	Tug used as proxy	MacGillivray and Racca (2006)	178	181	227
Jet Trencher / Plough Trencher	Based on measurements made at North Hoyle during trenching.	Nedwell *et al.* (2003)	178	181	227
Trawler Vessel	Tug used as proxy	Richardson (1995)	172	175	221

** At time of writing, the author is unaware of any empirical measurements of, or reported behavioural reactions to, the underwater noise produced by abrasive jet cutting. The source noise levels used for abrasive jet cutting in the assessment, and as shown in the table above, are based on assumptions. These assumptions are highlighted in Andre et al. (2009, p.12, footnote 23.), where an approximation of the range of RMS sound pressure levels at 1 m have been assumed. Andre et al. (2009) goes on to suggest peak sound pressure levels that are exceptionally high, and in fact, close to the peak sound pressure levels or large airgun arrays. This is considered highly unlikely and, as no alternative data is available, has been omitted from the table above and the subsequent assessment. In any case, this does not affect the assessment since there are no peak pressure criteria for non-pulsed sound.*

In the table, a correction of +3 dB has been applied to the rms sound pressure level to estimate the likely peak sound pressure level. Unweighted SELs have been estimated for each source based on 24 hours continuous operation, although it is important to note that it is highly unlikely that any marine mammal or fish would stay at a stationary location or within a fixed radius of a vessel (or any other noise source) for 24 hours. Hearing weighting has been applied to the frequency spectra at the receiver location in order to assess the weighted SEL.

Source noise levels for vessels depend on the vessel size and speed as well as propeller design and other factors. There can be considerable variation in noise magnitude and character between vessels even within the same class. Therefore, source data for this Project has been based largely on worst-case assumptions (i.e. using noise data toward the higher end of the scale for the relevant class of ship as a proxy).

There is no publicly available data for subsea shears / underwater mechanical cutting. Therefore it is very difficult to assess this type of activity. It is unlikely that mechanical cutting would generate noise levels as high as those predicted for underwater abrasive jet cutting; furthermore they are expected to produce different types of noise. On this basis we cannot assess activities associated with subsea shears and mechanical cutting.

It is important to highlight the paucity of data available for underwater abrasive jet cutting. As referenced in Table 5.1, the source noise levels used for abrasive jet cutting in the assessment are based on assumptions that are likely to be a significant over-estimate of the actual noise levels generated in practice.

There is only one known paper available in the public domain (Pangerc *et. al.,* 2016) that is based on field measurements of an underwater cutting technique. However, the cutting technique measured was diamond wire cutting. The measurements were carried out at distances of 100 m, 250 m and 800 m from the source. The conclusions of the study indicated that increases of between 4 dB and 15 dB were detectable for one-third octave band spectral levels at some frequencies, and for frequencies above 5 kHz there was generally an observable increase in the spectral levels. The paper also concludes that the sound radiated from the cutting activity was often not easily discernible above the background noise.

Abrasive jet cutting and diamond wire cutting are two very different cutting techniques: jet cutting involves a stream of ultra-high pressure water through a cutting head nozzle; diamond wire cutting involves a diamond wire moving at high speeds through a hydraulic or electrically powered pulley system. Therefore, using the Pangerc *et. al.,* (2016) conclusions, without any comparable data and observations for abrasive jet cutting, it is not possible to further inform the source levels used in the assessment and subsequent injury and disturbance ranges. Despite this, the Pangerc *et. al.,* (2016) conclusions further indicate that the source levels used for abrasive jet cutting are likely to be a significant over-estimate of the noise levels generated in practice.

6.6 Acoustic Assessment Criteria

6.6.1 General

Underwater noise has the potential to affect marine life in different ways depending on its noise level and characteristics. Richardson *et al*. (1995) defined four zones of noise influence which vary with distance from the source and level. These are:

- **The zone of audibility**: this is the area within which the animal is able to detect the sound. Audibility itself does not implicitly mean that the sound will have an effect on the marine mammal.
- **The zone of masking**: This is defined as the area within which noise can interfere with detection of other sounds such as communication or echolocation clicks. This zone is very hard to estimate due to a paucity of data relating to how marine mammals detect sound in relation to masking levels (for example, humans are able to hear tones well below the numeric value of the overall noise level).
- **The zone of responsiveness**: this is defined as the area within which the animal responds either behaviourally or physiologically. The zone of responsiveness is usually smaller that the zone of audibility because, as stated previously, audibility does not necessarily evoke a reaction.
- **The zone of injury / hearing loss**: this is the area where the sound level is high enough to cause tissue damage in the ear. This can classified as either temporary threshold shift (TTS) or permanent threshold shift (PTS). At even closer ranges, and for very high intensity sound sources (e.g. underwater explosions), physical trauma or even death are possible.

For the noise assessment study, it is the zones of injury and disturbance (i.e. responsiveness) that are of concern (there is insufficient scientific evidence to properly evaluate masking). In order to determine the potential spatial range of injury and disturbance, a review has been undertaken of available evidence, including international guidance and scientific literature. The following sections summarise the relevant thresholds for onset of effects and describe the evidence based used to derive them.

6.6.2 Injury (Physiological Damage) to Marine Mammals

Sound propagation models can be constructed to allow the received noise level at different distances from the source to be calculated. To determine the consequence of these received levels on any marine mammals which might experience such noise emissions, it is necessary to relate the levels to known or estimated impact thresholds.

The JNCC guidance (JNCC, 2010a) recommends using the injury criteria proposed by Southall *et al*. (2007). However, the guidance suggests that criteria will need to be updated as and when more recent scientific studies become available. The Southall *et al.* (2007) guidelines have now been updated and superseded using more up-to-date scientific research as detailed in the NOAA Guidelines (2016) and these new guidelines are therefore the most applicable criteria to use for assessing the likelihood of injury to marine mammals.

The injury criteria proposed by NOAA (2016) are based on a combination of linear (i.e. un-weighted) peak pressure levels and mammal hearing weighted sound exposure levels (SEL). The hearing weighting function is designed to represent the bandwidth for each group within which acoustic exposures can have auditory effects. The categories include:

- **low-frequency (LF) cetaceans** (i.e. marine mammal species such as baleen whales which includes Minke whale) with an estimated functional hearing range between 7 Hz and 35 kHz);

- **mid-frequency (MF) cetaceans** (i.e. marine mammal species such as dolphins, toothed whales, beaked whales and bottlenose whales which includes Atlantic white-sided dolphin) with an estimated functional hearing range between 150 Hz and 160 kHz);
- **high-frequency (HF) cetaceans** (i.e. marine mammal species such as true porpoises which includes harbour porpoise) with an estimated functional hearing range between 275 Hz and 160 kHz); and
- **phocid pinnipeds (PW)** (i.e. true seals with an estimated functional hearing range between 50 Hz and 86 kHz).

These weightings have therefore been used in the noise assessment and are shown in Figure 6.3. The decommissioning project activities are located in close proximity to the boundary of the Southern North Sea pSAC which has been identified as an area of importance for the Annex II species, harbour porpoise and has been put forward to the EU for formal designation. An assessment of the potential impact from the decommissioning project noise on the Annex II species is presented in Section 6.7.6.

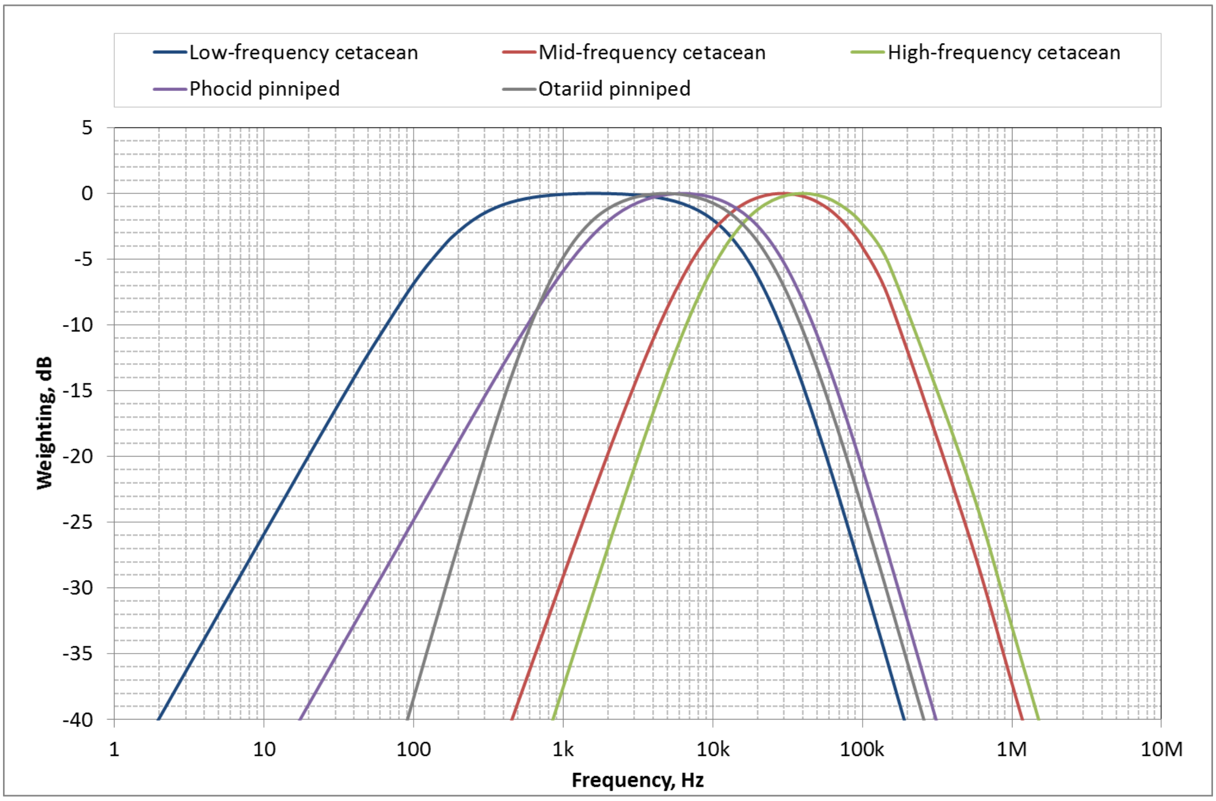

Figure 6.3 Hearing weighting functions for pinnipeds and cetaceans (NOAA, 2016)

Injury criteria are proposed in NOAA (2016) for two different types of sound as follows:

- **Impulsive sounds** which are typically transient, brief (less than 1 second), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay (ANSI 1986; NIOSH

1998; ANSI 2005). This category includes sound sources such as seismic surveys, impact piling and underwater explosions; and

- **Non-impulsive sounds** which can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent and typically do not have a high peak sound pressure with rapid rise/decay time that impulsive sounds do (ANSI 1995; NIOSH 1998). This category includes sound sources such as continuous running machinery, sonar and vessels.

The criteria for impulsive sound have been adopted for the noise assessment given the nature of the sound produced by explosives. The criteria proposed by NOAA (2016) for both impulsive sounds, including the use of explosives, are as summarised in Table 6.2.

Table 6.2 Summary of PTS onset acoustic thresholds (NOAA, 2016)

Hearing Group	Parameter	Impulsive	Non-impulsive
Low-frequency (LF) cetaceans	Peak, unweighted	219	-
	SEL, LF weighted	183	199
Mid-frequency (MF) cetaceans	Peak, unweighted	230	-
	SEL, MF weighted	185	198
High-frequency (HF) cetaceans	Peak, unweighted	202	-
	SEL, HF weighted	155	173
Phocid pinnipeds (PW)	Peak, unweighted	218	-
	SEL, PW weighted	185	201

6.6.3 Disturbance to Marine Mammals

Beyond the area in which injury may occur, the effect on marine mammal behaviour is the most important measure of impact. The JNCC guidance (JNCC, 2010a) proposes that a disturbance offence may occur when there is a risk of animals incurring sustained or chronic disruption of behaviour or when animals are displaced from an area, with subsequent redistribution being significantly different from that occurring due to natural variation.

To consider the possibility of a disturbance offence resulting from the project, it is necessary to consider both the likelihood that the sound could cause non-trivial disturbance and the likelihood that the sensitive receptors will be exposed to that sound. Southall *et al*. (2007) recommended that the only currently feasible way to assess whether a specific sound could result in disturbance is to compare the circumstances of the situation with empirical studies. The JNCC guidance (JNCC, 2010a) indicates that, with reference to Clearly, there is much intra-category and perhaps intra-species variability in behavioural response. As such, a conservative approach should be taken to ensure that the most sensitive cetaceans remain protected from moderate to strong behavioural responses. The evidence in Southall et al. (2007) suggests that stronger responses (e.g. avoidance behaviour) are only likely to occur at sound levels in excess of 140 dB re 1 µPa (rms). Therefore, this threshold has been adopted for the assessment as an indication of the range of onset of moderate to strong disturbance for continuous sound. Onset of mild disturbance is based on the 120 dB re 1 µPa (rms) NMFS threshold.

Table 6.4, a score of 5 or more on the Southall *et al*. (2007) behavioural responses severity scale could be significant. The more severe the response on the scale, the lower the amount of time that the animals will tolerate it before there could be significant negative impacts on life functions, which would constitute a disturbance under the relevant regulations.

Southall *et al*. (2007) present a summary of observed behavioural responses for various mammal groups exposed to different types of noise (single pulse, multiple pulse and non-pulse).

For the noise assessment, a precautionary approach has been adopted to assessing the potential for behavioural effects. For a single pulse, Southall *et al.* (2007) recommends behavioural criteria should be based on temporary threshold shift (TTS) onset levels because TTS can deter animals from the ensonified area. This is often referred to as a 'fleeing response'. This assessment has therefore been carried out using the most recent NOAA guidelines (2016) for the onset of TTS due to explosions, as follows:

Table 6.3 Summary of disturbance and TTS onset acoustic thresholds (NOAA 2016)

Hearing Group	Parameter	Impulsive	Non-impulsive
Low-frequency (LF) cetaceans	Peak, unweighted	213	-
	SEL, LF weighted	168	184
Mid-frequency (MF) cetaceans	Peak, unweighted	224	-
	SEL, MF weighted	170	183
High-frequency (HF) cetaceans	Peak, unweighted	196	-
	SEL, HF weighted	140	158
Phocid pinnipeds (PW)	Peak, unweighted	212	-
	SEL, PW weighted	170	186

For non-pulsed sound (e.g. vessels etc.) the lowest sound pressure level at which a score of 5 or more, on the Southall *et al*. (2007) behavioural responses severity scale, occurs for low frequency cetaceans is 90 to 100 dB re 1 µPa (rms[2]). However, this relates to a study involving migrating grey whales. The only study for minke whales showed a response score of 3 at a received level of 100 to 110 dB re 1 µPa (rms), with no higher severity score encountered for this species. For mid frequency cetaceans a response score of 8 was encountered at a received level of 90 to 100 dB re 1 µPa (rms), but this was for one mammal (a sperm whale). For these species a response score of 3 was encountered for received levels of 110 to 120 dB re 1 µPa (rms) with no higher severity score encountered. For high frequency cetaceans a number of individual responses with a response score of 6 are noted ranging

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[2] The root mean square (rms) is a statistical measure of the magnitude of a varying quantity, especially useful when variates are both positive and negative.

from 80 dB re 1 µPa (rms) and upwards. There is a significant increase in the number of mammals responding at a response score of 6 once the received sound pressure level is greater than 140 dB re 1 µPa (rms).

According to Southall *et al.* (2007) there is a general paucity of data relating to the effects of sound on pinnipeds in particular. One study using ringed, bearded and spotted seals (Harris, 2001) found onset of a significant response at a received sound pressure level of 160 – 170 dB re 1 µPa (rms), although larger numbers of animals showed no response at noise levels of up to 180 dB re 1 µPa (rms). It is only at much higher sound pressure levels in the range of 190 – 200 dB re 1 µPa (rms) that significant numbers of seals were found to exhibit a significant response. For non-pulsed sound, one study elicited a significant response on a single harbour seal at a received level of 100 – 110 dB re 1 µPa (rms), although other studies found no response or non-significant reactions occurred at much higher received levels of up to 140 dB re 1 µPa (rms). No data are available for higher noise levels and the low number of animals observed in the various studies means that it is difficult to make any firm conclusions from these studies.

Southall *et al*. (2007) also notes that, due to the uncertainty over whether high-frequency cetaceans may perceive certain sounds and due to paucity of data, it was not possible to present any data on responses of high frequency-cetaceans. However, Lucke *et al.* (2008) showed a single harbour porpoise consistently showed aversive behavioural reactions to pulsed sound at received sound pressure levels above 174 dB re 1 µPa (peak-peak) or a SEL of 145 dB re 1 µPa2s, equivalent to an estimated[3] rms sound pressure level of 166 dB re 1 µPa.

The United States (US) National Marine Fisheries Service guidance (NMFS, 2005) sets the level B harassment threshold[4] for marine mammals at 120 dB re 1 µPa (rms) for continuous noise. This value sits approximately mid-way between the range of values identified in Southall *et al*. (2007) but is lower than the value at which the majority of mammals responded at a response score of 6 (i.e. once the received rms sound pressure level is greater than 140 dB re 1 µPa). Taking into account the paucity and high level variation of data relating to onset of behavioural effects due to continuous sound, using this number to predict disturbance ranges could be viewed as probabilistic and possibly over-precautionary, as only a minor or limited response may be experienced by the most sensitive cetaceans.

Clearly, there is much intra-category and perhaps intra-species variability in behavioural response. As such, a conservative approach should be taken to ensure that the most sensitive cetaceans remain protected from moderate to strong behavioural responses. The evidence in Southall et al. (2007) suggests that stronger responses (e.g. avoidance behaviour) are only likely to occur at sound levels in excess of 140 dB re 1 µPa (rms). Therefore, this threshold has been adopted for the assessment as an

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[3] Based on an analysis of the time history graph in Lucke *et al*. (2007) the T90 period is estimated to be approximately 8 ms, resulting in a correction of 21 dB applied to the SEL to derive the rms_{T90} sound pressure level. However, the T90 was not directly reported in the paper.

[4] Level B Harassment is defined as having the potential to disturb a marine mammal or marine mammal stock in the world by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild.

indication of the range of onset of moderate to strong disturbance for continuous sound. Onset of mild disturbance is based on the 120 dB re 1 µPa (rms) NMFS threshold.

Table 6.4 Southall *et al*. (2007) behavioural disturbance scale

Response Score	Corresponding Behaviours in free-ranging subjects
0	• No observable response.
1	• Brief orientation response (investigation / visual orientation).
2	• Moderate or multiple orientation behaviours; • Brief of minor cessation/modification of vocal behaviour; and • Brief or minor change in respiration rates.
3	• Prolonged orientation behaviour; • Individual alert behaviour; • Minor changes in locomotion speed, direction, and/or dive profile but no avoidance of sound source; • Moderate change in respiration rate; and • Minor cessation or modification of vocal behaviour (duration more or less equal to the duration of source operation.
4	• Moderate changes in locomotion speed, direction, and/or dive profile but no avoidance of sound source; • Brief, minor shift in group distribution; and • Moderate cessation or modification of vocal behaviour (duration more or less equal to the duration of source operation).
5	• Extensive or prolonged changes in locomotion speed, direction, and/or dive profile but no avoidance of sound source; • Moderate shift in group distribution; • Change in inter-animal distance and/or group size (aggregation or separation); and • Prolonged cessation or modification of vocal behaviour (duration > duration of source operation).
6	• Minor or moderate individual and/or group avoidance of sound source; • Brief or minor separation of females and dependent offspring; • Aggressive behaviour related to noise exposure (e.g. Tail/flipper slapping, fluke display, jaw clapping/gnashing teeth, abrupt direct movement, bubble clouds); • Extended cessation or modification of vocal behaviour; • Visible startle response; and • Brief cessation of reproductive behaviour.
7	• Extensive or prolonged aggressive behaviour;

Response Score	Corresponding Behaviours in free-ranging subjects
	• Moderate separation of females and dependent offspring; • Clear anti-predator response; • Sever and/or sustained avoidance or sound source; and • Moderate cessation or reproductive behaviour.
8	• Obvious aversion and/or progressive sensitisation; • Prolonged or significant separation of females and dependent offspring with disruption of acoustic reunion mechanisms; • Long-term avoidance of area (>source operation); and • Prolonged cessation or reproductive behaviour.
9	• Outright panic, flight, stampede, attack of conspecifics, or stranding events; and • Avoidance behaviour related to predator detection.

6.6.4 Injury to Fish

Adult fish not in the immediate vicinity of the noise generating activity are generally able to vacate the area and avoid physical injury. However, larvae and spawn are not highly mobile and are therefore more likely to incur injuries from the sound energy in the immediate vicinity of the sound source, including damage to their hearing, kidneys hearts and swim bladders. Such effects are unlikely to happen outside of the immediate vicinity of even the highest energy sound sources.

For fish, the most relevant criteria for injury are considered to be those contained in the Sound Exposure for Fishes and Sea Turtles (Popper *et al.*, 2014). The guidelines set out criteria for injury due to different sources of noise. Those relevant to this project are considered to be those for injury due to impulsive noise (explosions) and continuous noise (shipping, cutting, thrusters and other continuous sources of noise).

For both types of noise source (i.e. impulsive and continuous), where insufficient data exists to determine a quantitative guideline value, the risk is categorised in relative terms as “high”, “moderate” or “low” at three distances from the source: “near” (i.e. in the tens of metres), “intermediate” (i.e. in the hundreds of metres) or “far” (i.e. in the thousands of metres).

It should be noted that the qualitative criteria mentioned above cannot differentiate between exposures to different noise levels and therefore all sources of noise, no matter how noisy, would theoretically elicit the same assessment result. However, because the qualitative risks are generally qualified as “low”, with the exception of a moderate risk at “near” range (i.e. within tens of metres) for some types of animal and impairment effects, this is not considered to be a significant issue with respect to determining potential effect of noise on fish.

The criteria for onset of injury in fish due to impulsive sound, caused by underwater explosions, used in this assessment are provided in Table 6.5.

Table 6.5 Criteria for onset of injury to fish due to explosives (Popper *et al.*, 2014)

Type of animal	**Mortality and potential mortal injury**	**Impairment**	
		Recoverable injury	**TTS**
Fish: no swim bladder (particle motion detection)	229 – 234 dB re 1 µPa (peak)	*(Near)* High *(Intermediate)* Low *(Far)* Low	*(Near)* High *(Intermediate)* Moderate *(Far)* Low
Fish: where swim bladder is not involved in hearing (particle motion detection)	229 – 234 dB re 1 µPa (peak)	*(Near)* High *(Intermediate)* High *(Far)* Low	*(Near)* High *(Intermediate)* Moderate *(Far)* Low
Fish: where swim bladder is involved in hearing (primary pressure detection)	229 – 234 dB re 1 µPa (peak)	(Near) High (Intermediate) High (Far) Low	(Near) High (Intermediate) High (Far) Low
Eggs and larvae	>13 mm s-1 (peak velocity)	(Near) High (Intermediate) Low (Far) Low	(Near) High (Intermediate) Low (Far) Low

Notes:

- *Range of effect classified as Near = tens of meters / Intermediate= hundreds of meters / Far = thousands of meters*
- *Relative risk classified as high, moderate or low*

The criteria for onset of injury in fish due to continuous sound used in this assessment are provided in Table 6.6.

Table 6.6 Criteria for onset of injury to fish due to continuous sound (Popper *et al.*, 2014)

Type of animal	Mortality and potential mortal injury	Impairment	
		Recoverable injury	TTS
Fish: no swim bladder (particle motion detection)	(Near) Low (Intermediate) Low (Far) Low	(Near) Low (Intermediate) Low (Far) Low	(Near) Moderate (Intermediate) Low (Far) Low
Fish: where swim bladder is not involved in hearing (particle motion detection)	(Near) Low (Intermediate) Low (Far) Low	(Near) Low (Intermediate) Low (Far) Low	(Near) Moderate (Intermediate) Low (Far) Low
Fish: where swim bladder is involved in hearing (primary pressure detection)	(Near) Low (Intermediate) Low (Far) Low	170 dB re 1 µPa (rms) for 48 hours	158 dB re 1 µPa (rms) for 12 hours
Eggs and larvae	(Near) Low (Intermediate) Low (Far) Low	(Near) Low (Intermediate) Low (Far) Low	(Near) Low (Intermediate) Low (Far) Low

Notes:

- *Range of effect classified as Near = tens of meters / Intermediate= hundreds of meters / Far = thousands of meters*
- *Relative risk classified as high, moderate or low*

6.6.5 Disturbance to Fish

Behavioural reaction of fish to sound has been found to vary between species based on their hearing sensitivity. Typically, fish sense sound via particle motion in the inner ear which is detected from sound-induced motions in the fish's body. The detection of sound pressure is restricted to those fish which have air filled swim bladders; however, particle motion (induced by sound) can be detected by fish without swim bladders[5].

Highly sensitive species such as herring have elaborate specialisations of their auditory apparatus, known as an otic bulla – a gas-filled sphere, connected to the swim bladder, which enhances hearing ability. The gas filled swim bladder in species such as cod and salmon may be involved in their hearing capabilities, so, although there is no direct link to the inner ear, these species are able to detect lower sound frequencies and as such are considered to be of medium sensitivity to noise. Flat fish and elasmobranchs have no swim bladders and as such are considered to be relatively less sensitive to sound pressure.

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[5] It should be noted that the presence of a swim bladder does not necessarily mean that the fish can detect pressure. Some fish have swim bladders that are not involved in the hearing mechanism and can only detect particle motion.

For assessing the likelihood of behavioural effects in fish, use can be made of the dBht (species) scale (Nedwell *et al.,* 2007a). This is simply a decibel scale reflecting the level above the hearing threshold (i.e. quietest perceptible sound) of that species. In order to determine the dBht (species) level it is necessary to possess audiometric data for that species. However, the range of species for which suitable data are available to allow use of the dBht metric is highly restricted, limiting the current value of such a metric. Furthermore, there is a paucity of peer reviewed dose-responses studies to determine relevant criteria. Consequently, the use of dBht is not considered to be a useful metric for assessing the effects of noise on fish (or indeed marine mammals) until suitable peer reviewed data and dose-response studies are published.

The most recent criteria for disturbance are considered to be those contained in Popper *et al*. (2014) which set out criteria for disturbance due to different sources of noise. The risk of behavioural effects is categorised in relative terms as “high”, “moderate” or “low” at three distances from the source: “near” (i.e. in the tens of metres), “intermediate” (i.e. in the hundreds of metres) or “far” (i.e. in the thousands of metres), as shown in Table 6.7.

Table 6.7 Criteria for onset of behavioural effects in fish (Popper *et al.*, 2014)

Type of animal	**Relative risk of behavioural effects (continuous sound)**	**Relative risk of behavioural effects (impulsive sound - explosions)**
Fish: no swim bladder (particle motion detection)	(Near) Moderate (Intermediate) Moderate (Far) Low	(Near) High (Intermediate) Moderate (Far) Low
Fish: where swim bladder is not involved in hearing (particle motion detection)	(Near) Moderate (Intermediate) Moderate (Far) Low	(Near) High (Intermediate) High (Far) Low
Fish: where swim bladder is involved in hearing (primary pressure detection)	(Near) High (Intermediate) Moderate (Far) Low	(Near) High (Intermediate) High (Far) Low
Eggs and larvae	(Near) Moderate (Intermediate) Moderate (Far) Low	(Near) High (Intermediate) Low (Far) Low
Notes: - *Range of effects classified as Near= tens of meters / Intermediate= hundreds of meters / Far = thousands of meters* - *Relative risk classified as high, moderate or low*		

It is important to note that the Popper *et al*. (2014) criteria for disturbance due to sound are qualitative rather than quantitative. Consequently, a source of noise of a particular type (e.g. continuous sound from vessels) would result in the same predicted impact, no matter the level of noise produced or the propagation characteristics. Therefore, the criteria presented in the Washington State Department of Transport Biological Assessment Preparation for Transport Projects Advanced Training Manual (WSDOT, 2011) have been used in this study to provide an indication of how the range of effect is likely to vary for each noise source. The WSDOT manual suggest an un-weighted sound pressure level of 150 dB re 1 µPa (rms) as the criterion for onset of behavioural effects, based on work by Hastings (2002). Sound pressure levels in excess of 150 dB re 1 µPa (rms) are expected to cause temporary behavioural changes, such as elicitation of a startle response, disruption of feeding, or avoidance of an area. The document notes that levels exceeding this threshold are not expected to cause direct permanent injury, but may indirectly affect the individual fish (such as by impairing predator detection). It is important to note that this threshold is for onset of potential effects, and not necessarily an 'adverse effect threshold'. As stated previously, the predicted range of effects (i.e. exceedance of the 150 dB re 1 µPa (rms) criterion) should be used in conjunction with the Popper *et al*. (2014) qualitative criteria in order to understand how the range of effect might vary with distance (as opposed to using the WSDOT criterion as a line beyond which an effect definitely will or will not occur).

6.7 Potential Impacts

6.7.1 Phase 1 – Topsides Preparation, Removal and Disposal

6.7.1.1 Injury to Marine Mammals

Table 6.8 shows the estimated injury ranges for marine mammals due to Phase 1 continuous noise.

Table 6.8 Estimated injury ranges for marine mammals exposed to Phase 1 continuous noise

Activity / Source	**SEL Injury Zone Radius (assuming 1.5 ms^{-1} swim speed) (N/E = not exceeded)**			
	LF Cetacean	**MF Cetacean**	**HF Cetacean**	**Phocid pinnipeds**
HLV	N/E	N/E	N/E	N/E
MODU / JUB	N/E	N/E	N/E	N/E
Cargo Barge (towed by tugs)	N/E	N/E	N/E	N/E
Supply Boat	N/E	N/E	N/E	N/E
All Sources	N/E	N/E	N/E	N/E

Table 6.9 shows the estimated injury times for marine mammals exposed to phase 1 continuous noise if stationary at 50 m from the source.

Table 6.9 Estimated injury times for stationary marine mammals exposed to Phase 1 continuous noise at 50 m from source

Activity / Source	Time take to reach SEL injury threshold at 50m from source for stationary mammals (N/E = not exceeded)			
	LF Cetacean	MF Cetacean	HF Cetacean	Phocid pinnipeds
HLV	N/E	N/E	N/E	N/E
MODU / JUB	N/E	N/E	N/E	N/E
Cargo Barge (towed by tugs)	N/E	N/E	N/E	N/E
Supply Boat	N/E	N/E	N/E	N/E
All Sources	22 hrs	N/E	14 hrs	N/E

Based on an animal swimming at a constant speed of 1.5 ms-1 from the source of noise, the noise modelling shows that injury to marine mammals is unlikely to occur due to the vessels involved in Phase 1. It should be noted that this is a worst case result, given that movement speeds for marine mammals have been recorded well in excess of the 1.5 ms-1 modelled here. Low frequency cetaceans and high frequency cetaceans would have to be stationary at 50 m from the sources for a period of 22 hours and 14 hours respectively before the permanent injury threshold would be reached.

6.7.1.2 Disturbance to Marine Mammals

The estimated ranges for onset of disturbance effects are shown in Table 6.10.

Table 6.10 Estimated disturbance ranges for marine mammals, for Phase 1 activity

Source / Activity	Estimated range for onset of disturbance
HLV	Mild disturbance: 5.4 km Strong disturbance: 310 m
MODU / JUB	Mild disturbance: 313 m Strong disturbance: 15 m
Cargo Barge (towed by tugs)	Mild disturbance: 1.2 km Strong disturbance: 55 m
Supply Boat	Mild disturbance: 1.2 km Strong disturbance: 55 m
All Sources	Mild disturbance: 5.8 km Strong disturbance: 310 m

It is important to place the results in Table 6.10 in the context of the baseline noise environment, i.e. that the 120 dB re 1 µPa rms sound pressure level criterion for mild disturbance from continuous noise is within the range of typical baseline noise levels in the area.

It is important to understand that exceeding the criteria for potential onset of disturbance does not in itself mean that disturbance will occur. Southall *et al*. (2007) notes that "…the available data on behavioural responses do not converge on specific exposure conditions resulting in particular reactions, nor do they point to a common behavioural mechanism. Even data obtained with substantial controls, precision, and standardized metrics indicate high variance both in behavioural responses and in exposure conditions required to elicit a given response. It is clear that behavioural responses are strongly affected by the context of exposure and by the animal's experience, motivation, and conditioning. This reality, which is generally consistent with patterns of behaviour in other mammals (including humans), hampered our efforts to formulate broadly applicable behavioural response criteria for marine mammals based on exposure level alone."

6.7.1.3 Injury to Fish

The potential for injury and disturbance to fish is shown in the following tables.

Table 6.11 shows the qualitative risk of injury and disturbance to different fish types depending on range, in accordance with ASA guidance.

Table 6.11 Effects of continuous noise on fish, based on ASA qualitative criteria, for Phase 1 activity

Qualitative risk due to exposure to continuous noise (vessels etc.)			
Range:	**Near (10s of metres)**	**Intermediate (100s of metres)**	**Far (1,000s of metres)**
ASA qualitative risk of recoverable injury:			
Fish: no swim bladder	Low	Low	Low
Fish: swim bladder not involved in hearing	Low	Low	Low
Fish: swim bladder involved in hearing	N/A - See Table 6.12		
Eggs and larvae	Low	Low	Low
ASA qualitative risk of potential disturbance:			
Fish: no swim bladder	Moderate	Moderate	Low
Fish: swim bladder not involved in hearing	Moderate	Moderate	Low
Fish: swim bladder involved in hearing	High	Moderate	Low
Eggs and larvae	Moderate	Moderate	Low

6.7.1.4 Disturbance to Fish

Table 6.12 shows the calculated ranges of injury to fish with swim bladders in like with ASA guidelines, based on exceedance of 170 dB re 1 µPa (rms) over 48 hours continuous exposure, and the potential disturbance radius to fish based on the WSDOT criterion of 150 dB re 1 µPa (rms).

Table 6.12 Effects of continuous noise on fish, based on WSDOT criterion, for Phase 1 activity

Activity / Source	ASA Radius of potential recoverable injury zone (assuming continuous exposure within that radius over 48 hour period)	Radius of potential disturbance zone (based on WSDOT criteria)
	Fish: swim bladder involved in hearing	**All fish**
HLV	4 m	72 m
MODU / JUB	N/E	N/E
Cargo Barge (towed by tugs)	N/E	12 m
Supply Boat	N/E	12 m
All Sources	4 m	79 m
Notes: N/E = Not Exceeded		

For continuous sounds such as vessels, only fish with swim bladders are likely to have a high risk of behavioural effects and then only within tens of metres to the source, according to the ASA guidelines. The relative risks for other fish should be downgraded accordingly.

6.7.2 Phase 2 – Jacket Removal and Disposal: Explosive Pile Severance

6.7.2.1 Injury to Marine Mammals

During phase 2, the worst case scenario is likely to be due to pile severance explosions. As seen in the previous phases, the vessels involved are not causing any potential onset of injury. Therefore, the assessment for pile severance noise impact on marine mammals during phase 2 only takes into consideration the pile severance explosions.

The relationship between peak pressure and distance is shown in Figure 6.4 for the 87.5kg charge detonated inside the piles at the sea floor, along with the proposed peak pressure injury criteria for potential onset of permanent threshold shift in hearing. Calculations based on Goertner 1982 indicate that there is no likelihood of mortal injury at any range.

Please note it is assumed that all four charges will be detonated on each pile simultaneously. Therefore, there will only be one occurrence of noise due to explosions in a 24 hour period.

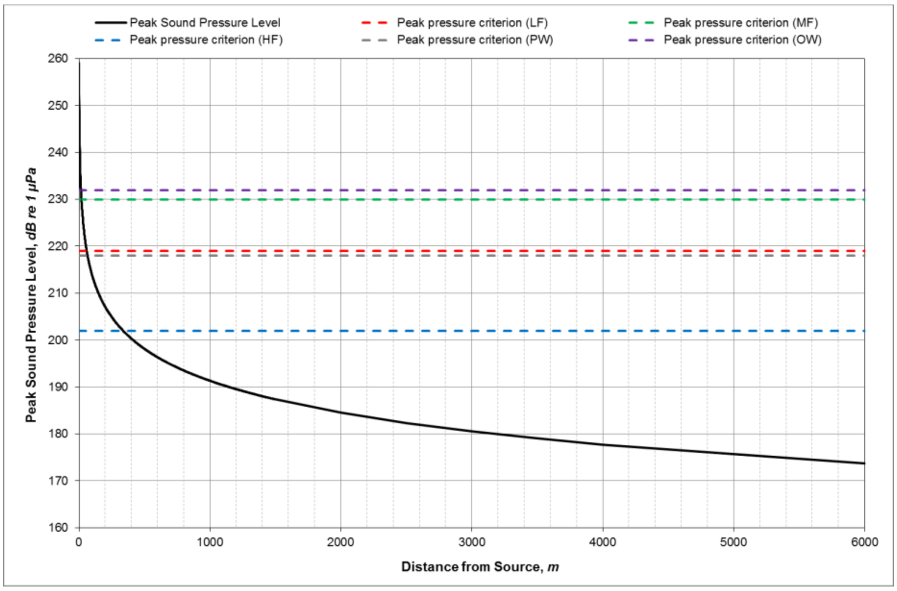


Figure 6.4 Predicted ranges for onset of injury criteria due to a single explosion using an 87.5 kg charge based on peak SPL thresholds. Dashed lines represent the PTS onset criteria for each marine mammal hearing group based on the NOAA (2016) thresholds presented in Table 6.2

The relationship between SEL and distance is shown in Figure 6.5 along with the proposed SEL injury criteria.

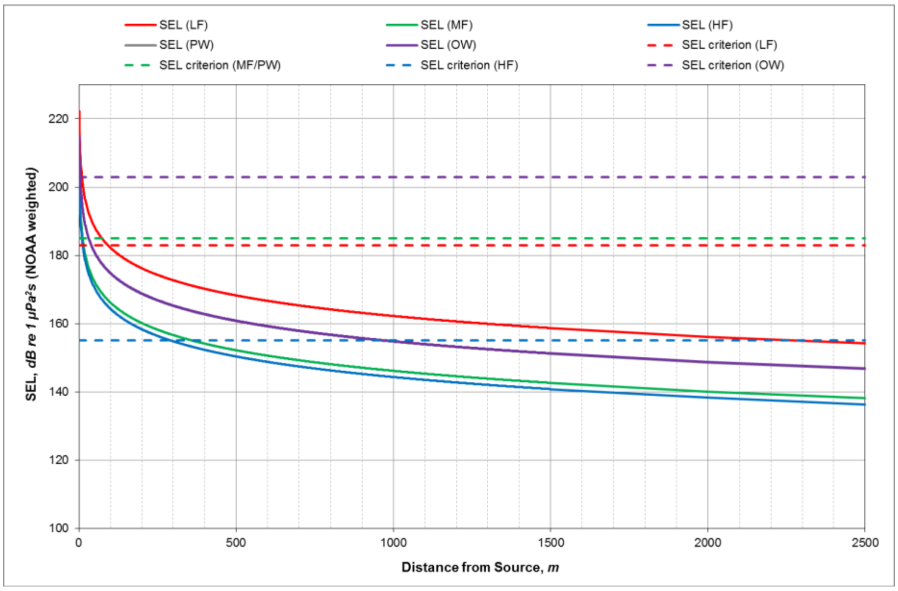


Figure 6.5 Predicted ranges for onset of injury criteria due to a single explosion using an 87.5 kg charge based on SEL thresholds. Dashed lines represent the PTS onset criteria for each marine mammal hearing group based on the NOAA (2016) thresholds presented in Table 6.2

The NOAA-weighted SEL and un-weighted peak pressure injury criteria ranges for the various mammal groups are summarised in Table 6.13. The largest of the two injury ranges (SEL or peak) should be used to predict the ranges for each marine mammal group beyond which no injury would occur. It should be noted that the SEL injury ranges presented in this report assume that each charge on each pile will be detonated simultaneously whereas in reality each charge on each pile will be detonated one after the other.

Table 6.13 Summary of PTS injury ranges due to a single 87.5 kg charge on a single pile

Mammal Group (species potentially present in the vicinity of the project)	Maximum Injury Range, *m*		Density (animals per square kilometre) per SCANS III survey area	Potential area of injury (km^2)	Estimated number of mammals potentially impacted
	Based on peak pressure , Ppk	Based on SEL			
Low frequency cetaceans (Minke Whale)s	477	685	0.010	1.4741	0.02
Mid frequency cetaceans (Atlantic white-sided dolphin)	156	79	No data	N/A	No data
High frequency cetaceans (Harbour Porpoise)	2,697	1,152	0.888	22.85	20.29
Phocid pinnipeds	528	240	N/A	N/A	N/A

Based on the results in Table 6.13, it is estimated that the maximum possible range at which permanent threshold shift injury could occur is 2.7 km for high frequency cetaceans. For other marine mammal hearing groups, the predicted injury ranges are less.

An estimate of the number of mammals potentially impacted has been calculated based on the largest of the two injury ranges (SEL or peak) and the density of animals likely to be found in the project vicinity (per square kilometre) per the SCANS III survey area (Block O) (see Table 3.10). A potential circular area of injury was calculated assuming the noise travels for equal distance in all directions from the noise source. An estimated 0.02 individual low frequency cetaceans (Minke Whale) and an estimated 20.29 individual high frequency cetaceans (harbour porpoise) could be potentially injured due to the noise associated with explosives.

6.7.2.2 Disturbance to Marine Mammals

The potential maximum disturbance ranges for marine mammals due to a single explosion using an 87.5 kg charge detonated inside a pile at the sea floor are summarised in Table 6.14.

Table 6.14 Summary of disturbance and TTS ranges due to a single 87.5 kg charge

Mammal Group	**Maximum Disturbance Range, m**	
	Based on peak pressure, Ppk	**Based on SEL**
Low frequency cetaceans	879	3,459
Mid frequency cetaceans	287	398
High frequency cetaceans	4,971	2,944
Phocid pinnipeds	974	1,217

As shown in Table 6.14, the maximum disturbance range for cetaceans (based on high–frequency cetaceans) is 4.9 km (an area of approximately 75 km^2) and the maximum disturbance range for pinnipeds is 1,217 m.

Behavioural changes (e.g. disturbance, such as temporary displacement) which may occur as a result of the noise emissions do not necessarily imply that detrimental effects will result for the animals involved (JNCC, 2010a). In addition, the explosive pulse will be a one-off event lasting approximately one second, rather than a continuous sound, minimising the period over which sound is emitted to the environment.

6.7.2.3 Injury and Disturbance to Fish

The potential for injury and disturbance to fish is shown in the following tables. Table 6.15 shows the qualitative risk of injury and disturbance to different fish types depending on range, in accordance with ASA guidance.

Table 6.15 Effects of explosive noise on fish, based on ASA qualitative criteria, for Phase 2 activity associated with explosive pile severance

Qualitative risk due to exposure to explosive noise			
Range:	**Near (10s of metres)**	**Intermediate (100s of metres)**	**Far (1,000s of metres)**
ASA qualitative risk of recoverable injury:			
Fish: no swim bladder	High	Low	Low
Fish: swim bladder not involved in hearing	High	High	Low
Fish: swim bladder involved in hearing	High	High	Low
Eggs and larvae	High	Low	Low
ASA qualitative risk of potential disturbance:			
Fish: no swim bladder	High	Moderate	Low
Fish: swim bladder not involved in hearing	High	High	Low
Fish: swim bladder involved in hearing	High	High	Low
Eggs and larvae	High	Low	Low

Table 6.16 shows the potential maximum ranges for mortality or mortal injury.

Table 6.16 Effects of impulsive noise (i.e. explosions) on fish, based on ASA qualitative criteria, for Phase 2 activity associated with explosive pile severance

Quantitative risk due to exposure to impulsive noise (explosions)	
Type of Animal	**Mortality and potential mortal injury range, m**
Fish: no swim bladder	172
Fish: swim bladder not involved in hearing	172
Fish: swim bladder involved in hearing	172
Eggs and larvae	500

As shown in Table 6.16, it is predicted that the maximum potential range that mortality or mortal injury could occur is 172 m for all fish. Fish eggs and larvae are more sensitive and the potential range of mortality or mortal injury is 500 m.

6.7.3 Phase 2 – Jacket Severance: Abrasive Jet Cutting

6.7.3.1 Injury to Marine Mammals

Phase 2 activities are also likely to include the severance of the jacket structure by underwater abrasive jet cutting. Table 6.17 shows the estimated injury ranges for marine mammals due to cutting and the associated vessels during Phase 2.

Table 6.17 Estimated injury ranges for marine mammals exposed to Phase 2 continuous noise associated with jacket structure severance

Activity / Source	**SEL Injury Zone Radius (assuming 1.5 ms-1 swim speed) (N/E = not exceeded)**			
	LF Cetacean	**MF Cetacean**	**HF Cetacean**	**Phocid pinnipeds**
HLV	N/E	N/E	N/E	N/E
DSV / ROV Support Vessel	N/E	N/E	N/E	N/E
Cargo Barge (towed by tugs)	N/E	N/E	N/E	N/E
Trawler Vessel	N/E	N/E	N/E	N/E
Jacket Severance (abrasive jet cutting)	N/E	N/E	N/E	N/E
All Sources	N/E	N/E	N/E	N/E

Table 6.18 shows the estimated injury times for marine mammals exposed to phase 2 noise associated with jacket structure severance if stationary at 50 m from the source.

Table 6.18 Estimated injury times for stationary marine mammals exposed to Phase 2 continuous noise associated with jacket structure severance at 50 m from source

Activity / Source	**Time take to reach SEL injury threshold at 50m from source for stationary mammals (N/E = not exceeded)**			
	LF Cetacean	**MF Cetacean**	**HF Cetacean**	**Phocid pinnipeds**
HLV	N/E	N/E	N/E	N/E
DSV / ROV Support Vessel	N/E	N/E	N/E	N/E
Cargo Barge (towed by tugs)	N/E	N/E	N/E	N/E
Trawler Vessel	N/E	N/E	N/E	N/E
Jacket Severance (abrasive jet cutting)	1 hr	N/E	10 min	3 hrs
All Sources	1 hr	N/E	10 min	3 hrs

Based on an animal swimming at a constant speed of 1.5 ms^{-1} from the source of noise, the noise modelling shows that injury to marine mammals is unlikely to occur due to the vessels involved in Phase 2. It should be noted that this is a worst case result, given that movement speeds for marine mammals have been recorded well in excess of the 1.5 ms^{-1} modelled here.

Injury due to underwater cutting activity (abrasive jet) is also shown to be unlikely, where low frequency and high frequency cetaceans would have to be stationary at 50 m from the source for 1 hour and 10 minutes respectively before the permanent injury threshold would be reached.

6.7.3.2 Disturbance to Marine Mammals

The estimated ranges for onset of disturbance effects are shown in Table 6.19.

Table 6.19 Estimated disturbance ranges for marine mammals, for Phase 2 noise associated with jacket structure severance

Source / Activity	Estimated range for onset of disturbance
HLV	Mild disturbance: 5.4 km Strong disturbance: 310 m
DSV / ROV Support Vessel	Mild disturbance: 2.9 km Strong disturbance: 145 m
Cargo Barge (towed by tugs)	Mild disturbance: 1.2 km Strong disturbance: 55 m
Trawler Vessel	Mild disturbance: 1.2 km Strong disturbance: 55 m
Jacket Severance (abrasive jet cutting)	Mild disturbance: 15.6 km Strong disturbance: 3.6 km
All Sources	Mild disturbance: 16.3 km Strong disturbance: 3.6 km

It is important to place the results in Table 6.19 in the context of the baseline noise environment, i.e. that the 120 dB re 1 µPa rms sound pressure level criterion for mild disturbance from continuous noise is within the range of typical baseline noise levels in the area.

It is therefore important to understand that exceeding the criteria for potential onset of disturbance does not in itself mean that disturbance will occur.

Southall *et al.* (2007) notes that "*…the available data on behavioural responses do not converge on specific exposure conditions resulting in particular reactions, nor do they point to a common behavioural mechanism. Even data obtained with substantial controls, precision, and standardized metrics indicate high variance both in behavioural responses and in exposure conditions required to elicit a given response. It is clear that behavioural responses are strongly affected by the context of exposure and by the animal's experience, motivation, and conditioning. This reality, which is generally consistent with patterns of behaviour in other mammals (including humans), hampered our efforts to formulate broadly applicable behavioural response criteria for marine mammals based on exposure level alone.*"

In addition to the above, and with reference to the last three paragraphs of section 6.5, the estimated ranges for onset of disturbance due to abrasive jet cutting are considered to be unrealistically very high. As discussed previously, this is unlikely to be the case in practice, where disturbance ranges are likely to be significantly lower. Until field data is available in the public domain for underwater abrasive jet cutting, it will be highly problematic predicting disturbance and injury ranges for this activity.

6.7.3.3 Injury and disturbance to Fish

The potential for injury and disturbance to fish is shown in the following tables.

Table 6.20 shows the qualitative risk of injury and disturbance to different fish types depending on range, in accordance with ASA guidance.

Table 6.20 Effects of continuous noise on fish, based on ASA qualitative criteria, for Phase 2 activity

Qualitative risk due to exposure to continuous noise (vessels etc.)			
Range:	**Near (10s of metres)**	**Intermediate (100s of metres)**	**Far (1,000s of metres)**
ASA qualitative risk of recoverable injury:			
Fish: no swim bladder	Low	Low	Low
Fish: swim bladder not involved in hearing	Low	Low	Low
Fish: swim bladder involved in hearing	N/A – See Table 6.21		
Eggs and larvae	Low	Low	Low
ASA qualitative risk of potential disturbance:			
Fish: no swim bladder	Moderate	Moderate	Low
Fish: swim bladder not involved in hearing	Moderate	Moderate	Low
Fish: swim bladder involved in hearing	High	Moderate	Low
Eggs and larvae	Moderate	Moderate	Low

6.7.3.4 Disturbance to Fish

Table 6.21 shows the calculated ranges of injury to fish with swim bladders in like with ASA guidelines, based on exceedance of 170 dB re 1 µPa (rms) over 48 hours continuous exposure, and the potential disturbance radius to fish based on the WSDOT criterion of 150 dB re 1 µPa (rms).

Table 6.21 Effects of continuous noise on fish, based on WSDOT criterion, for Phase 2 activity

Activity / Source	ASA Radius of potential recoverable injury zone (assuming continuous exposure within that radius over 48 hour period)	Radius of potential disturbance zone (based on WSDOT criteria)
	Fish: swim bladder involved in hearing	All fish
HLV	4 m	72 m
DSV / ROV Support Vessel	1 m	33 m
Cargo Barge (towed by tugs)	N/E	12 m
Trawler Vessel	N/E	12 m
Jacket Severance (abrasive jet cutting)	21 m	456 m
All Sources	22 m	468 m
Notes: N/E = Not Exceeded		

For continuous sounds such as vessels, only fish with swim bladders are likely to have a high risk of behavioural effects and then only within tens of metres to the source, according to the ASA guidelines. The relative risks for other fish should be downgraded accordingly.

6.7.4 Phase 3 – Pipeline Decommissioning

6.7.4.1 Injury to Marine Mammals

Table 6.22 shows the estimated injury ranges for marine mammals due to Phase 3 continuous noise.

Table 6.22 Estimated injury ranges for marine mammals exposed to Phase 3 continuous noise

Activity / Source	**SEL Injury Zone Radius (assuming 1.5 ms-1 swim speed) (N/E = not exceeded)**			
	LF Cetacean	**MF Cetacean**	**HF Cetacean**	**Phocid pinnipeds**
DSV / ROV Support Vessel	N/E	N/E	N/E	N/E
Cargo Barge (towed by tugs)	N/E	N/E	N/E	N/E
Trawler Vessel	N/E	N/E	N/E	N/E
Jet Trencher / Plough Trencher	N/E	N/E	N/E	N/E
All Sources	N/E	N/E	N/E	N/E

Table 6.23 shows the estimated injury times for marine mammals exposed to phase 4 continuous noise if stationary at 50 m from the source.

Table 6.23 Estimated injury times for marine mammals exposed to Phase 3 continuous noise at 50 m from source

Activity / Source	**Time take to reach SEL injury threshold at 50m from source for stationary mammals (N/E = not exceeded)**			
	LF Cetacean	**MF Cetacean**	**HF Cetacean**	**Phocid pinnipeds**
DSV / ROV Support Vessel	N/E	N/E	N/E	N/E
Cargo Barge (towed by tugs)	N/E	N/E	N/E	N/E
Trawler Vessel	N/E	N/E	N/E	N/E
Jet Trencher / Plough Trencher	N/E	N/E	N/E	N/E
All Sources	N/E	N/E	N/E	N/E

Based on an animal swimming at a constant speed of 1.5 ms^{-1} from the source of noise, the noise modelling shows that injury to marine mammals is unlikely to occur due to the vessels and activities involved in Phase 3. It should be noted that this is a worst case result, given that movement speeds for marine mammals have been recorded well in excess of the 1.5 ms^{-1} modelled here.

6.7.4.2 Disturbance to Marine Mammals

The estimated ranges for onset of disturbance effects are shown in Table 6.24.

Table 6.24 Estimated disturbance ranges for marine mammals, for Phase 3 activity

Source / Activity	Estimated range for onset of disturbance
DSV / ROV Support Vessel	Mild disturbance: 2.9 km Strong disturbance: 145 m
Cargo Barge (towed by tugs)	Mild disturbance: 1.2 km Strong disturbance: 55 m
Trawler Vessel	Mild disturbance: 1.2 km Strong disturbance: 55 m
Jet Trencher / Plough Trencher	Mild disturbance: 3.9 km Strong disturbance: 256 m
All Sources	Mild disturbance: 4.6 km Strong disturbance: 270 m

It is important to place the results in Table 6.24 in the context of the baseline noise environment, i.e. that the 120 dB re 1 µPa rms sound pressure level criterion for mild disturbance from continuous noise is within the range of typical baseline noise levels in the area.

It is therefore important to understand that exceeding the criteria for potential onset of disturbance does not in itself mean that disturbance will occur.

Southall *et al.* (2007) notes that "*…the available data on behavioural responses do not converge on specific exposure conditions resulting in particular reactions, nor do they point to a common behavioural mechanism. Even data obtained with substantial controls, precision, and standardized metrics indicate high variance both in behavioural responses and in exposure conditions required to elicit a given response. It is clear that behavioural responses are strongly affected by the context of exposure and by the animal's experience, motivation, and conditioning. This reality, which is generally consistent with patterns of behaviour in other mammals (including humans), hampered our efforts to formulate broadly applicable behavioural response criteria for marine mammals based on exposure level alone.*"

6.7.4.3 Injury and disturbance to Fish

The potential for injury and disturbance to fish is shown in the following tables. Table 6.25 shows the qualitative risk of injury and disturbance to different fish types depending on range, in accordance with ASA guidance.

Table 6.25 Effects of continuous noise on fish, based on ASA qualitative criteria, for Phase 3 activity

Qualitative risk due to exposure to continuous noise (vessels etc.)			
Range:	**Near (10s of metres)**	**Intermediate (100s of metres)**	**Far (1,000s of metres)**
ASA qualitative risk of recoverable injury:			
Fish: no swim bladder	Low	Low	Low
Fish: swim bladder not involved in hearing	Low	Low	Low
Fish: swim bladder involved in hearing	N/A - See Table 6.26		
Eggs and larvae	Low	Low	Low
ASA qualitative risk of potential disturbance:			
Fish: no swim bladder	Moderate	Moderate	Low
Fish: swim bladder not involved in hearing	Moderate	Moderate	Low
Fish: swim bladder involved in hearing	High	Moderate	Low
Eggs and larvae	Moderate	Moderate	Low

6.7.4.4 Disturbance to Fish

Table 2.26 shows the calculated ranges of injury to fish with swim bladders in line with ASA guidelines, based on exceedance of 170 dB re 1 µPa (rms) over 48 hours continuous exposure, and the potential disturbance radius to fish based on the WSDOT criterion of 150 dB re 1 µPa (rms).

Table 6.26 Effects of continuous noise on fish, based on WSDOT criterion, for Phase 3 activity

Activity / Source	**ASA Radius of potential recoverable injury zone (assuming continuous exposure within that radius over 48 hour period)**	**Radius of potential disturbance zone (based on WSDOT criteria)**
	Fish: swim bladder involved in hearing	**All fish**
DSV / ROV Support Vessel	1 m	33 m
Cargo Barge (towed by tugs)	N/E	12 m
Trawler Vessel	N/E	12 m
Jet Trencher / Plough Trencher	3 m	43 m
All Sources	3 m	58 m
Notes: N/E = Not Exceeded		

For continuous sounds such as vessels, only fish with swim bladders are likely to have a high risk of behavioural effects and then only within tens of metres to the source, according to the ASA guidelines. The relative risks for other fish should be downgraded accordingly.

6.7.5 Phase 4 – Post-decommissioning Verification Surveys

The only source considered in the final decommissioning phase is a trawler vessel carrying out verification surveys. The source data used as proxy for the trawler vessel has been assessed in the above phases and is unlikely to result in any adverse effects on marine mammals and fish.

6.7.6 Impact on the Annex II Species, Harbour Porpoise

The Southern North Sea cSAC boundary is located approximately 12 kilometres north of the Schooner installation and approximately 23 kilometres north-west of the Ketch Installation and has been identified as an area of importance for the Annex II species, harbour porpoise. The conservation objectives of the site are presented in Section 3.3.8. Within the draft Conservation Objectives ‘no significant disturbance of the species’ is described as ‘any disturbance should not lead to the exclusion of harbour porpoise from a significant portion of the site for a significant period of time’. Although there is no definition within the draft Conservation Objectives of what is a significant portion or significant period. The aim is to ensure that the site ‘contributes, as best it can, to maintaining the Favourable Conservation Status of the wider harbour porpoise population. As such, how the impacts within the site translate into effects on the North Sea Management Unit population are of greatest concern’ (JNCC, 2016). In order to determine whether the noise from the decommissioning project will adversely affect the sites ability to achieve its conservation objectives and favourable conservation status the noise modelling results have been used to estimate the number of harbour porpoise that may be affected. There are no set thresholds at which impacts on site integrity are considered to be adverse. However, a threshold of 1.7% of the relevant harbour porpoise population above which a population decline is inevitable has been agreed with Parties to the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS), with an intermediate precautionary objective of reducing the impact to less than 1% of the population (Defra, 2003, ASCOBANS, 2015). This threshold relates to impacts from fisheries by-catch on harbour porpoise where the impact on the harbour porpoise is permanent, i.e. up to 1.7% of the population may be caught as by-catch before a population decline is inevitable. An equivalent level of impact from disturbance, which is temporary and non-lethal, on a population will have a lower level of impact on the population compared to that from a fisheries by-catch.

There are three Management Units identified for harbour porpoise in the north-east Atlantic, of which, the SNS cSAC lies within North Sea Management Unit. The harbour porpoise population within the North Sea Management Unit was originally estimated to be 227,298 (176,360 – 292,948) individuals (IAMMWG, 2015). However, following the revision of the regional SCANS harbour porpoise population figures, the population of harbour porpoise within the North Sea Management Unit has also been revised and is now estimated to be 333,808 individuals (JNCC 2017d). The SAC selection assessment document estimates that the site holds 17.5% of the UK part of North Sea Management Unit harbour porpoise population with an estimated population of 18,500 individuals (98% C.I. 11,864 – 28,899) (JNCC 2017c). This was equivalent 8.1% of the whole North Sea Management Unit population at the time (Hammond et al., 2013, IAMMWG, 2015). Based on the latest North Sea Management Unit population of 308,666 individuals the harbour porpoise population within the cSAC may be 26,237 individuals.

The assessment on the potential impacts from decommissioning related noise on harbour porpoise is based on the results from the noise modelling. From this it is possible to estimate the number of harbour porpoise that may be affected and the percentage of the North Sea Management Unit population this would equate to. JNCC advise that it is not appropriate to use the site population estimates in any assessments of effects of plans or projects, as it is necessary to take into consideration population estimates at the management unit level to account for daily and seasonal movements of the animals (JNCC 2017c).

6.7.6.1 Injury

The potential injury zones calculated by the noise modelling for the noise generated during the different phases of the decommissioning project fall outwith the boundary of the Southern North Sea cSAC for the harbour porpoise. However, Harbour porpoise are highly mobile animals and are therefore not limited to within the site boundary therefore it is possible that individuals may be injured out with the site.

The noise modelling shows that instantaneous injury to harbour porpoise is unlikely to occur for any of the continuous noise sources (MODU/JUB, HLV, Cargo Barge, Supply Boat, DSV/ROV Support Vessel, Trawler Vessel, Jet Trencher / Plough Trencher). High frequency cetaceans would have to be stationary at 50 m from the sources (all phase 1 noise sources combined) for a period of 14 hours before the permanent injury threshold would be reached. Injury due to underwater cutting activity (abrasive jet) is also shown to be unlikely, where high frequency cetaceans would have to be stationary at 50 m from the source for 10 minutes before the permanent injury threshold would be reached.

If used, there is a likely risk, that explosives may result in permanent injury to harbour porpoise with the maximum injury range calculated as 2,697 m. This equates to an area of 22.85 km^2. Based on the

SCANS III survey density, approximately 20 (see Table 6.13) harbour porpoise could be injured by the use of explosives during Phase 2 of the decommissioning operations equivalent to 0.0066% of the management unit population.

6.7.6.2 Disturbance

A potential maximum mild disturbance range of 16.3 km and a potential maximum strong disturbance range of 3.6 Km for harbour porpoise were generated from the noise modelling due to all noise sources associated with jacket severance using abrasive jet cutting. Given the Schooner installation is located approximately 12 km from the Southern North Sea cSAC boundary it is possible that harbour porpoise within the site could experience mild disturbance. This mild disturbance range equates to an area of approximately 835 km^2. Based on the SCANS III survey density, approximately 741 harbour porpoise could experience mild disturbance caused by abrasive water jet cutting equivalent to 0.0024 % of the management unit population.

6.8 Mitigation and Control Measures

None of the vessel based continuous noise sources (MODU/JUB, HLV, Cargo Barge, Supply Boat, DSV/ROV Support Vessel, Trawler Vessel, Jet Trencher / Plough Trencher) have been identified as likely to produce significant levels of noise to cause injury to marine mammals and fish. Subsequently, there is no requirement for mitigation for any of these activities, however where possible operations will draw on standard methodologies and equipment and SIMOPS for vessel activity will be in place.

Due to the paucity of data for underwater cutting (abrasive jet cutting) there is a significant uncertainty factor in the assessment predictions. The assumptions and extrapolations of the data have predicted that all cutting activities are unlikely to produce significant levels of noise to cause injury to marine mammals and fish. Furthermore, mammals would need to be stationary at 50 m from the noise source for 30 minutes to 60 minutes to experience any permanent hearing damage. Subsequently, there is no requirement for mitigation for any of these activities.

The maximum predicted injury range due to the detonation of an 87.5 kg charge inside each pile is 2.7 km for high frequency cetaceans based on peak pressure. By splitting this total charge weight into several co-operating charges, if practicable and safe to do so, the maximum injury and disturbance ranges could reduce significantly, however it is not known at this stage of the project whether this will be possible. In order to further reduce the risk of permanent injury due to pile severance explosions, the JNCC guidelines for minimising the risk of injury to marine mammals from using explosives (JNCC, 2010b) should be applied and the following mitigation measures should be followed:

- **Marine Mammal Observers (MMOs):** An experienced Marine Mammal Observers to be present for the duration of the pile severance explosions to undertake cetacean and pinniped visual monitoring during daylight hours.

- **Passive Acoustic Monitoring (PAM):** The PAM system comprises of a short hydrophone array station, a desk cable and data processing system which processes and stores selected data. Using PAM should clearly distinguish between major cetacean groups (i.e. baleen whales, large odontocetes, and small odontocetes). The PAMGUARD PAM system could be used for night-time and low visibility conditions if the explosions were to take place in such conditions.

- **Pre-detonation search:** The MMO and PAM operative would begin observations 60 minutes before the commencement of the charge detonations and the detonation would be subsequently delayed if any cetaceans are detected within 500 m of the site. The 500m search zone is sufficient to avoid potential injury to marine mammals based on the results in Table 6.13.
- **Soft-start:** To ensure that marine mammals are given the opportunity to swim away from the explosion site, a small number of smaller explosions could be detonated or an airgun could be fired with slowly increasing energy to the maximum level. This is a process called 'soft start'.

6.9 Conclusions

There will be continuous noise generated during each phase of decommissioning, due to the various vessels, trenching and cutting.

Based on an animal swimming at an average speed of 1.5 ms^{-1} away from the sources and activities pertaining to decommissioning noise, the noise modelling shows that instantaneous injury to marine mammals and fish is unlikely to occur for any of the continuous noise sources (MODU/JUB, HLV, Cargo Barge, Supply Boat, DSV/ROV Support Vessel, Trawler Vessel, Jet Trencher / Plough Trencher) therefore the significance of the impact is considered 'low'.

If used, explosions will generate one high impulsive noise assuming that all charges on each pile will be detonated simultaneously. The use of explosives is a contingency option if both internal and external cutting of the piles fails and has been presented as the worst case scenario from a noise perspective. There is a likely risk of permanent injury to cetaceans, pinnipeds and fish resulting from the pile severance explosions. The maximum predicted injury range is 2.7 km for high frequency cetaceans based on peak pressure, and 500 m for fish eggs and larvae. The worst case disturbance range due to explosive severance of piles, based on high frequency cetaceans is estimated to be approximately 4.9 km. MMO's, a PAM system and the inclusion of a ten minute 'soft start' procedure, will reduce the potential injury ranges considerably for marine mammals. The use of explosives will be for a relatively short duration and the mitigation measures will reduce the potential impact, therefore the significance of the impact to fish and marine mammals is considered 'low'.

It is important to note that the assessment for explosives is somewhat limited as there is currently only recorded data for unconstrained (in open water) or constrained (confined in rock) explosives use, neither of which are a comparable scenario to the use of explosives as a contingency option for jacket pile severance. Until field data is available in the public domain for the use of explosives for jacket pile severance, it will be highly problematic predicting disturbance and injury ranges for this activity.

Mild disturbance ranges for marine mammals due to the worst-case continuous noise scenarios in phases 1, 2 and 3 are likely to be 5.8 km, 16.3 km and 4.6 km. Strong disturbance ranges for marine mammals due to the worst-case continuous noise scenarios in phases 1, 2 and 3 are likely to be 310 m, 3.6 km and 270 m respectively. The disturbance zones for fish are likely to be less than 500 m for all phases and given the short duration of the noise related activities the impact on fish and indirect impact on fisheries is considered to be low. All injury and disturbance ranges are based on the worst case scenario (i.e. all sources acting simultaneously) therefore, in practice it is likely that actual disturbance and injury ranges will be smaller.

The Southern North Sea cSAC and MPA has been identified as an area of importance for the Annex II species, harbour porpoise, a high frequency hearing group species. Given that the Southern North Sea cSAC and MPA lies out with the maximum injury range for high frequency cetaceans, it is unlikely that injury may occur to individuals within the site. It is concluded that based on the results from the noise modelling, the decommissioning project activities on their own will not have an adverse effect upon the integrity of the Southern North Sea cSAC. The estimated potential injury from use of explosives of no more than 0.0066% of the North Sea Management Unit population over the 24 hour period is predicted not to cause an adverse effect on the favourable conservation status of the species nor the integrity of the site. The estimated potential temporary displacement or disturbance from jacket severance using abrasive jet cutting of no more than 0.0024% of the North Sea Management Unit population over the cutting period is predicted not to cause an adverse effect on the favourable conservation status of the species nor the integrity of the site. Additionally, given the lack of data, the source noise levels used for abrasive jet cutting in the noise assessment are based on assumptions that are likely to be a significant over-estimate of the actual noise levels generated in practice. Until field data is available in the public domain for underwater abrasive jet cutting, it will be highly problematic predicting disturbance and injury ranges for this activity.

However, it is recognised that there is potential for noise generating activities associated with the decommissioning project to cause an in-combination impact with noise generated from other industries (e.g. consented windfarms) and other decommissioning projects. These in-combination impacts are addressed in Section 8.3.

7 Accidental Events

This section describes the potential impacts associated with accidental (i.e. un-planned events). The accidental events identified within the ENVID for the decommissioning project (refer to Aspect Register in Appendix C) included:

- Dropped Objects;
- Potential unintentional releases of fuel or other fluids (e.g. diesel, jet fuel, hydraulic oil, lubricants or chemicals) during day-to-day operations (including re-fuelling);
- Loss of hydraulic fluid from cutting shears/equipment;
- An emergency incident (e.g. vessel collision), leading to potential unintentional releases.

The ENVID process identified that the risks posed by the above accidental events are considered low given the mitigation measures that will be in place (refer to Aspect Register in Appendix C).

7.1 Emergency Incidents

The ENVID used a variety of evidence to support the conclusions drawn, including audit history, past environmental performance and previous oil spill modelling studies. In order to confirm that the assessment within the ENVID remains valid for the proposed operations as the detailed project design progresses, a further oil spill modelling study has been conducted. The oil spill modelling study assessed a worst-case hydrocarbon release scenario involving the loss of the entire fuel oil inventory of the decommissioning vessel.

7.1.1 Oil Spill Modelling Study

Oil spill modelling has been conducted to assess the potential impact from a significant release of diesel from the decommissioning vessel operating at the proposed decommissioning project location. The Schooner NUI location was chosen for the modelling release point as this is the closest to shore of the two NUI locations (130 kilometres).

An emergency incident, such as a collision, could potentially result in the entire inventory of hydrocarbons stored on the decommissioning vessel potentially being released to the sea. In practice, it is most likely that any release of hydrocarbons would occur over a period of time. An immediate release could, however, occur in the unlikely event that all compartments/tanks containing hydrocarbons were instantaneously fractured in some way.

The oil spill modelling conducted assumes a total instantaneous loss of the decommissioning vessel diesel inventory of 3,513 cubic metres. This volume is based on the diesel inventory of the McDermott Derrick Barge 32 heavy lift vessel (*McDermott International Inc., 2018*). A vessel of this type was chosen as it is the absolute worst case in terms of lifting capacity and fuel oil inventory. Four modelling scenarios have been conducted, each using metocean data from a different period:

- Winter (January to March);
- Spring (April to June);
- Summer (July to September);
- Autumn (October to December).

This is in order to gauge the effect of seasonality depending on the time of year the decommissioning operations take place. The oil spill model input parameters are shown in Table 7.1. The results of the modelling are summarised in Table 7.2 below, and are illustrated in Figures 7.1 and 7.2.

Table 7.1. Diesel stochastic spill scenarios at the Schooner NUI location; spill modelling input parameters

<table>
<tr><th colspan="9">Inventory Loss Parameters</th></tr>
<tr><td colspan="2">Loss from:</td><td colspan="3">Works location –NUI</td><td colspan="2">Instantaneous loss?</td><td colspan="2">No</td></tr>
<tr><td colspan="2">Worst case volume</td><td colspan="3">3,513 m^3</td><td colspan="2" rowspan="2">Will the well self-kill?
If yes, when?</td><td colspan="2" rowspan="2"><i>N/A</i></td></tr>
<tr><td colspan="2">Flow rate</td><td colspan="3">Instantaneous</td></tr>
<tr><td colspan="2">Justification for predicted worst case volume</td><td colspan="7">Worst case inventory of vessels on site, assumes McDermott Derrick Barge 32 – worst case heavy lift vessel.</td></tr>
<tr><th colspan="9">Location</th></tr>
<tr><td colspan="2">Spill source point:</td><td>Lat:</td><td colspan="2">54° 03’ 35.30” N</td><td colspan="2">Long:</td><td colspan="2">02° 04’ 40.10" E</td></tr>
<tr><td colspan="2">Installation/facility name:</td><td colspan="3">Schooner NUI</td><td colspan="2">Quad/Block</td><td colspan="2">44/26a</td></tr>
<tr><th colspan="9">Hydrocarbon Properties</th></tr>
<tr><td colspan="2">Hydrocarbon name</td><td colspan="3">Diesel</td><td colspan="2">Condensate/gas ratio:</td><td colspan="2"><i>N/A</i></td></tr>
<tr><td colspan="2">Assay Available:</td><td><i>N/A</i></td><td colspan="4">Was an analogue used for spill modelling?</td><td colspan="2">No</td></tr>
<tr><th></th><th>Name</th><th>ITOPF Category</th><th>Specific Gravity</th><th>API</th><th>Pour point (°C)</th><th>Wax content (%)</th><th>Asphaltene content (%)</th><th>Viscosity (Cp @ °C)</th></tr>
</table>

Hydrocarbon	Diesel 2002	Group 2	0.83	38.8	-	-	-	V1: 2.76 @ 25 V2: 2.76 @ 15

Metocean parameters					
Model Name	**Season**	**Air Temperature**	**Sea Surface Temperature**	**Wind data**	**Current data**
Faroe1.INS	Winter (Jan-Mar)	4°C	7°C	7 years (2008-2015) Navy Operational Global Atmospheric Prediction System (NOGAPS) dataset.	7 years (2008-2015) seasonal 3D HYCOM daily current dataset.
Faroe2.INS	Spring (Apr-Jun)	12°C	10°C	7 years (2008-2015) Navy Operational Global Atmospheric Prediction System (NOGAPS) dataset.	7 years (2008-2015) seasonal 3D HYCOM daily current dataset.
Faroe3.INS	Summer (Jul-Sep)	16°C	13°C	7 years (2008-2015) Navy Operational Global Atmospheric Prediction System (NOGAPS) dataset.	7 years (2008-2015) seasonal 3D HYCOM daily current dataset.
Faroe4.INS	Autumn (Oct-Dec)	9°C	11°C	7 years (2008-2015) Navy Operational Global Atmospheric Prediction System (NOGAPS) dataset.	7 years (2008-2015) seasonal 3D HYCOM daily current dataset.

Modelled release parameters			
Surface or Subsurface:	Surface	**Release depth:**	0 m
Release duration:	3 hours	**Instantaneous?**	Yes
Persistence duration:	9 days, 21 hours	**Release rate:**	1,171 $m^3.hr^{-1}$
Total simulation time:	10 days	**Total release:**	3,513 m^3

Spill Modelling Software			
Name of software:	OILMAP	**Version:**	7.1.6.0

Table 7.2. Diesel stochastic spill scenarios at the Schooner NUI location; spill modelling results

<table>
<tr><th colspan="9">Median line(s) crossed</th></tr>
<tr><th></th><th colspan="3">Median Line</th><th colspan="2">Minimum crossing time (days:hours)</th><th colspan="3">Probability of surface oiling >0.3um crossing median line (%)</th></tr>
<tr><td rowspan="3">Faroe1.INS (Jan-Mar)</td><td colspan="3">UK / Netherlands</td><td colspan="2">1:16</td><td colspan="3">0-10%</td></tr>
<tr><td colspan="3">UK / Germany</td><td colspan="2">5:0</td><td colspan="3">0-10%</td></tr>
<tr><td colspan="3">Germany / Denmark</td><td colspan="2">5:20</td><td colspan="3">0-10%</td></tr>
<tr><td>Faroe2.INS (Apr-Jun)</td><td colspan="3">UK / Netherlands</td><td colspan="2">2:2</td><td colspan="3">0-10%</td></tr>
<tr><td>Faroe3.INS (Jul-Sep)</td><td colspan="3">UK / Netherlands</td><td colspan="2">2:22</td><td colspan="3">0-10%</td></tr>
<tr><td rowspan="3">Faroe4.INS (Oct-Dec)</td><td colspan="3">UK / Netherlands</td><td colspan="2">1:6</td><td colspan="3">0-10%</td></tr>
<tr><td colspan="3">UK / Germany</td><td colspan="2">7:2</td><td colspan="3">0-10%</td></tr>
<tr><td colspan="3">Germany / Denmark</td><td colspan="2">8:8</td><td colspan="3">0-10%</td></tr>
<tr><th colspan="9">Landfall</th></tr>
<tr><th></th><th colspan="4">Faroe1.INS (Jan-Mar)
Initial beaching sites</th><th colspan="4">Faroe2.INS (Apr-Jun)
Initial beaching sites</th></tr>
<tr><th></th><th>Sim. ID No. (out of 100)</th><th>Beaching time (days:hrs)</th><th>Volume Ashore (m^3)</th><th>Max. probability of shoreline oiling* (%)</th><th>Sim. ID No. (out of 100)</th><th>Beaching time (days:hrs)</th><th>Volume Ashore (m^3)</th><th>Max. probability of shoreline oiling* (%)</th></tr>
<tr><td></td><td colspan="4"><i>No beaching predicted</i></td><td colspan="4"><i>No beaching predicted</i></td></tr>
<tr><th></th><th colspan="4">Faroe3.INS (Jul-Sep)
Initial beaching sites</th><th colspan="4">Faroe4.INS (Oct-Dec)
Initial beaching sites</th></tr>
<tr><th></th><th>Sim. ID No. (out of 100)</th><th>Beaching time (days:hrs)</th><th>Volume Ashore (m^3)</th><th>Max. probability of shoreline oiling* (%)</th><th>Sim. ID No. (out of 100)</th><th>Beaching time (days:hrs)</th><th>Volume Ashore (m^3)</th><th>Max. probability of shoreline oiling* (%)</th></tr>
<tr><td></td><td colspan="4"><i>No beaching predicted</i></td><td colspan="4"><i>No beaching predicted</i></td></tr>
</table>

*: % probability of shoreline oiling above 0.3 µm thickness (as required by OPRED, 2017); threshold between silver sheen and rainbow sheen visual appearance in the Bonn Agreement Oil Appearance Code (BAOAC) (*Bonn Agreement, 2017*).

Figure 7.1. Diesel stochastic spill scenarios at the Schooner NUI location; Spill modelling results - probability of surface oiling above a threshold of 0.3 µm thickness

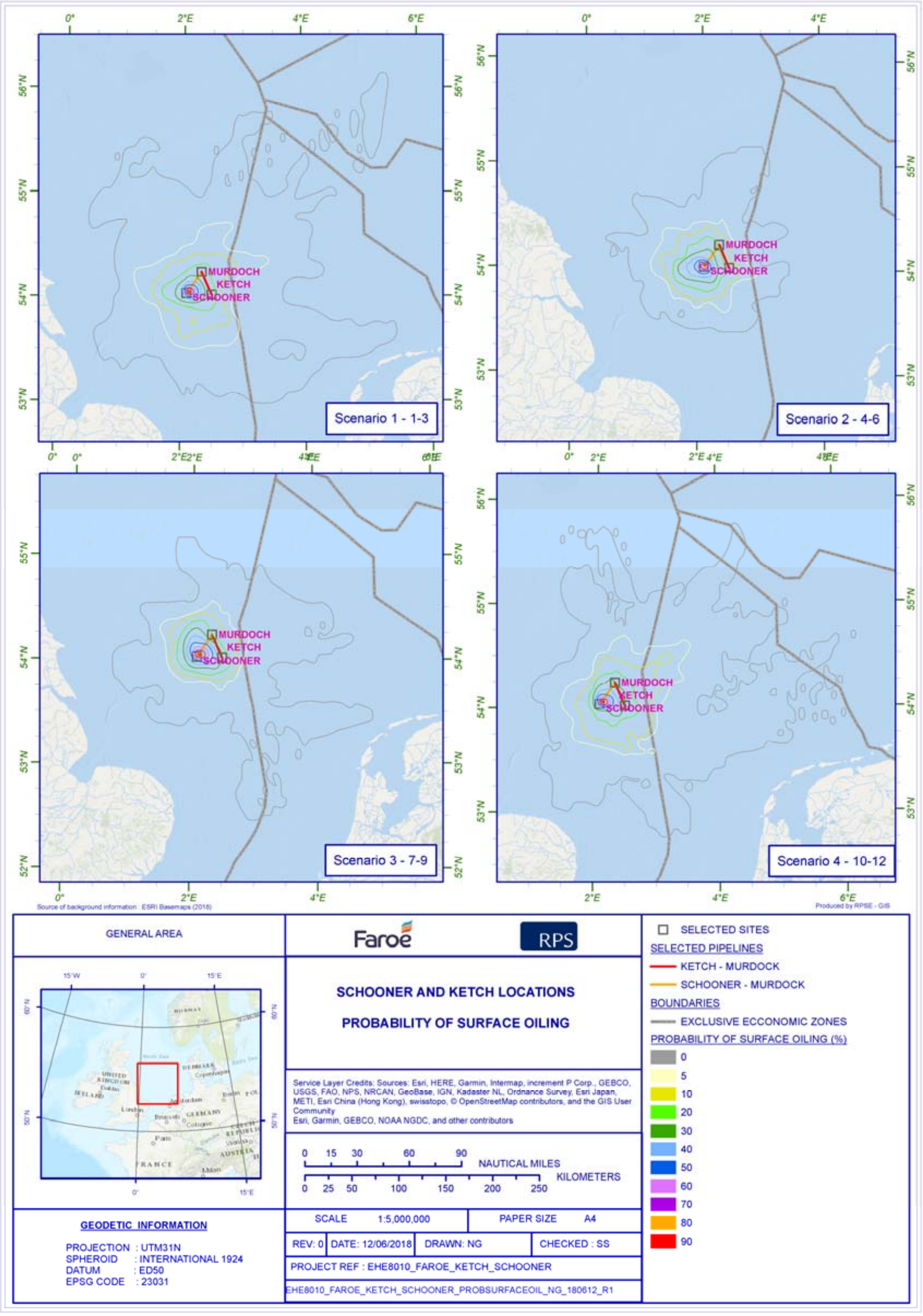
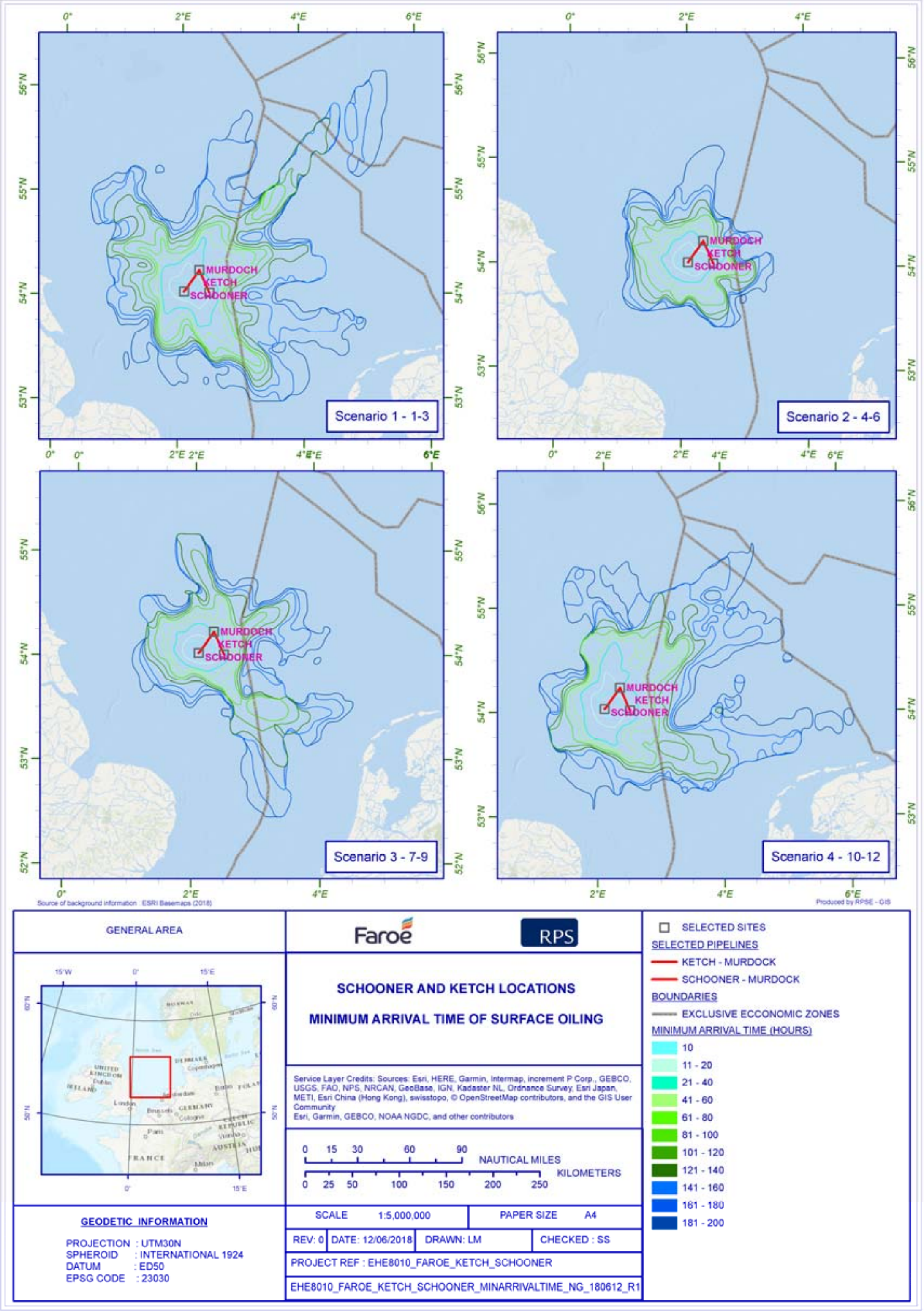


Figure 7.2 Diesel stochastic spill scenarios at the Schooner NUI location; Spill modelling results - minimum arrival time of surface oiling above a threshold of 0.3 µm thickness



7.1.2 Modelling Results and Potential Impacts

The modelling results have been rendered and displayed to the threshold required by the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) (*OPRED, 2017*) of 0.3 µm thickness. This threshold corresponds to the visual observation threshold between silver sheen and rainbow sheen as per the Bonn Agreement Oil Appearance Code (BAOAC) (*Bonn Agreement, 2017*).

The four scenarios predict that the diesel will weather offshore under the influence of the prevailing winds and currents. Figure 7.1 shows that the autumn and winter scenarios push the oil further from the release location than the spring and summer scenarios. None of the oil spill modelling scenarios predict that oil will beach.

The pattern of dispersion between the scenarios indicates that surface oiling probability between 20 and 100% is broadly restricted to a distance of approximately 30-40 kilometres from the release location. Beyond this (between 0 and 10% surface oiling probability) represents the majority of the far-field dispersion from the release location. Although oil does have the ability to travel greater distances from the release location, the probability of surface oiling in these far-field areas is very low.

Fish populations have the potential to be affected by oil spills. There is evidence that fish have the ability to detect contaminated waters through olfactory (smell) or gustatory (taste) systems (*DCENR, 2011*) and therefore avoid oil contaminated areas, although avoidance may not always be possible when large areas become oiled. Where fish come into contact with an oil spill, they may become 'tainted'. Tainting is a general term used to describe an odour or flavour that is foreign and undesirable to a food product. Fish tainting is when the fish stock acquire an objectionable oil-derived taste within their flesh, and is a direct result of the fish coming into physical contact with oil spills. The tainting of fish arises through the fish ingesting oil contaminated water. The oil toxicity levels that cause fish tainting are not at a point to cause mortality to the fish, but are at a sufficiently high level as to be ingested, assimilated through their digestive and circulatory system and finally stored within the fatty tissues of their body. It is this storage of hydrocarbon molecules in fatty tissues that causes the tainting effect. Species that have a higher fat content in their tissues are more susceptible to tainting effects (*ITOPF, 2012*).

Spills such as a large release of diesel do have the potential to cause a fish tainting effect as diesel is a light product and has the potential to disperse into the water column to a greater extent than an equivalent heavy crude oil spill. However, as diesel is also a very light product and disperses relatively rapidly in the marine environment, the potential exposure time is much reduced when compared to an equivalent heavy crude oil spill. Any potential effects on fish from a worst-case hydrocarbon release are therefore expected to be temporary and short-term. Significant effects on fish populations are therefore not expected.

Seabirds rafting on the surface of the water are vulnerable to the effects of a hydrocarbon release. Oil clings to their feathers, reducing the insulating properties of their plumage. This can subsequently lead to hypothermia and possibly eventual mortality. Birds are also vulnerable to the toxic effects of hydrocarbons through ingestion of the oil through attempted cleaning of their plumage and through the potential ingestion of contaminated prey. Birds are particularly vulnerable to hydrocarbon spills on water as they often show no avoidance behaviour of oiled areas. However, the light nature of diesel fuel and the fact that it disperses relatively rapidly in the marine environment means that potential sea surface oil exposure times for seabird species are relatively short-lived. Seabird oiling risks are much greater for an equivalent crude oil spill which has the potential to remain on the sea surface for a significantly longer period of time. Significant effects on seabird species from a worst-case hydrocarbon release are therefore not expected.

Potential impacts on marine mammals are discussed in section 7.1.2.1 below.

7.1.2.1 Potential Impacts on Designated Sites

Figures 7.3 and 7.4 show the probability of surface oiling and minimum time to surface oiling (respectively) overlaid onto offshore protected areas. Table 7.3 shows the protected areas whose surface waters may be impacted by oiling above a probability of 0% (i.e. probability of any surface oiling). It also shows the area of potential surface water oiling and the percentage of the area of the protected site the potential oiling represents. It can be seen that several protected areas have the potential to be impacted by oiling (Figure 7.3 and Table 7.3). By far the greatest extent of sea area coverage is represented by the 0-10% probability range, which represents a very low probability of surface oiling.

Table 7.3 includes the qualifying features of the protected areas identified as being at risk of surface water oiling identified by the spill modelling. The majority of the features of the sites are broad-scale habitats along with the Annex I features '*sandbanks which are slightly covered by seawater all the time*' and reefs of the ross worm *Sabellaria spinulosa* which are commonly associated with these sandbanks in the SNS. As these features are on the seabed, none of these features will be affected by surface oiling.

OILMAP is able to make broad predictions of total hydrocarbons (TH) in the water column. The spill modelling results show that near to the seabed the probability between 0 and 10% of TH greater than 1 part per billion (ppb) in the water column is limited to very localised areas within approximately 20 km of the release location (Figure 7.5).

Studies into the effects of hydrocarbons in sea water on marine organisms are vast and wide-ranging. A recent literature review has attempted to collate studies in marine organism toxicology of TH in seawater (Dupuis & Ucan-Marin, 2015). Exposure of *Calanus finmarchicus*, a common zooplankton copepod species showed relatively low Lethal Concentration (LC) 50 (96 hour) values ranging from 0.7 to 1 mg TH per litre (Hansen *et al.,* 2012, In: Dupuis & Ucan-Marin, 2015). This is equivalent to approximately 0.7 to 1 parts per million (ppm). LC50 values (96 hour) are also reported by the US National Research Council (2005) for benthic bivalve species in the range of 1.14 to 1.83 mg TH per litre (NRC, 2005, In: Dupuis & Ucan-Marin, 2015), equivalent to approximately 1.14 to 1.83 ppm. Near the seabed (70 metres water depth) the model does not predict that TH water column concentrations reach 0.1 ppm (the next threshold rendered within the model) in any scenario. Therefore, no effects on benthic organisms are expected in the event of a worst-case scenario hydrocarbon release.

The SNS candidate Special Area of Conservation (cSAC) is designated for the Annex II species harbour porpoise (*Phocoena phocoena*). It has been rare for marine mammals to be affected following an oil spill (*DCENR, 2011*) as they are able to detect hydrocarbons in the water column and move away from contaminated areas and often have the ability to move great distances away from spills. Marine mammals are not commonly impacted by physical oiling nor are they subject to sensitivity to cold through oiling, as they have a thick insulation of internal blubber to keep them warm. Although the extent of sea-surface oiling from a worst-case hydrocarbon release may be quite large in the short term, due to the light nature of diesel fuel it will disperse rapidly in the marine environment. Significant effects on marine mammal species are therefore not expected.

Table 7.3. Offshore protected areas whose surface waters may be impacted by oiling above a probability of 0% (also refer to Figure 7.3)

Protected Area	**Qualifying Features**	**Total area (km^2)**	**Area of surface oiling (km^2)**	**Area affected by oiling (%)**
Scenario 1: January to March				
Markham's Triangle rMCZ	Broad-scale habitats: Subtidal coarse sediment, Subtidal sand (*JNCC, 2012*)	200.1	200.1	100%
Silver Pit rMCZ	Broad-scale habitats: Subtidal sand, Subtidal mixed sediments Features of Conservation Importance: *Sabellaria spinulosa* reefs, Subtidal sands and gravels (*JNCC, 2012*).	168.1	122.8	73%
Swallow Sand MCZ / SAC	Broad-scale habitats: Subtidal coarse sediment, Subtidal sand Geological/geomorphological feature: North Sea glacial tunnel valleys (Swallow Hole) (*JNCC, 2013*)	4,746.5	29.6	0.6%
Wash Approach rMCZ	Features of Conservation Importance: Subtidal sands and gravels. Broad-scale habitats: Subtidal sand, Subtidal mixed sediments (*JNCC, 2012*)	724.5	33.4	4.6%
Dogger Bank MPA / SAC	Annex I Habitat: Sandbanks which are slightly covered by seawater all the time (*JNCC, 2018a*)	12,331.3	10,700.1	86.8%
Inner Dowsing, Race Bank and North Ridge SAC	Annex I Habitat: Sandbanks which are slightly covered by seawater all the time, Reefs (in particular *Sabellaria spinulosa* reefs) (*JNCC, 2018b*)	845.2	2.0	0.2%
North Norfolk Sandbanks and Saturn Reef SAC	Annex I Habitat: Sandbanks which are slightly covered by seawater all the time, Reefs (in particular *Sabellaria spinulosa* reefs) (*JNCC, 2018c*)	3,603.5	2833.5	78.6%
Southern North Sea cSAC and MPA	Annex II species: Harbour porpoise (*Phocoena phocoena*) (*JNCC, 2017*)	36,927.9	16,869.3	45.7%
Scenario 2: April to June				

Protected Area	Qualifying Features	Total area (km^2)	Area of surface oiling (km^2)	Area affected by oiling (%)
Markham's Triangle rMCZ	Broad-scale habitats: Subtidal coarse sediment, Subtidal sand	200.1	200.1	100.0%
Dogger Bank MPA / SAC	Annex I Habitat: Sandbanks which are slightly covered by seawater all the time (*JNCC, 2018*)	12,331.3	7,064.9	57.3%
North Norfolk Sandbanks and Saturn Reef SAC	Annex I Habitat: Sandbanks which are slightly covered by seawater all the time, Reefs (in particular *Sabellaria spinulosa* reefs) (*JNCC, 2018c*)	3,603.5	1,277.3	35.4%
Southern North Sea cSAC and MPA	Annex II species: Harbour porpoise (*Phocoena phocoena*) (*JNCC, 2017*)	36,927.9	11,335.5	30.7%
Scenario 3: July to September				
Markham's Triangle rMCZ	Broad-scale habitats: Subtidal coarse sediment, Subtidal sand	200.1	200.1	100.0%
Dogger Bank MPA / SAC	Annex I Habitat: Sandbanks which are slightly covered by seawater all the time (*JNCC, 2018*)	12,331.3	6,018.5	48.8%
North Norfolk Sandbanks and Saturn Reef SAC	Annex I Habitat: Sandbanks which are slightly covered by seawater all the time, Reefs (in particular *Sabellaria spinulosa* reefs) (*JNCC, 2018c*)	3,603.5	1,381.8	38.3%
Southern North Sea cSAC and MPA	Annex II species: Harbour porpoise (*Phocoena phocoena*) (*JNCC, 2017*)	36,927.9	12,138.8	32.9%
Scenario 4: October to December				
Markham's Triangle rMCZ	Broad-scale habitats: Subtidal coarse sediment, Subtidal sand	200.1	200.1	100.0%
Dogger Bank MPA / SAC	Annex I Habitat: Sandbanks which are slightly covered by seawater all the time (*JNCC, 2018*)	12,331.3	8,092.6	65.6%
North Norfolk Sandbanks and Saturn Reef SAC	Annex I Habitat: Sandbanks which are slightly covered by seawater all the time, Reefs (in particular *Sabellaria spinulosa* reefs) (*JNCC, 2018c*)	3,603.5	2,879.3	79.9%
Southern North Sea cSAC and MPA	Annex II species: Harbour porpoise (*Phocoena phocoena*) (*JNCC, 2017*)	36,927.9	12,862.2	34.8%

Figure 7.3. Diesel stochastic spill modelling results; Probability of surface oiling above a threshold of 0.3 µm thickness overlaid onto protected areas

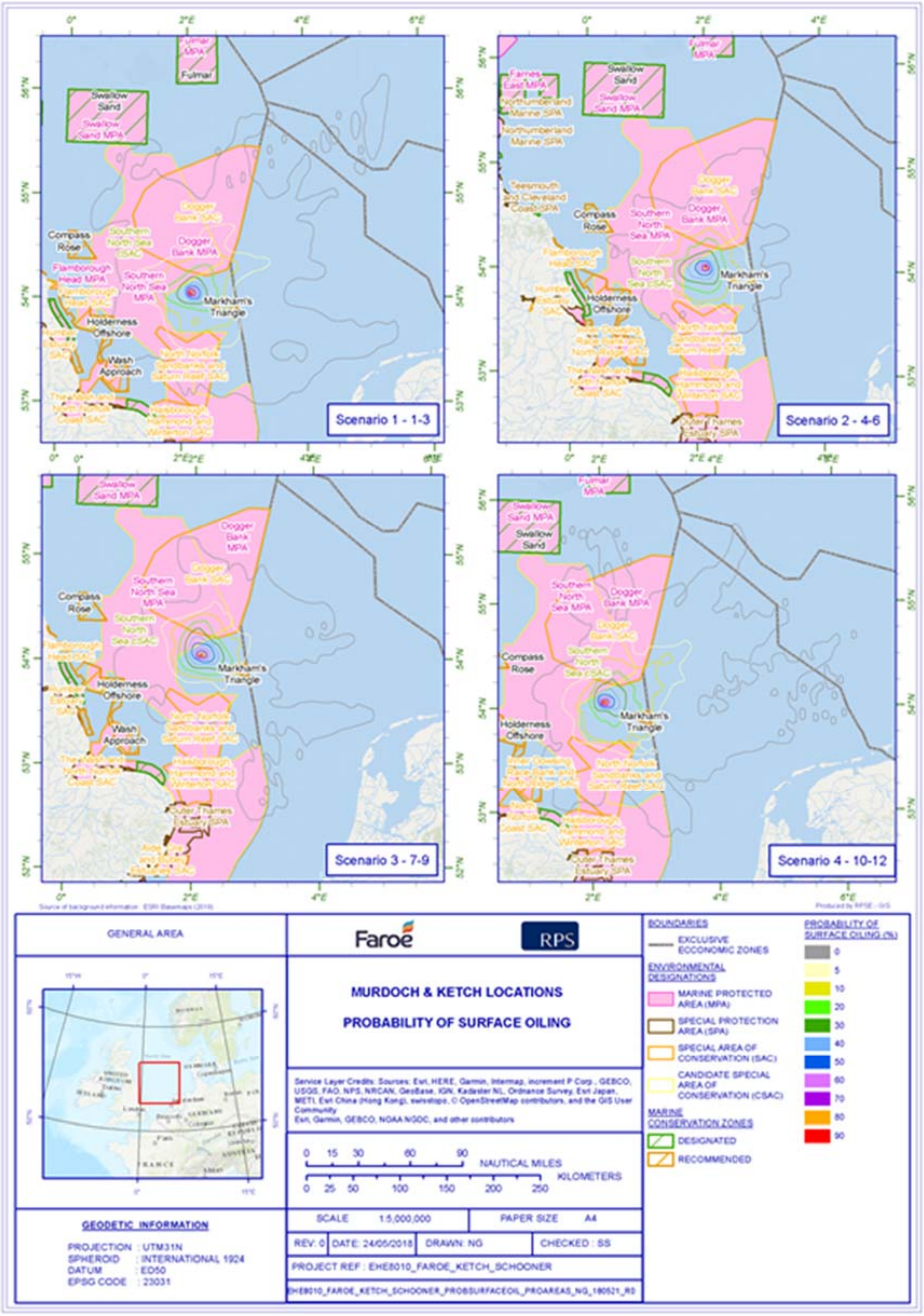


Figure 7.4. Diesel stochastic spill modelling results; Minimum arrival time of surface oiling above a threshold of 0.3 µm thickness overlaid onto protected areas

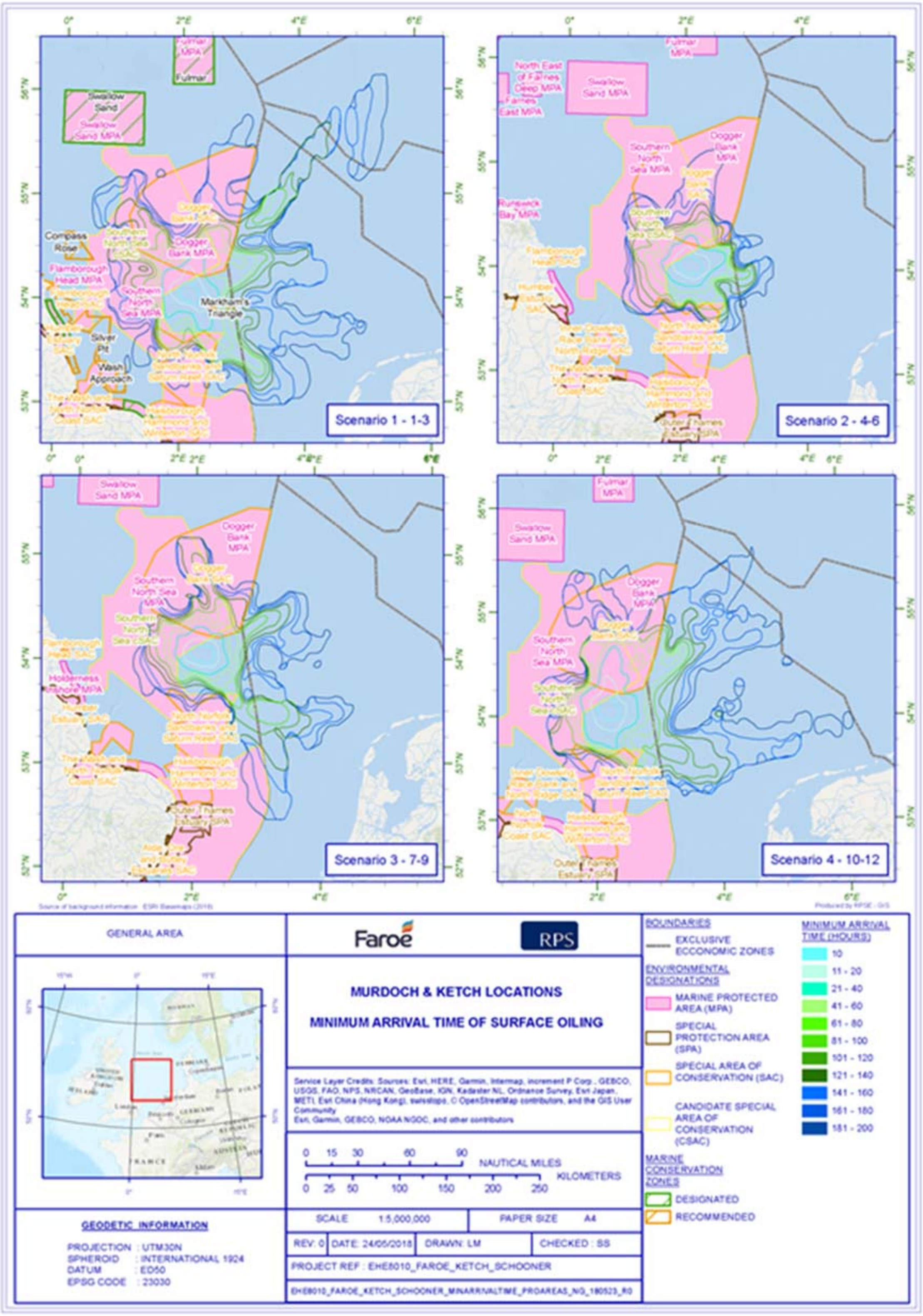
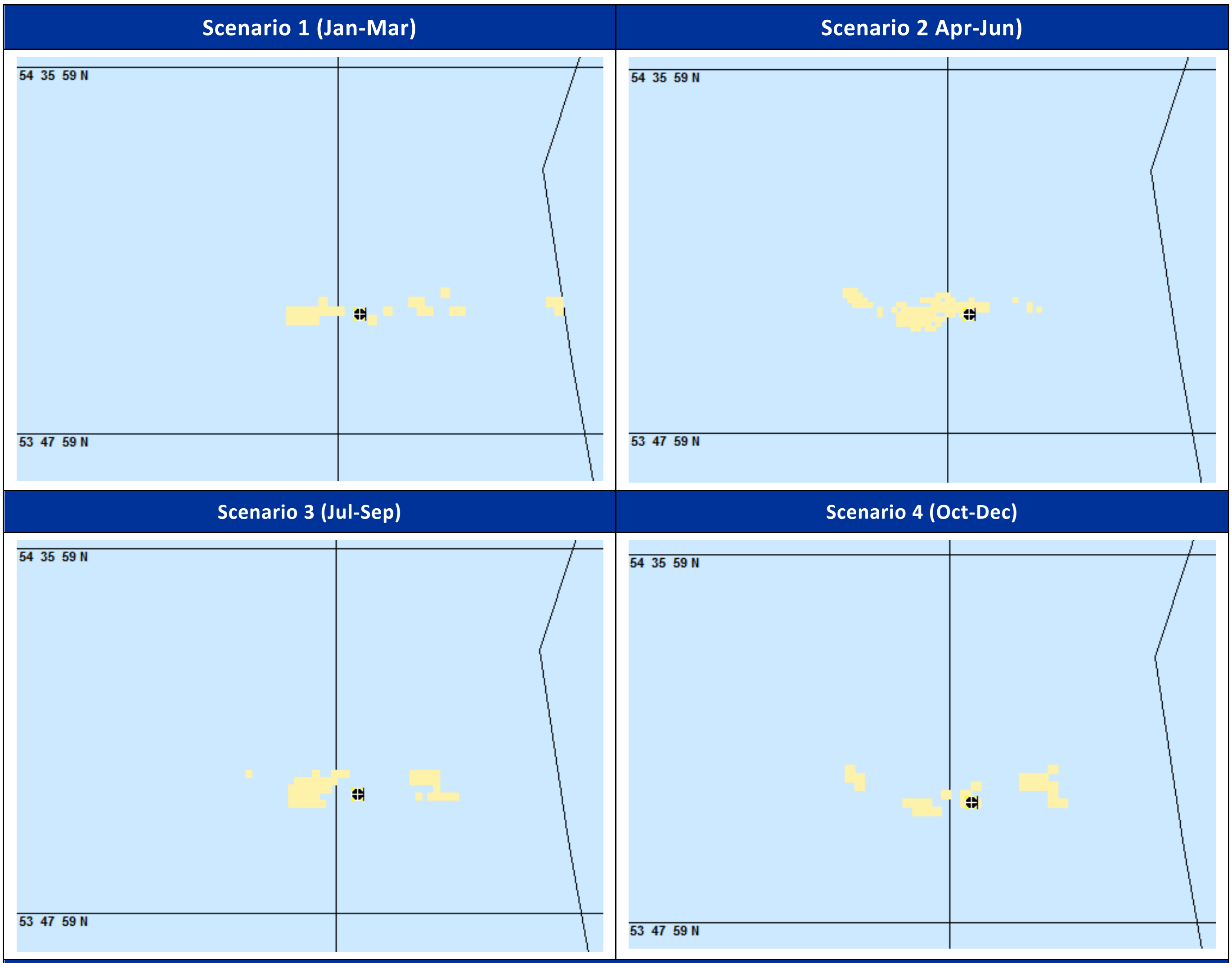


Figure 7.5. Diesel stochastic spill modelling results; Probability of Total Hydrocarbon (TH) water column concentration greater than 1 part per billion (ppb) near the seabed (70 metres water depth)


Scenario 1 (Jan-Mar)

Scenario 2 Apr-Jun)

Scenario 3 (Jul-Sep)

Scenario 4 (Oct-Dec)

Key: Probability of sub-surface oiling (%) above a threshold of 1 ppb near the seabed (70 metres water depth)

🟨	🟨	🟩	🟩	🟪	🟦	🟪	🟪	🟧	🟥
0->10	10->20	20->30	30->40	40->50	50->60	60->70	70->80	80->90	90->100

7.1.2.1 Potential Trans-boundary Impacts

The modelling predicts that the oil has the potential to cross various median lines (Table 7.2). The spring and summer scenarios predict that surface oil will cross the UK/Netherlands median line in minimum times of 2 days 2 hours and 2 days 22 hours (respectively), each with a probability of surface oiling lying between 0 and 10%. The autumn scenario predicts that surface oil will cross the UK/Netherlands median line in a minimum time of 1 day 6 hours, the UK/Germany median line in 7 days 2 hours and the Germany/Denmark median line in 8 days 8 hours, each with a probability of surface oiling lying between 0 and 10%. The winter scenario predicts that surface oil will cross the UK/Netherlands median line in 1 day 16 hours, the UK/Germany median line in 5 days 0 hours and the

UK/Denmark median line in 5 days 20 hours, each with a probability of surface oiling lying between 0 and 10%.

In the event of a spill entering the waters of either The Netherlands, Denmark, or Germany it will be necessary to implement the Bonn Agreement. The Bonn Agreement sets out the mechanism by which North Sea States and the European Community work together to combat pollution in the North Sea area from maritime disasters and chronic pollution from ships and offshore installations. It also recommends the command structure and operational co-ordination between the parties. The relevant Oil Pollution Emergency Plan (OPEP) for the decommissioning project will therefore need to provide details of Bonn Agreement and how this is activated through the UK National Contingency Plan (*MCA, 2017*).

7.1.3 Conclusions

In summary, the modelling has shown that in the event of a worst-case hydrocarbon release (inventory loss from the decommissioning vessel), the diesel would weather offshore in the waters immediately surrounding the well location. Diesel is not predicted to beach in any scenario. Significant impacts on fish and seabird species are not expected. The impact on offshore designated sites is expected to be low given the very low probability of surface oiling (0-10% range) over the clear majority of the sites (Figure 7.3), and the fact that most protected features are on the seabed where minimal impacts are expected from a surface oil spill. The impact on offshore protected species (harbour porpoise – associated with the Southern North Sea cSAC and MPA) is also expected to be low given the avoidance behaviour that marine mammals in general show towards oil spills. Oil does have the potential to cross various median lines, albeit at very low probabilities.

The conclusions drawn in the ENVID (refer to Section 4.1.7) therefore remain valid and the mitigations defined therein remain valid and appropriate to mitigate the environmental risks of a worst-case hydrocarbon release to a low level during the decommissioning project.

7.2 The Offshore Safety Directive

The Offshore Installations (Offshore Safety Directive) Safety case etc) Regulations 2015 require confirmation that the likelihood of a Major Environmental Incident (MEI) has been identified and its environmental consequences assessed.

For the decommissioning project, one worst-case hydrocarbon release scenario was defined and modelled based on Major Accident Hazard (MAH) scenario:

- Loss of diesel inventory of the decommissioning vessel due to a collision which has the potential to reach offshore SACs.

Based on the oil spill modelling conducted and the assessment of the modelling results presented in section 7.1, this scenario was not identified as a potential MEI. The spill modelling has played a key part in the MEI identification process. The MAH and likelihood of a MEI for the well plug and abandonment phase will be considered in the well notification and safety case submissions.

8 Cumulative Impacts

This section identifies and assesses the potential cumulative impacts from the proposed decommissioning project and other activities in the vicinity. Cumulative impacts are those that may result from the combined or incremental effects of past, present or future activities. While a single activity may not have a significant impact when treated in isolation, it may, when combined with other impacts occurring at the same time and in the same geographical area, result in a cumulative impact that is significant. There are three main areas that do have the potential for cumulative impacts which are discussed in this section:

- Physical presence;
- Seabed disturbance; and
- Underwater noise.

8.1 Physical Presence

8.1.1 Fisheries

Section 3.4.1 describes commercial fishing activities in the vicinity of the proposed decommissioning project as generally low, increasing to moderate during August and September, targeting demersal and shellfish species. In this area, fisheries tend to target sandeel populations and are largely focused on the Dogger Bank during the summer months (*Rogers & Stocks, 2001*).

The vessels and associated operating corridors during the decommissioning project will represent only temporary obstructions to fishing activities during the project and are not significantly over and above the existing obstruction represented by the Schooner and Ketch platforms themselves. The removal of the platform jackets and topsides will indeed increase the sea area available for fishing once the project is completed. In addition, the project is located on the edge of the Dogger Bank area away from where the majority of fishing activity in the vicinity is focused.

Although there is the possibility that the Murdoch platform may be decommissioned at the same time as the proposed decommissioning project, the scopes of work will be similar both spatially and temporally and will not result in significant cumulative impacts to the fishing industry. Cumulative impacts on the fishing industry from physical presence are therefore not expected.

8.1.2 Shipping

Section 3.4.2 describes shipping activity in the vicinity of the proposed decommissioning project as relatively high, with a number of main routes passing within the vicinity of the Schooner and Ketch platforms. However, significant cumulative impacts on shipping from the decommissioning project from the vessels and the associated operating corridors are not significant as these routes do not pass sufficiently close to the platforms to cause a significant impact. There are also no significant cumulative impacts on shipping from seabed disturbance with other projects; Although there is the possibility that the Murdoch platform may be decommissioned at the same time as the proposed decommissioning project, this will not result in any significant additional obstruction to shipping that the Murdoch platform already represents. Cumulative impacts on shipping from the physical presence of the project are therefore not expected.

8.1.3 Oil and Gas

Section 3.4.4 describes oil and gas activity near the decommissioning project as moderate compared to other blocks to the north-east. Figure 8.1 shows the oil and gas infrastructure in the vicinity of the proposed decommissioning project.

No detrimental impacts on the offshore oil and gas industry as a result of the physical presence of the vessels and their operating corridors are expected. The oil and gas industry in the wider area is mature and is well used to oil and gas activities taking place simultaneously in neighbouring fields. Cumulative impacts on the oil and gas industry as a result of the physical presence of the decommissioning project are therefore not expected.

8.2 Seabed Disturbance

The impact assessment presented in section 5 has made a full assessment of the areas of seabed disturbance estimated (on a worst-case basis) to be impacted by the proposed decommissioning project. The results of this assessment are summarised in Table 8.1.

Table 8.1. Estimated areas of seabed disturbance associated with the proposed decommissioning project (summarised from section 5)

Area	Total area (km^2)	Area within Dogger Bank SAC/SCI (km^2)	% area of Dogger Bank SAC/SCI
Estimated temporary area of seabed impacted	4.51	0.51763	0.0042%
Estimated permanent area of seabed impacted	0.02395	0.00242	0.00002%

8.2.1 Fisheries

Whilst there will be some potential obstruction to fishing operations during the decommissioning project, the areas of seabed disturbed will not result in a significant cumulative impact on the fishing industry as access to the seabed for fishing will be restored following the completion of the project. There are also no significant cumulative impacts on the fishing industry from seabed disturbance with other projects.

8.2.2 Oil and Gas

Whilst the decommissioning project itself will increase the cumulative level of oil and gas activity in the wider area, no cumulative impacts from seabed disturbance are expected as the areas of seabed disturbed by the project are very small (refer to Table 8.1) and do not represent a significant incremental increase in seabed disturbance when compared to existing oil and gas infrastructure.

Table 8.2. Marine aggregate and offshore wind farm sites shown on the extent of Figure 8.2 (The Crown Estate, 2018)

The Crown Estate Marine Aggregate Sites			
Area Name	**Company and Area No.**	**Type**	**Area (km^2)**
Humber 5	DEME Building Materials Ltd (483)	Aggregate Application Area	28.2
Humber Estuary	Hanson Aggregates Marine Ltd (106/1)	Aggregate Production Area	3.9
Humber Estuary	Hanson Aggregates Marine Ltd (106/2)	Aggregate Production Area	3.2
Humber Estuary	Hanson Aggregates Marine Ltd (106/3)	Aggregate Production Area	35.4
Off Saltfleet	Tarmac Marine Ltd (197)	Aggregate Production Area	26.2
Humber Estuary	Hanson Aggregates Marine Ltd (400)	Aggregate Production Area	14.3
Inner Dowsing	Tarmac Marine Ltd (481/1)	Aggregate Production Area	6.1
Inner Dowsing	Tarmac Marine Ltd (481/2)	Aggregate Production Area	1.9
Humber 3	DEME Building Materials Ltd (484)	Aggregate Production Area	17.2
Humber Overfalls	Tarmac Marine Ltd (493)	Aggregate Production Area	12.1
Humber 4 and 7	DEME Building Materials Ltd (506)	Aggregate Production Area	51.2
Humber 1	CEMEX UK Marine Ltd (514/1)	Aggregate Production Area	16.7
Humber 2	CEMEX UK Marine Ltd (514/2)	Aggregate Production Area	9.5
Humber 3	CEMEX UK Marine Ltd (514/3)	Aggregate Production Area	4.2
Humber 4	CEMEX UK Marine Ltd (514/4)	Aggregate Production Area	22.0
Outer Dowsing	Westminster Gravels Ltd (515/1)	Aggregate Production Area	33.6
Outer Dowsing	Westminster Gravels Ltd (515/2)	Aggregate Production Area	26.2
		Total:	**311.7**

The Crown Estate Offshore Wind Farm Sites			
Name	**Company**	**Status**	**Area (km^2)**
Sheringham Shoal	SCIRA Offshore Energy Limited	Active/In Operation	35.0
Lincs	Lincs Wind Farm Limited	Active/In Operation	36.9
Dudgeon	Dudgeon Offshore Wind Ltd	Under Construction	55.1
Race Bank	Race Bank Wind Farm Limited	Under Construction	62.3
Humber Gateway	E.ON Climate & Renewables UK Humber Wind Limited	Active/In Operation	26.0
Westermost Rough	Westermost Rough Ltd	Active/In Operation	34.5
Lynn	Lynn Wind Farm Ltd	Active/In Operation	7.9
Inner Dowsing	Inner Dowsing Wind Farm Ltd	Active/In Operation	8.8
Hornsea Project Two (HOW02)	Breesea Limited	Consented	461.8
Hornsea Project Four (HOW04)	Orsted Hornsea Project Four Limited	Pre-planning Application	845.8
Hornsea Project Three (HOW03)	Orsted Hornsea Project Three (UK) Limited	Pre-planning Application	695.7
East Anglia North Tranche 2 (Norfolk Boreas)	Vattenfall Wind Power Ltd	Pre-planning Application	724.6
East Anglia North Tranche One West (Norfolk Vanguard West)	East Anglia FOUR Limited	Pre-planning Application	294.9
Hornsea Project One - Heron East	Hornsea 1 Limited	Under Construction	129.2
Hornsea Project One - Heron West	Hornsea 1 Limited	Under Construction	119.0
Hornsea Project One - Njord	Njord Limited	Under Construction	158.7
Triton Knoll	Triton Knoll Offshore Windfarm	Consented	149.4
		Total:	**3,845.5**

8.2.3 Other Industries

Figure 3.7 shows offshore wind and marine aggregate activities in relation to the proposed decommissioning project. There is a major offshore wind site located 11.5 km from the Schooner platform - the Hornsea 1 offshore wind farm site. To the south of the proposed decommissioning project there are also a number of marine aggregate production areas and one marine aggregate application area. Table 8.2 lists the offshore wind and marine aggregate sites shown on the extent of the map in Figure 3.7, Section 3.

The seabed footprint of these areas as shown in Table 8.2 is 1,284.5 km^2 for all offshore wind farm areas marked as consented, active or under construction (excluding export cable routes), and 311.7 km^2 for all marine aggregate production and application areas. This can be considered as the worst-case area of seabed disturbance, assuming all of the seabed within these licensed areas is or will be disturbed by the relevant activity. These represent very large areas when compared to the estimated temporary and permanent areas of seabed disturbance of the decommissioning project shown in Table 8.1. Any further increase in seabed disturbance in the wider area therefore has the potential to be significant.

However, the majority of seabed disturbance from the decommissioning project is temporary in nature (4.51 km^2). The estimated area of permanent seabed disturbance (0.02395 km^2) is very small and represents a very small incremental increase in the seabed disturbance in the wider region in combination with the offshore wind and marine aggregates areas (Figure 3.7, Section 3 and Table 8.2). Significant cumulative impacts on seabed disturbance with the offshore wind and marine aggregates industries are therefore not expected.

8.2.4 Potential Cumulative Impacts on SACs

The pipeline decommissioning activities at the Murdoch platform end fall within the Dogger Bank SAC/SCI. However, the areas of seabed estimated (on a worst-case basis and including overtrawl as a worst case) to be subject to temporary and permanent disturbance within the Dogger Bank SAC/SCI are very small (0.51763 km^2 and 0.00242 km^2 respectively; refer to Table 8.1). These represent 0.0042% and 0.00002% of the total area of the Dogger Bank SAC/SCI respectively. In isolation, the significance of any impact from the temporary and permanent disturbance of the seabed from the proposed decommissioning project has been assessed as ‘low’ (Section 5). However, consideration of potential cumulative or in-combination effects from other activities and developments in the area is required by current EIA guidance (BEIS, 2017b). Given that seabed disturbance would occur in the Dogger Bank SAC/SCI, designated for the protection of the Annex I seabed habitat ‘Sandbanks which are slightly covered by seawater all the time’, a wider assessment of seabed disturbance within the SAC is necessary.

8.2.4.1 Other Industries

Figure 3.7 shows offshore wind and marine aggregate activities as well as subsea cables that are located within the Dogger Bank SAC/SCI.

The consented Dogger Bank Creyke Beck A and B, and Dogger Bank Teeside A and B wind farms are located to the north of the proposed decommissioning project, inside the Dogger Bank SAC/SCI, but construction has not yet commenced. It is currently not known when construction of these wind farms will commence. Typically, onshore construction commences first, with offshore construction typically beginning a year or more later. Indications are that the earliest construction will commence is 2020, and it is therefore possible that early offshore construction may overlap with the proposed decommissioning project operations. The area of seabed that will be permanently disturbed by these wind farm developments is summarised in Table 8.3, based on the use of monopile foundations.

Table 8.3. Permanent seabed disturbance from consented wind farm infrastructure within the Dogger Bank SAC/SCI (Forewind, 2013;2014)

Wind Farm	**Area permanently disturbed (km^2)**
Creyke Beck A	3.60
Creyke Beck B	3.48
Teesside A	2.79
Teesside B	2.79
Total	**12.66**

The JNCC (2018a) note that there is a proposal for licensing two areas for marine aggregate extraction which overlap with the Dogger Bank SAC/SCI. Data showing the current location and extent of aggregate exploration and licence areas does not indicate activity in the SAC/SCI (Crown Estate, 2018), however, these areas may be subject to activity in the future.

Five subsea telecommunications cables pass through the Dogger Bank SAC/SCI, TATA North Europe, MCCS, NorSea Comm 1 (Tampnet), UK-Denmark 4 (disused) and UK-Germany 6 (disused). The approximate combined length of all cables within the SAC/SCI is 376.63 km. Assuming a maximum cable diameter of 50 mm (KIS-ORCA, 2018), then the total area of permanent impact is 0.01883 km^2.

8.2.4.2 Oil and Gas

Figure 3.8 shows the oil and gas activity present within the Dogger Bank SAC/SCI, primarily in the south of the protected area where there are a number of existing platforms, pipelines and other subsea infrastructure.

As well as existing infrastructure, a number of oil and gas licence blocks in the southern and central area of the SAC/SCI have been provisionally awarded in the 30th Round for future exploration and development (OGA, 2018).

There are currently 13 platforms installed within the Dogger Bank SAC/SCI; these are:

- Cygnus A (three bridge-linked platforms) (Block 44/12) and B (Block 44/11);

- Cavendish (Block 43/19);
- Katy (Block 44/19);
- Kelvin (Block 44/18);
- Munro (Block 44/17);
- Murdoch (three bridge-linked platforms) (Block 44/22);
- Tyne (Block 44/18); and
- Wingate (Block 44/24)

A draft DP is under consideration for the decommissioning of Perenco's Tyne South Installations. Removal to shore of the Tyne platform and site clearance activities are anticipated at some point between approval of the Decommissioning Programme and Q4 2020 (Perenco, 2018).

Faroe are also aware that Conoco Phillips are planning to decommission the Caister Murdoch System (CMS) through which the Schooner and Ketch produced gas and condensate is processed. Currently there is no draft or approved DP for the decommissioning of the Conoco CMS and therefore the proposed schedule of operations is unknown.

The average footprint of the four Cygnus platforms is 662.5 m^2 each (GDF Suez, 2011). Using this as a proxy for all platforms, the total permanent footprint of platforms in the SAC/SCI is calculated as 8,612.5 m^2 or 0.00861 km^2. It should be noted that this is a conservative estimate, given that all platforms are of a jacket construction with individual legs which do not cover the whole of the seabed underneath the platform.

Using Geographic Information Systems (GIS) data (UKOilandGasData.com, 2018), 33 items of existing subsea infrastructure (excluding pipelines) have been identified within the Dogger Bank SAC/SCI. These are of varying sizes and include manifolds, SSIVs, drilling templates, skids, tees and wellheads. All of these have a permanent impact on the seabed. Assuming an average footprint of 0.00017 km^2 (based on a maximum and minimum size from the Cygnus and Katy developments, see GDF Suez, 2011; ConocoPhilips, 2011), then the total potential area of permanent impact from existing subsea infrastructure is 0.00554 km^2.

There is a total of 47 different existing pipelines/flowlines within or traversing the Dogger Bank SAC/SCI. Of these, 40 are noted as being active, two are in pre-commissioning and five are abandoned (UKOilandGasData.com, 2018). Using GIS data and analysis, it has been calculated that the total length of the pipelines/flowlines within the SAC/SCI is 679.90 km. The largest of these is the Shearwater to Bacton (Shearwater Elgin Area Line - SEAL) pipeline (PL1570) which runs between the Shell operated Shearwater and Elgin Franklin platforms and the Bacton gas terminal on the Norfolk coast. It has a diameter of 44" (112 cm) and is surface laid. The remaining pipelines are assumed to be trenched and buried.

Rock cover and other protection and stabilisation features will also have been installed at certain locations along these pipelines (e.g. pipeline crossings and trench transitions) although the exact volume and footprint of these is not known. For the Cygnus Field Development, the footprint of each pipeline crossing was calculated as 0.00336 km^2 (320 m x 10.5 m) (GDF Suez, 2011).

Using GIS, six crossings have been identified for the existing pipelines within the Dogger Bank SAC/SCI. Taking the Cygnus Field Development crossings footprint as a proxy, it can be estimated that a total area of approximately 0.02016 km^2 is permanently impacted by rock cover at the pipeline crossings. Contingency spot rock cover may also have been used along the length of each pipeline to provide additional protection and stabilisation. It is expected that this has been minimised, and exact quantities used are only known following post-lay pipeline surveys. Assuming that as a worst case 10% of each pipeline length required spot rock cover to a width of 7 m (ConocoPhilips, 2011), then excluding the Shearwater to Bacton line (which is surface laid), the total length of pipeline potentially having spot rock cover can be estimated as approximately 60.32 km with a total potential permanent impact area of 0.42223 km^2. The Shearwater to Bacton line within the SAC/SCI is 76.72 km in length and 0.00112 km diameter. The area of impact of this pipeline is calculated to be 0.08593 km^2.

The total area permanently impacted by existing pipelines and associated protection materials within the Dogger Bank SAC/SCI is therefore estimated to be approximately 0.54247 km^2, as summarised in Table 8 4.

Table 8.4. Permanent seabed disturbance from existing oil and gas infrastructure within the Dogger Bank SAC/SCI

Source	Area permanently disturbed (km^2)
Platforms	0.00861
Subsea infrastructure	0.00554
Pipelines (trenched and buried) crossings	0.02016
Pipelines (trenched and buried) spot rock cover	0.42223
Pipelines (surface laid)	0.08593
Total	**0.54247**

The area of the Dogger Bank SAC/SCI is 12,331 km^2 (JNCC, 2018a). The total area of the SAC estimated to be permanently impacted by existing oil and gas infrastructure (0.54247 km^2) accounts for approximately 0.0044% of the SAC/SCI. Combined with the area of permanent disturbance from the proposed decommissioning project (0.02395 km^2) this would increase to approximately 0.0046% of the SAC/SCI. It is assumed that seabed communities will have recovered from temporary disturbance associated with the installation of existing oil and gas infrastructure.

8.2.4.3 Summary

Proposed decommissioning activities will increase the footprint of seabed permanently disturbed within the Dogger Bank SAC/SCI (Table 8.5).

Table 8.5. Cumulative permanent seabed disturbance within the Dogger Bank SAC/SCI

Source	Area permanently disturbed (km^2)	Percentage of SAC/SCI
Schooner and Ketch proposed decommissioning project	0.02395	0.00002 (existing)
Offshore windfarms	12.66	0.1027 (planned)
Other oil and gas infrastructure	0.54247	0.0044 (existing)
Telecommunications cables	0.01883	0.0002(existing)
Total	**13.2452**	**0.1073**

Based on the information available, the area of seabed permanently disturbed by the proposed decommissioning project within the SAC/SCI represents a fraction (approximately 4%) of the existing area of permanent disturbance within the SAC/SCI, constituting approximately 0.00002% of the protected area (Table 8.5). Furthermore, permanent seabed disturbance from the proposed decommissioning project will be only 0.19% of that associated with the consented wind farms in the Dogger Bank SAC/SCI.

Given the small area of permanent seabed disturbance relative to the extent of seabed habitats in the Dogger Bank SAC/SCI and wider SNS, the significance of the cumulative impact associated with permanent disturbance of seabed communities has been assessed as low.

8.3 Underwater Noise

The cumulative impact of increased background noise levels in the marine environment is an ongoing and widespread issue of some concern. Criteria for establishing acceptable limits for cumulative impact of underwater noise have not yet been defined (*DECC, 2016*). The decommissioning project will generate underwater noise from a variety of activities (refer to section 6.3). Potential impacts from underwater noise sources are fully described and assessed in section 6.

The underwater noise assessment has taken into consideration that a number of operating scenarios may exist for the decommissioning operations, which may combine a number of noise sources (section 6.4). Therefore, cumulative effects from the decommissioning project noise sources themselves have already been assessed as per best industry practice as part of the noise assessment.

The underwater noise modelling has shown that there is no risk of permanent injury to either marine mammals or fish species resulting from any of the continuous noise sources (refer to section 6.9). The noise modelling has also provided an assessment of behavioural disturbance. For fish species for continuous sounds, only fish species with swim bladders are at high risk of behavioural effects and often only within tens of metres from the source, but potentially out to 468 m (refer to section 6.7). For marine mammals for continuous sounds, a range of mild disturbance distances are predicted by the noise modelling and range from 313 m (noise from MODU/JUB – refer to section 6.7.1.2) to 16.3 km (all sound sources combined for phase 2 noise associated with jacket structure abrasive jet cutting - refer to section 6.7.3.2). Cumulative behavioural impacts on fish and marine mammal species from passing vessels are therefore possible but are not expected to be significant. The safety exclusion zone around the platforms will prevent passing vessels approaching within 500 metres, which will help to mitigate any cumulative behavioural impact, as the cumulative effects of the underwater sound are then reduced.

The underwater noise modelling has shown that from single pulse noise sources (associated with the use of explosive charges), injury ranges for marine mammals are predicted within 4 156 m to 2.7 km (Table 6.13 in section 6.7.2.1), whilst disturbance ranges are predicted within 36 m to 4.9 km (Table 6.14 in section 6.7.2.2) of the noise source. Injury ranges for fish are predicted within 172 m of the noise source for fish with or without a swim bladder and within 500 m of the noise source for eggs and larvae (Table 6.16 in section 6.7.2.3).

8.3.1 Wind Farms

At the present time, the Hornsea 1 offshore wind farm is under construction which lies 27.5 km from the Ketch platform and 11.5 km from the Schooner platform at the closest point (see Figure 3.7). The consented Hornsea 2 offshore wind farm site is located 27.5 km from the Ketch platform and 7.3 km from the Schooner platform, and is due to commence construction in 2020 (*Ørsted Hornsea Project 3 Ltd., 2018*). There is the potential for the temporal overlap of the decommissioning project with the construction periods for both Hornsea 1 and Hornsea 2.

Hornsea 1 and Hornsea 2 are utilising piles for the construction of the wind turbine foundations, the installation of which will create underwater noise. These have the potential to create a cumulative impact in combination with the activities at the decommissioning project, assuming that the construction phase of Hornsea 1 is still ongoing at the time of the decommissioning project and that the construction phase of Hornsea 2 has commenced at the time of the decommissioning project. The noise modelling undertaken for the piling operations at Hornsea 1 and Hornsea 2 has been consulted. The estimated areas of impact for the highest energy pile hammer types that could be used for pile driving during construction at Hornsea 1 (Smartwind, 2013) and Hornsea 2 (Smartwind, 2015) are presented in Table 8.6.

Table 8.6. Estimated Impact Ranges for Pile Driving during Construction at Hornsea 1 and Hornsea 2 windfarms

Windfarm	Hammer Energy (KJ)	Species	Instantaneous Injury range	Fleeing/ Startle Response	Possible Avoidance of Area (marine mammals)/ General Behavioural Response (fish) (km)
Hornsea 1	2,300	Harbour porpoise	<600 m	<4.6 km	28.8 – 46.6
		Mid Frequency Cetaceans	<50 m	<100 m	7.1 – 7.7
		Low Frequency Cetaceans	<50 m	<300 m	31.7 – 57.5
		Fish (Pelagic)	<150 m	<500 m	11.9 – 27.9
		Fish (Demersal)	<150 m	<500 m	9.5 – 21.2
Hornsea 2	3,000	Harbour porpoise	Mitigated by soft-start (<1 km)[1]	5 – 7 km	29 - 62
		Mid Frequency Cetaceans	Mitigated by mitigation zone (< 500 m)[2]	<500 m	8 - 11
		Low Frequency Cetaceans	Mitigated by mitigation zone (< 500 m) [3]	<500 m	36 - 82
		Fish	<200 m	<600 m	13 - 34

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1 Assumes a fleeing animal and a 500 m mitigation zone (JNCC, 2010).

2 Assumes a 500 m mitigation zone is employed (JNCC, 2010)

3 Assumes a 500 m mitigation zone is employed (JNCC, 2010)

Based on the distances of the Hornsea 1 site (27.5 km and 11.5 km from Ketch and Schooner, respectively) and the Hornsea 2 site (27.5 km and 7.3 km from Ketch and Schooner, respectively) from the decommissioning project and the noise assessment results for both single pulse noise sources (use of explosives for jacket cutting) and continuous noise sources (jacket severance utilising abrasive jet cutting, HLV, barges, supply vessels) (section 6) and the estimated impact ranges for pile driving at the windfarms (Table 8.3). No cumulative impact is expected with regard to injury but there is a potential cumulative impact with regard to disturbance to all species (apart from possible avoidance of area/general behavioural response by mid frequency cetaceans in relation to Hornsea 1 piling and the Ketch installation decommissioning noise as the piling response range is less than the distance of Ketch from Hornsea 1). Given that the calculated possible avoidance of area/general behavioural response ranges calculated for both Hornsea 1 and Hornsea 2 windfarms, for all species, are greater than the distance to the Ketch and Schooner installations there is a potential for in combination noise impacts between the decommissioning project and Hornsea 1 and Hornsea 2 windfarms.

Marine mammal and fish species are highly mobile meaning they are not restricted to the possible area of avoidance. Their occurrence in the vicinity is also seasonal whereby they may or may not be present at the time of the operations. Cumulative behavioural impacts on fish and marine mammal species from these activities are possible but are not expected to be significant.

8.3.2 Oil and Gas

There is the possibility that the Murdoch platform may be decommissioned at the same time as the proposed decommissioning project. For the purposes of this assessment, the scopes of work (and hence the activities with the potential to create underwater noise) are expected to be similar. The Murdoch platform is located approximately 26 km and 28 km from the Schooner and Ketch platforms respectively. Due to the distances and based on the noise modelling results for continuous and single impulse noise sources (as discussed above), there is not expected to be any potential for cumulative noise impacts from the potential interaction between the decommissioning project and possible decommissioning activities at the Murdoch platform.

8.3.3 Potential Cumulative Impacts on Annex II Species, Harbour Porpoise

The Southern North Sea cSAC and MPA is located approximately 12 km north of the Schooner (see Figure 3.4) installation and has been identified as an area of importance for the Annex II species, harbour porpoise. Both the Hornsea 1 and Hornsea 2 offshore wind farms are located within the Southern North Sea cSAC and MPA. There is potential for noise generating activities associated with the decommissioning project to cause an in-combination impact with noise generated from other industries (e.g. consented windfarms) and other decommissioning projects on the harbour porpoise. The potential injury zones calculated by the noise modelling for the noise generated during the different phases of the decommissioning project fall outwith the boundary of the site and therefore no cumulative injury impact on harbour porpoise is anticipated.

A potential maximum mild disturbance range for harbour porpoise of 16.3 km was calculated from the noise modelling due to all noise sources associated with jacket severance using abrasive jet cutting. Given the Schooner installation is located approximately 12 km from the Southern North Sea cSAC boundary it is possible that harbour porpoise within the site could experience mild disturbance. It is acknowledged that noise sources associated with the Hornsea 1 and Hornsea 2 windfarms and other oil and gas decommissioning activity in the vicinity (see section 3.4.4) may cause some displacement of harbour porpoise from particular areas similar to how disturbance is expected as a result of the jacket severance using abrasive jet cutting. It is out with the scope of this EA to carry out a comprehensive assessment of all noise sources in the wider area to determine the overall in combination effects on harbour porpoise. However, given the short duration of the individual sources of noise associated with the decommissioning project activities and the mitigation and control measures proposed in Section 6.8 any in combination effects resulting from the underwater noise generated from the proposed decommissioning project are not considered significant.

8.4 Mitigation and Control Measures

Given the assessment of potential cumulative impacts conducted above, although there are potential cumulative impacts arising from seabed disturbance and underwater noise, the risks are low and are considered to be acceptable. Therefore, no additional mitigation measures for cumulative impacts are required.

9 Conclusions

Faroe plan to decommission the Schooner field facilities and Ketch field facilities in tandem between 2018 and 2024. Both the Schooner and Ketch platforms and the NW Schooner wellhead and integral protection structure will be completely removed and transported to onshore. The CA for both Schooner and Ketch pipelines concluded that only the section of pipelines, mattresses and grout bags that form the Caister pipeline's crossing adjacent to the Murdoch platform (the final 60m of the pipelines before the Murdoch platform) will be removed and transported to onshore (Faroe, 2018d), with the remainder of both pipelines being decommissioned in-situ. The entire Ketch pipeline will be trenched and buried prior to being decommissioned *in-situ*. Decommissioning of items *in-situ* will be subject to the results of an over-trawl assessment to ensure they do not present a snagging hazard.

This EA report documents the results of the EA process undertaken to consider the impact of the planned activities and possible accidental events associated with the decommissioning of the Schooner field facilities and Ketch field facilities. The impact was determined considering each of the planned activities and assessing the level of environmental risk using a standard risk assessment methodology. An ENVID workshop was undertaken to determine the level of environmental risk of all project aspects, taking existing control and mitigation measures into consideration. The level of environmental risk was assessed as 'low' and not significant except for disturbance to the seabed, underwater noise and accidental events from a large spill.

Following further assessment, including an oil spill modelling study, and implementation of additional control and mitigation measures where necessary, the level of environmental risk from disturbance to the seabed, underwater noise and accidental events from a large spill was determined to be 'low' and not significant. In addition, the cumulative impact from seabed disturbance and underwater noise was assessed and determined to be 'low' and not significant.

9.1 Environmental Management

Faroe's existing Environmental Management System (EMS) was audited in March 2017, and was granted verification as meeting the requirements of an EMS in relation to OSPAR Recommendation 2003/5. Faroe will ensure that the decommissioning activities will be integrated into, and carried out in accordance with, the company EMS. The EA process has concluded that the activities associated with the decommissioning of the Schooner field facilities and Ketch field facilities are unlikely to significantly impact the environment if control and mitigation measures are effectively applied. A summary of the control and mitigation measures is presented in Table 9.1.

Table 9.1 Control and Mitigation Measures

General and Standard mitigation/ control measures
All contracted vessels will have a ship-board oil pollution emergency plan (SOPEP) in place.
All contracted vessels will operate in line with IMO regulations and MARPOL regulations.
Existing processes and procedures will be implemented for contractor management to manage environmental risks.
A contract with an oil spill response organisation will be in place to ensure a timely and efficient mobilisation of oil spill response resources and competent response personnel.
The Schooner and Ketch existing field OPEP is one of the controls included to reduce the likelihood of a large hydrocarbon release and to mitigate the impact should a release occur.
500m safety zone around NUIs already in place and patrol of safety zone by ERRV. ERRV will have Automatic Radar Plotting Aid (ARPA) in place.
Consent to Locate approved and in place prior to operations commencing. Any necessary variations to the existing Schooner and Ketch Platforms Consent to Locates will be in place to cover all phases of the decommissioning operations.
All contracted vessels will have an appropriate communication system onboard.
A Collision Risk Management Plan will be developed and implemented.
A Notice to Mariners and Kingfisher Bulletins will be issued prior to operations commencing.
Seabed Disturbance
The removal and recovery of items will be planned and carefully executed.
The vessels involved will position themselves directly over each item before lifting so that the item can be lifted vertically as far as possible, to avoid dragging on the seabed and therefore minimise the area of seabed disturbed.
If anchored vessels are required to be used an anchor management plan will be implemented.
In order to minimise disturbance to the seabed from the over-trawl assessment, the area that requires assessment will be optimised through liaison with fishing organisations and the regulator.
Underwater Noise
Vessel, cutting and trenching operations where possible will draw on standard methodologies and equipment. In addition, SIMOPS for vessel activity will be in place.
The measures presented in the JNCC guidelines for minimising the risk of injury to marine mammals from using explosives including MMO’s, a PAM system, pre-detonation search and the inclusion of a ten minute ‘soft start’ procedure will be adhered to.
Accidental Events
Leaks, spills and releases will be managed under the Schooner and Ketch existing field OPEP. The OPEP will be updated as necessary to reflect additional inventory from vessels involved in decommissioning. Based on the spill modelling conducted for the EA, additional control measures should not be necessary from those already included within the existing field OPEP.

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Appendix A – Consequence Categories

Table A1 - Definitions of Consequence (Severity Categories)

Category	Environmental Receptors	Social Receptors
5 **Severe**	Catastrophic, widespread and long term / potentially irreversible effects on the marine and / or coastal environment and ecosystems at a national and international level. Massive deterioration of air and water quality, changes or reduction in biodiversity abundance or distribution.	Catastrophic, widespread and potentially irreparable damage to national and international archaeological, cultural or natural resources. Massive negative and potentially irreversible impacts on critical international and national socio-economic aspects. Those affected will not be able to adapt to changes and will not be able to maintain pre-impact livelihoods. Will result in immediate intervention by governmental bodies and the international community who would implement extensive response measures. High profile international (worldwide) media and public community outrage.
4 **Major**	Highly significant, major and widespread, deterioration / impact on the marine and / or coastal environment and ecosystems over the medium – long term at a national level / international (regional, i.e. neighbouring countries). Highly significant deterioration of air and water quality, and changes / reduction in the abundance and biodiversity (or size of the genetic pool).	Highly significant and major damage with medium to long term loss of archaeological, cultural or natural resources of regional importance. Highly significant negative impacts on the national and international community (regional, i.e. neighbouring countries). Those affected will be able to adapt to changes with some difficulty, and will only be able to maintain pre-impact livelihoods with a degree of support. Will result in alarm being raised by stakeholders and possible intervention by governmental bodies requiring rapid implementation of response measures. Serious international (regional, i.e. neighbouring countries) media and community concerns and complaints.
3 **Moderate**	Moderate, medium term deterioration / impact on the marine and / or coastal environment and ecosystem on a local / national level, leading to observable and measurable changes. Moderate deterioration of air and water quality; and changes / reduction in the abundance and biodiversity of the area.	Moderate damage over the medium term to archaeological, cultural or natural resources of local importance. Moderate negative impacts on the national population. Vulnerable groups significantly affected. Significant community / government bodies concerns raised / on-going social issues.
2 **Minor**	Minor, short term effects on the marine and / or coastal environment and ecosystem at	Minor damage / impact to archaeological, cultural or natural resources at a local level.

Category	Environmental Receptors	Social Receptors
	a local level, leading to observable and measurable changes. Minor deterioration of air and water quality; and changes / reduction in the abundance and biodiversity of the area similar in effect and magnitude to natural variation in the ecosystem due to ambient environmental conditions.	Measurable negative impacts on the local population and / or vulnerable groups. Unlikely to result in concerns being raised by governmental bodies or stakeholders. May result in enquiries and concerns from local communities.
1 Negligible	Insignificant, short term effects on the marine and / or coastal environment and ecosystem in the immediate vicinity of the project site. Unlikely to be observable or measurable above small random changes due to ambient environmental conditions.	Insignificant effect on the archaeological, cultural or natural resources in the immediate vicinity of the project site. Insignificant impacts on the local community. Highly unlikely to result in concerns being raised by governmental bodies, stakeholders or the local community.

Appendix B – Likelihood Categories

Likelihood Category	Likelihood (Frequency) of Occurrence
A	Remote - Has not occurred in similar projects but is foreseeable
B	Unlikely - Known to happen, but only rarely
C	Possible - Occurred in a minority of similar studies or projects
D	Likely - Could easily occur and has generally occurred in similar projects
E	Certain - Could be expected to occur more than once during project delivery

Appendix C – Aspect Register

ENVID Keyword	Aspect (Activity)	Description of potential Impact	Existing mitigation/ control measures	Residual Risk to Receptors (After mitigation)																		Comments and Actions
				Physical			Biological								Socio-economic							
				Marine Water Quality	Air Quality	Sediments	Terrestrial Communities	Benthic communities	Plankton	Fish/ Shellfish	Offshore Seabirds	Coastal Seabirds	Marine Mammals	Protected/ Sensitive Areas	Shipping	Fishing	Oil and Gas activity	Pipeline/ Cables	Tourism/Leisure	Resource Use/ Energy Use	Coastal populations	
Topsides Removal for Onshore Disposal - Piece small and/or reverse installation																						
Discharge to Sea	Vessel discharges and ballast related discharges, lead based paint. Potentially a barge for removal. Floating barge (from other location) Ballast water discharge (invasive species).	Water quality impact and potential seabed deposition. Impact on marine flora and fauna. Localised Impacts	Operating in line with IMO regulations. MARPOL regs. Potential for unpermitted chemicals (biocides/corrosion inhibitors etc). Chemical audit - contractors.	1E		1E			1E	1E			1E			1E						Faroe will review the vessel contractors operating guidelines, including their HSE provisions prior to contract award.
Discharge to Sea	Discharges from pipeline/riser disconnections	Damage to aquatic environment, impact on marine flora and fauna. Localised Impacts	Topsides, vessels and piping flushed and isolated (cut) prior to operations. Seawater only.	1E		1E		1E	1E	1E			1E									Discharges from vessels will be greater for piece small removal as vessels will be in field for longer, however the consequence is still considered negligible
Discharge to Sea	Discharges from pipeline/riser disconnections	Damage to aquatic environment, impact on marine flora and fauna. Localised Impacts	Topsides, vessels and piping flushed and isolated (cut) prior to operations. Seawater only.	1D		1D		1D	1D	1D			1D									Discharges from vessels will be greater for piece small removal as vessels will be in field for longer, however the consequence is still considered negligible
Atmospheric Emissions	Emissions from in-field vessels. Exhausts.	Localised deterioration of air quality for duration of operations and contribution to GHG.	Maintenance of vessel combustion equipment and certification, adherence to international standards (sulphur content)		1E																	Emissions from vessels will be greater for piece small removal as vessels will be in field for longer, however the consequence is still considered negligible
Atmospheric Emissions	Emissions from additional activity for piece small (cutting). More emissions offshore.	Localised deterioration of air quality for duration of operations and contribution to GHG.	Maintenance of vessel combustion equipment and certification, adherence to international standards (sulphur content)		1E																	Emissions from vessels will be greater for piece small removal as vessels will be in field for longer, however the consequence is still considered negligible
Waste Production	Deconstruct waste and personnel waste. Cutting on the platform.	Localised impact on water quality in surrounding area.	Adherence to IMO standards and WMP	1E																		More waste associated with piece small. Collect in skips. Skip and ship. Contamination prevention.
Vessel presence and operations, impacts to other sea users (e.g. fishing vessels)	Vessels on location and in transit	Potential for navigation hazard and interference with shipping activities. Potential emergency situation due to collision. (Within 500m zone). Potential anchoring outside 500m zone.	500m safety zone around NUIs already in place. Notice to Mariners prior to operations commencing. Kingfisher Bulletins issued prior to operations commencing. Collision Risk Management Plan developed and implemented. Patrol of safety zone by ERRV. ERRV will have Automatic Radar Plotting Aid (ARPA) in place. Consent to Locate approved and in place prior to operations commencing. Any neccessary variations to the exisiting Schooner and Ketch Platforms Consent to Locates will be in place to cover all phases of the decommisisoning operations. Vessel communication systems. Fishsafe bulletins.												1B	2B						Minor due to limited potential for anchoring outside the 500m exclusion zone.
Vessel presence and operations, impacts to other sea users (e.g. fishing vessels)	Vessels anchoring on location	The potential exists for vessel anchors and anchor chains to snag fishing gear if these extend beyond the exclusion zone.	Faroe will ensure the location of anchors/ anchor chains will be communicated to other sea users, in particular Faroe will consult with the NFFO in regard to a possible anchor pattern to minimise the risk of snagging.													3A						
Vessel presence and operations, impacts to other sea users (e.g. fishing vessels)	Vessels anchoring on location	The potential exists for anchor mounds to be formed when the anchors are removed from the seabed. These anchor mounds have the potential to create a snagging hazard for fishing gear. Lost gear / compensation	Faroe will ensure the location of anchors/ anchor chains will be communicated to other sea users, in particular Faroe will consult with the NFFO in regard to a possible anchor pattern to minimise the risk of snagging. Sand sediment. Currents will dissipate mounds.													3A						
Seabed disturbance, presence of infrastructure	Vessel anchoring, jack-up barge or lift vessel footprint, potential stabilisation material for jack-up barge	Reduced number, type and size of habitats. Impact will be dependant on vessel types selected.	Anchor management plan and results from pre-decommissioning environmental baseline survey.					1E		1E												Schooner and Ketch NUIs both fall out with Dogger Bank MPA/SAC so no interaction with protected site from potential anchoring operations expected.

Noise (air and subsea) and vibration	Vessel noise including DP, cutting noise above sea level and vibration below sea level, general deconstruct activity noise.	Potential disturbance to marine mammals and fish. Potential behavioural changes in fish and marine mammals due to increase in background marine noise levels. Indirect impact to fisheries caused by potential behavioural changes in fish.	Operations will draw on standard methodologies and equipment, SIMOPS for vessel activity will be in place.							1B			1B			1B						High existing background noise levels from shipping in the vicinity.
Leaks and spills/unplanned events	Dropped Objects	Dropped objects have the potential to cause disturbance to the seabed and benthic faunal communities. They also pose a potential risk of snagging gear to fisheries.	All items will be securely stowed. Lifting operations will be planned to manage the risk, meet requirements of Lifting Operations and Lifting Equipment Regulations (LOLER) 1998 and will use the correct lifting equipment that is tested and certified. Recovery of dropped objects will take place where practicable. Dropped object reporting as per PON2 requirements. Dropped Object sweep of seabed. Incident log/register.			1A		1A								3A						
Leaks and spills/unplanned events	Potential unintentional releases of fuel or other fluids (e.g. diesel, jet fuel, hydraulic oil, lubricants or chemicals) during day-to-day operations (including re-fuelling)	During general operations there is the potential for unintentional releases. These releases have the potential to cause localised toxic effects on marine fauna and flora and localised pollution, which may impact local marine wildlife and rafting seabirds on the sea surface.	Schooner and Ketch field OPEP in place and vessel SOPEP Vessels fitted with closed drainage containment and monitoring systems in all environmentally critical areas as part of their specification. Vessel contractors to have procedures for fuel bunkering which will be required to meet Faroes standard. Subject to audit/assessment prior to decommissioning operations commencing. Where practicable, re-fuelling will be undertaken during daylight hours only. Transfer operations will be supervised at all times. Breakaway couplings will be used in transfer hoses. Transfer operations will be undertaken by trained and competent personnel.	2B				2B	2B	2B	2B	2A	2B			2B			2B			
Leaks and spills/unplanned events	An emergency incident (e.g. vessel collision), leading to potential unintentional releases.	Potential total loss of containment of entire inventories of diesel, utility fuels and chemicals from vessels potentially causing significant hydrocarbon and chemical pollution. Potential impacts on water quality and marine wildlife in the affected area.	All mitigation measures as defined above for unintentional releases during day to day operations. All contracted vessels will have a ship-board oil pollution emergency plan (SOPEP) in place. An Emergency response plan (ERP) in place prior to operations commencing. A contract with an oil spill response organisation will be in place to ensure a timely and efficient mobilisation of oil spill response resources and competent response personnel. The ERRV will have 5 cubic metres of dispersant on board. Oil spill modelled in OPEP. Consent to Locate - Collision Risk Management Plan in place.	3A					3A	3A	3A	3A	3A		3A	3A			2A		3A	
Jackets Removal for Onshore Disposal (abrasive water jet cutting/diamond wire cutting and/or explosive severance)																						
Discharge to Sea	Vessel discharges and ballast related discharges, lead based paint. Potentially a barge for removal. Floating barge (from other location) Ballast water discharge (invasive species).	Water quality impact and potential seabed deposition. Impact on marine flora and fauna. Localised Impacts	Operating in line with IMO regulations. MARPOL regs. Potential for unpermitted chemicals (biocides/corrosion inhibitors etc). Chemical audit - contractors.	1E		1E			1E	1E			1E			1E						Faroe will review the vessel contractors operating guidelines, including their HSE provisions prior to contract award.
Atmospheric Emissions	Emissions from in field vessels	Localised deterioration of air quality for duration of operations and contribution to GHG.	Maintenance of vessel combustion equipment and certification, adherence to company standards		1E																	Emissions from vessels will be greater for piece small removal as vessels will be in field for longer, however the consequence is still considered negligible
Waste Production	Deconstruct waste and personnel waste from vessels.	Localised impact on water quality in surrounding area.	Adherence to IMO standards and WMP	1E																		
Vessel presence and operations, impacts to other sea users (e.g. fishing vessels)	Vessels on location and in transit	Potential for navigation hazard and interference with shipping activities. Potential emergency situation due to collision.	500m safety zone around NUIs already in place. Notice to Mariners prior to operations commencing. Kingfisher Bulletins issued prior to operations commencing. Collision Risk Management Plan developed and implemented. Patrol of safety zone by ERRV. ERRV will have Automatic Radar Plotting Aid (ARPA) in place. Consent to Locate approved and in place prior to operations commencing.												3A	3A						

Vessel presence and operations, impacts to other sea users (e.g. fishing vessels)	Vessels anchoring on location	The potential exists for vessel anchors and anchor chains to snag fishing gear if these extend beyond the exclusion zone.	500m safety zone around NUIs already in place. Notice to Mariners prior to operations commencing. Kingfisher Bulletins issued prior to operations commencing. Collision Risk Management Plan developed and implemented. Patrol of safety zone by ERRV. ERRV will have Automatic Radar Plotting Aid (ARPA) in place. Consent to Locate approved and in place prior to operations commencing													3A						
Vessel presence and operations, impacts to other sea users (e.g. fishing vessels)	Vessels anchoring on location	The potential exists for anchor mounds to be formed when the anchors are removed from the seabed. These anchor mounds have the potential to create a snagging hazard for fishing gear.	500m safety zone around NUIs already in place. Notice to Mariners prior to operations commencing. Kingfisher Bulletins issued prior to operations commencing. Collision Risk Management Plan developed and implemented. Patrol of safety zone by ERRV. ERRV will have Automatic Radar Plotting Aid (ARPA) in place. Consent to Locate approved and in place prior to operations commencing													3A						
Seabed disturbance, presence of infrastructure	Vessel anchoring, jack-up barge or lift vessel footprint, potential stabilisation material for jack-up barge	Reduced number, type and size of habitats. Impact will be dependant on vessel types selected.	500m safety zone around NUIs already in place. Notice to Mariners prior to operations commencing. Kingfisher Bulletins issued prior to operations commencing. Collision Risk Management Plan developed and implemented. Patrol of safety zone by ERRV. ERRV will have Automatic Radar Plotting Aid (ARPA) in place. Consent to Locate approved and in place prior to operations commencing					1E		1E												Schooner and Ketch NUIs both fall out with Dogger Bank MPA/SAC so no interaction with protected site from potential anchoring operations expected.
Seabed disturbance, presence of infrastructure	Over-trawl assessment survey following decommissioning operations	Abrasion/disturbance of the substrate on the surface of the seabed and benthic communitites	In order to minimise disturbance to the seabed from the over-trawl assessment the area that requires assessment will be optimised through liaison with fishing organisations and the regulator.					1E		1E												The over trawl assessment will be discussed with OPRED taking into account how the schedule of the Faroe decommissioning project is timed with the proposed decommissioning of Caister Murdoch facilities by Conoco Phillips.
Seabed disturbance, presence of infrastructure	Disturbance associated with displacement of seabed sediments - If internal cutting fails due to technical reasons piles will need to be cut externally using a diamond wire cutter mounted on an ROV. Removal of seabed around each of the piles to approx. 3.5m below natural seabed level.	Reduced number, type and size of habitats. Impact will be dependant upon size of area disturbed.	500m safety zone around NUIs already in place. Notice to Mariners prior to operations commencing. Kingfisher Bulletins issued prior to operations commencing. Collision Risk Management Plan developed and implemented. Patrol of safety zone by ERRV. ERRV will have Automatic Radar Plotting Aid (ARPA) in place. Consent to Locate approved and in place prior to operations commencing					1E		1E												
Noise (subsea) and vibration	Abrasive water jet cutting noise or diamond wire cutting	Potential disturbance to marine mammals and fish. Potential behavioural changes in fish and marine mammals due to increase in background marine noise levels. Indirect impact to fisheries caused by potential behavioural changes in fish.	500m safety zone around NUIs already in place. Notice to Mariners prior to operations commencing. Kingfisher Bulletins issued prior to operations commencing. Collision Risk Management Plan developed and implemented. Patrol of safety zone by ERRV. ERRV will have Automatic Radar Plotting Aid (ARPA) in place. Consent to Locate approved and in place prior to operations commencing							1B			1B			1B						

Noise (subsea) and vibration	Severance of jacket piles using explosives (Internal charge - 3.5m depth).	Potential disturbance and/or injury to marine mammals and fish. Potential behavioural changes in fish and marine mammals due to increase in background marine noise levels. Indirect impact to fisheries caused by potential behavioural changes in fish.	500m safety zone around NUIs already in place. Notice to Mariners prior to operations commencing. Kingfisher Bulletins issued prior to operations commencing. Collision Risk Management Plan developed and implemented. Patrol of safety zone by ERRV. ERRV will have Automatic Radar Plotting Aid (ARPA) in place. Consent to Locate approved and in place prior to operations commencing							1B			2B	2B		1B						Preference is not to use explosives. Explosives is a contingency option only if internal cutting and external cutting both fail due to technical reasons.
Noise (subsea) and vibration	Vessel noise including DP	Potential disturbance to marine mammals and fish. Potential behavioural changes in fish and marine mammals due to increase in background marine noise levels. Indirect impact to fisheries caused by potential behavioural changes in fish.	500m safety zone around NUIs already in place. Notice to Mariners prior to operations commencing. Kingfisher Bulletins issued prior to operations commencing. Collision Risk Management Plan developed and implemented. Patrol of safety zone by ERRV.							1B			1B			1B						
Leaks and spills/unplanned events	Dropped Objects.	Dropped objects have the potential to cause disturbance to the seabed and benthic faunal communities. They also pose a potential risk of snagging gear to fisheries.	500m safety zone around NUIs already in place. Notice to Mariners prior to operations commencing. Kingfisher Bulletins issued prior to operations commencing. Collision Risk Management Plan developed and implemented. Patrol of safety zone by ERRV. ERRV will have Automatic Radar Plotting Aid (ARPA) in place. Consent to Locate approved and in place prior to operations commencing			1A		1A								3A						Few objects to be dropped (sections of jacket).
Leaks and spills/unplanned events	Potential unintentional releases of fuel or other fluids (e.g. diesel, jet fuel, hydraulic oil, lubricants or chemicals) during day-to-day operations (including re-fuelling)	During general operations there is the potential for unintentional releases. These releases have the potential to cause localised toxic effects on marine fauna and flora and localised pollution, which may impact local marine wildlife and rafting seabirds on the sea surface.	500m safety zone around NUIs already in place. Notice to Mariners prior to operations commencing. Kingfisher Bulletins issued prior to operations commencing. Collision Risk Management Plan developed and implemented. Patrol of safety zone by ERRV. ERRV will have Automatic Radar Plotting Aid (ARPA) in place. Consent to Locate approved and in place prior to operations commencing	2B				2B	2B	2B	2B	2A	2B			2B			2B			
Removal of habitat / marine growth	Removal of habitat / marine growth	Loss of habitat / hard substrate for flora and fauna. Important area for shellfish species.	500m safety zone around NUIs already in place. Notice to Mariners prior to operations commencing. Kingfisher Bulletins issued prior to operations commencing. Collision Risk Management Plan developed and implemented. Patrol of safety zone by ERRV. ERRV will have Automatic Radar Plotting Aid (ARPA) in place. Consent to Locate approved and in place prior to operations commencing					1E		1E												
Leaks and spills/unplanned events	An emergency incident (e.g. vessel collision), leading to potential unintentional releases.	Potential total loss of containment of entire inventories of diesel, utility fuels and chemicals from vessels potentially causing significant hydrocarbon and chemical pollution. Potential impacts on water quality and marine wildlife in the affected area.	500m safety zone around NUIs already in place. Notice to Mariners prior to operations commencing. Kingfisher Bulletins issued prior to operations commencing. Collision Risk Management Plan developed and implemented. Patrol of safety zone by ERRV. ERRV will have Automatic Radar Plotting Aid (ARPA) in place. Consent to Locate approved and in place prior to operations commencing	3A					3A	3A	3A	3A	3A		3A	3A			3A		3A	Schooner and Ketch field OPEP will be updated as necessary to cover any increases in inventory due to decommisisoning. A Vessel Traffic Survey or Navigational Risk Assessment may be undertaken if requested by the regulator as part of the Consent to Locate application/ variation process.
Schooner Pipeline - Leave in situ with material placement on cut ends (new grout bags or existing mattresses)																						

Discharge to Sea	Vessel discharges	Water quality impact and potential seabed deposition. Impact on marine flora and fauna. Localised Impacts.	Operating in line with IMO regulations. MARPOL regs.	1E		1E			1E	1E						1E						Faroe will review the vessel contractors operating guidelines, including their HSE provisions prior to contract award.
Discharge to Sea	Discharges from Cutting debris	Water quality impact and potential seabed deposition. Impact on marine flora and fauna. Localised Impacts	Use of subsea shears does not generate debris.	1E		1E		1E	1E	1E			1E									Very little debris potential(if any).
Discharge to Sea	Breakdown of pipeline and coating over time. Breakdown of stabilisation material (grout, concrete, mattresses etc). In addition, concrete will be present (in chunks) on the seabed. Plastic wrapped pipeline - potential for contamination.	Water quality impact and potential seabed deposition. Impact on marine flora and fauna. Possible debris on seabed.	Pipeline left buried - contained in seabed. Corrosion will occur from the inside out. Ongoing monitoring of the pipeline will be undertaken.	1C		1C		1C														
Atmospheric Emissions	Emissions from survey vessels (due to ongoing monitoring requirement)	Localised deterioration of air quality for duration of operations and contribution to GHG.	Maintenance of vessel combustion equipment and certification, adherence to company standards. Plan activities to limit time in field		1E																	
Atmospheric Emissions	Emissions from in field vessels	Localised deterioration of air quality for duration of operations and contribution to GHG.	Maintenance of vessel combustion equipment and certification, adherence to company standards. Plan activities to limit time in field		1E																	
Fuel/Resource Use/Energy Use	Grout bags required for ends . Pipeline steel left on the seabed not available for recycling.	Stabilisation material requirements. Loss of pipeline material. Use of resources.	Grout bags will be biodegradable																	1E		
Pipeline presence and operations, impacts to other sea users (e.g. fishing vessels)	Pipelines remaining *in-situ*	Interference with fishing gear with associated economic impact. Potential loss of livelihood, national interest/reputation risk. Habitats undisturbed.	Marking on admiralty charts. Addition to Fishbase. Schooner pipeline will be left buried. Ketch pipeline will be trenched and buried.			P		P		P						2B						A positive potential impact to sediments, benthos and fish/shellfish has been noted due to no disturbance occuring to these communtities from pipeline removal and the potential habitat created by the pipeline remains. Ongoing monitoring should be sufficient to identify snagging risks.
Vessel presence and operations, impacts to other sea users (e.g. fishing vessels)	Vessels on location and in transit for surveys and placement of materials on cut ends	Potential for navigation hazard and interference with shipping activities. Potential emergency situation due to collision.	Notice to Mariners prior to operations commencing. Kingfisher Bulletins issued prior to operations commencing. Collision Risk Management Plan developed and implemented.												3A	3A						
Seabed disturbance, presence of infrastructure	Grout bags/mattresses required for ends .	Permanent modification of seabed substrate in local area. Altering of the baseline environment, introduction of new habitat.	Minimise quantity of mattresses and grout bags required. Re-use of existing mattresses where possible. Grout bags will be biodegradable.			1E		1E						1E								
Seabed disturbance, presence of infrastructure	Over-trawl assessment survey following decommissioning operations	Abrasion/disturbance of the substrate on the surface of the seabed and benthic communitites	In order to minimise disturbance to the seabed from the over-trawl assessment the area that requires assessment will be optimised through liaison with fishing organisations and the regulator.					1E		1E												The over trawl assessment will be discussed with OPRED taking into account how the schedule of the Faroe decommissioning project is timed with the proposed decommissioning of Caister Murdoch facilities by Conoco Phillips.
Noise (air and subsea) and vibration	Cutting shears noise	Potential disturbance to marine mammals, fish and seabirds. Potential behavioural changes in fish and marine mammals due to increase in background marine noise levels. Indirect impact to fisheries caused by potential behavioural changes in fish.	Operations will draw on standard methodologies and equipment							1C	1B		1C			1B						High existing background noise levels from shipping in the vicinity.
Leaks and spills/unplanned events	Dropped Objects	Dropped objects have the potential to cause disturbance to the seabed and benthic faunal communities. They also pose a potential risk of snagging gear to fisheries.	All items will be securely stowed. Lifting operations will be planned to manage the risk, meet requirements of Lifting Operations and Lifting Equipment Regulations (LOLER) 1998 and will use the correct lifting equipment that is tested and certified. Recovery of dropped objects will take place where practicable. Dropped object reporting as per PON2 requirements. Dropped Object sweep of seabed. Incident log/register.			1A		1A								3A						

Leaks and spills/unplanned events	Potential unintentional releases of fuel or other fluids (e.g. diesel, jet fuel, hydraulic oil, lubricants or chemicals) during day-to-day operations (including re-fuelling)	During general operations there is the potential for unintentional releases. These releases have the potential to cause localised toxic effects on marine fauna and flora and localised pollution, which may impact local marine wildlife and rafting seabirds on the sea surface.	Vessel SOPEP will be used for response. Vessels fitted with closed drainage containment and monitoring systems in all environmentally critical areas as part of their specification. Vessel contractors to have procedures for fuel bunkering which will be required to meet Faroes standard. Subject to audit/assessment prior to decommissioning operations commencing. Where practicable, re-fuelling will be undertaken during daylight hours only. Transfer operations will be supervised at all times. Breakaway couplings will be used in transfer hoses. Transfer operations will be undertaken by trained and competent personnel.	2B				2B	2B	2B	2B	2B	2B			2B			2B			
Leaks and spills/unplanned events	Loss of hydraulic fluid from cutting shears.	During general operations there is the potential for unintentional releases. These releases have the potential to cause localised toxic effects on marine fauna and flora and localised pollution, which may impact local marine wildlife and rafting seabirds on the sea surface. Dispersion and dilution within the water column expected to be rapid due to currents.	Vessel SOPEP will be used for response. Ensure use of environmentally friendly hydraulic fluid.	1A					1A	1A	1A		1A			1A						
Leaks and spills/unplanned events	An emergency incident (e.g. vessel collision), leading to potential unintentional releases.	Potential total loss of containment of entire inventories of diesel, utility fuels and chemicals from vessels potentially causing significant hydrocarbon and chemical pollution. Potential impacts on water quality and marine wildlife in the affected area.	All mitigation measures as defined above for unintentional releases during day to day operations. All contracted vessels will have a ship-board oil pollution emergency plan (SOPEP) in place. An Emergency response plan (ERP) in place prior to operations commencing. A contract with an oil spill response organisation will be in place to ensure a timely and efficient mobilisation of oil spill response resources and competent response personnel. The ERRV will have 5 cubic metres of dispersant on board.	3A					3A	3A	3A	3A	3A		3A	3A			3A		3A	
Ketch Pipeline - Leave in situ with trenching and burial of exposed sections																						
Discharge to Sea	Vessel discharges and ballast related discharges	Water quality impact and potential seabed deposition. Impact on marine flora and fauna. Localised Impacts	Operating in line with IMO regulations.	1E		1E			1E	1E						1E						Faroe will review the vessel contractors operating guidelines, including their HSE provisions prior to contract award.
Discharge to Sea	Breakdown of pipeline and coating over time. Breakdown of stabilisation material (grout, concrete, mattresses etc). In addition, concrete will be present (in chunks) on the seabed.	Water quality impact and potential seabed deposition. Impact on marine flora and fauna. Possible debris on seabed.	Pipeline left buried - contained in seabed. Corrosion will occur from the inside out. Ongoing monitoring of the pipeline will be conducted.	1C		1C		1C														Ongoing monitoring frequency to be discussed and agreed with OPRED
Atmospheric Emissions	Emissions from survey vessels (due to ongoing monitoring requirement)	Localised deterioration of air quality for duration of operations and contribution to GHG.	Maintenance of vessel combustion equipment and certification, adherence to company standards. Plan activities to limit time in field.		1E																	
Atmospheric Emissions	Emissions from in field vessels	Localised deterioration of air quality for duration of operations and contribution to GHG.	Maintenance of vessel combustion equipment and certification, adherence to company standards. Plan activities to limit time in field.		1E																	
Fuel/Resource Use/Energy Use	Pipeline steel left on the seabed not available for recycling.	Loss of pipeline material. Use of resources.																		1E		
Vessel presence and operations, impacts to other sea users (e.g. fishing vessels)	Permanent presence of pipeline on seabed.	Interference with fishing gear with associated economic impact. Potential loss of livelihood, national interest/reputation risk.	Marking pipelines on admiralty charts and addition to FISHSAFE. Trenching and burial of pipeline. Over trawl survey performed to confirm over trawlability.													2B					1C	Ongoing monitoring should be sufficient to identify snagging risks.
Vessel presence and operations, impacts to other sea users (e.g. fishing vessels)	Vessels on location and in transit for surveys and placement of materials on cut ends	Potential for navigation hazard and interference with shipping activities. Potential emergency situation due to collision.	Notice to Mariners prior to operations commencing. Kingfisher Bulletins issued prior to operations commencing. Collision Risk Management Plan developed and implemented.												3A	3A						
Seabed disturbance, presence of infrastructure	Use of jet trencher and/or plough trencher	Temporary modification of seabed and suspension of sediments in water column. Smothering of benthic species. Potential cumulative impact from other decommisisoning projects and/or activities in the area.	Minimise length of pipeline to be jetted/trenched and use results from pre-decommissioning EBS to inform operations.			1E		1E						1E								

Seabed disturbance, presence of infrastructure	Over-trawl assessment survey following decommissioning operations	Abrasion/disturbance of the substrate on the surface of the seabed and benthic communitites	In order to minimise disturbance to the seabed from the over-trawl assessment the area that requires assessment will be optimised through liaison with fishing organisations and the regulator.					1E		1E												The over trawl assessment will be discussed with OPRED taking into account how the schedule of the Faroe decommissioning project is timed with the proposed decommissioning of Caister Murdoch facilities by Conoco Phillips.
Noise (subsea) and vibration	Cutting shears noise for cutting ends	Potential disturbance to marine mammals, fish and seabirds. Potential behavioural changes in fish and marine mammals due to increase in background marine noise levels. Indirect impact to fisheries caused by potential behavioural changes in fish.	Operations will draw on standard methodologies and equipment							1B			1B			1B						High existing background noise levels from shipping in the vicinity.
Leaks and spills/unplanned events	Dropped Objects	Dropped objects have the potential to cause disturbance to the seabed and benthic faunal communities. They also pose a potential risk of snagging gear to fisheries.	All items will be securely stowed. Lifting operations will be planned to manage the risk, meet requirements of Lifting Operations and Lifting Equipment Regulations (LOLER) 1998 and will use the correct lifting equipment that is tested and certified. Recovery of dropped objects will take place where practicable. Dropped object reporting as per PON2 requirements. Dropped Object sweep of seabed. Incident log/register.			1A		1A								2A						
Leaks and spills/unplanned events	Hydraulic fluid from cutting equipment	Damage to aquatic environment, impact on marine flora and fauna. Spill volumes expected to be low, resulting in minor localised impacts.	Vessel SOPEP will be used for response. Ensure use of environmentally friendly hydraulic fluid.	2B				2B	2B	2B	2B	2B	2B			2B			2B			
Leaks and spills/unplanned events	Potential unintentional releases of fuel or other fluids (e.g. diesel, jet fuel, hydraulic oil, lubricants or chemicals) during day-to-day operations (including re-fuelling)	During general operations there is the potential for unintentional releases. These releases have the potential to cause localised toxic effects on marine fauna and flora and localised pollution, which may impact local marine wildlife and rafting seabirds on the sea surface.	Vessels fitted with closed drainage containment and monitoring systems in all environmentally critical areas as part of their specification. Vessel contractors to have procedures for fuel bunkering which will be required to meet Faroes standard. Subject to audit/assessment prior to decommissioning operations commencing. Where practicable, re-fuelling will be undertaken during daylight hours only. Transfer operations will be supervised at all times. Breakaway couplings will be used in transfer hoses. Transfer operations will be undertaken by trained and competent personnel.	2B				2B	2B	2B	2B	2B	2B			2B			2B			
Leaks and spills/unplanned events	An emergency incident (e.g. vessel collision), leading to potential unintentional releases.	Potential total loss of containment of entire inventories of diesel, utility fuels and chemicals from vessels potentially causing significant hydrocarbon and chemical pollution. Potential impacts on water quality and marine wildlife in the affected area.	All mitigation measures as defined above for unintentional releases during day to day operations. All contracted vessels will have a ship-board oil pollution emergency plan (SOPEP) in place. An Emergency response plan (ERP) in place prior to operations commencing. A contract with an oil spill response organisation will be in place to ensure a timely and efficient mobilisation of oil spill response resources and competent response personnel. The ERRV will have 5 cubic metres of dispersant on board.	3A					3A	3A	3A	3A	3A		3A	3A			3A		3A	Schooner and Ketch field OPEP will be updated as necessary to cover any increases in inventory due to decommisisoning.

Appendix D – Noise Modelling methodology

Swim Model

11.1 Increasing the distance from the noise source usually results in the level of noise getting lower, due primarily to the spreading of the sound energy with distance, analogous to the way in which the ripples in a pond spread after a stone has been thrown in.

11.2 The way that the noise spreads (geometrical divergence) will depend upon several factors such as bathymetry, pressure, temperature gradients, and salinity, as well as surface and bottom conditions. Thus, even for a given locality, there are seasonal variations to the way that sound will propagate. However, in simple terms, the sound energy may spread out in a spherical pattern (close to the source) or a cylindrical pattern (much further from the source) or somewhere in between, depending on several factors. In shallow waters, the propagation mechanism is also coloured by multiple reflections from the seabed and water surface.

11.3 There are several methods available for estimating the propagation of sound between a source and receiver ranging from very simple models (which simply assume spreading according to a 10 log (r) or 20 log (r) relationship (where r is the distance from source to receiver) to full acoustic models[1] e.g. ray tracing, normal mode, parabolic equation, wavenumber integration and energy flux models). In addition, semi-empirical models are available which lie somewhere in between these two extremes in terms of complexity. In choosing which propagation model to employ, it is important to ensure that it is fit for purpose and produces results with a suitable degree of accuracy for the application in question, taking into account the context. Thus, in some situations (e.g. very low risk due to underwater noise, range dependent bathymetry is not an issue) a simple model will be sufficient, particularly where other uncertainties outweigh the uncertainties due to modelling. On the other hand, some situations (e.g. very high source levels, complex source and propagation path characteristics, highly sensitive receivers and low uncertainties in assessment criteria) warrant a more complex modelling methodology.

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[1] It is worth noting that additional complexity does not always equate to greater accuracy and may not always be preferable. Many more complex models work over a limited frequency range and the complexity and range of inputs can make them very context specific. Consequently, the model outputs can vary significantly depending on the input assumptions which in themselves can change day-to-day and season-to-season.

11.4 The first step in choosing a propagation model is therefore to examine these various factors, as set out below:

- **Balancing of errors / uncertainties:** There is a paucity of data relating to the effects of sound on marine life, particularly for behavioural effects. Many of the studies for behavioural disturbance fail to properly define dose-response relationships (concentrating on the animal response with little analysis of the noise "dose") and, taking into account context and location specific factors as well as habituation, it is extremely difficult to estimate the potential error in the effect thresholds. However, referring to the wide ranging spread of onset levels leading to an effect presented in NOAA 2016 and Southall *et al*., 2007, it is speculated that the uncertainty due to onset of effects could well be a magnitude of tens of decibels.
- **Range dependant bathymetry:** The Schooner and Ketch fields are located in water depth between approximately 57 and 70 m depth. For this assessment, modelling the effects at distances from the proposed location of decommissioning activities can assume a consistent average water column depth. However, if the fields were located in an area of varying depths, then the model should ideally take range dependant bathymetry and bottom conditions into account.

11.5 On the basis of the above factors, it is considered that potential errors due to uncertainty regarding the effects of sound on marine mammals and fish as well as uncertainties in source data are likely to be greater than the uncertainties inherent in acoustic modelling. RPS has chosen a semi-empirical sound propagation model which provides a reasonable balance between complexity and technical robustness. It should be borne in mind that calculated noise levels (and associated range of effects) will vary depending on actual conditions at the time (day-to-day and season-to-season) and that the semi-empirical model predicts a typical worst case scenario. Taking into account factors such as animal behaviour and habituation, any injury and disturbance ranges should be viewed as indicative and probabilistic ranges to assist in understanding potential impacts on marine life rather than lines either side of which an impact definitely will or will not occur (this is a similar approach to that adopted for airborne noise where a typical worst case is taken, though it is known that day to day levels may vary to those calculated by 5 - 10 dB depending on wind direction etc.).

11.6 Noise propagation modelling for this assessment was carried out using the sound propagation model developed by Rogers (1981). The Rogers sound propagation model is a semi-empirical, range dependent propagation model which is based on a combination of theoretical considerations and extensive experimental data. Consequently, unlike purely theoretical sound propagation models, the calibration for the Rogers model is built into the model itself and it has subsequently been successfully benchmarked against other sound propagation models (e.g. Etter 2013, Toso *et al.*, 2014, Schulkin and Mercer, 1985) and has been used previously in underwater noise assessments for energy developments (e.g. Dawoud *et al.*, 2015). The model taking in account the following parameters:

- third-octave band source sound level data;
- range (distance from source to receiver);
- water column depth (input as bathymetry data grid);
- sediment type;
- sediment and water sound speed profiles and densities; and
- sediment attenuation coefficient.

11.7 The propagation loss is calculated as follows:

$$TL = 15log_{10}R + 5\,log_{10}(H\beta) + \frac{\beta R\theta_L^2}{4H} - 7.18 + \alpha_w R$$

where R is the range, H the water depth, β the bottom loss, $\theta_L$the limiting angle and α_w the absorption coefficient of sea water (α_w is a frequency dependant term which was calculated based on Ainslie and McColm (1998)).

11.8 The limiting angle, $\theta_L$is the larger of θ_g and θ_c where θ_g is the maximum grazing angle for a skip distance and θ_c is the effective plane wave angle corresponding to the lowest propagating mode, as follows:

$$\theta_g = \sqrt{\frac{2Hg}{c_w}} \qquad \theta_c = \frac{c_w}{2fH}$$

where g is the sound speed gradient in water (taken to be 0.2 s^{-1} for the purposes of the modelling) and f is the frequency.

11.9 The bottom loss β is approximated as follows:

$$\beta \approx \frac{0.477(\rho_s/\rho_w)(c_w/c_s)K_s}{[1-(c_w/c_s)^2]^{3/2}}$$

where ρ_s is the density of sediment, ρ_w the density of water, c_s the sound speed in the sediment, c_w the sound speed in water and K_s is the sediment attenuation coefficient.

11.10 The propagation model also takes into account the depth dependent cut-off frequency for propagation of sound (i.e. the frequency below which sound does not propagate), as follows:

$$f_{cut-off} = \frac{c_w}{4h\sqrt{1-\frac{c_w^2}{c_s^2}}}$$

where c_s and c_w are the sound propagation speeds in the substrate and water.

11.11 As well as calculating the sound pressure levels at various distances from the source, it is also necessary to calculate the SEL for a mammal using the relevant M-weightings described previously taking into account the amount of sound energy to which it is exposed over the course of a day. In order to carry out this calculation, it has been assumed that a mammal will swim away from the noise source at an average speed of 1.5 ms^{-1}. The calculation considers each 1-second period of exposure to be established separately, resulting in a series of discrete SEL values of decreasing magnitude (Figure E.1). As the mammal swims away, the noise will become progressively quieter; the cumulative SEL is worked out by logarithmically adding the SEL to which the mammal is exposed as it travels away from the source. For fish, the same assumptions about the movement of individual animals relative to the sound source are not as well understood, and are therefore not considered in the model. This calculation was used to estimate the approximate minimum start distance for a marine mammal in order for it to be exposed to sufficient sound energy to result in the onset of potential injury. It should be noted that the sound exposure calculations are based on the simplistic assumption that the source is active continuously over a 24 hour period and that the animal will continue to swim away at a fairly constant relative speed. The real world situation is more complex and the noise source will vary in space and time and the animal is likely to move in a more complex manner[2].

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[2] Swim speeds of marine mammals have been shown to be up to 5 ms^{-1} (e.g. cruising minke whale 3.25 ms^{-1} (Cooper et al. 2008) and, harbour porpoise up to 4.3 ms^{-1} (Otani et al. 2000)). The more conservative swim speed of 1.5 ms^{-1} used in this assessment allows some headroom to account for the potential that the marine mammal might not swim directly away from the source, could change direction or does not maintain a fast swim speed over a prolonged period.

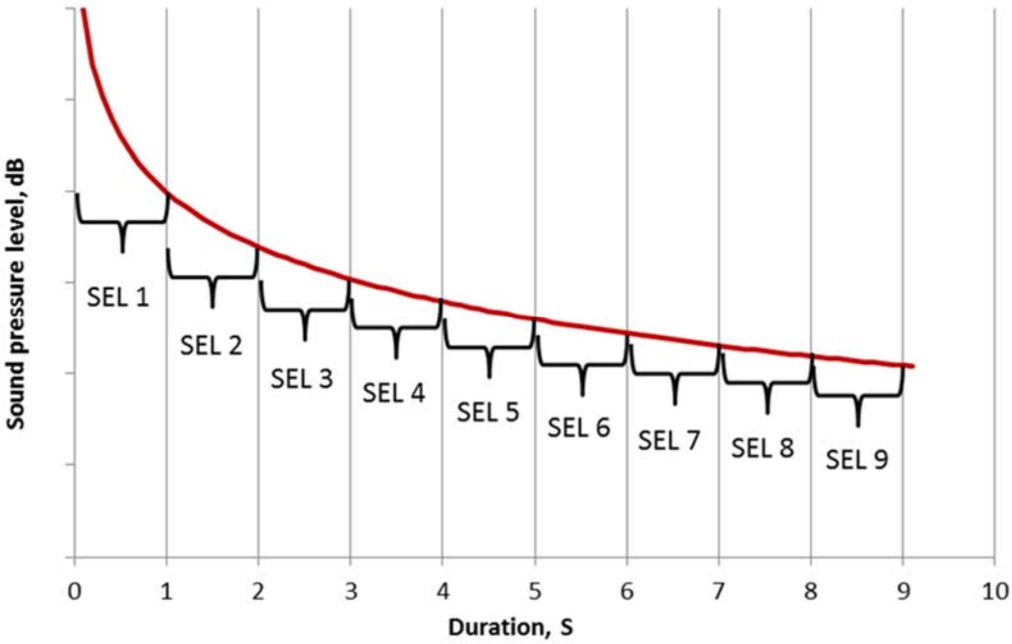

Figure E.1 Conversion of continuous noise sources into discrete 1-second windows

11.12 The model requires inputs relating to the physical characteristics of the marine environment in which the activities are taking place. These input parameters are given in Table E.1.

Table E.1 Model input parameters

Parameter	Value
Sediment classification	Muddy sand
Sound speed gradient, ***g***	0.2 s^{-1}
Speed of sound in water, C_w	1488 ms^{-1}
Speed of sound in sediment, C_s	1646 ms^{-1}
Water density, ρ_w	1.027 kgm^{-3}
Sediment density, ρ_s	1.772 kgm^{-3}
Sediment attenuation coefficient, K_s	0.59 $dBm^{-1}kHz^{-1}$

Underwater Explosion Model

11.13 The assumed worst case scenario for pile severance considers shaped charges (i.e. an explosive charge with a cavity that allows the blast to be concentrated into a small area) attached internally to each pile, and subsequently detonated simultaneously.

11.14 Because both platforms at the respective Schooner and Ketch fields will utilise similar methodology, and are in similar water depth and sea bottom conditions, only one noise model was developed which applies to both platforms.

11.15 There is considerable literature on the peak pressures that arise due to underwater explosive operations (e.g. Richardson, 1995, Barett 1996, Urick, 1983, Nedwell & Edwards, 2004, Nedwell & Howell, 2004).

11.16 When a charge is detonated inside a pile below the mudline, much of the acoustic energy is absorbed by the pile structure and sediment. Barkaszi *et al.* (2016)measured explosive charges used for offshore platform pile severance in the Gulf of Mexico and found that measured sound pressure levels during pile severance operations were lower than predicted amplitudes of an unconstrained charge for all charge weights, indicating that using an unconstrained model calculation would consistently overestimate the size of the impact area for detonations at any charge weight or depth of charge below the mud line.

11.17 Another study (Connor Jr, 1990) found that peak pressures reduced by 50% to 75% compared to values expected for unconstrained detonations for pile severance operations.

11.18 The method used in this assessment has therefore been that set forward in MMS (MMS, 2004) for unconstrained TNT charges in deep water, with a 50% reduction in the pressure values based on the study carried out by Connor Jr (1990).

11.19 The expression for estimating the value of peak pressure (in Pa) is as follows:

$$P_{max} = \sigma \times\ 5.24 \times 10^{7} \times \left(\frac{W^{1/3}}{r}\right)^{1.13}$$

where W is the TNT charge weight in kilograms, r is the range from the explosive in metres and σ is the pressure reduction factor of 0.5 based on Connor Jr (1990).

11.20 As the criteria for assessing physiological damage due to peak noise levels are based on un-weighted overall levels, there is no need to take the frequency content into account in this calculation. For assessing physiological damage using the NOAA weighted SEL criteria it is, however, necessary to account for frequency. For this purpose, a reference frequency spectrum has been taken from Nedwell & Howell (2004) and applied to the calculated source levels. Attenuation due to molecular absorption in the water at various distances was also taken into account (this being frequency dependant).

11.21 The only (known) reference to date that gives a specific relationship between values of underwater SEL and peak pressure is that associated with the Hay Point Coal Terminal (Duncan & McCauley, 2009). This document, prepared by Curtin University of Technology, Centre for Marine Science and Technology, sets forward a best-fit curve between SEL and peak pressure for the development based upon measurements made by the University using “small explosive charges”. The specific relationship is given by the expression:

$$SEL = K \times SPL(pk)$$

where K = 0.8859 and SPL(pk) = Peak sound pressure level in dB re 1 µPa. This reference advises the standard deviation in the estimate of K as 0.0143.

11.22 The resulting third-octave band levels were then M-weighted.

11.23 Furthermore, for this assessment, the worst case peak pressure level generated by the pile severance explosions are considered to be generated due to one of the charges (i.e. due to the spatial variation of each pile, the pressure wave generated by each explosion, providing each charge is detonated simultaneously, is unlikely to result in an additive pressure wave).

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