Beatrice Environmental Impact Assessment Report

Consultation Version

August 2018

SUMMARY INFORMATION SHEET

Project Name	Beatrice Field Decommissioning Environmental Impact Assessment
Block and Licence No.	Block Number 11/30a. Licence No. P187
Project Reference No.	RP-DTABEA001-HS-0051
Type of Project	Decommissioning
Undertaker	Repsol Sinopec Resources UK Limited 163 Holburn Street, Aberdeen AB10 6BZ.
Licensees/Owners	The equity holders comprise:

Co-venturers	**Equity interest (%)**
Beatrice Hydrocarbon Facilities	
Repsol Sinopec Resources UK Limited	75
Repsol Sinopec North Sea Limited	25
Wind Turbine Generators	
Repsol Sinopec Resources UK Limited	37.5 %
Repsol Sinopec North Sea Limited	12.5%
SSE Generation Limited	50%

Short Description	This document considers the impact of the activities associated with the decommissioning of the Beatrice Field in the Central North Sea. The development comprises the bridge-linked Beatrice Alpha Drilling (AD) and Beatrice Alpha Production (AP) platforms which are centrally located in the field, with the Beatrice Bravo (B) and Beatrice Charlie (C) platforms located 5.6 km to the northeast and 5 km to the southwest of the Alpha complex respectively. A power cable connects the Alpha complex to Dunbeath and during production hydrocarbons were exported to Nigg Bay via an export pipeline. A series of infield pipelines and power cables connect the platforms. Apart from the nearshore section of the power cable to Dunbeath, which was surface laid, all pipelines and power cables are trenched and buried. Two experimental Wind Turbine Generators (WTGs) connected via a power cable to Beatrice AP are also within the scope of the decommissioning project. All topsides, jackets and WTGs will be recovered to shore. In line with the results of a Comparative Assessment all pipelines and power cables will be decommissioned *in situ*. Any exposed sections and pipeline/power cable ends will be trenched and buried. Base case is to recover all protective structures. Repsol Sinopec Resources UK are in ongoing discussions with the Department for Business, Energy and Industrial Strategy and Marine Scotland Science regarding the optimal approach to decommissioning a small cuttings pile at Beatrice AD. Decommissioning activities including plug and abandonment, recovery of installations, trenching and burying activities and the post decommissioning surveys are expected to span 10 to 12 years.
EIA Prepared by	Repsol Sinopec Resources UK Limited and Genesis Oil and Gas Consultants Ltd.

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EXECUTIVE SUMMARY

The Beatrice Field lies in the Central North Sea (CNS) and is operated by Repsol Sinopec Resources UK Limited (hereafter referred to as Repsol Sinopec Resources UK). Repsol Sinopec Resources UK has prepared this Environmental Impact Assessment (EIA) under the Petroleum Act 1998, in support of four draft Decommissioning Programmes (DPs) that are being submitted to the Department for Business, Energy and Industrial Strategy (BEIS) to seek approval for the following decommissioning works:

- Programme 1 covers four oil installations covered by four Section 29 (S29) notices;
- Programme 2 covers two wind turbines covered by one S29 notice;
- Programme 3 covers eight pipelines supported by five S29 notices; and
- Programme 4 covers one power cable covered by one S29 notice.

Background Information

The Beatrice Field has a main Alpha complex, comprising a drilling and accommodation platform (AD) bridge linked to a production platform (AP), and two satellite facilities: Bravo and Charlie. The Bravo platform is located *c*. 5.6 km northeast of the Beatrice Alpha complex whilst the Charlie platform is located *c*. 5 km southwest of the Alpha complex. Both satellites are connected back to AP via subsea pipelines (Figure 1).

When producing, Beatrice oil was exported via pipeline from the Alpha complex to a terminal at Nigg. Subsea power cables connect Beatrice Alpha to Dunbeath (onshore) and to Beatrice Bravo.

In 2007 two 'demonstrator' wind turbine generators (WTG A and WTG B) were installed *c*. 2 km southeast of the Alpha complex and are linked by a power cable, in series, back to the AP platform. The decommissioning of these WTGs is also captured within the scope of the Beatrice Field Decommissioning Project.

Apart from the nearshore section of the Dunbeath power cable, all pipelines and power cables were trenched and buried when installed. The nearshore section of the Dunbeath power cable was surface laid due to the rocky nature of the seabed in the area, which prevented trenching activities.

The Beatrice Field was discovered in the 1970's, reached peak production in 1982 and had Cessation of Production (CoP) granted in March 2015. In 2008 Ithaca Energy (UK) Limited leased the offshore Beatrice facilities including the Nigg onshore terminal and the export pipeline from Beatrice to Nigg. During Ithaca's operatorship of Beatrice, the Jacky Field (Block 12/21c) was produced over the Beatrice facilities. The development of Jacky extended the economic viability of the Beatrice Field for five years (2009 – 2014), following which the facilities reverted to Talisman Sinopec Energy UK (now Repsol Sinopec Resources UK).

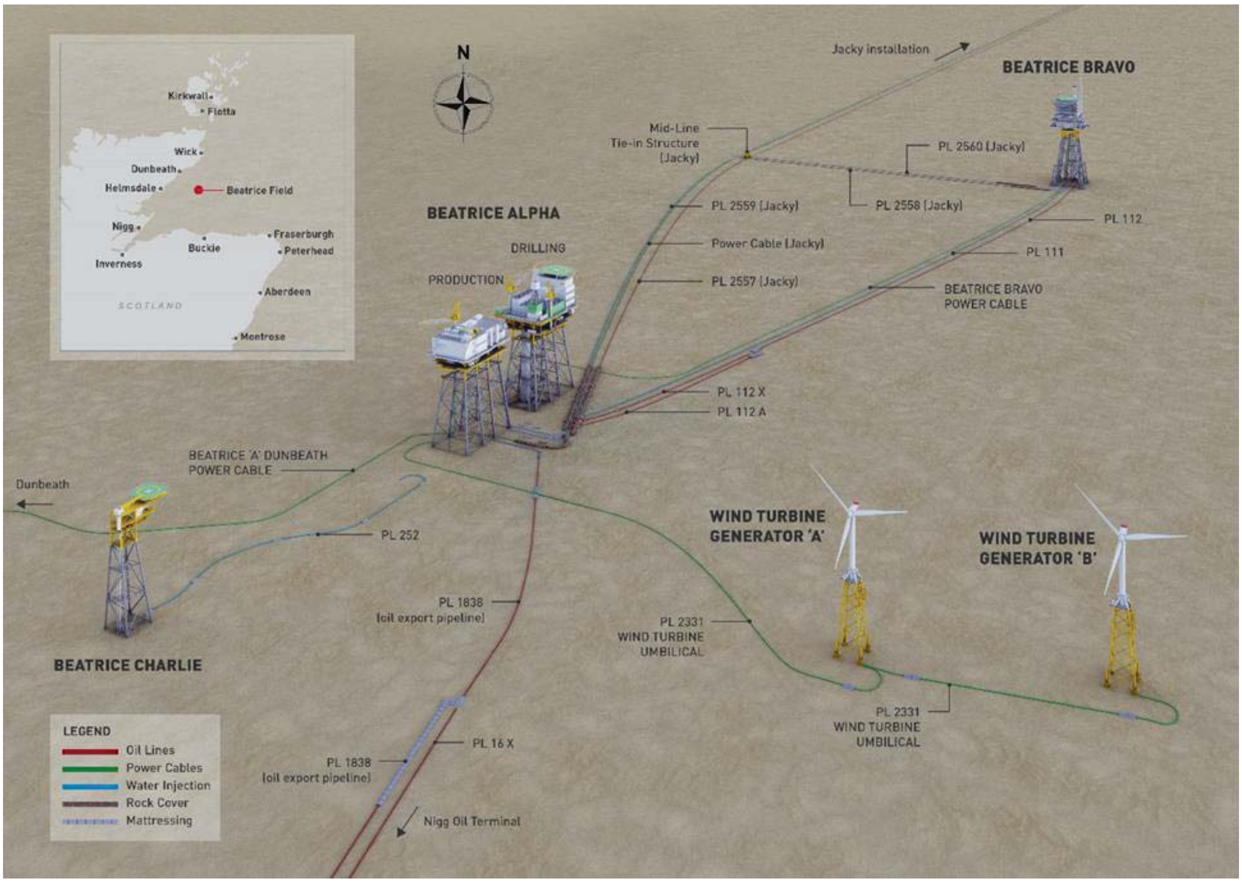


Figure 1: Schematic of the Beatrice Field facilities to be decommissioned.

Stakeholder Engagement

Consulting with stakeholders is an important part of the decommissioning EIA process as it allows any concerns or issues which stakeholders may have, to be communicated and addressed. In May 2017, as part of the informal stakeholder engagement process a Scoping Report was issued to a number of stakeholders. The Scoping Report provided an overview of the Beatrice Field, the proposed decommissioning activities (as known at the time) and an overview of the impacts to be assessed in this EIA. Stakeholders were invited to comment on the Scoping Report with respect to any concerns they may have. In addition to issuing the Scoping Report, Repsol Sinopec Resources UK have carried out a number of informal stakeholder engagement sessions. These have included separate meetings with various stakeholders and a Stakeholder Engagement Workshop. Comments received on the Scoping Report and issues raised during the meetings have been addressed in this report.

Decommissioning Activities

A number of activities are required to be carried out to decommission the Beatrice Field. These include:

- Preparatory works associated with cleaning the topsides and pipelines;
- Plugging and abandonment (P&A) of the wells;
- Removal of the topsides, jackets and subsea structures in line with OSPAR 98/3;
- Decommissioning of the pipelines and power cables in line with the results of a Comparative Assessment (CA); and
- Recovery of the WTGs.

The preparatory works are primarily aimed at making the infrastructure (topsides and pipelines) hydrocarbon free. There are a total of 43 wells to be decommissioned across the three facilities: 30 at Beatrice AD, 11 at Bravo and 2 at Charlie. P&A activities have been completed at Charlie and at the time of writing had commenced at Bravo. It is anticipated that P&A activities across all 43 wells will be completed by Q4 2024.

In line with the requirements of OSPAR 98/3 the topsides and jackets will be recovered to shore for dismantling and treatment in line with the waste hierarchy: reuse, recycle, disposal. The base case is to cut the jacket legs internally, though given the greater level of seabed disturbance associated with external cutting, the latter approach is assessed in the EIA. The piles will be severed below the natural seabed level, with best endeavours to achieve -3 m. Any change in this depth will be discussed with BEIS at the time of execution.

A CA was carried out to determine the best method of decommissioning the pipelines and power cables. The CA determined that decommissioning the buried pipelines and cables *in situ* whilst trenching and burying any exposed ends and mid-line sections was the optimal approach. In addition, it determined that decommissioning the nearshore surface laid section of the Dunbeath power cable *in situ* without remedial action is the best option.

The Beatrice infrastructure has a number of different protective/stabilisation structures associated with it including, 25 kg grout bags, two concrete tunnels, flexible concrete mattresses, grout filled mattresses and large grout bags (11.25 te and 22.5 te bags). In line with BEIS guidelines (DECC, 2011) the base case is to remove all of these structures.

For the most part it is expected the flexible concrete mattresses will be recovered using a grab. A CA of the remaining decommissioning options has been carried out to determine the optimal approach for a series or group of flexible mattresses which cannot be recovered by grab due to their condition. Individual flexible concrete mattresses that cannot be recovered using a grab, will be broken up and transferred to debris baskets (either by Remotely Operated Vehicles (ROV) or by divers) for recovery. It should be noted that a review of ROV footage of the flexible concrete mattresses to be decommissioned has not identified any series of these mattresses in a condition expected to hinder recovery.

As for the flexible concrete mattresses, the base case for the grout filled mattresses and the large grout bags is full recovery. If during execution, some of these mattresses or grout bags cannot be recovered, Repsol Sinopec Resources UK will consult with BEIS before any alternative option is executed.

As a worst case the EIA assumes around 10% (i.e. 21 of a total of 208 mattresses) of the flexible concrete mattresses and all of the grout filled mattresses and larger grout bags are decommissioned *in situ*.

There is a small cuttings pile of c. 1,420 te (678 m^3) located at the Beatrice AD jacket. The rate of loss of oil from the Beatrice AD cuttings pile and the persistence of the pile are both below the OSPAR thresholds that are considered to represent an environmental risk. In order to recover the subsea infrastructure including the AD jacket it will be necessary to cause some disturbance to the pile. The level of disturbance will be dependent on the methods selected for recovery of the structures.

Repsol Sinopec Resources UK have carried out a Best Available Technique (BAT) assessment to determine the optimal approach for management of the Beatrice AD cuttings pile. In summary the assessment determined that the following approaches can each be considered to be BAT and are each technically feasible for this project:

1. Recover by suction dredging, treat and discharge offshore;
2. Recover by suction dredging, transport for treatment onshore, coastal discharge of aqueous waste, reuse or disposal of treated solids; and
3. Spreading of cuttings pile by high pressure water jet.

Repsol Sinopec Resources UK are in ongoing discussions with BEIS and Marine Scotland regarding the management of the cuttings pile. These discussions will continue following submission of the draft DPs for public consultation. The EIA assesses the impacts associated with the scenario whereby 85 % of the pile is disturbed to allow external cutting of the jacket piles. This scenario was selected to represent the worst case environmental impact associated with recovery of the Beatrice AD jacket.

Following decommissioning activities, Repsol Sinope Resources UK will provide evidence that the seabed is free of debris and the area is safe for other sea users. Should any of the stabilisation features be left *in situ* (either with or without rock cover added to them), they will be marked on FishSafe.

ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE

The Beatrice Field facilities are located in the Outer Moray Firth in Block 11/30a, at a minimum distance of 22 km south east of the nearest coastline. Water depths vary from around 40 to 50 m at the Beatrice platforms: from 0 m to 63 m along the Dunbeath power cable and from 0 m to 59 m along the export pipeline.

Given the number of protected areas associated with the region the Moray Firth can be considered to be an environmentally sensitive area (Figure 2). The Beatrice facilities are located out with any of the designated areas, however both the export pipeline to Nigg and the power cable to Dunbeath do pass through protected areas. Both areas have multiple designations. The nearshore section of the power cable passes through an area (East Caithness) that is designated as a Special Area of Conservation (SAC), a Special Protection Area (SPA) and a Nature Conservation Marine Protected Area (NCMPA). The primary designating features in this area are birds and for the SAC it is the cliffs. The export pipeline passes through the Moray Firth SAC which also overlaps with the Moray Firth SPA area. The primary designating features for the SAC is the bottlenose dolphin whilst a secondary designating feature is the presence of subtidal sandbanks which are slightly covered by sea water all the time. It should be noted the pipelines do not pass through the sandbanks.

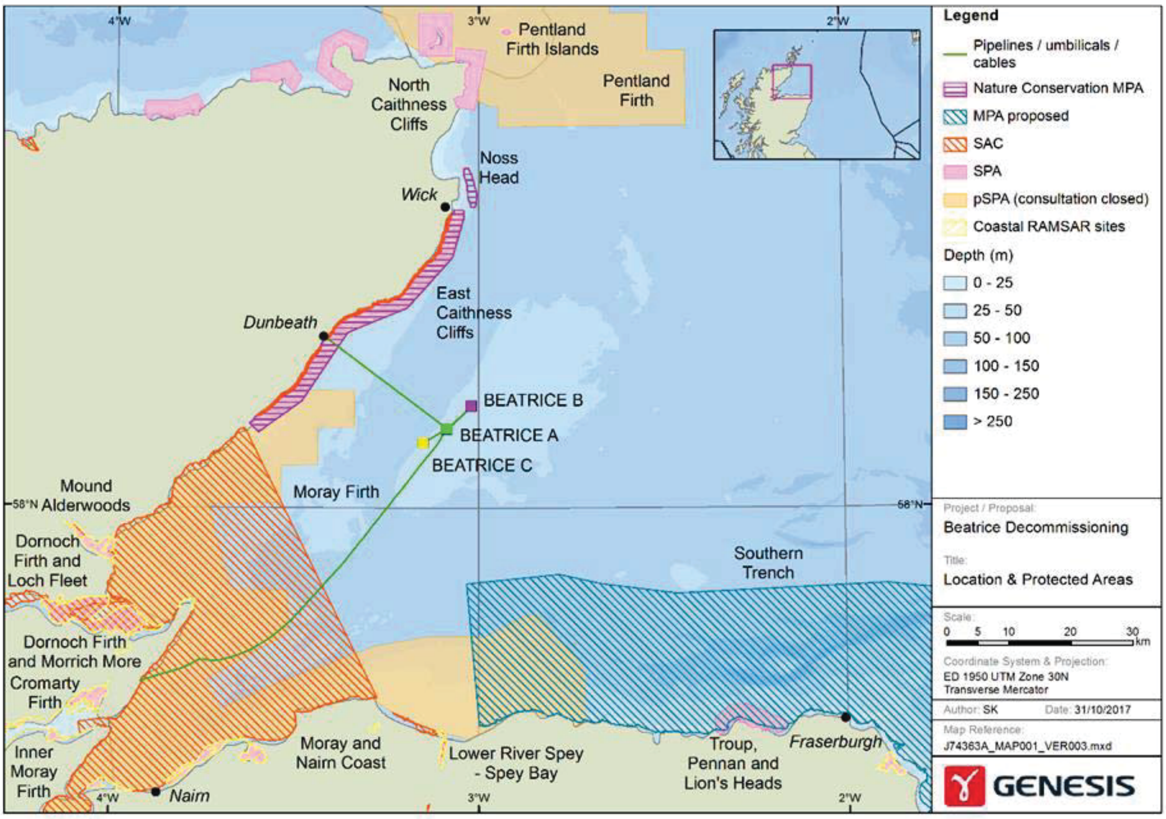


Figure 2: Map showing designated areas within the Moray Firth.

The seabed sediments across the area are broadly considered to be subtidal sands and gravels ranging from areas of fine sand, to muddy and mixed gravel to muddy sands. A small drill cuttings pile occurs at the Beatrice AD platform. The pile contains elevated concentrations of hydrocarbons and other contaminants associated with the historic discharge of contaminated cuttings.

Plankton, benthic and fish species in the area are typical of the Central North Sea. Benthic and fish species protected under Annex II of the Habitats Directive and known to occur in the area include the bivalve *Arctica Islandica*, and Atlantic salmon, sea lamprey, Allis shad and Twaite shad.

A number of marine mammals occur in the area. Cetaceans include the harbour porpoise, bottlenose dolphin, white-beaked dolphin and minke whale. Sightings of fin whale, humpback whale, killer whale and long-finned pilot whale have also been recorded in the outer Moray Firth. Grey and harbour seals occur in the vicinity and otters have been observed at the landfall end of the oil export line. A number of these species are protected under Annex II of the Habitats Directive.

A number of SPAs (designated for birds) occur along the Moray Firth coast. Many of the birds from these SPAs forage in the Moray Firth area. The most frequently observed species include kittiwake, auks, fulmar, gannet and arctic terns.

A number of fishing gear types are active in the Beatrice Field area including seine nets, demersal trawls, *Nephrops* trawls, scallop dredges and pots. The area is an important fishing ground for smaller vessels whilst in terms of effort and landings it is of less importance to larger vessels. For both larger and smaller vessels, shellfish comprise the most valuable landings and these are targeted with a mixture of static and mobile gear.

Shipping activity in the area is considered low. There are a number of wind farm development projects associated with the wider Moray Firth area.

IMPACT ASSESSMENT

In order to determine the impact of the proposed decommissioning activities, Repsol Sinopec Resources UK held an Environmental Impact Identification Workshop which considered the proposed decommissioning activities and their potential environmental and socio-economic impacts.

Receptors considered in the workshop included: air, water and sediment quality, plankton, benthic species, fish, marine mammals, seabirds, designated area, coastal communities, fisheries, shipping, landfill resources, resource use, local communities and cultural heritage. The impacts of emissions to air, discharges to sea, seabed disturbance, underwater noise, and waste production on each of these receptors was considered. In addition, the physical presence of the vessels during operations and the items to be decommissioned *in situ* were considered.

For the majority of the planned activities the environmental and social impacts were considered to be of low significance. Only one environmental impact of significance was considered to be of moderate significance whilst none were considered to be of high significance.

Disturbance to the Beatrice AD cuttings pile during recovery of the substructures at Beatrice AD was considered to be of moderate significance. The extent of disturbance depends on the method to be used to cut the jacket piles. It should be noted a worst case disturbance was assessed and Repsol Sinopec Resources UK are continuing to explore technologies to minimise the amount of disturbance. The cuttings pile is below the OSPAR thresholds considered to be of environmental significance and given its small size and relatively small hydrocarbon content will remain below these thresholds following disturbance. However, there is expected to be some slow leaching of contaminants into the water column such that the impact significance is considered to be Moderate. It is also anticipated that scallop dredges would be restricted from accessing the area covered by the cuttings pile.

Decommissioning the Beatrice AD cuttings pile in *situ* would restrict access by scallop dredges to the area. In addition, it is possible that rock will be used to fill in any depressions resulting from removing the jackets.

Assessing a worst case whereby (i) 10% of the flexible concrete mattresses and all of the grout filled mattresses and large grout bags are rock covered and decommissioned *in situ*, (ii) rock is used to backfilled jacket leg holes and (iii) the Beatrice AD cuttings pile is decommissioned in situ following jacket recovery, it is expected that scallop dredges would continue to be excluded from an area of less than 0.01 km^2, whilst trawl gear would have to fish these areas with care. However, following recovery of the Beatrice facilities and the WTGs, Repsol Sinopec Resources UK will surrender the 500 m exclusions associated with them (five in total). In addition, trenching and burying of the pipeline ends and exposed mid line sections will allow fishing gear to access these areas such that it is estimated that around 3.9 km^2 will be returned to the fishing industry.

The Impact Significance of the proposed activities on the designated areas traversed by the pipelines was considered Low, due to the limited activities associated with those sections of the pipelines and power cables.

The Environmental Impact Identification Workshop identified two accidental events that have the potential to be a significant environmental risk: a loss of diesel during bunkering operations and a loss of diesel due to vessel collision.

When the impact significance and likelihood were taken into account for both, the environmental risk was considered to be medium. This ranking reflects the sensitive nature of the Moray Firth and the potential impacts on the receptors rather than the likelihood of such incidents occurring.

ENVIRONMENTAL MANAGEMENT

The Beatrice Decommissioning Project will be aligned to Repsol Sinopec Resources UK goal to 'minimise the impact to the environment'.

Atmospheric emissions will be managed by inspection of the vessels contracted to carry out the work and by planning vessel schedules to ensure efficient operations. Fuel consumption will be recorded throughout the decommissioning operations.

Repsol Sinopec Resources UK will implement a Waste Management Plan. The inventory of decommissioned items will distinguish equipment that can be reused, materials that can be recycled and waste for appropriate disposal. Naturally Occurring Radioactive Material (NORM) is not expected to be present, but if it is detected, the contaminated waste will be sent for appropriate treatment. Waste management activities will be conducted in full compliance with all relevant legislation and regulatory controls. Disposal to landfill will be the waste management option of last resort.

Pre-decommissioning surveys have identified some debris items which will be recovered as part of the decommissioning activities. Following decommissioning activities independent verification of the seabed state will be obtained for the pipeline areas and installation locations and evidence of clearance will be provided to all relevant governmental and non-governmental organisations. A post-decommissioning environmental survey will be carried out following decommissioning activities to establish the condition in which the seabed is left. Ongoing monitoring surveys will be carried out to verify recovery of the seabed and that the pipelines and power cables decommissioned *in situ* remain buried and do not present a risk of snagging to other users of the sea.

Stringent control measures and operational procedures will be implemented to prevent accidental events involving the release of hydrocarbons or chemicals.

Table 1 lists procedural and technical controls and mitigation measures identified in the preparation of this EIA to reduce impacts to a level that is 'as low as reasonably practicable'.

Table 1: Decommissioning of Beatrice Field: project specific commitments.

Aspect	Commitment
Physical presence	• Ongoing consultation with SFF; • Notice to mariners will be circulated; • A Vessel Traffic Survey will be undertaken to support a CtL application; • A Collision Risk Management Plan will be produced if required; • Vessel use will be optimised and Repsol Sinopec Resources UK will continue to explore synergies, e.g. the potential to share supply boats, with wind farm developers in the area; • All vessels engaged in the project operations will have markings and lightings as per the International Regulations for the Prevention of Collisions at Sea (COLREGS) (International Maritime Organisation, 1972). • If used rock cover will be optimised and carefully managed. A fall pipe will be used to ensure accuracy of the rock dumping. Size of rock cover will be in accordance with industry practice which is also the preferred SFF / industry best practices. • Locations of remaining materials (could possibly include unrecovered stabilisation features, rock cover and the Beatrice AD cuttings pile) will be marked on FishSafe.
Atmospheric emissions and energy use	• As part of the tendering process, proposed vessels will go through a detailed assurance process which will include a review of generator and

Aspect	Commitment
	engine maintenance which leads to better efficiency in line with manufacturer's specifications. • Decommissioning vessel schedules will be planned to optimise (minimise) vessel use. Repsol Sinopec Resources UK will continue to investigate synergies with other projects in the area (e.g. wind farm developers) to optimise vessel use. • Prior to the contract award, Repsol Sinopec Resources UK will audit the decommissioning yards to ensure suitable permits are in place and that atmospheric emissions are being managed. • Activities will be carried out in line with Repsol Sinopec Resources UK's environmental policy which includes minimising emissions.
Discharges to sea	• Repsol Sinopec Resources UK will carry out a detailed assurance process on all vessels prior to contract award. • Work procedures will be in place to minimise offshore campaigns. • Only MARPOL compliant vessels will be used. • Flushing and cleaning of topsides and pipelines is completed in line with BAT/BEP requirements. • All contracted vessels will be signed up to IMO and will adhere to their guidelines. • Any associated discharges will be managed to minimise impact.
Physical disturbance of the seabed and marine species	• Pre anchor lay surveys to be carried out. • Work procedures in place. • Excavation methods at the jacket legs will be explored to identify how displaced material could be used to backfill any remaining depressions. Repsol Sinopec Resources UK will also explore use of fine rock particles to fill any holes that may remain. • Should it not be possible to recover some of the stabilisation features, Repsol Sinopec Resources UK will consult with BEIS before an alternative approach to decommissioning them is applied. • Ongoing discussions with BEIS and Marine Scotland regarding the optimal approach to managing the Beatrice AD cuttings pile.
Nuisance (e.g. noise, odour)	• Vessel use will be optimised. Repsol Sinopec Resources UK will continue to explore possible synergies with Ithaca and windfarm developers in the area e.g. sharing of supply boats. • Procedures will be in place to minimise the number and duration of cutting operations.
Onshore activities	• Contract award will be to an established yard with appropriate experience, capability, licences, consents and community engagement in place.
Waste generation and resource use	• The Beatrice Project will have in place a WMP developed to describe and quantify waste arising from decommissioning activities and identify available disposal options for those wastes. • Waste management options will take account of the waste hierarchy. • As part of Repsol Sinopec Resources UK's Duty of Care, contract award will be to an established yard with appropriate experience, capability, licences and consents in place.
Accidental events	• Any infrastructure decommissioned *in situ* will be marked on FishSafe and communicated accordingly. • Work procedures in place. • Use of trained personnel to carry out bunkering operations.

Aspect	Commitment
	• Bunkering operations would be manned continuously with radio contact between the vessels at all times. • Regular maintenance checks of fuel transfer hose. • Vessel assurance inspections. • Pre-hire vessel audits. • Emergency response plans in place including SOPEPs (shipboard oil pollution emergency plan). • SIMOPS (simultaneous operations) will be managed through bridging documents and communications.

CONCLUSION

This Environmental Impact Assessment has assessed the impacts and risks associated with the proposed decommissioning activities in the context of the environment within which the Beatrice Field is situated. With implementation of the proposed mitigation measures, the environmental impact of the removal of the facilities is likely to be minimal and temporary with regard to disturbed seabed within the project footprint. Recovery of the ecology is expected to begin immediately on completion of the activities.

If rock is placed over any of the stabilisation features (base case is full recovery) or is used to fill in any depressions resulting from removal of the jackets, it will have a long-term presence, but will be very limited in extent. It is possible that scallop fishermen will be excluded from a very limited footprint of 0.01 km^2, however, following surrender of the five exclusion zones associated with the platforms and WTGs, and the trenching and burying of the exposures, fishing vessels will have access to an additional 3.9 km^2 of seabed.

To conclude the proposed decommissioning of the Beatrice Field will leave the area in a condition suitable for re-colonisation by local species and safe for fishermen.

ACRONYMS

%	Percent
"	Inches
<	Less than
>	More than
µM	Micro meter
µg g^{-1}	Micro grams per gram
3D	3-dimensional
3LPP	Three Layer Polypropylene
A	Alpha
ACOPS	Advisory Committee on Protection of the Sea
AD	Alpha Drilling and Accommodation Platform
AHV	Anchor Handling Vessel
AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
AP	Alpha Production Platform
AP	Alkylphenols
APE	Alkylphenol Ethoxylates
ASSI	Area of Special Scientific Interest
AU	Aberdeen University
B	Bravo
BAC	Background Assessment Concentrations
BAT	Best Available Technology
BC	Background Concentrations
Beatrice A	Beatrice A
Beatrice AD	Beatrice Alpha Drilling and Accommodation Platform
Beatrice AP	Beatrice Alpha Production Platform
Beatrice B	Beatrice Bravo
Beatrice C	Beatrice Charlie
BEIS	(Department of) Business, Energy and Industrial Strategy
BEP	Best Environmental Practice
BNOC	British National Oil Company
BAOAC	Bon Agreement Oil Appearance Code
BOWL	Beatrice Offshore Wind Farm
BOWL	Beatrice Offshore Wind Farm Limited
BP	British Petroleum
BPA	Bis-phenol A
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
C	Charlie
CA	Comparative Assessment
CEMP	Coordinated Environmental Monitoring Programme
CES	Crown Estate Scotland
CH_4	Methane
CMID	Common Marine Inspection Documents
CNS	Central North Sea
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide equivalent
COLREGS	International Regulations for the Prevention of Collisions at Sea
CoP	Cessation of Production
CRA	Collision Risk Assessment
CSS	Conductor Support Structures
CSV	Construction Support Vessel
CtL	Consent to Locate

dB	Decibel
dB re µPa-2S	Decibel relative to 1 squared Micro Pascal per second
dB re µPa-m	Decibel relative to Micro Pascal to a metre
DECC	Department of Energy and Climate Change
DP	Decommissioning Programme
DP	Dynamic Positioning
DREAM	Dose-related Risk and Effect Assessment Model
DSV	Dive Support Vessel
DTI	Department of Trade and Industry
E	East
EAC	Environmental Assessment Criteria
EC	European Commission
ECMWF	European Centre for Medium range Weather Forecasts
ED	European Datum
EEC	European Economic Community
EIA	Environmental Impact Assessment
EIF	Environmental Impact Factor
EMT	[BEIS] Environmental Management Team
ENSCO	ENSCO International (ESV)
ENVID	Environmental Issues Identification
EPS	European Protected Species
ER	Effects Range
ERL	Effects Range - Low
ERMS	Environmental Risk Management System
ERT	Electrical Resistivity Tomography
ESAS	European Seabirds at Sea
ESIA	Environmental and Socio-Economic Impact Assessment
ESRA	Environmental and Socio-Economic Risk Assessment

EU	European Union
EUNIS	European Nature Information System
GEBCO	Bathymetric Chart of the Oceans
GEN	National Marine Plan General Policies
GIS	Geographic Information System
GJ	Giga-Joule (1 billion Joules)
GWP	Global Warming Potential
H	Height
HLV	Heavy Lift Vessel
HLCV	Heavy Lift Crane Vessel
HM	Her Majesty's
HMS	Her Majesty's Ship
HRA	Habitat Regulations Appraisal
hrs	Hours
HSE	Health, Safety and Environmental
HVDC	High Voltage, Direct Current
HYCOM	Hybrid Co-ordinate Ocean Model
Hz	Hertz
IAMMWG	Inter-Agency Marine Mammal Working Group
ICES	International Council for the Exploration of the Sea
IEEM	Institute of Ecology and Environmental Management
IHM	Inventory of Hazardous Materials
IMO	International Maritime Organisation
IoP	Institute of Petroleum
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature

JCP	Joint Cetacean Protocol
JIP	Joint Industry Project
JNCC	Joint Nature Conservation Committee
kg	kilogram
kHz	Kilo-Hertz
km	kilometres
km^2	Kilometres squared
K_{oc}	Organic carbon water partition coefficient
K_{ow}	Octanol water partition coefficient
KP	Kilometer Point
kW/m	Kilowatts per meter
L	Length
LAT	Lowest Astronomical Tide
LTOBM	Low Toxicity Oil Based Mud
LUC	Land Use Consultants
m	Meter
m^3	Meters cubed
m^2	Square meters
MAH	Major Accident Hazard
MAS	Marine Assurance Standards
MARPOL	The International Convention for the Prevention of Pollution from Ships
MAT	Master Application Template
MBES	Multi-beam Echo Sounder
MCAA	Marine and Coastal Access Act
MEI	Major Environmental Incident
MEMW	Marine Environmental Modelling Workbench
MESA	Marine Ecosystem Analysis
mg/kg	milligrams per kilogram
MoD	Ministry of Defence
MPA	Marine Protected Area
MPI	Major Pollution Incident

MSS	Marine Science Scotland
MSV	Multipurpose Support Vessel
MU	Management Units
MW	Mega Watt – 1 million watts
N	North
N/A	Not Applicable
NCMPA	Nature Conservation Marine Protected Area
nm	Nautical miles
NMP	National Marine Plan
NMPi	National Marine Plan Interactive
NNA	Not Normally Attended
NORM	Naturally Occurring Radioactive Materials
N_2O	Nitrous Oxide
NO_x	Nitrogen oxides
NPCA	Norwegian Pollution Control Authority
NPD	Naphthalenes, Phenanthrenes and Dibenzothiopenes
NSA	National Scenic Area
NUI	Normally Unmanned Installation
OBM	Oil Based Mud
OCR	Offshore Chemical Regulations
ODU	Offshore Decommissioning Unit
OGA	Oil and Gas Authority
OGUK	Oil and Gas UK
OPEP	Oil Pollution Emergency Plan
OPPC	Oil Pollution Prevention and Control
OSCAR	Oil Spill Contingency and Response
OSPAR	Oslo/Paris Convention
OVI	Offshore Vulnerability Index
P&A	Plug and Abandonment

Pb	Lead
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PEC	Predicted Environmental Concentration
PETS	Portal Environmental Tracking System
PL	Pipeline
PLONOR	Pose Little or No Risk
PMF	Priority Marine Feature
PNEC	Predicted No Effect Concentration
PON2	Petroleum Operations Notice
ppb	Parts per Billion
ppt	Parts per trillion
PSD	Particle Size Distribution
pSPA	potential SPA
PWA	Pipeline Works Authorisation
Q	quarter
RAG	Red-Amber-Green
Ramsar	Ramsar sites are wetlands of international importance designated under the Ramsar Convention
re	Relative to
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
Rms	Root-Mean-Square
ROV	Remotely Operated Vehicle
ROVSV	Remotely Operating Vehicle Support Vessel
S	South
SAC	Special Area of Conservation
SCANS	Small Cetacean Abundance in the North Sea
SCI	Sites of Community Importance
SCR_{05}	The Offshore Installations (Safety Case) Regulations 2005
SDM	Species Distribution Modelling

SEMS	Safety and Environmental Management System
SEPA	Scottish Environment Protection Agency
SFF	Scottish Fisheries Federation
SIMOPS	Simultaneous Operations
SINTEF	Stiftelsen for Industriell og Teknisk Forskning
SNH	Scottish Natural Heritage
SNS	Southern North Sea
SO_2	Sulphur Dioxide
SOPEP	Ship Oil Pollution Emergency Plan
SOSI	Seabird Oil Sensitivity Index
SPA	Special Protection Area
SPL	Sound Pressure Levels
SSS	Side Scan Sonar
SSSI	Sites of Special Scientific Interest
TBT	Tributyltin
Te / te	Tonnes
THC	Total Hydrocarbon Concentration
UCM	Unresolved Complex Mixture
UK	United Kingdom
UKHO	United Kingdom Hydrographic Office
UKBAP	UK Biodiversity Action Plan
UKCS	United Kingdom Continental Shelf
UKOOA	UK Offshore Operators Association
UTM	Universal Transverse Mercator
VMS	Vessel Monitoring Systems
VOC	Volatile Organic Compounds
W	Width
W	West
WBM	Water Based Mud
WeBS	Wetland Bird Survey
WEEE	Waste Electrical and Electronic Equipment

WFD	Waste Framework Directive
WGS84	World Geodetic System
WHP	Wellhead Platform
WMP	Waste Management Plan
WTG	Wind Turbine Generator
WWI	World War One
WWII	World War Two
yr	year

1. INTRODUCTION

The Beatrice Field lies in the Central North Sea (CNS) and is operated by Repsol Sinopec Resources UK Limited (hereafter referred to as Repsol Sinopec Resources UK). Repsol Sinopec Resources UK has prepared this Environmental Impact Assessment (EIA) under the Petroleum Act 1998, in support of four draft Decommissioning Programmes (DPs) that are being submitted to the Department for Business Energy and Industrial Strategy (BEIS) to seek approval for the following decommissioning works:

- Programme 1 covers four oil installations covered by four Section 29 (S29) notices;
- Programme 2 covers two wind turbines covered by one S29 notice;
- Programme 3 covers eight pipelines supported by five S29 notices; and
- Programme 4 covers one power cable covered by one S29 notice.

1.1 Project Background

The Beatrice Field has a main Alpha (A) complex, comprising a drilling and accommodation platform (AD) bridge linked to a production platform (AP), and two satellite facilities: Bravo (B) and Charlie (C). The Beatrice B platform comprises water injection and minimum production facilities and the Beatrice C platform has facilities for water injection purposes only. The B platform is located *c*. 5.6 km northeast of the Beatrice A complex whilst the C platform is located *c*. 5 km southwest of the A complex. Both satellites are connected back to AP via subsea pipelines.

When producing, Beatrice oil was exported via a 16" pipeline from the A complex to a terminal at Nigg. Subsea power cables connect Beatrice A to Dunbeath (onshore) and to Beatrice B.

Two 'demonstrator' wind turbine generators (WTG A and WTG B) were installed *c*. 2 km southeast of the A complex and are linked by a power cable, in series, back to the AP platform. The decommissioning of these WTGs is also captured within the scope of the Beatrice Field Decommissioning Project.

Figure 1-1 shows a schematic of the Beatrice Field facilities to be decommissioned as part of the Decommissioning Project.

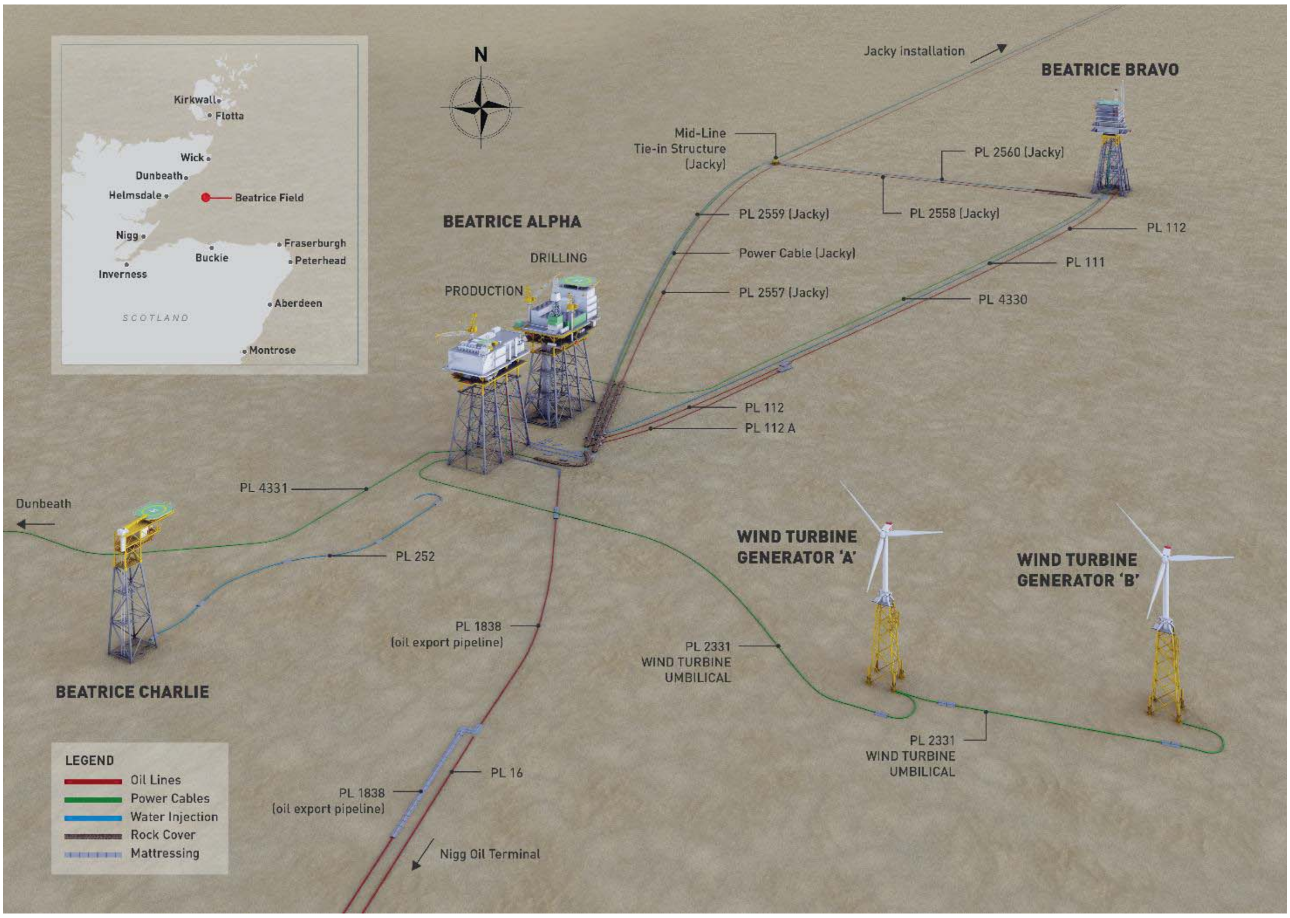


Figure 1-1: Schematic of the Beatrice Field facilities to be decommissioned.

1.2 Beatrice Field History

Figure 1-2 provides a timeline of the key events in the history of the Beatrice Field. The Field was discovered in the mid-1970s by MESA Petroleum and was subsequently bought by the British National Oil Company (BNOC). In 1982, BNOC transferred their business to Britoil and under Britoil's ownership the Field reached peak production in 1985. The Field was bought by BP in 1988 and subsequently by Talisman Energy UK Ltd in 1996. In 2012 a joint venture company formed between Talisman Energy UK Ltd and the Sinopec Group: Talisman Sinopec Energy UK. This new company maintained ownership of the Field until 2015 when Repsol bought Talisman Energy. In 2016 the company was renamed Repsol Sinopec Resources UK.

A DP for Beatrice was previously submitted by Talisman Energy UK Ltd and approved in 2004 by the DTI (Department of Trade and Industry: relevant regulatory functions now within BEIS and OGA). This DP was based on an agreement with the Ministry of Defence (MoD) to use the platforms for military training after Cessation of Production (CoP). The MoD subsequently exercised their right to terminate the agreement, and therefore the DP is required to be updated.

In 2007 two WTGs were installed as part of a joint venture; the Beatrice Wind Farm Demonstrator Project, between Scottish and Southern Energy and Talisman Energy UK Ltd. When operational the electricity produced was fed to the Beatrice Alpha complex.

In 2008, Ithaca Energy (UK) Limited (Ithaca) leased the offshore facilities from Talisman Energy UK Limited, including the Nigg onshore terminal and the export pipeline from Beatrice to Nigg. Under the terms of the lease Talisman Energy UK Limited retained decommissioning liability for the Beatrice facilities. During Ithaca's operatorship of Beatrice, the Jacky Field (Block 12/21c) was developed, with the installation in 2009 of a normally unmanned platform 10 km to the north east of Beatrice AP. The development of Jacky extended the economic viability of the Beatrice Field for five years.

In March 2014, Ithaca handed back the Beatrice facilities to Talisman Sinopec Energy UK which initiated a review of potential options for continued and future field use, and ultimately led to CoP of the Beatrice Field in March 2015. Ithaca retains the decommissioning liability for the Jacky facilities whilst Repsol Sinopec Resources UK are responsible for the Decommissioning of the Beatrice Field including the infrastructure associated with the Beatrice Wind Farm Demonstrator Project.

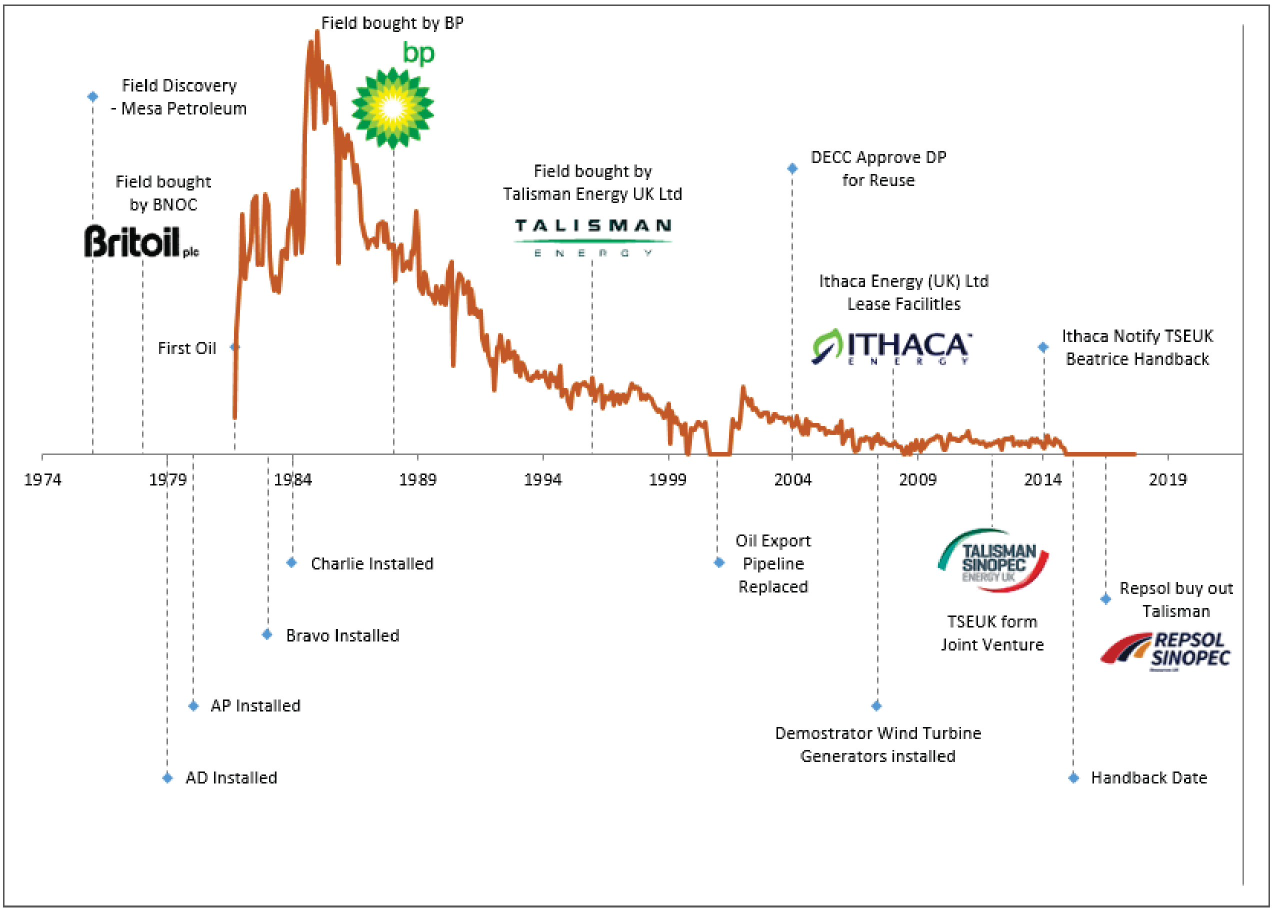


Figure 1-2: Representative schematic of the Beatrice Field timeline.

1.3 Purpose of the Document

Under Section 6 of the Decommissioning of Offshore Oil and Gas Installations and Pipelines under Petroleum Act 1998 Guidance Notes (DECC, 2011) there is a requirement for an assessment of the potential environmental impacts and risks to be carried out for the proposed decommissioning activities captured in a DP.

The EIA identifies those activities likely to have an environmental impact. An ENVironmental Issues IDentification (ENVID) workshop was undertaken to discuss the proposed activities and their potential environmental and socio-economic aspects (e.g. emissions to air, discharges to sea, seabed disturbance, underwater noise, waste generation impacts on other sea users etc.). The workshop also identified the mitigation measures that will be used to reduce the environmental and socio-economic impacts associated with these aspects.

1.4 Document Layout

To determine the environmental and socio-economic impacts of the Beatrice Field Decommissioning Project, an understanding of the regulatory context, stakeholder concerns, the proposed activities and the environmental and socio-economic baseline is required. Table 1-1 details the structure of the EIA report.

Table 1-1: Structure of the EIA Report.

Chapter No.	Title	Contents
	Non-Technical Summary	A summary of the EIA Report.
1	Introduction	Introduction to the project and scope of the EIA. This chapter also includes a summary of applicable legislation.
2	Stakeholder Engagement	Details of the consultation process to date.
3	Project Description	A description of the facilities (platforms, WTGs, pipelines, power cables and stabilisation features) to be decommissioned, the proposed decommissioning activities and an indicative schedule of activities.
4	Comparative Assessment	Summary of the results of the CA carried out for the pipelines, power cables and mattresses.
5 and 6	Environmental and Socio-Economic Baseline	A description of the environmental (Chapter 5) and socio-economic (Chapter 6) receptors in the area.
7	Impact and Risk Assessment Methodologies	Description of the methodologies used to determine the environmental and socio-economic impact significance of planned activities and the environmental and socio-economic risk of accidental events.
8 to 13	Assessment of Aspects	Detailed assessment of Physical Presence (Chapter 8); Energy Use and Emissions (Chapter 9); Discharges to Sea (Chapter 10); Seabed Disturbance (Chapter 11); Underwater Noise (Chapter 12); and Onshore Activities (Chapter 13).
14	Waste Management	Details of the waste likely to be generated and the management processes to be implemented during decommissioning activities.
15	Accidental Events	Details of accidental events identified during the ENVID workshop.
16	Environmental Management	A description of Repsol Sinopec Resources UK's Environmental Management Procedures and how they apply to the Beatrice Decommissioning Project.
17	Conclusions	Key findings including a register of commitments.
Appendix A: ENVID table		Results of the ENVID workshop.
Appendix B		Modelling of the impact of disturbing the Beatrice AD cuttings pile during removal of the Beatrice AD infrastructure.
Appendix C		Modelling of the impacts of a loss of diesel inventory in the event of a vessel collision.

1.5 Regulatory Context

The UK's international obligations on decommissioning are governed principally by the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic. Agreement on the regime to be applied in the decommissioning of offshore installations in the Convention area was reached at a meeting of the OSPAR Commission in July 1998 and is formalised as OSPAR Decision 98/3 on the Disposal of Disused Offshore Installations.

The Decision sets out OSPAR Contracting Parties' obligations on the decommissioning of offshore installations and prohibits the dumping and leaving wholly or partly in place of offshore installations. The topsides of all installations must be returned to shore for reuse, recycling or final disposal on land, as must all jackets weighing less than 10,000 tonnes (te).

None of the Beatrice Field jackets are above 10,000 te and therefore all Beatrice platform substructures will be removed in their entirety. For the purposes of this assessment it is assumed that foundation piles will be cut below the mudline and all structures above the cut will be removed.

In the UK, decommissioning is regulated by BEIS under the Petroleum Act 1998 as amended by the Energy Act 2008. BEIS requires that the decommissioning of pipelines must satisfy the requirements of the Petroleum Act, 1998, and that pipelines are assessed on a case-by-case basis. Therefore, all feasible decommissioning options should be considered and included in a Comparative Assessment (CA). A pipeline CA must take account of the safety, environmental, technical, societal and cost considerations of the feasible options. Cost impact may only be considered a determining factor when all other criteria emerge as equal.

The draft DPs must be supported by an EIA. Guidance Notes produced by the Department of Energy and Climate Change (DECC, now BEIS) state that an EIA should include an assessment of:

- All potential impacts on the marine environment including exposure of biota to contaminants, biological impacts arising from physical effects, and conflicts with the conservation of species and their habitats;
- Potential impacts on environmental compartments, including emissions to the atmosphere and discharges to sea;
- Consumption of natural resources and energy associated with reuse and recycling;
- Interference with other legitimate users of the sea and other consequential effects on the physical environment; and
- Potential impacts on amenities, the activities of communities and on future uses of the environment.

Under the Marine and Coastal Access Act 2009 (MCAA) (Her Majesty's (HM) Government, 2009) a licence application will be required at the time of decommissioning capturing the detail of all the proposed activities and assessing their impact.

Other relevant legislation includes:

- The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (HM Government, 2001);
- The Offshore Chemicals Regulations 2002 (HM Government, 2002) (as amended);
- The Offshore Petroleum Activities (Oil Pollution Prevention and Control (OPPC)) Regulations 2005 (HM Government, 2005b) and as amended 2011;
- The Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998 (requiring an Oil Pollution Emergency Plan (OPEP)) (HM Government, 1998);
- The Offshore Installations (Safety Case) Regulations 2005 (SCR05);
- The Pipelines Safety Regulations 1996;
- The Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (HM Government, 1999);
- Environmental Protection Act 1990 (HM Government, 1990);

- Special Waste Regulations 1996 (HM Government, 1996);
- Hazardous Waste (England and Wales) Regulations 2005 (HM Government, 2005a); and
- Trans-frontier Shipment of Waste Regulations (HM Government, 2007); and
- The EU Habitats Directive (92/43/EEC) and the EU Birds Directive (79/409/EEC) (further details are provided in Section 5.6).
- Scotland's National Marine Plan (NMP) in accordance with EU Directive 2014/89/EU (which came into force in July 2014)

The Scottish National Marine Plan (NMP) comprises plans for Scotland's inshore (out to 12 nautical miles) and offshore waters (12 to 200 miles) as set out under the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009. The NMP represents a framework of Scottish Government policies for the sustainable development of marine resources. Marine planning policies within the NMP require that 'any plans for decommissioning of infrastructure should consider the potential for infrastructure life to be extended to support potential combustible gas imports and to accommodate the growth of carbon capture ad storage networks for use in storage and enhanced oil recovery'. Further details on the NMP are provided in Section 5.7.

There are no cross boundary pipelines or power cables associated with the Beatrice Field, such that there is no requirement for consultation with other governments. However, any transboundary impacts do need to be considered in the EIA (e.g. the potential for transboundary impacts in the event of a hydrocarbon spill) whilst any waste shipped to a country other than the UK comes under the Trans-Frontier Shipment of Waste Regulations.

2. STAKEHOLDER ENGAGEMENT

Consulting with stakeholders is an important part of the decommissioning EIA process as it allows any concerns or issues which stakeholders may have, to be communicated and addressed. In May 2017, as part of the informal stakeholder engagement process Repsol Sinopec Resources UK issued a Scoping Report (Repsol Sinopec Resources UK, 2017) to a number of stakeholders. The Scoping Report provided an overview of the Beatrice Field, the proposed decommissioning activities and an overview of the impacts to be assessed in this EIA. Stakeholders were invited to comment on the Scoping Report with respect to any concerns they may have. Table 2-1 identifies the stakeholders that were issued the Scoping Report and captures the comments received.

In addition, to issuing the Scoping Report, Repsol Sinopec Resources UK have carried out a number of informal stakeholder engagement sessions. These have included separate meetings with various stakeholders and a Stakeholder Engagement Workshop. Comments received on the Scoping Report and issues raised during the separate meetings are summarised in Table 2-1.

Table 2-2 identifies those stakeholders in attendance at the Stakeholder Engagement Workshop (held on 21/09/17) and additional comments raised to those captured in Table 2-1.

The formal statutory and public consultation process will be triggered by the submission of the consultation draft of the DPs and supporting documents (including this EIA report) to BEIS. As the project progresses further consultation will be undertaken in line with the Beatrice Decommissioning Project's stakeholder engagement strategy.

Table 2-1:Third party consultations: comments on Scoping Report and from individual stakeholder meetings.

Date of contact	Comments / Issues / Concerns
Beatrice Offshore Wind Farm Limited (BOWL)	
Meeting 09/12/16	• The aims of the meeting were to share project information and identify where synergies may exist between the Beatrice Offshore Windfarm Limited (BOWL) Development and the Beatrice Field Decommissioning Project. *Given the timelines, synergies were not clearly identifiable (BOWL project is currently in the construction phase whilst offshore activities for Beatrice Decommissioning Project (excluding Plug and Abandonment (P&A) activities) are expected to commence around 2023/2024). Repsol Sinopec Resources UK will continue to look for synergy opportunities, including those with other windfarm developments.*
BEIS Environmental Management Team (EMT)	
Response letter to Scoping Report	• EMT advised that consideration should be given to the proposed operation(s) in the context of the Scottish Marine Plan and should include recognition that the operations will take place within the Scottish Marine Plan area, identification of the relevant policies in the Plan and a brief consideration as to how the operations complies with those requirements. *Where relevant impacts on the National Marine Plan have been addressed in the conclusion of each of the impact assessment chapters.* • EMT advised that the Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015 (SCR 2015) should be considered in particular during well abandonment and that during the decommissioning operations potential Major Accidental Hazards (MAHs) are identified and any that may lead to a Major Environmental Incident (MEI) are discussed. *The potential of a MAH resulting from a blowout during P&A will be addressed in the well notification and Safety Case submissions. As a result, it is not discussed further in the EIA. None of the activities associated with the proposed decommissioning activities are considered to be MAHs.*

<table>
<tr><th>Date of contact</th><th>Comments / Issues / Concerns</th></tr>
<tr><td></td><td>EMT advised that the current environmental survey data and any proposed future surveys cover the full area of where the decommissioning activities are to occur and consideration should be given to any gaps and how these may be filled.
Survey data is presented in Chapter 5</td></tr>
<tr><td>Meeting 28/07/17
(to discuss the Scoping Report and status to date of the Beatrice Decommissioning Project)</td><td>BEIS advised that any environmental impacts in relation to the area impacted and the duration of activities should be reduced as much as possible.
Noted and Repsol Sinopec Resources UK have taken and will continue to take this into consideration throughout every stage of the Beatrice Decommissioning Project.</td></tr>
<tr><td colspan="2">Marine Science Scotland (MSS)</td></tr>
<tr><td>Meeting 24/07/17
(to discuss the Scoping Report and status to date of the Beatrice Decommissioning Project)</td><td>MSS requested ongoing engagement.
Noted and Repsol Sinopec Resources UK will continue to engage with MSS when appropriate.
MSS advised that new data had been made available in the NMPi database illustrating 'hotspots' of fishing activity over pipelines in the North Sea. They requested that this information is included in the EIA.
Information is presented in Chapter 6.
MSS acknowledged that the cuttings pile at Beatrice AD would require to be disturbed in order to remove the jacket and conductor guide frame. They questioned if this disturbance could happen in advance of the removal of the platform and subsequent surrender of the 500 m zone. (Note based on the current schedule the Alpha platforms will be removed around 2028).
A BAT assessment has been carried out to determine the optimal approach for management of the cuttings pile. A summary of the assessment has been provided in Section 3.3.6. Repsol Sinopec Resources UK are in ongoing discussions with BEIS and MSS regarding the optimal approach to managing the Beatrice AD cuttings pile and these discussions will continue following submission of the draft DPs.
MSS were in agreement with Repsol Sinopec Resources UK that given the proposed activities noise modelling was not required (note there will be no piling activities or use of explosives).
Discussion on impacts of underwater noise associated with vessel use and cutting operations is presented in Chapter 12.</td></tr>
<tr><td colspan="2">Joint Nature Conservation Committee (JNCC)</td></tr>
<tr><td>Meeting 17/07/17
(to discuss the Scoping Report and status to date of the Beatrice Decommissioning Project)</td><td>JNCC requested ongoing engagement.
Noted and Repsol Sinopec Resources UK will continue to engage with JNCC when appropriate.
JNCC's default position is that the seabed should be returned to an 'as found' condition. However, there is an appreciation that there may be safety issues associated with the decommissioning programme which may make this impossible.
Noted and Repsol Sinopec Resources UK will continue to take this into account during each stage of the decommissioning project.
JNCC advised that for the OSPAR habitat 'Sea Pens and Burrowing Megafauna Communities' it is the burrows that are the defining feature and that sea pens do not necessarily need to be present to define the habitat.</td></tr>
</table>

Date of contact	Comments / Issues / Concerns
	Noted and Chapter 5 discusses those survey locations that showed evidence of burrows and no sea pens. • JNCC advised that should decommissioning activities take place in any area of protected habitat, the impact and duration should be reduced as much as possible. *Noted and Repsol Sinopec Resources UK will take this into consideration throughout the project.* • JNCC were in agreement with Repsol Sinopec Resources UK that given the proposed activities noise modelling was not required (note there will be no piling activities or use of explosives). *Discussion on impacts of underwater noise associated with vessel use and cutting operations is presented in Chapter 12.*
Scottish Fishermen's Federation (SFF)	
Meeting 05/07/17 (to discuss Scoping Report and status to date of the Beatrice Decommissioning Project)	• Discussions were held regarding the possibility of carrying out over trawlability trials of the grout filled bag mattresses. *Repsol Sinopec Resources UK commissioned SFF to carry out over trawlability trials on those mattresses out with existing 500 m exclusion zones.* • SFF raised concerns regarding pipeline degradation and subsequent risk of snagging in the future. *Addressed in Chapter 8.* • SFF base case is a clear seabed such that it can be fished by demersal and scallop gear. *Addressed in Chapter 8.*
Scottish Natural Heritage (SNH)	
Response letter to Scoping Report	• Recommend that Habitat Regulations Appraisal (HRA) considerations are submitted to the regulator with the decommissioning application to fully inform any appropriate assessment that may be required. *Noted. Repsol Sinopec Resources UK are aware of the requirements of an Appropriate Assessment (or HRA) and believe the information to inform an assessment is presented in Chapters 8 to 12.* • Request that EIA contains detailed benthic survey data. *Survey Reports for 2016 surveys (Fugro 2017a and 2017b) have been issued to SNH and Chapter 5 provides a comprehensive summary of the findings.* • Requested information regarding noise levels generated by cuttings tools during proposed operations. *Addressed in Chapter 12.* • Request information on proposed plans for near-shore and on-shore dismantling of structures. *The removal methodology and onshore yard selected will drive the requirement for any nearshore dismantling of structures. However, it is expected that nearshore work would be kept to a minimum with the majority of dismantling being done at the onshore yard. The impact of onshore activities is addressed in Chapter 13.*

Date of contact	Comments / Issues / Concerns
Meeting 12/10/17 (to discuss status to date of the Beatrice Decommissioning Project and outcome of the Stakeholder Engagement Session)	• SNH encouraged ongoing communication with Beatrice windfarm developments. *Noted and Repsol Sinopec Resources will continue to liaise with the windfarm developers in the area.* • SNH were informed of the option to relocate the cuttings pile at Beatrice AD in advance of commencement of jacket decommissioning activities. They recommended that consideration is given to environmental sensitivities when identifying the optimal timing for this activity. *Noted. Repsol Sinopec Resources UK will liaise with relevant stakeholders in advance of any activities offshore in relation to the management of the cuttings pile and will take note of any recommendations regarding timing of the spreading activities.* • SNH asked for clarification about the power cable and pipeline landfalls and whether there were any opportunities for re-use of either. *Reuse of the power cable landfall is not technically feasible due to the casings' design/construction. No reuse for the pipeline landfall has currently been identified*. • For note: SNH had been unable to attend the Stakeholder Engagement Workshop on 21/09/17. Repsol Sinopec Resources UK shared the minutes of that meeting and SNH had no further comments.
Aberdeen University (Lighthouse Research Station) (AU)	
Meeting 23/08/17 (to discuss Scoping Report and status to date of the Beatrice Decommissioning Project)	• AU requested that monitoring of the disturbed cuttings pile is carried out. • AU advised that evidence behind the decisions made for pipeline and power cable decommissioning and cuttings pile management is provided. *Details of the criteria considered for the decommissioning of the pipelines and power cables are provided in the CA accompanying the draft DPs. A BAT assessment has been carried out to determine the optimal approach for management of the cuttings pile. A summary of the BAT assessment is provided in Section 3.3.6.* • AU advised of the difficulty in laying a cable through the intertidal zone and requested that consideration be given to other uses of the conduit on the nearshore section of the power cable to Dunbeath. *Reuse of the power cable landfall is not technically feasible due to the casings' design/construction.* • AU requested that common dolphins and minke whales are discussed in the EIA. *Addressed in Chapter 5*. • AU agreed that noise modelling would not be required. However, they have requested that the EIA includes a comprehensive review of different underwater noise sources. *Addressed in Chapter 12*.
Highland Council	
Response to Scoping Report	Request for further information on disturbance to marine mammals. *Addressed in Chapter 12.*

Date of contact	Comments / Issues / Concerns
Crown Estate Scotland (CES)	
Meeting 15/02/18 to discuss	• CES queried whether Beatrice would be a suitable reservoir for carbon dioxide (CO_2) storage. *Repsol Sinopec Resources UK explained that the Beatrice wells were not suitable for CO_2 injection*. • CES queried whether the power cable from Dunbeath could be utilised by another project. *Repsol Sinopec Resources UK explained that reuse of the power cable is not technically feasible due to the casings' design/construction.* • CES confirmed they would not be responsible for residual liabilities and that they are currently progressing this line with the UK Government with a view to getting a watertight written agreement in place. *Repsol Sinopec Resources UK have taken this into consideration during all stages of the decommissioning project.* • CES requested that they are referenced in Sections 6.6 and 6.7 of the DP. *Repsol Sinopec Resources UK have added the CES to these Sections of the DP.*
Other consultees that received the Scoping Report	
Health and Safety Executive, Oil and Gas Authority, National Federation of Fishermen's Organisations, Northern Ireland Fish Producers Organisation, Scottish Environmental Protection Agency, The United Kingdom Hydrographic Office, Historic Scotland, Marine Management Organisation, Maritime and Coastguard Agency UK Fisheries Legacy Trust Fund, Royal Society for the Protection of Birds, Marine Conservation Society, Greenpeace, Scottish Wildlife Trust, Whale and Dolphin Conservation, Cetacean Research and Rescue Unit, a number of members of the Scottish Parliament, Oil and Gas UK, and a number of local councils. Note: at the time of writing, feedback on the Scoping Report had not been received from these consultees.	

Table 2-2: Third party consultations: comments from Stakeholder Engagement Workshop

Stakeholder Engagement Workshop	
Stakeholders / consultees represented	
• BEIS Environmental Management Team (EMT) • Marine Scotland Science • Scottish Fishermen's Federation • Health and Safety Executive • University of Aberdeen	• BEIS Offshore Decommissioning Unit (ODU) • Joint Nature Conservation Committee • Crown Estate • Ithaca
Comments / Issues / Concerns	
• Stakeholders were informed that the cuttings pile at the Beatrice AD platform falls below the thresholds set by OSPAR 2006/5 (thresholds are discussed further in Appendix B). Some disturbance to the cuttings pile will be required to remove all the structures. Discussions in relation to the management of the cuttings pile at Beatrice AD were held. Though below the OSPAR thresholds (and expected to remain so following disturbance, due to its small volume and low hydrocarbon content: discussed in Chapter 8) Repsol Sinopec Resources UK have taken into consideration the fishing activity in the area and are aware that it is possible that following decommissioning activities the pile could be disturbed by demersal trawl gear or scallop fishing gear. Consultees were informed that initial screening of the different management options suggest that dispersing of the pile in advance of the Alpha platforms being recovered appeared to be the optimal option. Repsol Sinopec Resources UK are investigating the option to disperse the cuttings pile (in close proximity to its current location) in 2018, around 10 years prior to removal of the Alpha platforms. Consultees asked for a BAT/BEP assessment of the available cuttings pile management options to be carried out. In addition, they requested that modelling of the dispersion of the whole pile is carried out to inform on the rate of breakdown of contaminants. A request for sampling of the cuttings pile in subsequent years was made. *A BAT assessment has been carried out to determine the optimal approach for management of the cuttings pile. This assessment has been shared with BEIS and a summary of the assessment has been provided in Section 3.3.6. Repsol Sinopec Resources UK are in ongoing discussions with BEIS and MSS regarding the optimal approach for managing the Beatrice AD cuttings pile and these discussions will continue following submission of the draft DPs.* • The proposed decommissioning plans for the pipelines and power cables were presented (including a summary of the CA process). The selected options presented for the pipelines and some of the power cables is to decommission them *in situ* and to remediate any exposed ends and mid-line sections. These exposures will be trenched and buried with cut and recover of exposed sections being taken forward as primary contingency. At the workshop, the stakeholders were informed that the power cable from Dunbeath would be fully recovered. *Subsequent to the workshop and with ongoing consultation with The Crown Estate, it has been determined that decommissioning of the power cable from Dunbeath to Beatrice Alpha in situ is the optimal approach. This is in line with the results of the CA. Selected decommissioning options for the pipelines and power cables are discussed in Chapters 3 and 4.* • SFF raised concerns that decommissioning the grout filled mattresses *in situ* (option selected via the CA process) could result in them being a snag hazard as they break down over time. Repsol Sinopec Resources UK committed to revisiting the selected option. *Subsequent to the workshop Repsol Sinopec Resources UK have undertaken a comprehensive technology appraisal, and have identified a methodology, that is notionally capable of breaking up the grout filled mattresses. Discussions are ongoing with BEIS about the emerging methodology/approach Repsol Sinopec Resources UK propose to trial, and as such removal is now the base case decommissioning option for these mattresses. Fate of the grout filled mattresses is addressed in Chapter 8.*	

3. PROJECT DESCRIPTION

This section describes the Beatrice facilities to be decommissioned and outlines the proposed decommissioning activities. P&A of the wells is covered by separate regulatory requirements and is therefore outside the scope of this EIA. However, for completeness and clarity, the planned P&A activities are also outlined in this chapter.

3.1 Beatrice Field Overview

As summarised in Section 1.1 the Beatrice Field has the main Beatrice A complex, comprising a drilling and accommodation (AD) bridge linked to a production platform (AP), a satellite B facility with injection and minimum production facilities and an unmanned C satellite facility for water injection purposes only.

When producing, Beatrice oil was exported via a 16" pipeline from the Beatrice A complex to a terminal at Nigg. Subsea power cables connect Beatrice A to Dunbeath (onshore) and to Beatrice B respectively. Apart from the nearshore section of the Dunbeath power cable all pipelines and power cables were trenched and buried when installed.

Two 'demonstrator' wind turbine generators (WTG A and WTG B) were installed *c*. 2 km southeast of the A complex and are linked by a power cable, in series, back to the AP platform.

There are a total of 43 wells to decommissioned across the three facilities: 30 at Beatrice AD, 11 at Beatrice B and 2 at Beatrice C.

3.1.1 Surface Installations (Topsides and Jackets)

The information provided in Table 3-1 is taken from Section 2.1 of the draft Beatrice Field DPs and provides a summary description of the surface facilities to be decommissioned. In line with OSPAR 98/3 all Beatrice topsides and jackets will be recovered to shore for dismantling and where possible recycling. The following sections provide a summary of the platform and WTG details provided in Section 3 of the DPs.

Table 3-1: Summary table describing the surface installations.

Name	Location (WGS84)	Topsides/Facilities		Jacket			
		Weight (Te)	No of modules	Weight (Te)	Number of legs	Number of piles	Weight of piles (Te)
Beatrice AD	58° 6.878' N 3° 5.261' W	7,723	18	2,201	8	8 Leg piles + 2 skirt piles	2,014
Beatrice bridge (links AP to AD)	Between both installations	221	1	n/a	n/a	n/a	n/a
Beatrice AP	58° 6.847' N 03° 5.341' W	7,680	9	1,769	8	8 leg piles	1,786
Beatrice B (including a conductor support structure)	58° 8.835' N 03° 1.300' W	5,743	8	2,946*	10	10 leg piles + 4 skirt piles	2,019
Beatrice C	58° 5.644' N 3° 9.200' W	406	1 + helideck	601	4	4 leg piles	530
Wind turbine A	58° 6.021' N 03° 4.941' W	651	1	804	4	4 skirt piles	430
Wind turbine B	58° 5.735' N 03° 4.400' W	651	1	804	4	4 skirt piles	430
*Weight includes weight of risers associated with the Jacky Development (riser numbers are PL2611 and PL2610 and they are associated with Jacky pipeline numbers PL2558 and PL2560).							

3.1.1.1 Beatrice Alpha Complex

The bridge linked AD and AP platforms were installed in 1979 and 1980 respectively and lie in water depths of *c*. 45 m (Figure 3-1).

The AD topsides weight 7,723 te and includes the drilling infrastructure, two pedestal cranes, the accommodation block and a helideck. The AD substructure is an eight legged steel jacket with through leg piles and two additional skirt piles. All pile annuli are grouted to the legs or pile sleeves. When installed, the jacket, including a conductor guide frame, was placed over an eight slot drilling template used to pre-drill wells before jacket installation (the drilling template is described further in Section 3.1.2). To mitigate integrity concerns the conductor guide frame has since been disconnected from the jacket. The conductors associated with both the drilling template and the conductor guide frame will be recovered as part of the P&A campaign. The AD jacket (including the conductor guide frame) and piles weigh 4,215 te.

Prior to severing the conductor guide frame from the jacket, a number of large grout bags were installed under the frame to stabilise it. These grout bags were of two sizes: 11.25 te and 22.5 te and are detailed further in Section 3.1.4.1.

The AP topsides comprises three main decks with a total weight of 7,680 te. The platform primarily houses the utilities and power generation modules, the processing and export facilities, water pumps and storage areas. The AP substructure is an eight legged steel jacket with through leg piles and grouted annuli. The jacket and piles combined weigh 3,555 te.

The AP/AD bridge is 47 m long and weighs 221 te.

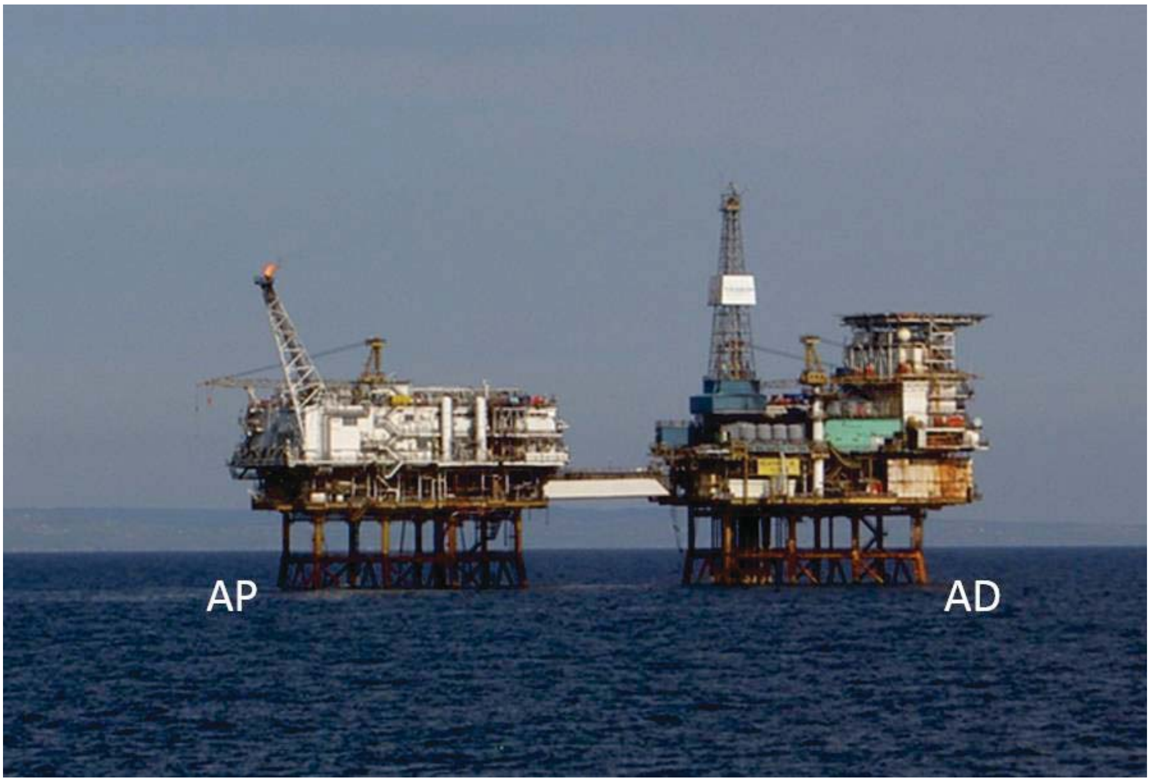


Figure 3-1: The Beatrice Alpha installations.

3.1.1.2 Beatrice Bravo

The Beatrice B platform is located *c.* 5.6 km to the northeast of the Beatrice A complex in a water depth of *c.* 46 m. Beatrice B comprises a main platform and a smaller Conductor Support Structure (CSS) located adjacent to the northeast end of the main platform (Figure 3-2). A frame supports an integrated deck structure (including a bridge), which spans across both the main and CSS jackets. The CSS was installed in 1979 with the main Beatrice B structures being installed in 1983. The CSS topsides weigh 295 te whilst those associated with the main B platform weigh 5,448 te.

The main B topsides includes modules for drilling, water injection, minimum production facilities (as produced fluids from Beatrice B were previously processed at Beatrice AP), an accommodation block, helideck, crane and flare tower. The CSS platform contains the wellheads and a closed drains containment tank. Power to the B platform is provided from the Beatrice AP platform by a subsea cable.

The main jacket is supported by six through-leg piles and four skirt piles, with grouted annuli. The CSS jacket is supported by four through-leg piles with grouted annuli. The total weight of the main jacket and piles combined is 4,002 te whilst total weight of jacket and piles of the CSS jacket is 963 te.

Beatrice B is no longer manned, and the former accommodation, drilling and production facilities have been taken out of service but are still on the platform.

Figure 3-2: The Beatrice Bravo installation.

3.1.1.3 Beatrice Charlie

Beatrice C is located *c*. 5 km southwest of the Beatrice A complex in a water depth of *c*. 50 m and was installed in 1984. The topsides structure comprises a helideck, a main deck cantilevered over the north side of the jacket and a crane (Figure 3-3). The platform originally served as an unmanned, minimum facilities, satellite water injection platform with no drilling capability. Two water injection wells were pre-drilled prior to the platform being installed. Injection water was imported from Beatrice AP and power was generated by on-board diesel generators.

All topside equipment has been placed out of service but is retained on the platform. A back-up generator is used during platform visits whilst solar panels, with battery storage, power navigation equipment. The Beatrice C topsides weigh 406 te.

The Beatrice C jacket is a four-leg piled structure and is un-grouted. The jacket and piles combined weigh 1,131 te.

Figure 3-3: The Beatrice Charlie installation.

3.1.1.4 Wind Turbine Generators

The Beatrice Wind Farm Demonstrator Project comprises two REpower 5MW turbines, each with three rotor blades 126 m in diameter (Figure 3-4). The WTGs were installed in 2006/2007 and are located *c*. 0.9 km apart, and *c*. 1.9 km southeast of the Beatrice A complex at a water depth of *c*. 45 m. The 'topsides' (comprising a transition piece between the jacket and the tower, the tower itself, the rotor and the three blades) for each WTG weighs 651 te.

Each of the turbines is mounted on a four-leg piled steel jacket structure. The piles are driven through pile sleeves attached to the jacket legs (one per leg). The jacket and piles combined weigh 1,234 te for each WTG.

The turbines are connected via a 0.9 km power cable with power supplied to Beatrice AP via a 1.9 km long power cable. It should be noted the WTGs are no longer operational.

Figure 3-4: Wind Turbine Generators with Beatrice Alpha in the background.

3.1.2 Subsea Installations

Other than stabilisation features, which are considered separately in Section 3.1.4, subsea installations at the Beatrice Field are limited to a drilling template at the Beatrice AD platform. The drilling template was installed to allow the pre-drilling of wells prior to installation of the Beatrice AD jacket.

As detailed in Table 2.2 of the draft DPs the Beatrice AD drilling template measures 8.7 m (L) x 5. 6 m (W) x 4. 1 m (H), weighs 43 te and is secured to the seabed via four piles each weighing *c*. 8.25 te.

For clarity, note that as the conductor guide frame at Beatrice AD was initially installed as part of the jacket, it is considered in Section 3.1.2 (in keeping with the structure of the draft DPs).

3.1.3 Pipelines and Power Cables

Table 3-2 summarises the details of the pipelines and power cables associated with the Beatrice Field (information is taken from Table 2.3 of the draft DPs).

The pipelines and power cables were trenched and buried when installed, apart from the nearshore section (*c*. 2 km) of the Dunbeath to Beatrice AP power cable which was surface laid due to the rocky nature of the seabed in the area. Some areas of exposures do occur along the pipelines and power cables. However, depth of burial studies has shown the seabed to be very stable with the average depth of burial across all pipelines and power cables ranging between 0.9 m and 2.2 m (see Table 3-6). In addition, mattresses were used to cover some sections of the pipelines and power cables with rock cover being added in support of the crossings associated with the Jacky tie-backs (see Section 3.1.4.4).

As discussed in Section 1.2 Ithaca have retained liability for the decommissioning of the Jacky facilities which includes any crossings associated with the Jacky infrastructure.

Table 3-3 identifies the Kilometer Point (KP) locations of the exposures, mattresses and rock cover whilst Figure 3-5 shows the approximate location of the exposures and mattresses.

Note two different types of mattress: flexible concrete mattress and grout filled mattresses have been used at the Beatrice Field. These mattress types are described in Section 3.1.4.2.

Table 3-2: Pipelines and power cables associated with the Beatrice Field.

Description	Pipeline Number (as per PWA)	Diameter (inches)	Length (km)	Description of Component Parts	Product Conveyed	From – To End Points	Pipeline Status	Current Content
Out of use section of export pipeline	PL16	16"	58.98	Concrete coated steel	Oil	From KP 2.6 of PL1838 (nearshore) to KP61.64 of PL1838 (offshore)	Out of use	Inhibited seawater
Export pipeline replacement	PL1838	16"	67.01	Epoxy coated steel	Oil	Beatrice AP Platform to Zero Point Valve onshore	Out of use	Inhibited seawater
Water injection pipeline	PL111	8"	5.28	Concrete coated steel	Water	Beatrice AP platform (disconnected) to Beatrice B platform	Out of use	Inhibited seawater
Water injection pipeline	PL252	8"	4.80	Composite flexible	Water	Beatrice AD platform (disconnected) to Beatrice C platform	Out of use	Inhibited seawater
Infield pipeline	PL112	6"	5.21	Concrete coated steel	Oil	Beatrice B platform (disconnected) to Beatrice AP platform	Out of Use	Inhibited seawater
Infield pipeline	PL112A	6"	1.55	3LPP coated steel	Oil	Tie in point to PL112 to Beatrice AP platform (disconnected)	Out of use	Inhibited seawater
Power cable	PL4331	4.25"	26.00	Composite flexible	Electricity	Dunbeath to Beatrice AP platform	Operational	N/A
Power cable	PL4330	2.9"	6.30	Composite flexible	Electricity	Beatrice AP platform to Beatrice B platform	Out of use	N/A
Power cable	PL2331	4.7"	2.90	Composite flexible	Electricity	Beatrice AP platform to WTG B	Operational	N/A
Note: in addition to the pipelines and power cables described here, two risers: PL2610 and PL2611, associated with the Jacky tie-back will be decommissioned as part of the Beatrice Field Decommissioning Project. Note these risers' tie-in to the Beatrice B platform and are an integral part of the Beatrice B jacket.								

Table 3-3: Summary of exposed / span lengths, mattress lengths and rock cover associated with the Beatrice Field (Note where relevant rock cover has been discussed in the comments column).

KP start location	Total exposed lengths (m)	Total mattressed lengths (m)	Comment
PL1838. Export pipeline from zero-point valve (KP 0) to Beatrice AP (KP 66.5)			
KP 2.688 (157 m)*	1	137	Tie-in point/trench transition. Along a length of 157 m there is 1 m of exposures and 137 m under flexible concrete mattresses.
KP30.619 (21 m)	0.5	20	Mattresses added to mitigate exposures. Along a length of 21 m there is 0.5 m of exposures and 20.5 m pipeline under flexible concrete mattresses.
KP 30.703 (15 m)	n/a	15	Mattresses added to mitigate exposures. 15 m pipeline section under flexible concrete mattresses.
KP 61.396 (195 m)	5	190	Tie-in point/trench transition. Along a length of 157 m there is 5 m of exposures and 190 m under flexible concrete mattresses.
KP 66.143 (456 m)*	336	76	Tie-in spools, pipeline transition, pipeline crossing. Along a length of 456 m there is 336 m exposures and 76 m under flexible concrete mattresses.
Total	**342.5**	**438**	
PL16. Abandoned section of export pipeline replaced by PL1838. Nearshore section disconnected from PL1838 at KP2.6 and offshore section disconnected at KP61.64			
KP 26.696 (1,258 m)	290	n/a	Along a length of 1,258 m there is 290 m of exposed sections.
KP 31.29 (14 m)	14	n/a	Exposed section measuring 14 m.
KP 44.086 (3 m)	3	n/a	Exposed section measuring 3 m.
KP45.086 (5 m)	5	n/a	Exposed section measuring 5 m.
Total	**312**	**0**	
PL111. Water injection pipeline from Beatrice B (KP 0) to Beatrice AP (KP 5.4)			
KP 5.306 to KP 5.395 (89 m)*	73	n/a	Two exposures and one free span (0.04 m in height) measuring between 6 and 40 m
KP 0.71	n/a	16	16 m of mattresses associated with Jacky crossings.
KP 5.28 (73 m)	n/a	n/a	Along a length of 73 m there is 46 m of rock cover at the AP platform where Jacky production and water injection pipelines cross PL 111 a second time.
Total	**73**	**16**	
PL112. Production pipeline from Beatrice B (KP 0) to Beatrice AP (KP 5.4). Includes redundant section from KP 3.95 to KP 5.4			
KP 0.75	n/a	6	6 m of mattresses associated with Jacky crossings.
KP 5.331 (45 m)	26	n/a	Along a length of 45 m there is 26 m of exposures.
KP 5.279 (73 m)	n/a	9	Associated with Jacky production and water injection pipeline crossings. Along a length of 73 m there is 9 m of mattresses and 35 m of rock cover.
Total	**26**	**15**	

KP start location	Total exposed lengths (m)	Total mattressed lengths (m)	Comment
PL112A. Replacement section for PL112 from tie-in at PL112 (KP 0) to Beatrice AP (KP 1.5)			
KP 0.012 (59 m)	6	59	Associated with tie-in to PL112.
KP 1.416 (12 m) *	7	n/a	Along a length of 12m there is 7 m of exposures.
KP 1.392 (32 m)	n/a	18	Associated with Jacky production and water injection pipeline crossings. Along a length of 32 m there is 18 m of mattresses and 20 m of rock cover (some of which overlays the mattresses).
Total	**13**	**77**	
PL252. Water injection pipeline from Beatrice AP (KP 0) to Beatrice C (KP 4.5). Note: line was installed in 5 sections.			
KP 0.0 (73 m) *	64	5	Along a length of 73 m there is a total length of 64 m exposed/free span sections and 5 m under flexible concrete mattresses.
KP 0.125 (42m)	1	47	Along a length of 42 m there is 1 m of exposures and 41 m covered by grout filled mattresses.
KP 0.971 (74 m)	n/a	71	Pipeline length of 11 m covered by grout filled mattresses.
KP 2.112 (11 m)	n/a	11	Pipeline length of 11 m covered by grout filled mattresses.
KP 3.308 (9 m)	2	12	Along a length of 9 m there is 2 m of exposures and 7 m covered by grout filled mattresses.
KP 4.309 (92 m)*	10	56	Along a length of 92 m there is 10 m of exposures and 63 m covered by grout filled mattresses.
Total	**77**	**202**	
PL4331. Dunbeath (KP 0) to Beatrice AP (KP 25) power cable.			
KP 0.926	1,899 m	n/a	This exposure corresponds to the nearshore section of the power cable which was surface laid on a rocky seabed.
KP 25.271 (86 m)	n/a	87	Pipeline length of 86 m covered by grout filled mattresses.
Total	**1,899**	**87**	
PL4330. Beatrice AP (KP 0) to Beatrice B (KP 5.6) power cable.			
KP 0.008 (79 m)	2	76	Along a length of 79 m there is 2 m of exposures and 77 m covered by grout filled mattresses.
KP 0.362 (18 m)	n/a	6	Associated with Jacky production and water injection pipeline crossings. Along a length of 18 m there is a total of 6 m covered by flexible concrete mattresses and rock cover associated with Jacky crossings.
KP5.611 (71 m)	5	34	Along a length of 71 m there is a total of 5 m exposures. In addition, there are 34 m of flexible mattresses associated with Jacky spools.
Total	**7**	**116**	

KP start location	Total exposed lengths (m)	Total mattressed lengths (m)	Comment
PL2331. Power cable from Beatrice AP to WTG B. Split in two sections when surveyed: PL2331A from Beatrice AP (KP 0) to WTG A (KP 1.9) and PL2331B from WTG A (KP 0) to WTG B (KP 0.9).			
PL2331A KP 0.006 (11 m)	11	n/a	11 m exposed section.
PL2331A KP 0.078 (3 m)	3	n/a	3 m exposed section.
PL2331A KP 0.189 (12 m)	12	3	There is also 3 m of flexible concrete mattresses associated with Jacky crossing.
PL2331A KP 1.718 (85 m)	41	n/a	Along a length of 85 m there is a total of 41 m of exposures.
PL2331B KP 0.007 (17 m)	17	n/a	17 m exposed section.
PL2331B KP 0.773 (70 m)*	50	n/a	Along a length of 70 m there is a total of 50 m of exposures.
Total	**134**	**3**	
* Where there are short sections of shallow burial within the exposures shown in the table the decommissioning option for the exposure will be applied to the buried section.			

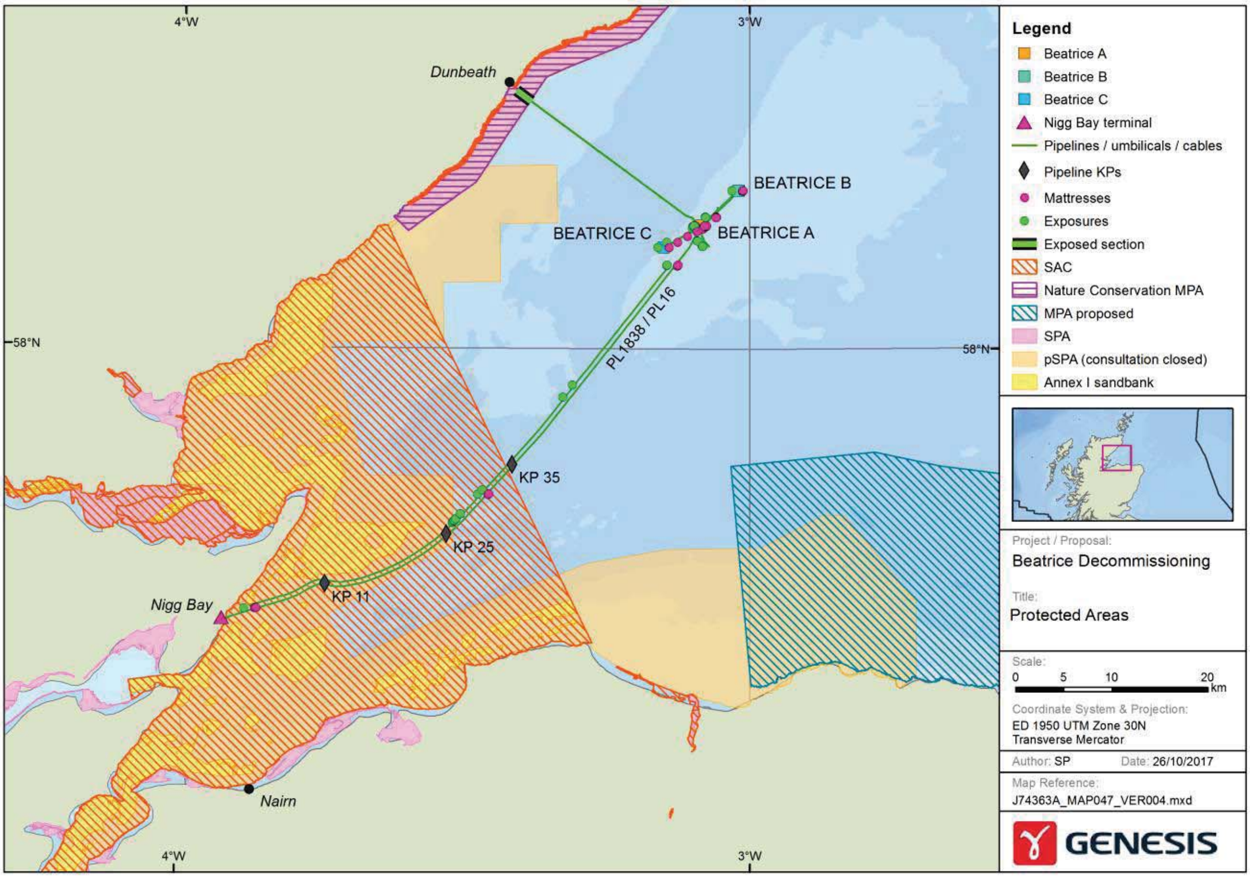


Figure 3-5: Approximate location of exposures and mattresses at the Beatrice Field.

3.1.4 Stabilisation Features

Stabilisation features associated with the Beatrice Field include grout bags and mattresses. In addition, there are two concrete tunnels: one associated with PL4330 (Dunbeath power cable) at the AP tie-in and one on PL4331 (Beatrice AP to Beatrice B power cable). Table 3-4 captures the number of mattresses and grout bags associated with the Beatrice Field and is a summary of the data presented in Table 2.2 and 2.4 of the draft DPs and the data presented in Table 3-3 of this report.

Table 3-4 : Summary of stabilisation features associated with the Beatrice Field.

Stabilisation Feature	Number	Weight (Te)	Location	Comments/Status
Stabilisation features associated with installations				
Flexible concrete mattresses	13	59.3	Beatrice A	These mattresses are on the seabed in the vicinity of the platform structures and are additional to pipeline protection mattresses captured below.
Large grout bags (11.25 te and 22.5 te)	12	157.5	Beatrice AD	These are located underneath the conductor guide frame at the Beatrice AD platform.
Flexible concrete mattresses	11	50.2	Beatrice B	These mattresses are on the seabed in the vicinity of the platform structures and are additional to pipeline protection mattresses captured below.
Stabilisation features associated with pipelines and power cables				
Flexible concrete mattresses	299	834	Over or under PL1838, PL112A, PL252, PL2331 and power cables	Of these mattresses, 15 are associated with the Jacky crossings and will be considered in the Jacky Decommissioning Project such that 184 are captures in the Beatrice DPs.
Grout filled mattresses	37	758	Over PL252, Dunbeath to Beatrice AP power cable and Beatrice AP to B power cable.	Mattresses are exposed.
Grout bags (25 kg bags)	1,920	48	Over or under PL1838, PL112A and PL2331	Grout bags are associated with areas also covered by pipelines and have been laid either under lines subsequently covered with mattresses or are intermingled with the mattresses. The quantities provided do not include grout bags associated with the Jacky crossings as these will be decommissioned as part of the Jacky Decommissioning Project.
Concrete tunnel	2	10	Over Dunbeath to Beatrice AP power cable at AP tie-in and on the Alpha to Bravo power cable	Exposed structure

3.1.4.1 Grout Bags

There is estimated to be 1,920 x 25 kg grout bags (hessian sacks filled with cement grout) associated with the Beatrice Field. This number does not include those grout bags associated with the Jacky crossings as they will be decommissioned as part of the Jacky Decommissioning Project. The grout bags are associated with PL1838 (800 bags), PL112A (320 bags) and PL2331 (800 bags) and are either intermingled with the mattresses or are laid under pipelines which have mattresses installed over them.

In addition, there are 12 large grout bags providing support to the conductor guide frame at Beatrice AD. Ten of these bags are 2.5 m in length and weigh 11.25 te each whilst the remaining two are 5 m in length and weigh 22.5 te each.

3.1.4.2 Mattresses

Two types of mattresses have been used at the Beatrice Field: concrete flexible concrete mattresses and grout filled mattresses (Figure 3-6).

The flexible concrete mattresses used typically measure either 5 m (L) x 3 m (W) or 6 m (L) x 3 m (W) and were laid at tie-in points at the platforms and on midline exposures as detailed in Table 3-3 and summarised in Table 3-4.

The grout filled mattresses measured 10 m (L) x 3.3 m (W). Hessian sacks were initially laid on the seabed and once in position were pumped full of grout. These mattresses were laid at six locations on PL252, at the tie-in point of the Dunbeath to Beatrice AP power cable and at the both tie-in points for the Beatrice AP to Beatrice B power cable (see Table 3-3).

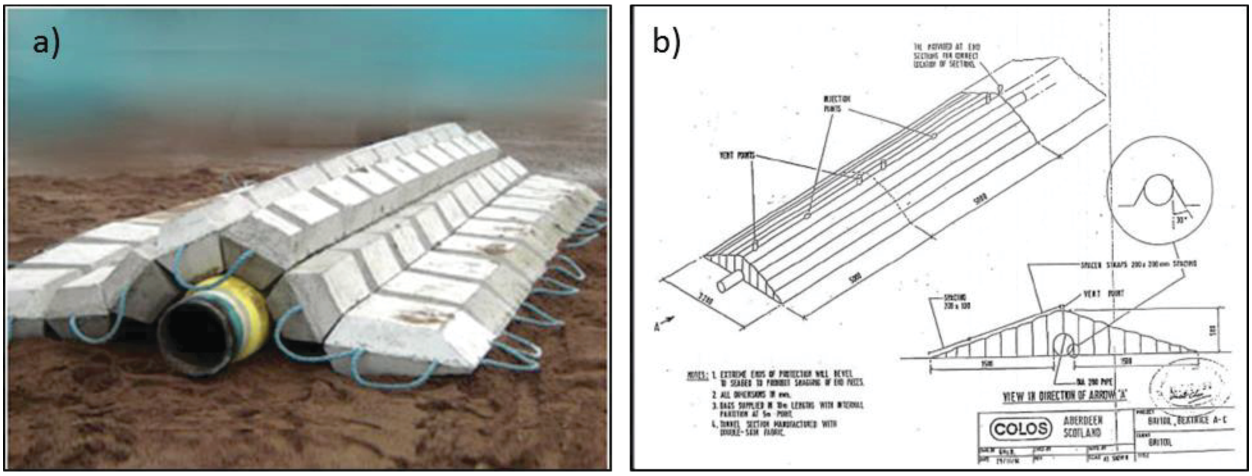


Figure 3-6: a) Photograph of flexible concrete mattresses and b) drawing of grout filled mattresses.

3.1.4.3 Rock Cover

All existing rock cover at the Beatrice Field is associated with the Jacky crossings and will therefore be decommissioned as part of the Jacky Decommissioning Project and is out with the scope of the Beatrice DPs.

3.1.4.4 Third Party Crossings

There are a number of third party crossings associated with the Jacky tie-back (Table 3-5). In all instances the Jacky infrastructure passes over the Beatrice Field infrastructure such that decommissioning of the crossings will be considered as part of the Jacky Decommissioning Project.

Table 3-5: Third party pipeline and power cable crossings.

Beatrice pipeline	Third party infrastructure*	Beatrice pipeline crossing over (O) / under (U) third party	Location (WGS 84)
Beatrice AP to B power cable (near Beatrice AP)	6" production (PL2557)	U	58° 6' 59.475" N 3° 5' 2.510" W
	8" water injection (PL2599) power cable (PLU2561)	U	58° 6' 57.921" N 3° 5' 5.623" W
PL111 (near Beatrice AP)	6" production (PL2557)	U	58° 6' 53.715" N 3° 5' 8.424" W
	8" water injection (PL2599) power cable (PLU2561)	U	58° 6' 52.679" N 3° 5' 11.048" W
PL112X (near Beatrice AP)	6" production (PL2557)	U	58° 6' 52.033" N 3° 5' 10.130" W
	8" water injection (PL2599) power cable (PLU2561)	U	58° 6' 51.126" N 3° 5' 12.633" W
PL112A (near Beatrice AP)	6" production (PL2557)	U	58° 6' 50.382" N 3° 5' 11.898" W
Beatrice AP to B power cable (by Beatrice B)	6" production (PL2558)	U	58° 8' 48.664" N 3° 1' 22.856" W
	8" water injection (PL2560)	U	58° 8' 49.214" N 3° 1' 21.266" W
PL111	6" production (PL2558)	U	58° 8' 48.470" N 3° 1' 22.428" W
	8" water injection (PL2560)	U	58° 8' 49.084" N 3° 1' 21.022" W

*All third party crossings are associated with the Jacky development and owned by Ithaca Energy (UK) Limited. All pipelines are out of use and are currently filled with inhibited seawater. The power cable is also out of use.

3.1.5 Details of Wells and Drill Cuttings

A total of 43 wells were drilled at the Beatrice Field: 30 at Beatrice AD, 11 at Beatrice B and 2 at Beatrice C. A combination of WBM, LTOBM and OBM was used. At Beatrice B only the WBM contaminated cuttings were discharged whilst at Beatrice AD and C all cuttings were discharged. Well names and well type (i.e. production or water injection) are detailed in Section 2.4 of the draft DPs.

In October 2016, a seabed survey was undertaken at the Beatrice Field (Fugro, 2017a and 2017b) (further details of which are provided in Chapter 5). No cuttings accumulations were identified at Beatrice B or Beatrice C; however, a cuttings pile was observed at the Beatrice AD platform. The volume of the cuttings pile is estimated to be 678 m^3 with a total weight of 1,420 te, a physical footprint of 1,698 m^2 and a maximum height of 1.4 m. It should be noted this mass is comparable to the cuttings from one to two wells drilled in the North Sea which suggests that a large portion of the cuttings initially discharged have dispersed.

The survey results show that the cuttings pile at Beatrice AD covers at least part of the structures to be removed including some of the lower jacket framing, the conductor guide frame and the drilling template (Figure 3-7).

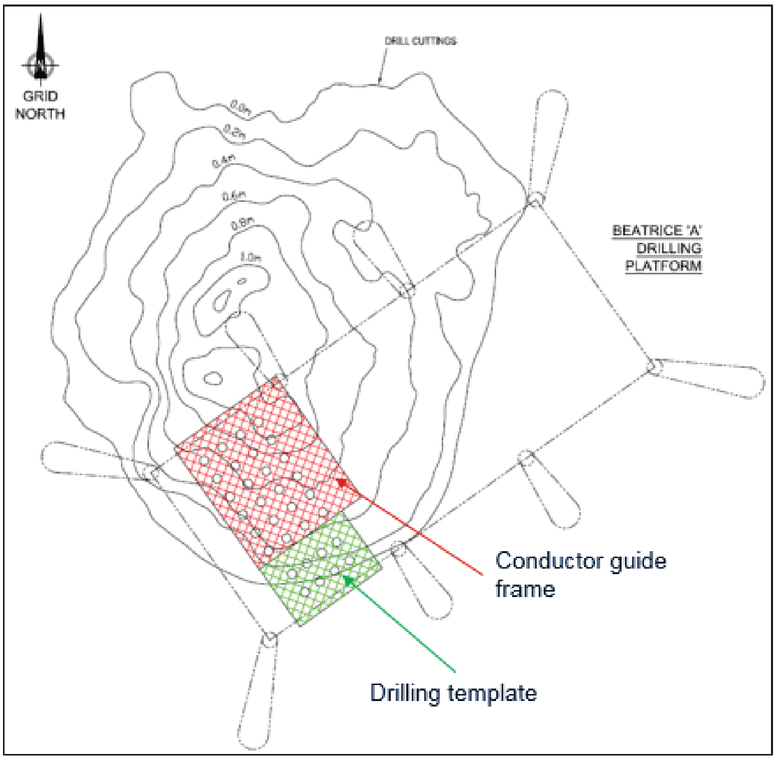


Figure 3-7: Location of the drill cuttings pile at the AD platform.

The survey carried out in October 2016 (Fugro 2017a and 2017b) found that the cuttings pile at Beatrice AD falls below both the thresholds set under OSPAR 2006/5 below which cuttings piles may be decommissioned *in situ*. These thresholds relate to leaching rates, area of contamination and persistence over time:

- a rate of oil loss to the water column of less than 10 tonnes/yr.; and
- a persistence over the area of seabed contaminated of less than 500 km^2.yr (*Note: a persistence of 500 km^2.yr could mean an area of 1 km^2 is contaminated for 500 years, or an area of 500 km^2 is contaminated for one year*).

The findings from the 2016 survey aligns with findings by ERT (2009) which estimated that the Beatrice AD cuttings pile had a leaching rate of 1.98-2.78 te/yr. and a persistence of <141 km^2.yr, both of which are significantly below the OSPAR thresholds.

3.2 Fate of the Beatrice Infrastructure

In line with OSPAR 98/3 the topsides, jackets and drilling template at AD will be recovered for reuse / recycling. Similarly, the WTGs including the jackets will be recovered for dismantling and recycling.

Table 3-6 summarises the proposed decommissioning options for the Beatrice pipelines and power cables. It is anticipated that all the pipelines and the power cables will be decommissioned *in situ* with remedial action being taken at existing exposures and at those exposures that will result from the removal of the stabilisation features (i.e. the flexible concrete and grout filled mattresses, the concrete tunnels and the 25 kg grout bags). Other than the nearshore surface laid section of the Dunbeath power cable, the base case is to trench and bury all exposed sections with cut and removal and addition of rock cover being taken forward as the first and second contingency options.

Repsol Sinopec Resources UK plan to recover all flexible concrete mattresses out with any pipeline crossings. However, should there be a series or group of mattresses that due to their condition cannot be recovered using a grab, Repsol Sinopec Resources will discuss with BEIS the potential to rock cover them in line with the results of the CA (summarised in Chapter 4). If BEIS are in agreement, Repsol Sinopec Resources UK will submit a Deposit Consent to the Oil and Gas Authority (OGA) and will update the Marine Licence to capture the environmental impact.

It should be noted those mattresses associated with the Jacky crossings are out with the scope of the Beatrice Field Decommissioning Project and will be captured in the Jacky Decommissioning Project.

The base case is full removal of the grout filled mattresses. If during the offshore campaign, some of these mattresses cannot be recovered, Repsol Sinopec Resources UK will consult with BEIS before any alternative option is executed. This EIA assesses the worst case impacts whereby none of the grout filled mattresses are removed and subsequent studies and consultation identify the addition of rock cover to be the optimal approach.

Where technically feasible to do so Repsol Sinopec Resources UK plan to recover all 25 kg grout bags out with the Jacky crossings and all of the large grout bags associated with stabilisation of the AD conductor guide frame. Should it not be possible to remove some of the grout bags, Repsol Sinopec Resources UK will consult with BEIS before any alternative option is executed. This EIA assesses the worst case impacts whereby none of the large grout bags are removed and subsequent studies and consultation identify the addition of rock cover to be the optimal approach.

The two concrete tunnels will be removed for disposal to landfill should an alternative use not be identified.

Table 3-6: Proposed decommissioning methods for the Beatrice Field pipelines and power cables.

Pipeline / power cable	Proposed decommissioning method
PL1838 (export pipeline)	As it is trenched and buried the pipeline will be decommissioned *in situ* (average depth of cover is at least 1.5 m based on 2016 survey). Total length of exposures is 342.5 m and total length of pipeline covered in mattresses is 438 m. There are 4 spool pieces associated with this pipeline comprising a total length of 115.56 m. These spools pieces will be removed and returned to shore for recycling. All mattresses are flexible concrete mattresses and base case is to recover all to shore for recycling / disposal. As a base case all exposures (780.5 m includes exposed pipeline resulting from removal of mattresses) will be (1) trenched and buried with (2) cut and removal and (3) rock cover being taken through as first and second contingency options respectively. There is no rock covered sections on this line. Of the 780.5 m exposures that will require to be mitigated *c.* 173.5 m occur within the Moray Firth Special Area of Conservation (SAC) (See Section 5.6). In Q1 2018 pigging, flushing and cleaning operations were completed and the pipeline filled with inhibited seawater.
PL16 (out of use section of export pipeline)	As it is trenched and buried the pipeline will be decommissioned *in situ* (average depth of cover is 1.5 m based on 2016 survey). Total length of exposures is 312 m. There are no mattresses associated with this pipeline. There are 2 spool pieces associated with this pipeline comprising a total length of 50 m. These spools pieces will be removed and returned to shore for recycling. As a base case all exposures will be (1) trenched and buried with (2) cut and removal and (3) rock cover being taken through as first and second contingency options respectively. There is no rock covered sections on this pipeline. Of the 312 m of exposures *c.* 304 m occur within the Moray Firth SAC. Both ends of the pipeline are plugged and the pipeline is filled with inhibited seawater.
PL111 (AP to B injection water line)	As it is trenched and buried the pipeline will be decommissioned *in situ* (average depth of cover is 1 m based on 2016 survey). Total length of exposures is 73 m and total length of pipeline covered in mattresses is 16 m. All mattresses are flexible concrete mattresses and base case is to recover all to shore for recycling / disposal. There is a 46 m section of rock cover at Beatrice AP end to accommodate Jacky production and water injection pipeline crossings. As a base case all exposures (89 m includes exposed pipeline resulting from removal of mattresses) will be (1) trenched and buried with (2) cut and removal and (3) rock cover being taken through as first and second contingency options respectively. The rock cover at the Jacky crossings will be left *in situ* and will be considered as part of the Jacky Decommissioning Project. The pipeline is filled with inhibited seawater.
PL112 (B to AP hydrocarbon line)	As it is trenched and buried the pipeline will be decommissioned *in situ* (average depth of cover is 1 m based on 2016 survey). Total length of exposures is 26 m and total length of pipeline covered in mattresses is 15 m. All mattresses are flexible concrete mattresses and base case is to recover all to shore for recycling / disposal. There is a 35 m section of rock cover at the Beatrice B end to accommodate Jacky production and water injection pipeline crossings. As a base case all exposures (41m includes exposed pipeline resulting from removal of mattresses) will be (1) trenched and buried with (2) cut and removal and (3) rock cover being taken through as first and second contingency options respectively. The rock cover at the Jacky crossings will be left *in situ* and will be considered as part of the Jacky Decommissioning Project. The pipeline is filled with inhibited seawater.

PL112A Replacement section of PL112.	As it is trenched and buried the pipeline will be decommissioned *in situ* (average depth of cover is 0.9 m based on 2016 survey). Total length of exposures is 13 m and total length of pipeline covered in mattresses is 77 m. All mattresses are flexible concrete mattresses and base case is to recover all to shore for recycling / disposal. There is a 2 m section of rock cover at Beatrice AP end to accommodate Jacky and Production pipeline crossings. As a base case all exposures (90 m includes exposed pipeline resulting from removal of mattresses) will be (1) trenched and buried with (2) cut and removal and (3) rock cover being taken through as first and second contingency options respectively. The rock cover at the Jacky crossings will be left *in situ* and will be considered as part of the Jacky Decommissioning Project. The pipeline is filled with inhibited seawater.
PL252 (AP to C injection water line)	As it is trenched and buried the pipeline will be decommissioned *in situ* (average depth of cover is 2.2 m based on 2016 survey). This pipeline was installed in five sections with exposures and mattresses associated with each connection point. Total length of exposures is 77 m and total length of pipeline covered in mattresses is 202 m. Apart from one mattress at the Beatrice AP end all mattresses are grout filled mattresses (197 m length of grout filled mattresses). As a base case all exposures (279 m includes exposed pipeline resulting from removal of mattresses) will be (1) trenched and buried with (2) cut and removal and (3) rock cover being taken through as first and second contingency options respectively. Base case is to recover all mattresses. The pipeline is filled with inhibited seawater.
PL4331 (power cable from Dunbeath to Beatrice AP)	<u>Offshore trenched and buried section (KP 2.82 to KP 26):</u> This section of the power cable will be decommissioned *in situ* (average depth of burial is 0.9 m based on 2016 survey). There are no exposures along this length of the power cable. There is 87 m of grout filled mattresses protecting the power cable at the Beatrice AP platform. At KP 2.82 where the near shore section will be severed from the offshore section the base case option to mitigate the resultant exposure and the exposures resulting from removal of the grout filled mattresses will be to 1) trenched and buried with (2) cut and removal and (3) rock cover being taken through as first and second contingency options respectively. Base case is to recover all mattresses. <u>Nearshore surface laid section (KP 0.9 to KP 2.82):</u> Due to the rocky nature of the seabed this section of the pipeline (1.89 km) was surface laid. This section of pipeline will be decommissioned *in situ*.
PL4330 (power cable from Beatrice AP to Beatrice B)	As it is trenched and buried the full length of the power cable will be decommissioned *in situ* (average depth of cover is 0.9 m based on 2016 survey). Total length of exposures is 7 m and total length of the power cable covered in grout filled mattresses is 76 m. Note as captured in Table 3-3 there are 40 m of flexible concrete mattresses, associated with the Jacky infrastructure that are not within the scope of this EIA). As a base case all exposures (83 m includes exposed pipeline resulting from removal of grout filled mattresses) will be (1) trenched and buried with (2) cut and removal and (3) rock cover being taken through as first and second contingency options respectively. The mattresses associated with the Jacky infrastructure will be left *in situ* and will be considered as part of the Jacky Decommissioning Project
PL2331 (power cable from AP to WTG B)	As it is trenched and buried the full length of the power cable will be decommissioned *in situ* (average depth of cover is 0.9 m based on 2016 survey). Total length of exposures is 134 m and total length of mattresses is 3 m. This mattress occurs at a crossing where PL2331 crosses over the export pipeline (PL1838). At the crossing a section (3 m) of PL2331 will be cut and recovered. As a base case all exposures (134 m) will be (1) trenched and buried with (2) cut and removal and (3) rock cover being taken through as first and second contingency options respectively. The flexible mattress will be recovered.

3.3 Proposed Activities

Repsol Sinopec Resources UK propose to continue P&A activities and to decommission the Beatrice Field in line with the indicative schedule shown in Figure 3-8.

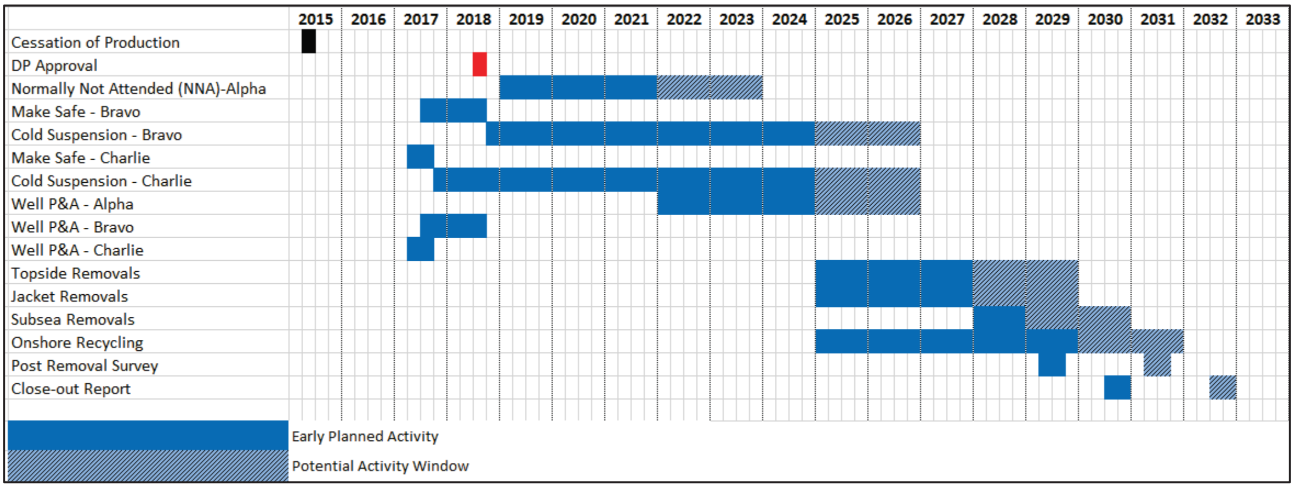


Figure 3-8: Indicative schedule for the Beatrice Decommissioning Project.

Prior to commencing the decommissioning activities at each installation a number of preparatory works are required to be carried out, primarily aimed at making the infrastructure hydrocarbon free. A brief description of the preparatory works and P&A activities is provided here, capturing which workscopes have already been completed. It should be noted that the preparatory works are out with the scope of the DPs and those still to be completed will be carried out under the facilities existing permits. In addition, the P&A activities are out with the decommissioning workscope and are being progressed under Well Intervention Operation permit applications being submitted to BEIS in advance of offshore activities.

3.3.1 Preparatory Works

3.3.1.1 Flushing / Cleaning / Engineering Down

All the Beatrice pipelines have been flushed and cleaned to reduce hydrocarbon content to As Low as Reasonable Practicable (ALARP) prior to filling with inhibited seawater. In addition, all the platforms' processing facilities have been flushed and cleaned to ALARP and isolated. The Beatrice C platform has already been engineered down and made safe. Beatrice B is expected to be engineered down by Q2 2018. Following cleaning and engineering down of the Beatrice A complex, Repsol Sinopec Resources UK propose to it to a Not Normally Attended (NNA) installation prior to its removal in 2028 (indicative timing). Conversion to a NNA installation is expect to occur in 2018/2019.

3.3.2 Plug and Abandonment

All the Beatrice wells will be P&A'd from a jack-up drilling rig in accordance with Oil & Gas Guidelines for the Abandonment of Wells (Issue 5, July 2015) and Repsol Sinopec Resources UK standards. At the time of writing, P&A of the Beatrice C wells (2 wells) was completed (completed in Q3 2017) and had commenced at the Beatrice B platform. P&A activities at Beatrice B are anticipated to be completed by the end of Q4 2018. The P&A campaign at Beatrice AD is anticipated to start in 2022 and to take up to 36 months.

Environmental permit applications for the P&A of the wells have been / will be submitted under a Well Intervention MAT (Master Application Template) via the PETS (Portal Environmental Tracking System). These include Consent to Locate (CtL) applications to locate the drilling rig, chemical permit applications detailing the chemicals to be used and discharged and Marine Licences for the removal of the casings.

3.3.3 Decommissioning of the Platform Topsides

All Beatrice topsides will be recovered to shore and disposal will be in line with the waste hierarchy (see Chapter 14). At the time of writing it was not yet finalised which of the following methods would be used:

- Piece small/medium removal;
- Reverse installation; and
- Single lift.

For all these methods the existing accommodation on Beatrice AD would initially be utilised to support the activities, until such time that the facilities were no longer habitable. At that point accommodation will be required to complete decommissioning of the topsides. Such accommodation could be provided on the lift vessel or alternatively a separate accommodation vessel. In both cases a gangway will provide access to the platform.

The accommodation facilities on Beatrice B were retired in 1992 such that they are no longer habitable and the platform is currently a NUI. Beatrice C was originally a NUI and therefore has no accommodation facilities. Both Beatrice B and Beatrice C will therefore require an accommodation vessel on site for the duration of the activities.

As mentioned in Section 3.3.1.1 Repsol Sinopec Resources UK propose to convert the Beatrice A complex to an NNA installation prior to its removal such that it is expected an accommodation vessel will also be required on site during decommissioning of these platforms. (Note: a NUI and an NNA can be distinguished by the number of times they are visited, with NUIs tending to be visited less frequently).

3.3.3.1 Piece Small/Medium Removal

Piece medium is a removal process whereby modules are cut into two to four pieces for removal to suit the capacity of the crane. Piece small removal involves demolition and therefore a greater level of dismantling, with material transported to shore in skips. Manual hot and cold cutting techniques will likely be used to dismantle modules prior to loading them into containers for shipment.

The piece small/medium approach would involve a significant amount of work offshore including:

- Preparatory removal and segregation of all regulated wastes from topsides for each platform (e.g. waste electrical and electronic equipment, asbestos);
- Dismantling of Beatrice AP and most of the Beatrice AD modules whilst using accommodation on Beatrice 'AD'; and
- Dismantling of remaining Beatrice AD modules, and those on Beatrice B and C using an accommodation / construction vessel with a heavy duty crane.

In addition to a small lift vessel, an accommodation vessel and supply boat would be required. The accommodation vessel will either be a jack-up vessel or DP submersible, comprising deck space, cranes and accommodation.

3.3.3.2 Reverse Installation

Relative to piece small /medium removal, reverse installation would involve significantly less time. Reverse installing the topside modules and decks could involve the use of a Heavy Lift Vessel (HLV) and possibly cargo barges to perform the removal and subsequent transport to an onshore location for dismantling. However, it is also possible that the topsides are transported on board the HLV. Using the HLV to transport the topsides would result in time lost to work on the Beatrice facilities during transit and offloading of the modules on shore, however, the advantages of this method include better weather uptime as back loading of modules to the HLV main deck is less sensitive to weather conditions than back loading to cargo barges.

The existing platform cranes on Beatrice AD would be utilised to support the activities such that module separation and preparation on AP and AD would be carried out before the HLV arrived on site. Accommodation during the preparation work would be on the HLV, with gangway access provided for personnel.

3.3.3.3 *Single Lift*

For topsides removals, offshore preparation time could be reduced as modules would not require separation. However, the requirement for strengthening the topsides prior to the lift may offset any time saved using the piece small/medium and reverse installation methods outlined above. As for reverse installation accommodation would be on the lift vessel.

3.3.4 Decommissioning of the Wind Turbine Generators

The base case for removal of the WTG's is reverse installation, however consideration may be given to a piece small / medium removal method at the time of contract award.

The turbine blades would be separated from the unit *in situ* and recovered to a vessel. It is then possible that the rotor is separated from the pylon such that there are two further lifts or it is possible that the rotor and pylon are recovered in a combined lift.

3.3.5 Decommissioning of Jackets and Piles

All Beatrice jackets will be recovered to shore for dismantling and disposal in line with the waste hierarchy (see Chapter 14). At the time of writing two options were being considered:

- Removal of jacket and piles as a single component; and
- Removal of jacket and piles in multiple sections.

A HLV will be used to recover the jackets, with size and type being dependent on contract award.

Prior to removal of the jackets all pipelines and power cables will have been disconnected at the base of the risers and J-tubes and the topsides will have been recovered.

The jackets will be released from the foundations by cuttings the piles below the mudline. There are two established methods for pile cutting:

- Internal cutting by air lifting or dredging the internal soil plug and deployment of an internal abrasive water jet cutting tool; or
- External cutting by excavation of the seabed and using an external diamond wire saw on a suitable deployment frame.

The piles will be severed below the natural seabed level, with best endeavours to achieve -3 m. Any change in this depth will be discussed with BEIS at the time of execution. At the time of writing, internal cutting is the preferred option and would result in a smaller impact to the seabed as external cutting would involve excavation of the seabed to allow access to the piles with ROV cutting tools. Potential risks associated with internal cutting include the presence of blockages in the pile bore. As a worst case this EIA assesses external cutting of the piles at each of the jackets. Repsol Sinopec Resources UK are investigating excavation methods such that following removal of the jacket the excavated material can be used to fill in the holes created. This EIA assesses the worst case whereby around 80 te of rock is required to fill each hole. This is the approximate volume of rock associated with external cutting of the piles 3 m below the surface. Should internal cutting be feasible, it is expected that the holes remaining after the jackets have been recovered will fill in naturally.

Removal of the jacket and piles in multiple sections would require the jacket legs and support braces to be cut into sections using a combination of cutting techniques. Once the jacket sections have been separated and lifted to the surface they would be sea fastened and transported onshore either on a dedicated transport barge or on the lift vessel.

A diamond wire saw will likely be used to cut the legs and primary braces whilst smaller braces and appurtenances could be cut using a hydraulic shearing tool. Diamond wire saws use abrasion rather than saw teeth and comprise a length of steel wire embedded with diamond particles. The saw is carried on a framework which is clamped onto the jacket leg during cutting. Diamond wire cuttings is proven for subsea cuts up to *c*. 3 m (120") (OGA, 2012). Hydraulic shears have been used extensively in decommissioning projects to cut sections with diameters of up to 1.2 m (48") (OGA, 2012).

As the conductor guide frame at Beatrice AD is no longer attached to the jacket, it will be recovered as a separate lift.

It will be necessary to relocate a portion of the Beatrice AD cuttings pile to get access to the conductor guide frame, the jacket bracings and the jacket legs. Repsol Sinopec Resources UK are consulting with BEIS and MSS regarding the optimal approach to managing the cuttings pile (see Section 3.3.6). This EIA assesses the environmental impacts associated with using a dredge to relocate a portion of the cuttings pile to four locations within 50 m of where it originated (i.e. will be relocated on seabed that is already covered with a thin layer of contaminated cuttings).

3.3.6 Management of the Beatrice AD Cuttings Pile

Repsol Sinopec Resource UK commissioned a BAT assessment to determine the optimal approach for decommissioning of the Beatrice AD cuttings pile (Genesis 2018). In accordance with OSPAR Recommendation 2006/5 the options considered in the BAT assessment were:

1. Leave undisturbed *in situ*;
2. Recover by suction dredging and dispose of by reinjection;
3. Recover by suction dredging, treat and discharge offshore;
4. Recover by suction dredging, transport for treatment onshore, coastal discharge of aqueous waste, reuse or disposal of treated solids; and
5. Spreading of cuttings pile by high pressure water jet.

The assessment undertook a high level comparative evaluation of several key environmental aspects (resuspension of the cuttings material, emissions to air (associated with vessel use), chemical use (likely to be required for reinjection), underwater noise, waste generation and accidental events) for each option. In addition, safety, technical feasibility, regulatory clarity and cost were considered. Given that a portion of the cuttings pile will require to be relocated to allow removal of the Beatrice AD jacket (minimum of 30% which is associated with internal cutting), Option 1 is not considered viable. The conclusion of the comparative evaluation was that the differences between Options 2 – 5 were small and, taken as a whole, the aggregated environmental impact was similar for all options. As such no single option was identified as BAT and any of these four options for managing the cuttings pile would be considered BAT. It should be noted that though reinjection of the cuttings (Option 2) is considered BAT, it is not considered technically feasible at Beatrice without the drilling of a new well.

Repsol Sinopec Resources UK are in ongoing discussions with BEIS and MSS regarding the optimal approach to managing the Beatrice AD cuttings pile. These discussions will continue following submission of the draft DPs with the aim of identifying the optimal approach to decommissioning the cuttings pile. The EIA assesses the impacts associated with scenario whereby 85% of the pile is disturbed to allow external cutting of the jacket piles. This scenario was selected to represent the worst case environmental impact associated with the removal of the jacket.

3.3.7 Decommissioning of Subsea Installations

The drilling template is likely to be recovered via a single lift either by the vessel undertaking the jacket removal or from a Remotely Operated Vehicle Support Vessel (ROVSV) or Construction Support Vessel (CSV).

3.3.8 Decommissioning of the Pipelines and Power Cables

As summarised in Table 3-6 the base case is to decommission all the pipelines and power cables *in situ*. This does not include the spool pieces associated with PL1838 and PL16 (see Table 3-6) which will be removed and returned to shore for recycling. It is proposed that the ends, trench transitions and exposed sections (does not include the nearshore surface laid section of the Dunbeath power cable) of the pipelines and power cables will be trenched and buried using a trenching / jetting unit deployed from a ROVSV (Figure 3-9). The trenching strategy would be in line with industry practise and would be agreed with all consultees during the works authorisation process. Following trenching and burying activities, future inspections of the pipelines left *in situ* will be required to confirm that no further exposures develop, the timeline of which will be agreed with BEIS.

Figure 3-9: Example of a trenching / jetting unit that could be used.

The nearshore surface laid section of the Dunbeath power cable will be decommissioned *in situ* with no remedial action. Given the rocky nature of the seabed the area is not trawled such that there is no anticipated risk to fishing gear (Figure 3-10).

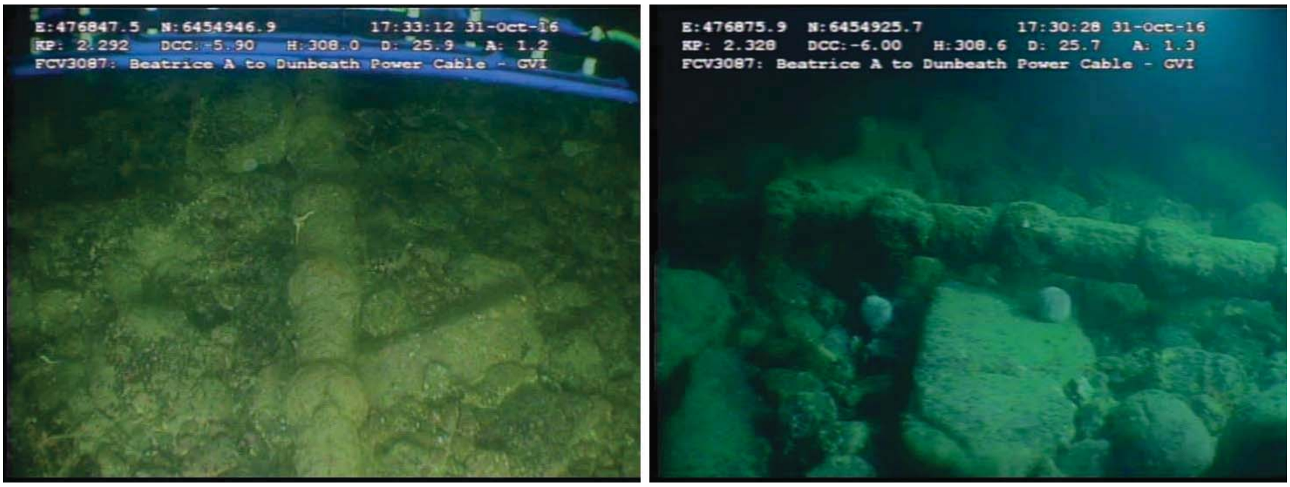


Figure 3-10: Photographs showing the rocky nature of the seabed associated with the surface laid section of the Dunbeath power cable.

3.3.9 Decommissioning of Stabilisation Features

3.3.9.1 Flexible Concrete Mattresses

The base case is that all flexible concrete mattresses out with any crossings associated with the Jacky infrastructure will be recovered. (Note the decommissioning of these mattresses will be considered as part of the Jacky Decommissioning Project). It is therefore planned to recover an estimated 208 flexible concrete mattresses as part of this project.

The flexible concrete mattresses will be recovered to a vessel either using a grab or will be lifted onto recovery frames or steel cargo nets or speed loaders while subsea, and then lifted to the surface via vessel crane. Where individual flexible concrete mattresses are severely degraded and at risk of disintegrating on removal, baskets may be deployed on the seabed for filling by Remotely Operate Vehicles (ROVs) or divers. Where a group of flexible concrete mattresses that due to their condition cannot be recovered using a grab the use of rock cover will be considered. Repsol Sinopec Resources UK will consult with BEIS and seek relevant approvals prior to any rock being laid. This EIA assesses a worst case where a group of 21 flexible concrete mattresses (*c.* 10% of total) cannot be recovered without the use of baskets and are subsequently rock covered. Rock cover estimates and the anticipated footprint assuming a depth of cover of 0.6 m are presented in Table 3-7.

3.3.9.2 Grout Filled Mattresses and Large 11.25 te and 22.5 te Grout Bags

The base case is full removal of the grout filled mattresses and the large grout bags beneath the Beatrice AD conductor guide frame. If during the offshore campaign, some of these mattresses and grout bags cannot be recovered, Repsol Sinopec Resources UK will consult with BEIS before any alternative option is executed. However as mentioned in Section 3.2 this EIA assesses the worst case impacts whereby none of the grout filled mattresses or large grout bags can be recovered and subsequent studies and consultation identify the addition of rock cover to be the optimal approach. Rock cover estimates and anticipated footprint assuming a depth of cover of 0.6 m are presented in Table 3-7.

Table 3-7: Anticipated maximum volumes of rock required to cover stabilisation features.

Pipeline / Location	Stabilisation feature	Length to be rock covered (m)[1]	Total quantity of rock required (te)[1]	Anticipated footprint (m^2)[2]
All pipelines and power cables	Flexible concrete mattresses	126	1,055	1,135
PL252	Grout filled mattresses	197	1,880	1,800
PL4331		87	830	795
PL4330		76	725	690
Beatrice AD conductor guide frame [3]	Large grout bags	20	1,380	675
Total			5,870	5,095

[1] Assumes (i) *c.* 10% of all flexible mattresses cannot be recovered, (ii) none of the grout filled mattresses or the larger grout bags can be recovered.

[2] Allows for a depth of rock cover of 0.6 m.

[3] Assumes the two rows of large grout bags are covered with a single rock berm.

Note: initial calculated volumes and footprint were increased by 20% to represent worst case.

3.3.9.3 Grout Bags (25 kg)

Where technically feasible to do so, Repsol Sinopec Resources UK plan to recover all (*c*. 1,920) of the 25 kg grout bags. It is likely these will be placed into baskets for removal to the surface. If during the offshore campaign it is found that any of these 25 kg grout bags cannot be recovered, Repsol Sinopec Resources UK will consult with BEIS before any alternative option is executed.

3.3.9.4 Other Stabilisation Features

The two concrete tunnels will be recovered and will go to landfill if an alternative use cannot be identified.

3.3.10 Vessel Use

A range of specialist and support vessels will be required throughout the proposed decommissioning workscopes. In order to complete the P&A activities the drilling rig is anticipated to be on station at the Beatrice Field for around 1,525 days: 60 days at Beatrice C, 365 days at Beatrice B and 1,100 days at Beatrice AD. The ENSCO 80 drilling rig was initially towed to the Beatrice C platform via three tugs which were also deployed to move the drilling rig to the Beatrice B platform. Whilst the drilling rig is on location a standby vessel will be present at all times and a supply vessel will support the rig. The number of days estimated is conservative and allows for delays such as waiting on weather.

In addition, the decommissioning activities will require a number of specialist and support vessels including ROVSVs, lift vessels, accommodation vessels, Anchor Handling Vessels (AHVs) and rock cover vessels. It has been assumed for the EIA that the ROVSVs, AHVs and rock cover vessels will hold their position using dynamic positioning, whilst the lift vessels and accommodation vessels will require to be anchored.

At the time of writing, specific vessels have not yet been identified, however, the types of vessel required are well known and standard performance characteristics for typical vessels have been used for the purposes of estimating energy consumption and emissions to air. By estimating the fuel use based on generic vessel types (Institute of Petroleum Guidelines (IoP), 2000 and industry experience) and the likely duration of the work programme for each vessel, estimates of fuel consumption can be made. Estimates are shown in Table 3-8. Although the detailed schedules for the different workscopes are still to be defined, the predicted maximum estimates of vessel use have been presented. In addition, Repsol Sinopec Resources UK are continuing to explore collaboration opportunities with wind farm developers in the area and with Ithaca to identify synergies whereby vessel use can be shared between projects. The estimated vessel use and associated fuel use presented in Table 3-8 does not capture these possible synergies and is therefore considered to represent a worst case.

Table 3-8: Anticipated vessel requirements and fuel usage.

Vessel type	Duration (days)	Fuel consumption rate (te/day)	Fuel usage (te)
Plug and abandonment			
Jack-up drilling rig	1,525	9[1]	13,725
Tow tugs (x3)	21	25	525
Anchor Handling Vessel (AHV) x 3 (assumes 5 days at each platform)	15	5[1]	75
Standby vessel	1,525	4	6,100
Supply vessel in transit and on location (assuming 50% time in transit and 50% on location)	763	10 (transit) 1.5 te (on location)	4,388
Installation removal			
HLV (assumes transporting on HLV)	110	40	4,400
Accommodation vessel (total across all platforms)	290	40	11,600
Supply vessel in transit and on location (assuming 50% time in transit and 50% on location)	200	10 (transit) 1.5 te (on location)	1,150
Rock dump vessel	9	15	135
Subsea decommissioning			
ROVSV	60	21.5	1,290
Rock dump vessel (assumes contingency of rock covering the grout filled mattresses)	7	15	105
Seabed clearance and over trawlability surveys			
Trawler (trawl sweeps and trawl trials) (if used)	40	4[2]	160
Post decommissioning survey			
Survey vessel (Assumes seabed sampling and visual surveys full length of lines and area of 500 m zones)	30	24	720
Maximum anticipated fuel use across all operations			**44,373**

1. IoP guidelines do not have exact equivalent vessel: e.g. for the CSV – figures for a Multipurpose Support Vessel (MSV) were used.
2. Industry advice.
Note vessel days provided are worst case estimates and include mobilisation, transit and working days. Prior to contract award it is difficult to determine accurately. Final vessel days will be captured in the Justification Document supporting the Marine Licence to be submitted prior to commencement of offshore activities.

3.4 Survey and Monitoring Programme

A post decommissioning site survey will be carried out on final completion of all decommissioning works. Surveys will be undertaken along all pipeline routes and at all sites where structures have been removed. Any significant debris will be recovered for onshore recycling or disposal. Independent verification of the seabed state will be obtained for the pipeline areas and installation locations and evidence of clearance will be provided to all relevant governmental and non-governmental organisations.

Inspections of the pipelines and power cables will be carried out to confirm that no further exposures develop. In addition, should any of the stabilisations features be rock covered and decommissioned *in situ*, surveys to determine the stability of the rock cover berms will be carried out. The timeline for inspections will be agreed with BEIS.

A post decommissioning environmental seabed survey (centred on the site of the installations and those sections of pipelines and power cables where remedial activities are required) will be carried out. The objective of the survey is to identify any chemical or physical disturbances to the seabed following decommissioning and to provide a baseline from which future surveys can be compared. The survey reports will be submitted to BEIS and a post monitoring survey regime will be agreed.

4. COMPARATIVE ASSESSMENT

As discussed in Section 1.4, in compliance with OSPAR Decision 98/3, Repsol Sinopec Resources UK will recover all the jackets (including the conductor guide frame at the Beatrice AD platform) and subsea structures (drilling template at AD, and the two concrete tunnels). In addition, mattresses and grout bags will be recovered where technically feasible to do so.

DECC's (now BEIS) Guidance Notes on the decommissioning of offshore installations and pipelines (DECC, 2011) recognise that removing pipelines already buried to a sufficient depth may not be the preferred decommissioning option and therefore provide for a case by case consideration of pipeline decommissioning alternatives on the basis of a CA. The Decommissioning Guidance Notes also state that if the condition of mattresses is such that they cannot be removed safely or efficiently, then any proposal to leave them in place should be supported by an appropriate CA of the options. Due to the potential technical challenges associated with the recovery of mattresses a CA was also carried out to determine the optimal approach for decommissioning them should recovery not be feasible.

The CAs were carried out in line with the Oil and Gas UK (OGUK) Guidelines for CA (OGUK, 2015). The CA Report (Repsol Sinopec Resources UK, 2017), submitted in support of the draft DPs provides full details of the assessment carried out for the decommissioning of the Beatrice pipelines, power cables and mattresses whilst this chapter summarises the process followed and the results of the CAs carried out.

4.1 Pipelines and Power Cables

In order to facilitate the CA workshop, and as per standard CA methodology, the Beatrice pipelines and power cables were split into groups dependent on:

- Type (flexible or rigid);
- Whether or not they were concrete coated; and
- Location in relation to designated protected areas.

Full details of the groupings are provided in the CA Report (Repsol Sinopec Resources UK, 2017). In summary, the pipeline and power cable groupings comprise:

Group A: Offshore concrete coated rigid pipelines: PL16 (offshore section), PL111 and PL112.

Group B: Offshore rigid pipelines that are not concrete coated: PL1838 (offshore section) and disused section of PL112A.

Group C: Offshore flexible pipelines: PL252.

Group D: Nearshore sections (within Special Area of Conservation (SAC)) of pipelines PL1838 and PL16.

Group E: Offshore power cables: Offshore section of Dunbeath power cable, Beatrice A to Beatrice B power cable and PL2331.

Group F: Nearshore section (within Nature Conservation Marine Protected Area (NCMPA)) of Dunbeath power cable.

Prior to the CA a pre-screening of a wide range of the potential decommissioning options for the pipeline and power cable groups was carried out. Options assessed for each group included:

Option 1A: Total removal by reverse reeling.

Option 1B: Total removal by reverse s-lay.

Option 1C: Total removal by cut and lift.

Option 2A: Partial remediation: rock cover exposed sections.

Option 2B: Partial remediation: trench and bury exposed sections.

Option 2C: Partial remediation: cut and remove exposed sections.

Option 3: Do nothing.

The total removal options (1A to 1C) refer to total removal of the pipelines or power cables. The partial remediation options (2A to 2C) refer to leaving the buried sections of pipeline and power cable *in situ* and remediating the exposed sections whilst Option 3 involves no activity and leaving the pipelines/power cables as found.

In the pre-screening each of the pipeline and power cable groupings were assessed against the above options. A qualitative assessment taking into account safety, environment, technical, societal and economic impacts was carried out using a Red-Amber-Green (RAG) evaluation method. The pre-screening is detailed in the CA Report submitted with the DPs (Repsol Sinopec Resources, 2017).

The results of the pre-screening of the decommissioning options are shown in Table 4-1.

Table 4-1: Results of the pre-screening of the decommissioning options for the pipelines and power cables.

Pipeline / power cable group	Full removal			Partial remediation			Do nothing
	1A	1B	1C	2A	2B	2C	3
Group A	X (NTF)	✓	X (SO)	✓	✓	✓	✓
Group B	✓	✓	X (SO)	✓	✓	✓	✓
Group C	✓	✓	X (SO)	✓	✓	✓	✓
Group D	X (NTF)	✓	X (SO)	✓	✓	✓	✓
Group E	✓	X (SO)	✓	✓	✓	✓	✓
Group F	✓	✓	✓	✓	X (SO)	X (NA)	✓

✓ Selected for assessment in CA	X (NTF) Not technically feasible	X (SO) Screened out	X (NA) Not applicable

For all options selected for each of the Groups, scoring at the CA was carried out against safety, environment, technical feasibility, societal impacts, and economics. Within each of these criteria a number of sub-criteria were considered. Each of the criteria carried a different weighting: safety (40%); environment (26%); technical (14%); societal (11%) and economic (9%).

For the pipeline groups and power cable Group E the partial remediation options scored best. Of these three options, trenching and burying of the exposed sections was found to be the preferred option for all groupings. For Group A, B and D, rock cover of exposed sections ranked second with cut and remove ranking third. For Group C and Group E, cut and recover of the exposed sections ranked second and rock cover ranked third. However, it should be noted the scoring of all three remedial options was very close and in line with the preferred approach (by stakeholders) Repsol Sinopec Resources UK will only rock cover if trench and bury or cut and recover options are found to not be technically feasible.

For power cable Group F, the CA identified decommissioning *in situ* with no remediation to be the best option.

Therefore, in keeping with the results of the CA, Repsol Sinopec Resources UK, plan to decommission the buried pipelines and power cables (Groups A to E) *in situ* whilst trenching and burying the ends and mid-line exposed sections. As contingency options, cut and removal; and rock cover of the ends and exposed sections will be taken through as first and second contingency options respectively. Also as per the CA, Repsol Sinopec Resources UK plan to decommission the nearshore surface laid section of the Dunbeath *in situ* without remediation. It should be noted that all options will require an ongoing survey programme to be agreed with BEIS.

4.2 Flexible Concrete Mattresses

Repsol Sinopec Resources UK plan to recover all flexible concrete mattresses. However, a CA of the remaining decommissioning options has been carried out to determine the optimal approach for a series or group of flexible mattresses which cannot be recovered by grab due to their condition. The EIA assumes a worst case whereby around 10% (i.e. 21 of a total of 208 mattresses) are not recoverable. Individual flexible concrete mattresses that due to their condition, cannot be recovered using a grab, will be broken up and transferred to debris baskets (either using an ROV or by divers) for removal. It should be noted that a review of ROV footage of the flexible concrete mattresses to be decommissioned has not identified any series of these mattresses in a condition expected to hinder recovery.

A pre-screening of the available decommissioning options was carried out using a similar RAG approach to that used for the pipeline and power cable such that the same criteria; safety, environment, technical, societal and economic impacts were qualitatively assessed.

Options considered in the pre-screening included:

Option 1A: Leave *in situ* and do nothing.

Option 1B: Leave *in situ* and rock cover.

Option 1C: Relocate and bury.

Option 2A: Recover using debris baskets (filled by divers or ROVs).

Option 2B: Recover using grabs.

Results of the pre-screening of the options for the concrete flexible mattresses are shown in Table 4-2.

Table 4-2: Results of the pre-screening of the decommissioning options for the concrete flexible mattresses.

Mattress type	Leave *in situ*		Relocate and bury (1C)	Recover	
	1A	1B		2A	2B
Grout filled bag mattresses	X (SO)	✓	X (SO)	✓	X (SO)
✓ Selected for assessment in the CA			X (SO) Screened out		

For the two options selected during pre-screening, a CA was carried out against the same criteria and sub criteria as for the pipelines and power cable CA and the same weightings were assigned to each. The results of the CA concluded that for those concrete flexible mattresses that cannot be recovered due to their condition, covering them with rock cover and decommissioning them *in situ* is the optimal approach.

To conclude, Repsol Sinopec Resources UK plan to recover all concrete flexible mattresses, however if during the offshore campaign the condition of any mattress is found to be such that recovery is not considered safe, it will be covered with rock and decommissioned *in situ*. Repsol Sinopec Resources UK will seek the relevant approvals prior to depositing any rock. Should any of these mattresses be decommissioned *in situ*, monitoring of the rock cover will be captured within a survey programme which will be agreed with BEIS.

4.3 Grout Filled Mattresses

A pre-screening of the available decommissioning options for the grout filled mattresses was carried out assessing the same options as those considered for the concrete flexible mattresses. The results of the pre-screening are shown in Table 4-3.

Table 4-3: Results of the pre-screening of the decommissioning options for the grout filled bag mattresses.

Mattress type	Leave *in situ*		Relocate and bury (1C)	Recover	
	1A	1B		2A	2B
Grout filled bag mattresses	✓	✓	X (SO)	✓	X (SO)
✓ Selected for assessment in the CA			X (SO) Screened out		

For each of the options selected during pre-screening a CA was carried out against the same criteria and sub criteria as for the pipelines and power cable CA and the same weighting were assigned to each. The results of the CA concluded that the 'Do Nothing' approach as optimal whilst the addition of rock cover was second. Subsequent to feedback at the Stakeholder Engagement Workshop held in September 2017 (details in Chapter 2) and results from an over trawl trial carried out by SFF (SFF, 2017), Repsol Sinopec Resources UK revisited the results of the CA. Further studies identified full recovery to be the preferred option. If during the offshore campaign, some of these mattresses cannot be recovered, Repsol Sinopec Resources UK will consult with BEIS before any alternative option is executed. It should be noted that the larger grout bags (11.25 te and 22.5 te) associated with the conductor guide frame were not considered in the CA which was limited to the pipelines and power cables and the associated stabilisation features. However, they were considered in the subsequent studies and the selected option (i.e. full recovery) was the same as for the grout filled mattresses.

5. ENVIRONMENTAL BASELINE

5.1 Introduction

As described in the EIA methodology chapter (Chapter 7), a thorough understanding of the environment is required to identify the environmental receptors, and assess their sensitivity and any potential environmental impacts of the proposed decommissioning activities.

This section describes the environment and the environmental receptors in the vicinity of the Beatrice development, with an assessment of their sensitivity. This section has been prepared with reference to available literature and the Beatrice pre-decommissioning environmental survey reports (see Section 5.2).

5.2 Pre-Decommissioning Environmental Surveys

The Beatrice Field pre-decommissioning environmental survey was carried out in October/November 2016 (Fugro, 2017a; Fugro, 2017b). Figure 5-1 shows the sample points used in the survey campaign.

A combination of geophysical and acoustic datasets, physical seabed samples and high definition seabed imagery were acquired during the survey campaign.

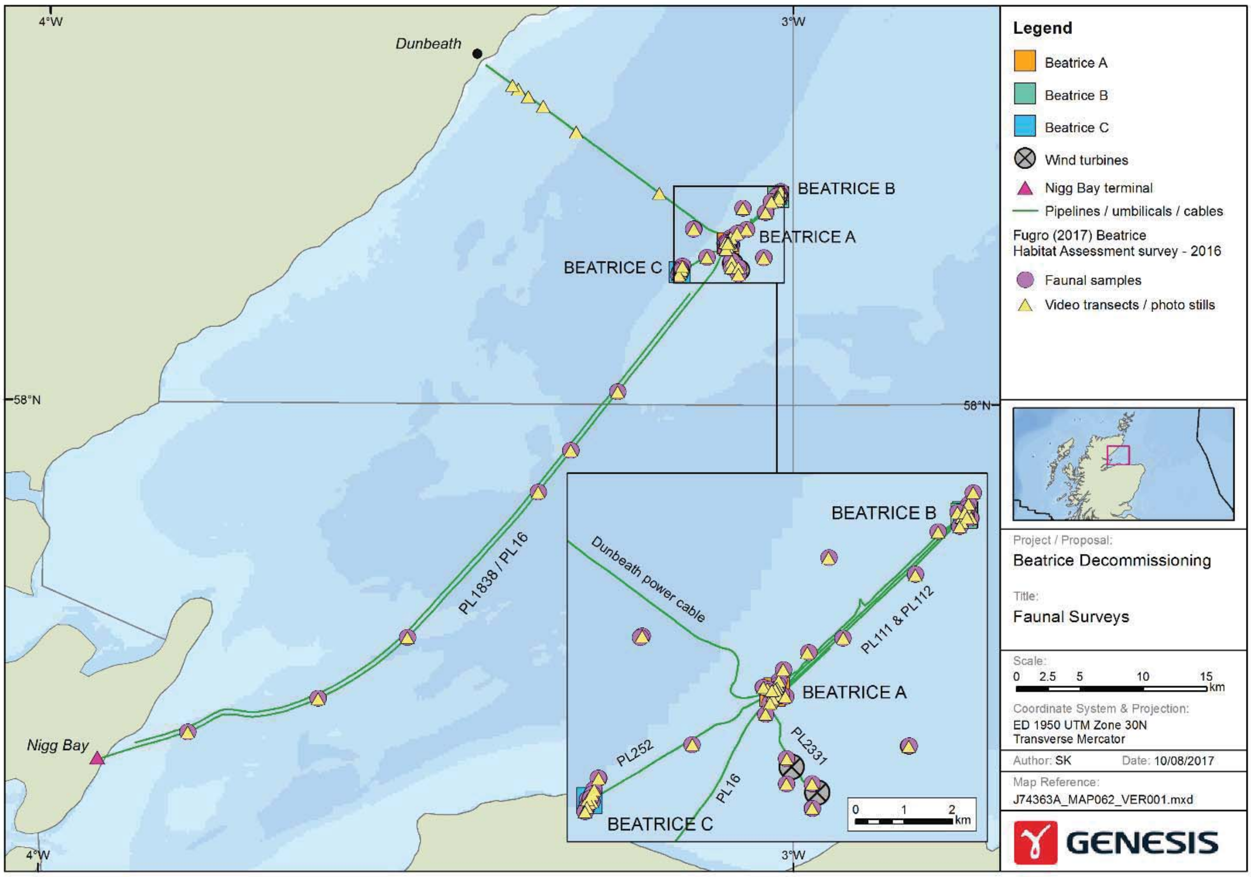


Figure 5-1: Pre-decommissioning survey sample points: faunal samples and video transects/photo stills.

5.3 Metocean Conditions

Metocean (meteorological and oceanographic) conditions influence the type and distribution of marine life in an area and also influence the behaviour of emissions and discharges (planned and unplanned) offshore. For example, the speed and direction of water currents have a direct effect on the transport, dispersion and ultimate fate of any discharges, while sediment type can influence the levels of contaminants that may be retained in an area.

5.3.1 Meteorology

The Moray Firth experiences a mild maritime climate (UKHO, 2012). Wind in the open sea areas may come from any direction, with winds from the southwest or north-northeast being marginally more common. Sudden changes in wind direction are also a feature of the indented coast of the Moray Firth (UKHO, 2012; BEIS, 2016). The 30-year average wind speed mean at 110 m ranges from 9.6-9.8 m/s, varying between <8 m/s in summer to 10.4 and 11.6 m/s in autumn and winter, respectively (Crown Estate, 2015). Frequency of precipitation in the northwest Moray Firth is higher in winter (~30 %) than in summer (~ 18 %) (UKHO, 2012). In the Moray Firth annual rainfall is in the range 201-400 mm (BEIS, 2016). Sea fog is most frequent in the Moray Firth in summer during periods of southeast winds (UKHO, 2012).

5.3.2 Bathymetry

Bathymetry plays a significant role in modifying coastal tidal and residual currents, especially in the North Sea (BEIS, 2016). Knowledge of the bathymetry of the area helps to provide an understanding of the movement of sediments and possible contaminants associated with the sediment.

The Beatrice development is located off the southwest corner of Smith Bank (Bennett and McLeod, 1998) which is 30 - 40 m deep and notably elevated from the surrounding seabed. To the south and east of the Smith Bank, along the export pipeline and power cable routes, the seabed deepens slightly to 50 - 60 m, before becoming shallower again towards the coast.

Water depths within the Beatrice A 500 m exclusion zone ranged from 40.5 to 42.6 m LAT, whilst at Beatrice B and Beatrice C they ranged from 40.5 – 45.3 m and 48.6 – 49.6 m LAT respectively Fugro (2017b). In the vicinity of the wind turbine generators, the water depth range from 46.6 m in the north to 47.7 m LAT in the south. Along the Nigg export pipeline route the depth ranges from 58.7 m at the lowest point to 0 m LAT at landfall. Similarly, the Dunbeath to Beatrice A power cable route ranges from 63 – 0 m LAT.

The shallowest water depth at Beatrice A is due to the small (*c*. 678 m^3 and *c*. 1.4 m high) cuttings pile at the AD jacket, whilst at Beatrice B three historic spud-can depressions are present to the northeast of the platform in an otherwise fairly flat seabed.

5.3.3 Water Currents, Waves and Tides

Water masses, and local current speeds and direction all influence the transport, dispersion and ultimate fate of marine discharges, nutrients, plankton and larvae (OSPAR, 2010).

The Beatrice development is located in an area influenced by Atlantic inflow along the east of the Shetland Isles and the Fair Isle Current moving in a south-southwesterly direction into the Moray Firth (Turrell, 1992). The waters over the inner and outer Moray Firth can be described as 'coastal or a region of freshwater influence' and 'shelf water'. Water column characteristics of the shelf water in the Beatrice area vary from stratified in summer to well-mixed in autumn and winter, before becoming weakly stratified in spring. The nearshore and shallow areas are influenced by freshwater inputs, resulting in some weak stratification throughout the year (Connor, *et al.* 2006).

The tidal streams present in the Moray Firth are complex and variable in direction (BEIS, 2016). Due to the passage of the tidal wave across the outer Firth, tidal currents are stronger in this area than inshore, where topographically induced localised gyres occur (BEIS, 2016). These currents are stronger than those typical for CNS and are more similar to those which occur in the SNS. Within the inner Moray Firth most of the area is subject to currents of less than 0.5 m/s (1 knot) (BEIS, 2016). In general, the tides in the outer Firth flow in a north to south-easterly direction, reversing to ebb northwards. Over Smith Bank, tidal streams show maximum speeds of 0.5 and 0.3 knots during spring and neap tides, respectively. Tidal streams are slightly stronger closer to the coast and the strongest tidal streams (up to 1.3 knots) are found at the entrances to the inner firths (BEIS, 2016). In the inner Firths of Dornoch, Cromarty and Beauly/Inverness, the tides trend in a more easterly direction. Along the southern shore of the Firth, a notable feature of the tidal current pattern is a flood lasting approximately nine hours of the tidal cycle, with an insignificant ebb flow for the remaining three hours. This phenomenon occurs up to 8 km offshore and is a result of the southern Moray coastline sheltering the area from the north flowing ebb current (BEIS, 2016). The resultant residual current is an eastward flow along the southern shore of the outer Firth (BEIS, 2016).

The annual mean significant wave height is approximately 1.3-1.4 m across the Beatrice area, with the lowest wave heights in summer (0.86-0.93m) and highest in winter (1.68-1.8 m) (BERR, 2008). The annual mean wave power is 6.1 – 12.0 kW/m and the mean spring tidal range is 3.1- 4.0 m, these ranges are considered typical for the northeast and northern coasts of the Scottish mainland (Scottish Government NMPi, 2017).

5.3.4 Sea Temperature and Salinity

According to data collected between 1971 and 2000, the annual mean seawater surface temperature in the Beatrice area is approximately 9 °C and the annual mean temperature at the seabed is between 8-9 °C (Scottish Government NMPi, 2017).

Fluctuations in salinity are largely caused by the addition or removal of fresh water to/from the sea through natural processes. The salinity of seawater around an installation has a direct influence on the initial dilution of marine discharges. As salinity decreases the solubility of aqueous effluents generally increases. The waters over the inner and outer Moray Firth are described as 'coastal or a region of freshwater influence' and 'shelf water', with typical salinities of 30 - 34 ppt and 34 - 35 ppt respectively (Connor *et al*. 2006). This is due to the area being influenced by both oceanic water and coastal/mixed waters of the inner Moray Firth. The annual mean salinity in the Moray Firth is between 34-35 %, and is generally *c*. 0.2 -0.4 % lower than offshore areas of the CNS (data from 1971 and 2000) (Scottish Government NMPI, 2017).

5.4 Sediments

The general physical and chemical characteristics of sediment particles have a significant effect on how chemical compounds and biological species interact with the seabed sediment (Fugro, 2017a) and are important factors in determining the potential effects of decommissioning activities on the seabed environment. Particles of various types and sizes, notably the silt / clay fraction, can absorb petroleum hydrocarbons from seawater and, through this pathway, hydrocarbons become incorporated into the sediment system. Organic matter within the sediment matrix is also likely to absorb hydrocarbons and heavy metals, providing a means of transport and incorporation into sediments. The bioavailability of contaminants that are adsorbed to sediment or organic matter is poorly understood. However, in general terms, prolonged contact between hydrocarbons and sediment may result in stronger bond formation and a subsequent reduction in bioavailability (Van Brummelen *et al*., 1998). This phenomenon is referred to as 'ageing' and is especially important for sediments with historic contamination such as prolonged discharge of drill cuttings or produced water.

5.4.1 Seabed Characteristics

The seafloor of the Moray Firth comprises Holocene sand and fine sand to a depth of approximately 50 m. Gravelly sand and sandy gravel typically dominate the shallower substrate closer to the coast (Reid & McManus 1987, Andrews *et al*. 1990).

Figure 5-2 shows that the sediments in Block 11/30a are shelf sublittoral sand and shelf sublittoral coarse sediment with a section of shallow/shelf sublittoral rock and biogenic reef in the north-eastern section of the block. The seabed sediment along the power cable and export pipeline routes is also largely shelf sublittoral sand which changes to shallow sublittoral sand towards the pipeline landfall at Nigg. Along the power cable route, the deeper sediments change to shelf sublittoral coarse sediment and shallow sublittoral coarse sediment towards the coastline where larger amounts of coarse material (pebbles, cobbles and boulders) occur towards its landfall site at Dunbeath.

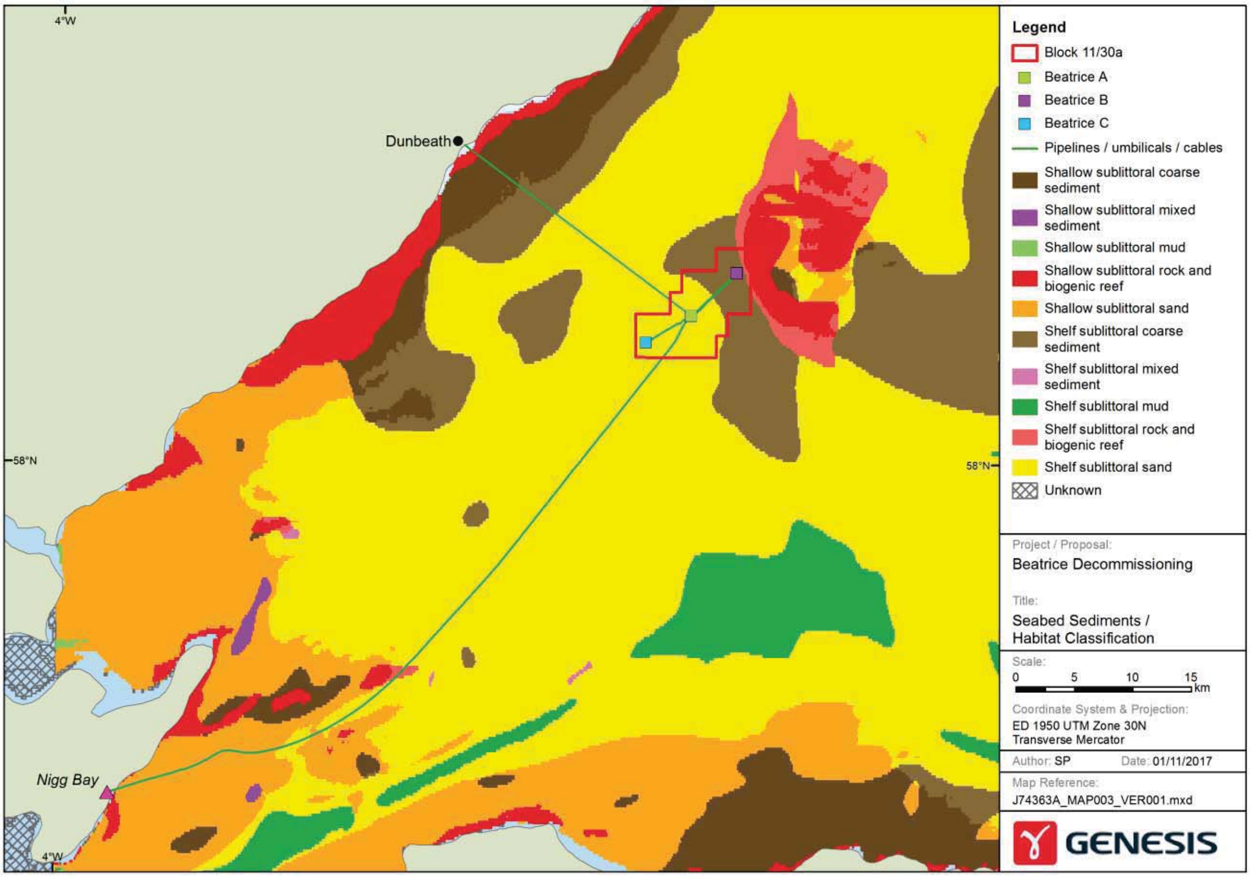


Figure 5-2: North Sea sediment distribution (Marine Strategy Framework Directive predominant habitat classification) (EMODnet, accessed 2016).

The Beatrice pre-decommissioning site survey report classifies sediments in the survey area as coarse silt, coarse sand, medium sand and fine sand (Fugro, 2017a). Sediments within the vicinity of the Beatrice platforms had a mean particle size diameter ranging from 46 µm (silt) to 456 µm (medium sand). Only fine sediment types (silt to fine sand) were recorded within 100 m of the Beatrice A platforms suggesting the presence of drill cuttings deposits (Fugro, 2017a). Sediments in the wind turbine survey area were relatively homogenous with mean particle size diameter 207 µm to 213 µm (fine sand) whilst the sediments collected along the infield pipelines and Nigg export pipelines showed a high degree of variation reflecting the large distances being surveyed. Mean particle size diameters ranged from 49 µm (silt) at Nigg (close to the coast) to 817 µm (coarse sand) along the infield pipelines. Sediment sorting at the individual sample sites varied from good (with fairly homogeneous particle sizes) to extremely poor (with a large variance in particle size) (Fugro, 2017a).

Historical survey data for this area also found sediments comprised moderately sorted medium to fine sand with shell fragments (Hartley & Bishop 1986, DTI 2004, Holmes *et al.* 2004, ERT, 2005, Gardline 2007). Video and grab sampling survey results from SNH's biotope mapping (Foster-Smith *et al*. 2009) of the seabed, which covers ~7km of the Nigg export pipeline's route as it approaches land, shows the presence of fine sediments with occasional shells. An area of very coarse sediment occurs within 3 km of the power cable landfall.

During the pre-decommissioning environmental surveys, the majority of the Beatrice area showed low reflectivity and was identified as the EUNIS biotope complex 'Circalittoral fine sand' (A5.25) with patches of 'Circalittoral mixed sediment' (A5.44). Stations in the Beatrice C area exhibited finer seabed sediment and were identified as 'Circalittoral muddy sand' (A5.26) (Fugro, 2017b). The EUNIS biotope distribution and example photographs are shown in Table 5-1, Figure 5-3, Figure 5-4 and Figure 5-5.

In summary, the sediments at the Beatrice platforms, infield pipelines, wind turbines and Nigg export pipeline comprised fine to coarse sand. The power cable is also largely located in an area of fine to coarse sand but crosses a 3 km long stretch of very coarse material (pebbles, cobbles and boulders) towards its landfall site at Dunbeath.

Table 5-1 Distribution of EUNIS biotope complexes in the Beatrice survey area.

Location	EUNIS biotope complexes		
	Circalittoral fine sand	Circalittoral mixed sediment	Circalittoral muddy sand
Beatrice A	✓	✓	✓
Beatrice B	✓	✓	
Beatrice C			✓
WTGs	✓		
Infield pipelines	✓		
Export line to Nigg	✓	✓	✓
Power cable from Dunbeath	✓		✓

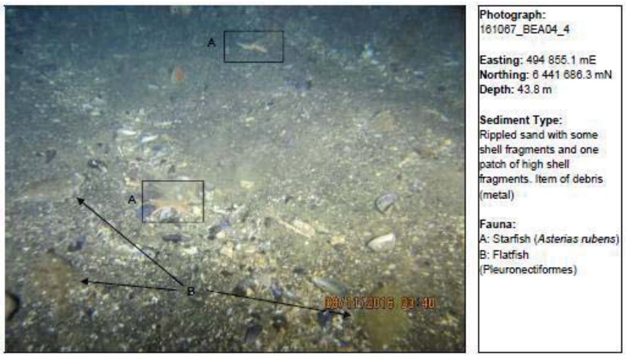


Figure 5-3 Example of circalittoral fine sand (Source: Fugro, 2017a). Figure 5-4 Example of circalittoral mixed sediment (Source: Fugro, 2017a).

Figure 5-5 Example of circalittoral muddy sand (Source: Fugro, 2017a).

At the Beatrice AD platform samples associated with an historic drill cuttings pile were assigned as 'Circalittoral muddy sand' and also as EUNIS biotope 'Industrial waste' (J6.5); this is described further in the following sections (5.4.2 and 5.4.3).

At Beatrice B shell fragments associated with the spud can depressions and associated rock dump were assigned as 'Circalittoral mixed sediment' whilst the rock-dump and other debris was defined as 'Industrial waste'.

5.4.2 Cuttings Pile and Debris

The pre-decommissioning environmental survey found that a cuttings accumulation was only evident at Beatrice AD platform. A plot of the cuttings pile and cross sections are presented in Figure 5-6 (note the different scale used in the cross sections).

The cuttings pile is surrounded by a relatively flat natural seabed (depth 44.0 m) with the pile being located predominantly beneath and to the north-west of the platform. The highest point of the deposits is just off the north face. Analysis of the cuttings data estimated that the total volume is *c*. 678 m³ covering a seabed area of 1,698 m² around the base of platform (Fugro, 2017a).

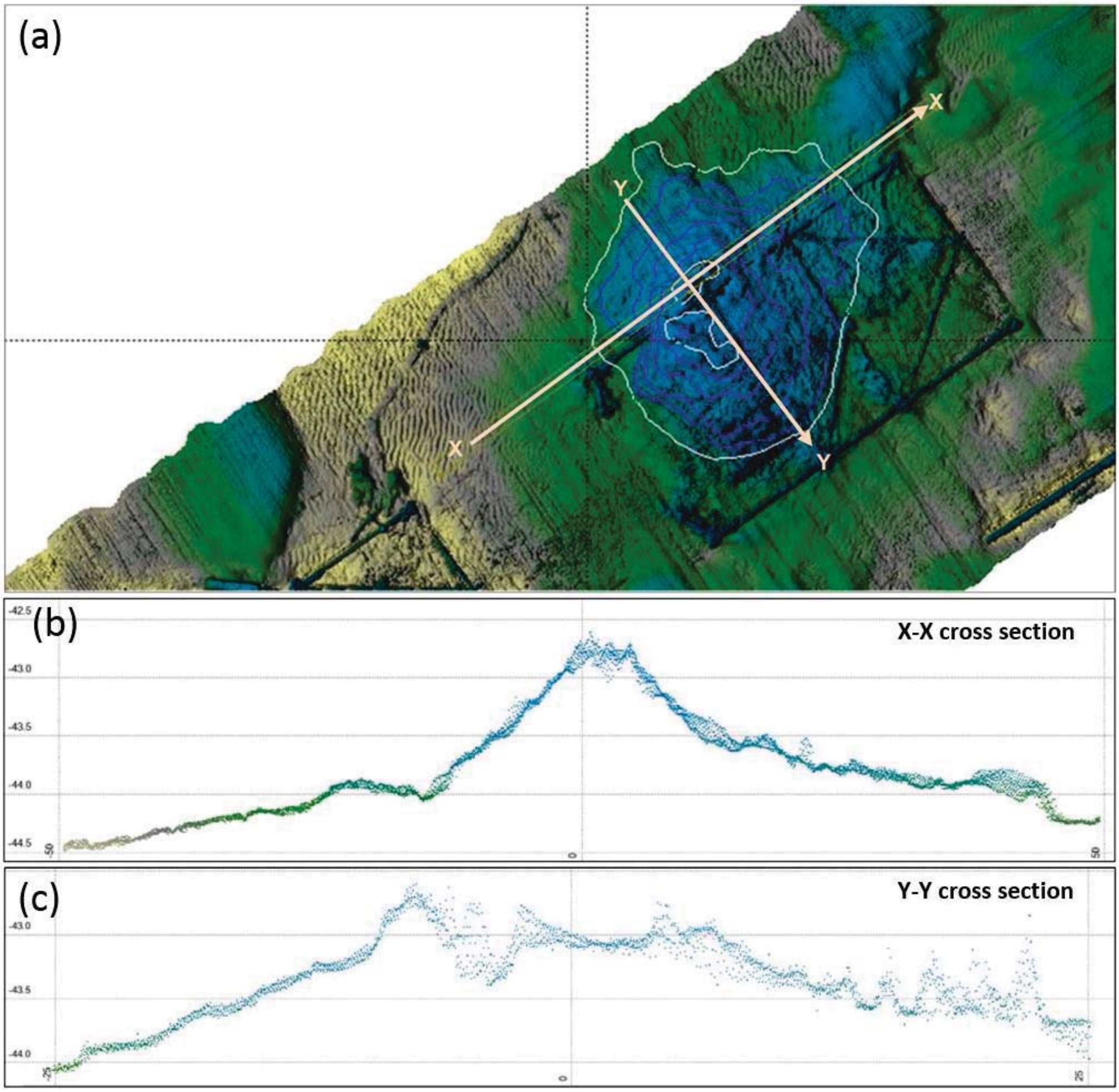


Figure 5-6: Beatrice Alpha drill cuttings profile with cross sections (b) west to east profile and (c) north to south profile (Source: Fugro, 2017a).

Anthropogenic debris was identified at all of the platforms, and a typical example can be seen in Figure 5-7. A total of 73 items with a dimension greater than 1 m were identified in the area around the Beatrice A platforms and were mostly scaffolding poles and other metal. Twenty-eight items with a dimension greater than 1 m at Beatrice B were identified as scaffolding, metal and cabling and at Beatrice C there were ten items larger than 1 m. No debris was identified at the infield pipeline or WTG locations.

Photograph:
161067_BEA03_3

Easting: 494 854.0 mE
Northing: 6 441 614.6 mN
Depth: 45.8 m

Sediment Type:
Rippled sand with some shell fragments. Items of debris (scaffold poles and metal) and patch of high shell fragments associated with the debris

Fauna:
A: Starfish (*Asterias rubens*)
B: Edible sea urchin (*Echinus esculentus*)
Actiniaria

Figure 5-7: Example of debris and associated shell fragments (Source: Fugro, 2017a).

5.4.3 Sediment Contaminants

Elevated levels of contaminants can affect flora and fauna in a variety of ways, ranging from cellular effects in individuals to ecosystem effects resulting from changes in population sizes or even the loss of an entire species (UK Marine SACs Project, 2001). The OSPAR Coordinated Environmental Monitoring Programme (CEMP) provides assessment criteria for contaminants in sediments in the form of Background Concentrations (BC), background assessment criteria (BAC), Environmental Assessment Criteria (EAC) and Effects Range (ER). Adverse effects on organisms are rarely observed when concentrations fall below the ER-Low (ERL) value (OSPAR, 2009).

Fugro (2017a) analysed sediment samples from 56 locations in the Beatrice survey area: Beatrice A (18 stations); Beatrice B (11 stations); Beatrice C (nine stations); reference stations (three stations); wind turbines (four stations); infield pipelines (five stations) and export pipeline (six stations). Two core samples were taken in the Beatrice AD cuttings pile. Analysis was carried out to determine hydrocarbon content (total hydrocarbon concentration (THC), polycyclic aromatic hydrocarbons (PAH), alkylphenols (AP) and alkylphenol ethoxylates (APE)), organotins, polychlorinated biphenyls (PCBs) and heavy metals.

Total Hydrocarbon Concentration

Seabed sediments collected within 100 m of the Beatrice AD platform and within 50 m of the Beatrice B and C platforms contained concentrations of several different hydrocarbon-based drilling fluids (diesel, low toxicity oil based mud and 'Cleanspot') originating from discharges of hydrocarbon contaminated cuttings at the platforms.

The maximum THC in the Beatrice AD seabed sediment samples was 19,700 µg g^{-1} which is consistent with concentrations recorded for samples collected from other North Sea cuttings piles (Fugro, 2017a). Sediments collected further from the platform contained lower concentrations of drilling fluids, primarily weathered 'Cleanspot'. As shown in Figure 5-8 THC were reduced to less than 10 µg g^{-1} outwith the 500 m exclusion zone.

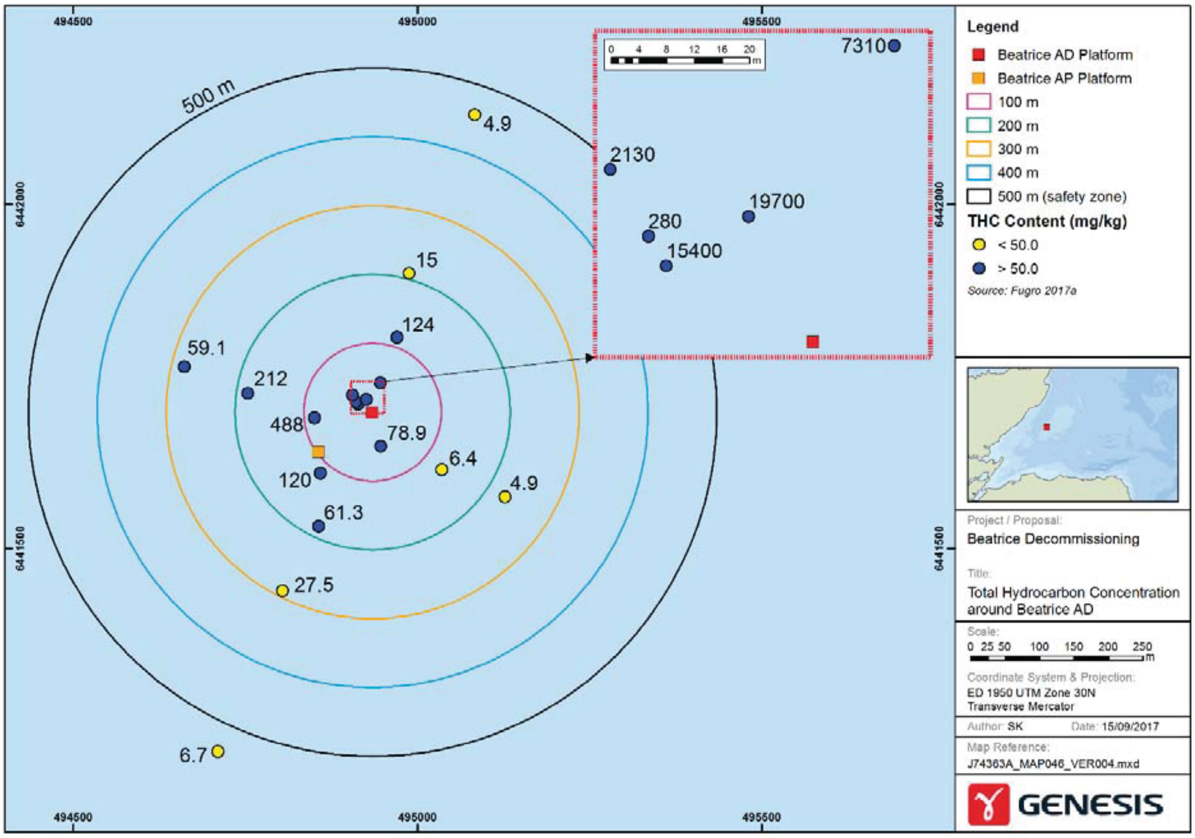


Figure 5-8: THC concentration of seabed sediment samples around Beatrice AD platform (source: Fugro, 2017a).

Sediments from survey stations within 50 m of the Beatrice B and C platforms contained diesel based drilling fluid components and elevated THC levels (up to 80.1 µg g^{-1} and 129 µg g^{-1}, respectively).

The concentrations and types of hydrocarbons present in the samples collected in the wind turbine area and along the pipeline routes were typical of North Sea background levels, ranging from 2.3 µg g^{-1} to 6.4 µg g^{-1} with the exception of export pipeline station NIGG06 (furthest from the platforms and *c.* 7.5 km from coastline) where the influence of terrestrial run-off was evident. A THC level of 17.7 µg g^{-1} was recorded at this station.

Core samples were collected at two locations near the Beatrice AD platform to investigate the depth and composition of the cuttings pile. The top surface sediment and mid-depth sediment layers were dominated by hydrocarbons originating from LTOBM and diesel inputs whilst the deeper sediment layers contained a relatively heavy mineral oil based drilling fluid. The highest THC concentration in the sediment cores was 45,600 µg g^{-1} in the middle section (27.5-37.5 cm deep) of sample BEACORE1. The top (0-10 cm) and bottom (55-65 cm) sections of this core showed THC concentrations of 2,910 µg g^{-1} and 2,880 µg g^{-1} respectively. THC concentrations at BEACORE2 were considerably lower, being 2,320 µg g^{-1}, 1,330 µg g^{-1} and 498 µg g^{-1} in the top, middle and bottom sections respectively.

The core samples indicated that a degree of biodegradation of the hydrocarbons has occurred, however, there was some suppression of biodegradation processes in areas where deeper deposits of cuttings are present. This is consistent with studies of other North Sea hydrocarbon-contaminated cuttings piles and is linked to a decrease in oxygen available for aerobic microbial processes. This results in the formation of anoxic, sulphate-reducing conditions and thus increased concentrations of compounds that are potentially toxic to microbes such as sulphides (Schaanning and Bakke, 2006).

Results from a survey carried out in 1992 (Auris, 1992) found total oil concentrations in sediments *c.* 150 m from the platform ranged from 8.41 µg g^{-1} (east southeast of the platform) to 1,121.5 µg g^{-1} north northeast of the platform). When compared against samples taken from a similar area (those samples taken between 100 m and 200 m from the platform as shown in Figure 5-8) it appears that the concentration of hydrocarbons in the sediment in this area has decreased over time.

Polycyclic Aromatic Hydrocarbons

The distribution of PAH concentrations shows the same pattern as the THC with the highest levels occurring closest to the platforms (Fugro, 2017a).

The total PAH concentrations in the surface sediments at Beatrice B and Beatrice C range from 0.011 µg g^{-1} to 1.64 µg g^{-1}. Considerably higher levels are associated with Beatrice AD, with levels of up to 265 µg g^{-1} (typical of values recorded in areas of OBM cuttings deposition) being recorded within 60 m of the platform. The highest level recorded more than 250 m from the platform is 0.571 µg g^{-1} (Fugro, 2017a) showing that the highest levels occur within a very small area.

The highest total PAH concentration of any sample was measured in the Beatrice AD cuttings pile core sample BEACORE1 (middle section) at 886 µg g^{-1} (Fugro, 2017a). The other core sections follow the same trend as the THC levels.

The concentrations of the specific PAH CEMP listed compounds (OSPAR, 2009) recorded for a number of the surface sediment samples collected within 100 m of the Beatrice A platform greatly exceeded the ERL threshold concentrations indicating that negative ecological impacts could be expected. However, the concentrations of the specific PAH CEMP listed compounds measured within 100 m the Beatrice B and C platforms were all well below the ERL threshold concentrations indicating that ecological affects would not be expected (Fugro, 2017a).

In the wind turbine and pipeline areas the total PAH concentrations were also below the ERL threshold, ranging from 0.024 µg g^{-1} to 0.131 µg g^{-1} (except for NIGG06 where a level of 0.562 µg g^{-1} was recorded). At the at the reference stations the PAH levels were generally comparable to the wind turbine and pipeline areas (between 0.029 µg g^{-1} and 0.119 µg g^{-1}.

Alkylphenol Ethoxylates and Alkylphenols

APEs were historically used as emulsifiers in drilling mud formulations. APEs degrade into AP (nonylphenol and octylphenol) which are potential endocrine disruptors. The Beatrice pre-decommissioning survey report uses the Norwegian Pollution Control Authority (NPCA) predicted no-effect concentration (PNEC) and 'Class V' (extensive toxic effects) levels to assess the concentrations of nonylphenol and octylphenol in the Beatrice sediments (Fugro, 2017a).

Nonylphenol was the dominant AP/APE compound present in the Beatrice survey area. Nonylphenol concentrations recorded from sample sites within 100 m of Beatrice A exceeded the NPCA PNEC, the NPCA Class V level and background reference site levels. All sample stations within 50 m of Beatrice B, and three quarters of sample stations within 50 m of Beatrice C, exceeded the nonylphenol Class V level.

The octylphenol concentrations recorded in the surface sediment samples exceeded the NPCA PNEC at all Beatrice A and Beatrice B stations and one station at Beatrice C. At Beatrice A most samples were also higher than the NPCA Class V level. Samples from Beatrice B and C were below the NPCA Class V level but some samples still exceeded the PNEC concentration (Fugro, 2017a).

Organotins

Organotin compounds, principally tributyltin (TBT), have historically been used in marine antifouling products. Their use is now prohibited due to the disruption of the reproductive capabilities of a number of gastropod species, however they may still be present in the offshore cuttings piles from use in the 1980s. The low concentrations of TBT recorded during the 2016 Beatrice pre-decommissioning survey are not expected to affect the reproductive capability of sensitive gastropod species (Fugro, 2017a).

Polychlorinated Biphenyls

PCBs tend to adsorb to particulate matter and have relatively low water solubility. They have been identified as endocrine disruptors and have been shown to be toxic to aquatic organisms at a range of concentrations between 12 µg/l to 10 mg/l; however, the main concern with PCBs is their potential to bioaccumulate.

The total PCB concentrations recorded in the sediments collected around the Beatrice infrastructure ranged from 0.09 ng g^{-1} to 0.98 ng g^{-1}, well below the ERL concentration of 11.5 µg kg^{-1} (Fugro, 2017a).

Heavy Metals

Elevated levels of barium were found in sediments within 100 m of Beatrice AD and between 150 m and 250 m from Beatrice B. Slightly elevated levels were recorded at stations within 50 m of Beatrice C. The concentrations of other heavy metals were found to generally follow the same trend as barium. At Beatrice AD, concentrations of cadmium, chromium, copper, mercury, lead and zinc exceeded the ERL threshold concentrations at various sample stations. This indicates that negative ecological impacts could be expected. Arsenic, nickel and lead were also above the Background Assessment Concentration (BAC) values.

Concentrations of barium from samples collects *c*. 150 m from the Beatrice AD platform have generally increased between 1992 (average 596 $mg.kg^{-1}$ across three samples) and 2017 (mean of 1,916 $mg.kg^{-1}$ across four samples) (AURIS, 1992 and Fugro, 2017a). High levels of total barium are frequently recorded following drilling operations. Subsequent to the 1992 samples an additional three wells were drilled at Beatrice AD (between 1997 and 2001). The discharged WBM contaminated cuttings from these wells will have contained barium and will likely be associated with the increased concentrations observed. Concentrations of other heavy metals (e.g. copper, lead, zinc, and nickel) were also found to be higher in the samples collected in 2016 (Fugro 2017a). It is known that barites often contain significant quantities of other trace metals (NRC, 1983; Chow and Snyder, 1980) and therefore it is likely this increase is associated with the wells drilled subsequent to 1992.

At the Beatrice B and C, chromium and zinc were greater than the ERL threshold concentrations at two survey stations, indicating that negative ecological impacts may be expected. Cadmium, chromium, copper, nickel, and zinc were at concentrations greater than the BAC value at a small number of stations whilst lead concentrations were slightly higher than natural background concentrations but lower than the BAC value.

All samples collected in the wind turbine area and along the pipeline routes had background levels of heavy metals with the exception of lead which was slightly higher than natural background concentrations at a number of sample stations, but lower than the BAC value (Fugro, 2017a).

Radionuclides

The activity of all naturally occurring radionuclides was found to be within the range typical of natural sediments. Anthropogenic radionuclides occurred at activities close to, or below the limit of detection indicating that there is no source of significant contamination in the survey area (Fugro, 2017a).

Summary

The sediment contaminants identified by the Fugro (2017a) survey are typical of those associated with oil and gas activities. Contaminant concentrations varied throughout the survey area; samples from the wider Beatrice area showed the concentrations of contaminants were generally within expected background levels for the CNS, whilst elevated concentrations of contaminants were found in the Beatrice AD cuttings pile beneath the platform, and within the surrounding within 100 m. It is of note that, in comparison to historic survey data, the zone of contamination around the Beatrice A platform has partially recovered naturally (previously a 250 m effect range was observed) (Addy *et al*. (1984). Elevated levels of contaminants (above normal background levels) were also found within 50 m of the Beatrice B and C platforms.

5.5 Marine Flora and Fauna

5.5.1 Plankton

The plankton community in the waters around Beatrice is similar to that found over a wide area of the central North Sea. The phytoplankton community is dominated by the dinoflagellate genus *Ceratium* (*C. fusus, C. furca, C. lineatum*), with diatoms such as *Thalassiosira spp*. and *Chaetoceros spp*. also abundant, whilst the zooplankton community is dominated by calanoid copepods, with *Paracalanus* and *Pseudocalanus* also abundant (BEIS, 2016). *Euphausiids*, *Acartia*, and decapod larvae are also important components of the zooplankton assemblage (BEIS, 2016).

Seasonal stratification of the water column into layers of different temperatures can have an important impact on phytoplankton abundance. Phytoplankton numbers usually peak in the spring and there may be an additional, but smaller, peak in phytoplankton numbers during the autumn. The seasonal timing of phytoplankton and zooplankton production has altered in recent decades with some species present up to four to six weeks earlier than twenty years ago, which affects predators, such as fish. During this period, there has been a significant increase in the presence of some warm water species such as *Calanus helgolandicus* with a corresponding decline in some cool water species, e.g. *Calanus finmarchius* (OSPAR, 2010).

5.5.2 Benthos

Bacteria, plants and animals living on or within the seabed sediments are collectively referred to as benthos. Species living on top of the sea floor may be sessile (e.g. seaweeds) or freely moving (e.g. starfish) and collectively are referred to as epibenthic or epifaunal organisms. Animals living within the sediment are termed infaunal species (e.g. tubeworms and burrowing crabs) while animals living on the surface are termed epifaunal (e.g. crabs and starfish). Semi-infaunal animals, including sea pens and some bivalves, lie partially buried in the seabed.

Epifauna

Visible epifauna observed at the majority of the Beatrice A, B and C survey stations included hermit crabs (*Pagurus. bernhardus*), flatfish (Pleuronectiformes) including dab (*Limanda limanda*), codfish (Gadidae), gurnards (Triglidae), starfish (*Asterias rubens*), scallops (Pectinidae) including possible king scallop (*Pecten maximus*) hydroids, bryozoan, polychaete tubes and possible swimming crab (*Liocarcinus* spp.). A curled octopus (*Eledone cirrhosa*) was observed at three stations.

Epifauna inhabiting the circalittoral fine sands at the WTG stations, the infield pipeline stations and the offshore ends of the Nigg export pipeline and the Dunbeath to Beatrice A power cable was relatively sparse and included hermit crabs (*P. bernhardus*), flatfish (Pleuronectiformes), starfish (*A. rubens*), codfish (Gadidae), crabs (Brachyura), hydrozoans, bryozoans and polychaete tubes. The soft coral dead man's fingers (*Alcyonium digitatum*) was observed at one station (Fugro, 2017b).

Patches of circalittoral mixed sediments along the Nigg export pipelines and the Dunbeath to Beatrice A power cable were populated by squat lobsters (*Munida rugosa*), edible sea urchin (*Echinus esculentus*), sea anemones (*Actinaria*), edible crab (*Cancer pagurus*) and dead man's fingers (*A. digitatum*). A spider crab (*Macropodia* sp.) was observed along the Nigg export pipeline and a small spotted catshark (*Scyliorhinus canicular*) was observed along the power cable route. The finer circalittoral muddy sands on the approach to landfall at Nigg were populated by phosphorescent seapens (*Pennatula phosphorea*) with occasional cobbles providing a substrate for dead man's fingers (*A. digitatum*) and plumose anemone (*Metridium dianthus*) (Fugro, 2017b). Typical epibenthic assemblages are illustrated in Figure 5-9.

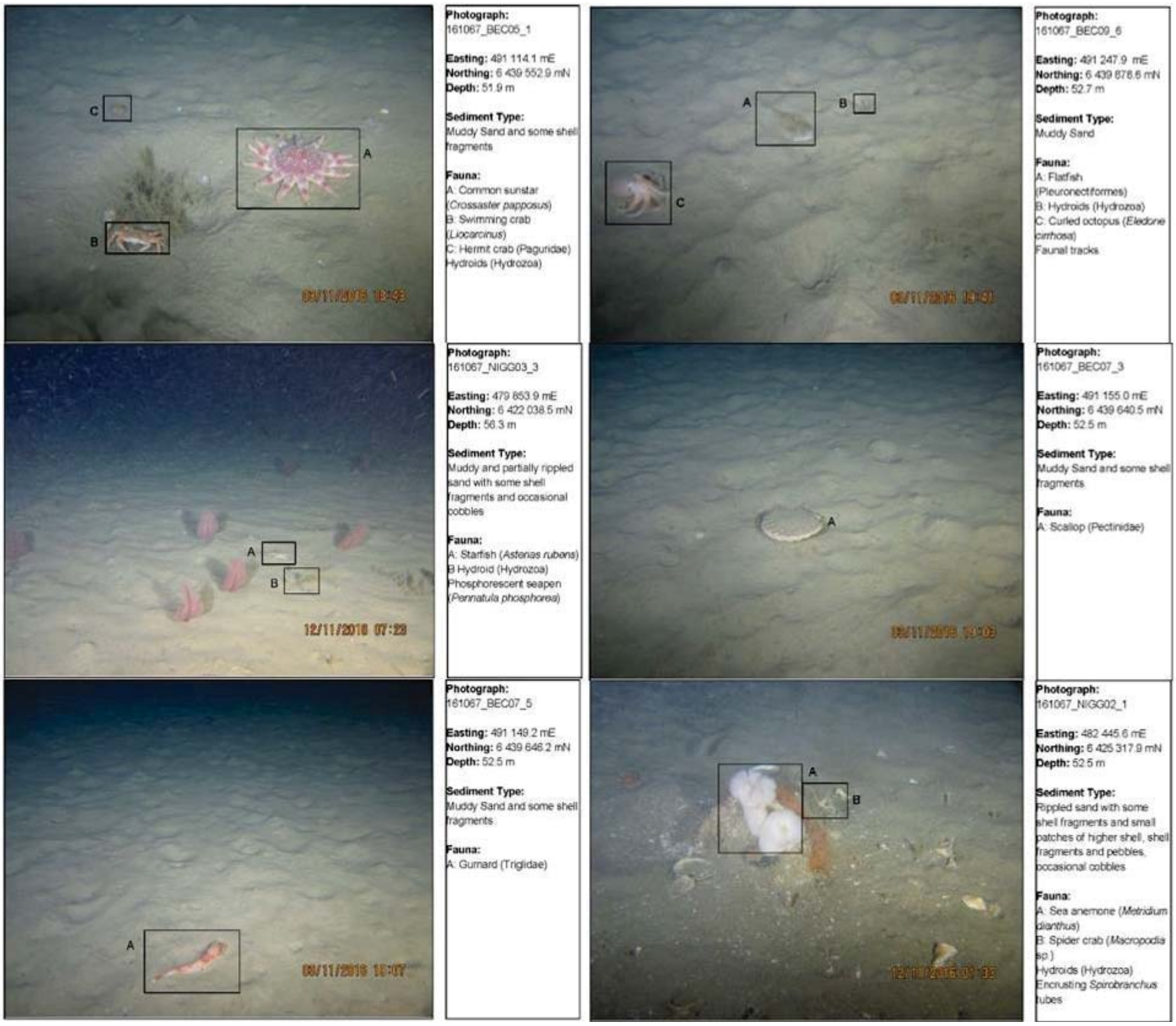


Figure 5-9: Example seabed macrofaunal from the Beatrice survey stations (Fugro, 2017a).

Infauna

A total of 56 stations were sampled across the entire survey area. A total of 404 taxa were identified from the samples; however, of these taxa, 167 were used in the statistical analysis (112 taxa including juveniles, damaged/indeterminable, and pelagic specimens were removed prior to statistical analysis).

Fugro (2017a) reported the occurrence of two adult *Arctica islandica* specimens at survey stations close to Beatrice A and Beatrice C (stations BEA12 and BEC03, respectively). *A. islandica* are a Priority Marine Feature (see Section 5.6.6.3). Although juveniles were removed from the macrofaunal data before analysis, it should be noted that 128 juvenile specimens of *A. islandica* were identified, across all of samples. Due to the small size of the juveniles about half of the total number (62) were found in the 0.5 mm fraction of the wind turbine samples. Previous survey data from 1995 (ERT, 1995) showed no juvenile or adult *A. islandica* around the wind turbine baseline location, but were present within the samples around Beatrice in the 1980s (UKBenthos V5.03) (Fugro, 2017a).

Beatrice Alpha

Of the 167 taxa identified at the survey stations around Beatrice A, 87 (52.1 %) were annelids, 41 (24.6 %) were arthropods, 25 (15.0 %) were molluscs, 6 (3.6 %) were echinoderm and 8 (4.8 %) were other phyla, including Cnidaria, Platyhelminthes, Nemertea, Sipuncula and Hemichordate. A total of 4,823 individual animals were identified in the data, of which 3,506 (72.7 %) were annelids, 416 (8.6 %) were arthropods, 654 (13.6 %) were molluscs, 38 (0.8 %) were echinoderms and 209 (4.3 %) were other phyla.

The majority of the stations greater than 150 m from the platform showed a broadly similar composition in both taxa and individuals, but at the stations nearest the Beatrice A platform some notable differences were identified. Gross effects of contaminated drill cuttings on the benthos were identified at three Beatrice A sample stations - two sample stations within the cuttings pile (BEACP01 and BEACP02), and one station northeast of the platform (BEA01). These stations had significantly reduced numbers of both taxa and individuals when compared with the other stations, likely to be due to the levels of contaminants and the sticky and oily nature of the sediment (Fugro, 2017a). BEACP01 and BEACP02 were missing echinoderm and other taxa, and molluscs were also absent from BEACP02. Echinoderms, and to a lesser extent other taxa, were also missing from the majority of the stations near the platforms (Fugro, 2017a). The taxa identified within these stations is comprised both pollution indicator and tolerant species (e.g. *Capitella capitate.* and *Tritia pygmaea*) to pollution sensitive species (e.g. *Gnathia sp.*) as identified by Rygg and Norling (2013). Similar results are also noted for station BEA01, which only had ten taxa and was dominated by the hydrocarbon tolerant polychaete *C. capitate*. Annelid taxa and individuals at stations within 150 m of the platform were generally higher than those at stations greater than 150 m from the platform (with the exception of BEACP0), showing an ecological transition zone progressively away from the platform.

A historic study by Addy *et al*. (1984) investigated the ecological transition zone around the Beatrice A platform following the discharge of cuttings contaminated with LTOBM. Results of surveys undertaken soon after the LTOBM cuttings were discharged indicated the presence of an ecological transition zone progressively away from the platform (up to around 250 m). Near the platform there were localised effects characterised by a significant reduction in the species diversity and species evenness of benthic communities in comparison to natural background reference stations, and an abundance of the hydrocarbon tolerant opportunistic polychaete *C. capitate*. With increased distance from the platform, fewer *C. capitata* individuals were observed and faunal richness generally increased to undisturbed sediment levels typical of the area.

The Beatrice pre-decommissioning survey (Fugro, 2017a) found that the ecological zoning described previously by Addy *et al.* (1984) was still apparent, however, the extent of it has reduced to within 150 m of the Beatrice A platform. This shows the contaminated area has partially recovered since the original 1984 study. This positive correlation between an increased distance from the platforms and an increase in the number and diversity of taxa confirms that that the historical drilling activities at Beatrice A have modified the local benthic community; however, the recent surveys show the area is recovering.

At the contaminated stations, many of the taxa identified were epibenthic, living on the surface of the sediments rather than within the sediments, and included the gastropod mollusc *T. pygmaea,* isopod crustacean *Gnathia* spp., porcelain crab *Pisidia longicornis,* hermit crab (*P. bernhardus*) and flatfish (Pleuronectiformes). An example image of benthic fauna associated with the cuttings pile is shown in Figure 5-10. *T. pygmaea* is considered to be a pollution tolerant indicator species (Rygg and Norling, 2013 cited in Fugro, 2017a). The hydrocarbon tolerant opportunistic polychaete *C. capitate* only dominated one of the cuttings pile sample stations with a total of 38 individuals when it is typically found in extremely high numbers (i.e. 1,000s) in North Sea cuttings pile locations (Fugro, 2017a).

There were also a number of epibenthic species found in association with anthropogenic debris and rock dump which provides an alternative hard substrate for species to utilise (e.g. station BEACP04 in the Beatrice AD cuttings pile, see Figure 5-11). Sea anemones including plumose anemone (*M. dianthus*) were commonly observed with debris as well as edible sea urchin (*E. esculentus*), edible crab (*C. pagurus*), cuckoo wrasse (*Labrus mixtus*), common lobster (*Homarus gammarus*) and faunal turf (possible hydrozoa, bryozoa and encrusting porifera). In the cuttings piles, the high number of debris items provided a suitable habitat for squat lobsters (*M. rugosa*) and edible crabs (Fugro, 2017b).

Figure 5-10: Fauna associated with Beatrice cuttings pile (source: Fugro, 2017a).

Figure 5-11: Fauna associated with anthropogenic debris (source: Fugro, 2017a).

No single taxon was dominant at all Beatrice A sample stations. The stations were found to be dominated primarily by the polychaetes *Lumbrineris cingulata* (13 stations) and *Spiophanes bombyx* (3 stations). *S. bombyx* is typically dominant in shallow, less silty, areas between Orkney and the Moray Firth (Basford *et al*., 1990 cited in BEIS, 2016), the three stations dominated by *S. bombyx* were all located to the north-east of the platform at 249 m (station BEA09), 499 m (station BEA13) and 3,000 m (station BEA16). The three other stations at Beatrice A were dominated by the pollution tolerant indicator gastropod, *T. pygmaea* (station BEACP01), the hydrocarbon tolerant polychaete *Capitella sp*. (station BEA01), and polychaete *Diplocirrus glaucus* (station BEA17).

The top ten taxa together at each station accounted for between *c*. 52 % (at station BEA13) and 100 % (at stations BEACP01, BEACP02 and BEA01) of the individuals recorded. The percentage abundance of the most common taxa recorded (*Lumbrineris cingulata*) ranged from 20.4 % at station BEA17 to 78.7 % at station BEACP01. This indicates a low to high degree of numerical dominance across the survey area. Numerical dominance was generally higher at the stations closest to the platform, again illustrating the ecological transition zone. Outwith these stations the macrofaunal communities were considered to be background for the area (Fugro, 2017a).

<u>Beatrice Bravo and Beatrice Charlie</u>

A gradual ecological transition zone was also identified within the benthic community at stations within 50 m of the Beatrice B and C platforms; however, there were no grossly impacted stations at the Beatrice B and C platforms.

Natural variability between the east (Beatrice B) and west (Beatrice C) of the survey area was evident due to differences in sediment type. Polychaetes such as *S. bombyx*, *Scoloplos armiger*, *Chaetozone christiei*, the bivalve *Fabulina fabula* and the crustacean *Bathyporeia elegans* showed a preference for the coarser sediment across the survey area. The opposite was observed for the polychaetes *Diplocirrus glaucus, Prionospio fallax* and *Galathowenia oculata*.

Of the 156 taxa identified at the Beatrice B sample stations, 82 (52.6 %) were annelids, 40 (25.6 %) were arthropods, 21 (13.5 %) were molluscs, 5 (3.2 %) were echinoderm and 8 (5.1 %) were other phyla, including Cnidaria, Platyhelminthes, Nemertea, Sipuncula and Hemichordate. A total of 3,423 individual animals were identified from the Beatrice Bravo stations, of which 2,416 (70.6 %) were annelids, 406 (11.9 %) were arthropods, 270 (7.9 %) were molluscs, 56 (1.6 %) were echinoderms and 275 (8.0 %) were other phyla (Table 8.5). All stations showed a broadly similar composition in numbers of taxa and individuals with the exception of stations BEB02 and BEB03, where echinoderms were absent from both stations. Stations closest to the B platform (BEB01 to BEB04) were dominated by the polychaete *L. cingulata* and all other stations dominated by *S. bombyx*. There was a low to high degree of numerical dominance across the survey area with species dominance generally higher at the stations within 50 m of the Bravo platform, showing the ecological transition zone.

Of the 142 taxa identified at the Beatrice Charlie sample stations, 74 (52.1 %) were annelids, 34 (23.4 %) were arthropods, 22 (15.5 %) were molluscs, 5 (3.5 %) were echinoderm and 7 (4.9 %) were other phyla, including Cnidaria, Platyhelminthes, Nemertea, Sipuncula and Hemichordate. A total of 3,301 individual animals were identified from the Beatrice C stations, of which 1,920 (58.2 %) were annelids, 331 (10.0 %) were arthropods, 805 (24.4 %) were molluscs, 86 (2.6 %) were echinoderms and 159 (4.8 %) were other phyla. All stations showed a similar composition in numbers of taxa and individuals with the exception of station BEC01 which had greater numbers of molluscs, due to the presence of high numbers of the bivalve *Thyasira flexuosa*. No single species was dominant at the Beatrice C sample stations; *T.*

flexuosa was ranked the most numerically abundant and shared species dominance with *L. cingulata*. The community at the Beatrice Charlie platform stations was largely comparable the reference stations, but showed subtle differences due to an ecological transition zone.

Overall, effects on the macrofauna at Beatrice B and C were limited to stations with 50 m on the prevailing current from the platform, with subtle differences identified between these stations and the background stations. Outwith these stations the macrofaunal communities were considered to be background for the area (Fugro, 2017a).

Beatrice Wind Turbines and Infield Pipelines

Of the 237 taxa identified in the Beatrice wind turbines and pipelines survey area, 122 (51.5 %) were annelids, 58 (24.5 %) were arthropods, 38 (16.0 %) were molluscs, 11 (4.6 %) were echinoderm and 8 (3.4 %) were other phyla, including Cnidaria, Platyhelminthes, Nemertea, Sipuncula and Hemichordata. A total of 5,851 individual animals were identified in the data, of which 3,765 (64.3 %) were annelids, 820 (14.0 %) were arthropods, 615 (10.5 %) were molluscs, 240 (4.1 %) were echinoderms and 411 (7.0 %) were other phyla.

The infield pipeline and wind turbine stations were typical sandy communities dominated by *S. bombyx*, *L.cingulata*, polychaete *Chaetozone christiei* and *F. fabula*. At stations along the Nigg pipeline route the communities were more variable depending on the sediment type and were dominated by *G. oculata*, *D. glaucus*, brittle star *Amphiura filiformis* and polychaete *Spiophanes kroyeri*. These results are comparable to previous data collected from around the turbine site in 2005 (ERT, 2005); and despite low similarity across the stations located along the pipeline routes and turbines, the benthic communities at these stations were generally considered to be background for the area (Fugro, 2017). Although there were higher levels of hydrocarbons at station NIGG06 due to terrestrial run off this does not appear to be affecting the benthic community.

5.5.3 Fish and Shellfish

More than 330 fish species are thought to inhabit the shelf seas of the UKCS (BEIS, 2016). Pelagic species (e.g. herring, mackerel, blue whiting, and sprat (*Sprattus sprattus*) are found in mid-water and typically make extensive seasonal movements or migrations. Demersal species (e.g. cod, haddock (*Melanogrammus aeglefinus*), sandeels (*Ammodytes tobianus*), sole (*Solea solea*) and whiting live on or near the seabed and similar to pelagic species, many are known to passively move (e.g. drifting eggs and larvae) and / or actively migrate (e.g. juveniles and adults) between areas during their lifecycle.

The most vulnerable stages of the life cycle of fish, to general disturbances such as disruption to sediments and oil pollution, are the egg and larval stages. Hence, recognition of spawning and nursery times and areas is important when considering potential disturbance caused by the proposed decommissioning activities.

The Beatrice development is within International Council for the Exploration of the Sea (ICES) rectangle 45E6 (see Section 6 for description of ICES rectangles). Table 5-2 and Figure 5-12 show the approximate spawning and nursery times of some of the fish species known to occur in the area. In addition to those species shown in Table 5-2 and Figure 5-12, Ellis *et al*. (2012) identified the area as a high intensity nursery ground for anglerfish (*Lophius spp*.) and a low intensity nursery ground for blue whiting (*Micromesistius poutassou*), European hake (*Merluccius merluccius*), ling (*Molva molva*), mackerel (*Scomber scombrus*), spotted ray (*Aetobatus narinari*), spurdog (*Squalus. acanthias*) and thornback ray (*Raja clavata*). It should be noted that spawning and nursery areas tend to be transient and therefore cannot be defined with absolute accuracy and tend to shift naturally over time (Coull *et al*., 1998; Ellis *et al.,* 2012).

Table 5-2 Summary of spawning and nursery activity for species known to occur in ICES rectangle □5E□ (Coull et al., 1998).

Month/Species	J	F	M	A	M	J	J	A	S	O	N	D	Nursery
Cod													
Haddock													
Herring													
Lemon sole													
Nephrops													
Plaice													
Saithe													
Sandeel													
Sprat													
Whiting													
Spawning				Peak spawning						Nursery areas			

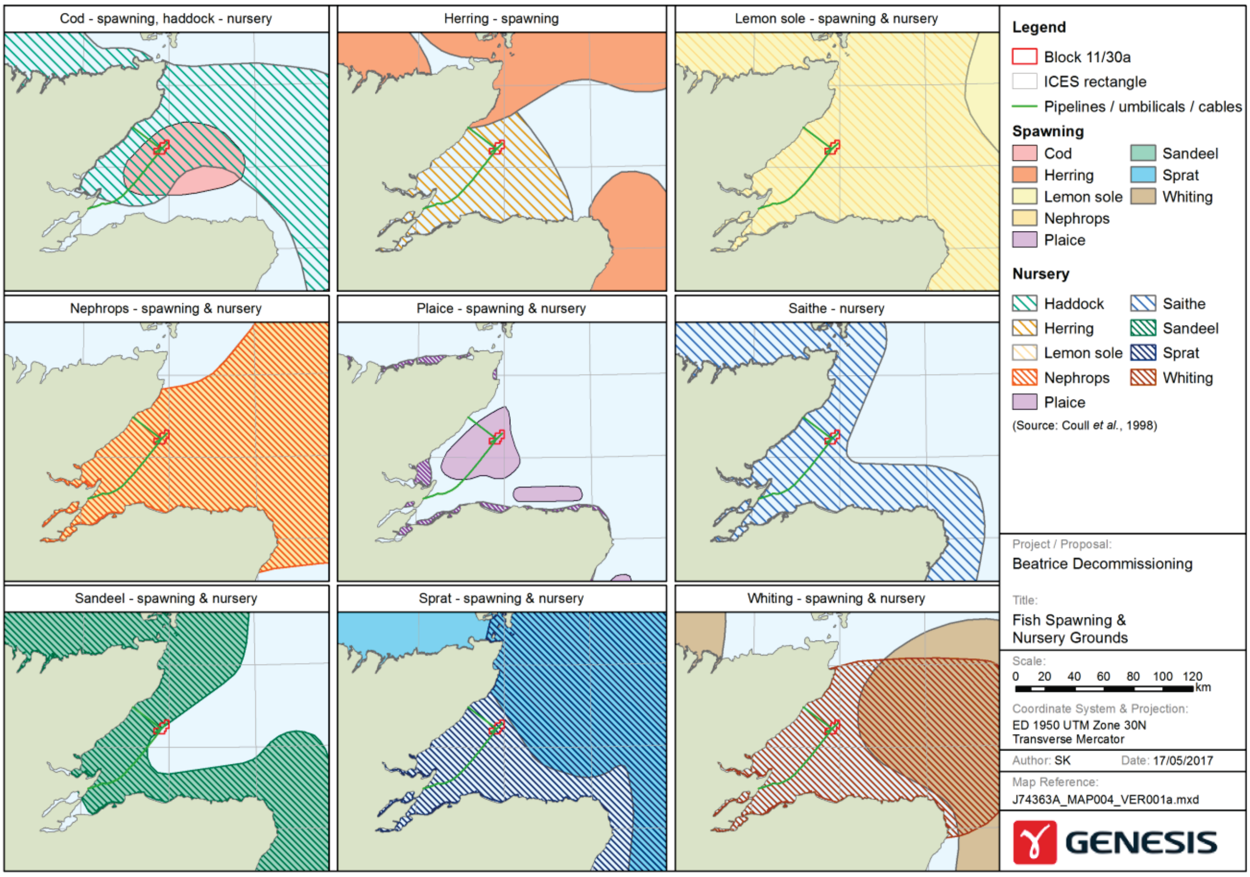


Figure 5-12 Fish spawning and nursery grounds in the Beatrice area (Coull et al., 1998).

Figure 5-13 shows the probability of juvenile fish for some species being present at any one time. These data were generated by Marine Scotland (Aires *et al.*, 2014) using Species Distribution Modelling (SDM) to predict where aggregations of 'Group 0' fish (fish in the first year of their life) may be found based on environmental information and catch records. These data indicate that juveniles of a number of species: anglerfish, cod, haddock, hake, herring, horse mackerel, Norway pout, plaice, sprat and whiting could be present in the area of the Beatrice infrastructure.

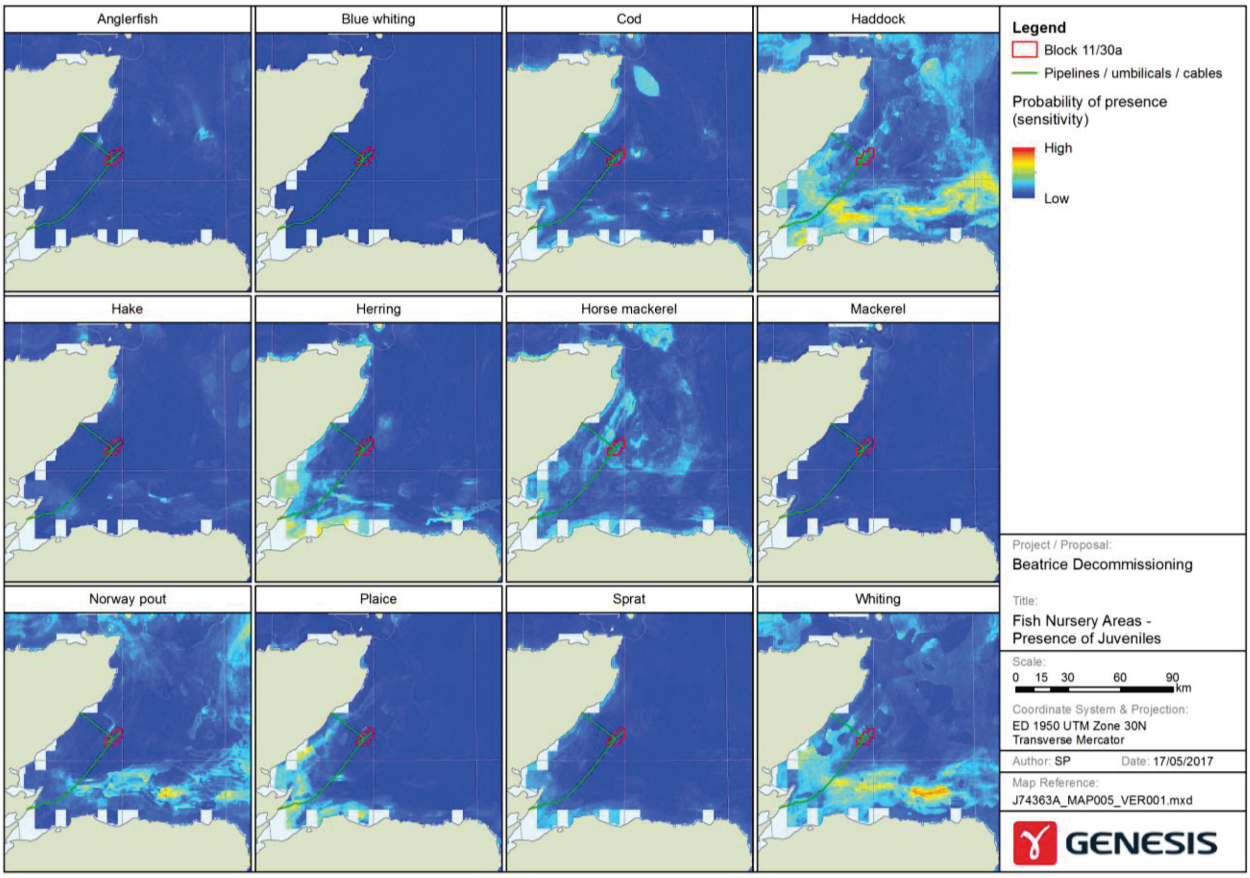


Figure 5-13 Probability of juvenile fish presence (Aries et al., 2014).

Of the fish species identified in the area, anglerfish, herring, mackerel, ling, blue whiting, cod, horse mackerel, ling, saithe, sandeels and whiting have been assessed by SNH and JNCC as Priority Marine Features (PMFs) in Scotland (SNH, 2014) (see Section 5.6.6.1).

Several species of shellfish including crabs, lobsters, scallops, edible winkles, edible mussels, whelks, razor clams and *Nephrops* are found in the Moray Firth area (Chapman, 2004). *Nephrops* are found along an area of suitable sediment which broadens out eastwards from the inner Moray Firth to Macduff (Coull *et al.*, 1998). Commercially important scallop fishing grounds exist on Smith Bank, and off the northwest coast between Wick and Golspie. Edible mussels form mussel beds in muddy and sandy areas, particularly in the Dornoch, Cromarty and Inverness/Beauly Firths, and also colonise rocky shores in the area. Cockles, although widespread, are generally concentrated in the intertidal habitats of the inner firths and along the southern coast of the Moray Firth.

5.5.3.1 Sharks, Skates and Rays (Chondrichthyes)

Due to their slow growth rates, delayed maturity and relatively low reproductive rates, sharks, rays and skates (all members of the class Chondrichthyes) tend to be vulnerable to anthropogenic activities. Historically, Chondrichthyes species have been targeted by commercial fisheries (specifically common skate (*Dipturus batis*), long-nose skate (*Dipturus oxyrinchus*) and angel shark (*Squatina squatina*) and overfishing has significantly depleted their numbers in the North Sea. More recently these species tend to be taken as bycatch to such an extent that the stocks are still being depleted in UK waters. In order to implement future management and conservation measures, the UK has a shark, skate and ray conservation plan and supported a binding OSPAR Recommendation (2010/6) targeted at furthering the protection of the common skate complex (*Dipturus batis*), white skate (*Rostroraja alba*), angel shark (*Squatina squatina*) and basking shark (*Cetorhinus maximus*), in the OSPAR maritime area UK Government, 2013).

The Moray Firth area is important for several commercial species including spurdog (*S. acanthias*), lesser spotted dogfish (*S. canicula*), starry ray (*Amblyraja radiata*) and cuckoo ray (*Leucoraja naevus*) as well as thornback ray (*R.*

clavata) and spotted ray (*Raja montagui*) (Ellis *et al.* 2004). In addition, sightings of basking shark (*Cetorhinus maximus*) occur regularly albeit infrequently during the summer (Solandt & Ricks 2009, Solandt & Chassin 2014).

Of the species identified in the area, spurdog and basking shark have been assessed by SNH and JNCC as PMFs in Scotland (SNH, 2014) (see Section 5.6.6.2).

5.5.3.2 Diadromous and Freshwater Species

Atlantic salmon (*Salmo salar*), sea lamprey (*Petromyzon marinus*) and sea trout (*Salmo trutta*) occur in the Moray Firth area, and are listed as Annex II protected species under the EU Habitats Directive, as well as being on the OSPAR List of Threatened and/or Declining Species and Habitats. Several sites in the region have been designated as Special Areas of Conservation (SACs) for the presence of one or more of these species (see Section 0).

More than one third of Scotland's main salmon rivers flowing into the Moray Firth catchment area (Moray Firth Partnership website). The main salmon rivers in the area are on the southern shore, especially the River Spey (a designated SAC with Atlantic salmon a primary feature) and its tributaries, and also the rivers Deveron, Findhorn and Nairn; these rivers are also important for sea trout. Other important salmon rivers flowing in to the Moray Firth include the Berriedale and Langwell Waters and the river Oykel on the northwest coast.

Sea lamprey spawn in freshwater but complete their life cycle at sea. Sea lamprey have been recorded from several rivers in the Moray Firth area, most notably in the Spey, where they are a primary feature for the river's designation as a SAC.

The freshwater pearl mussel (*Margaritifera margaritifera*) is a threatened species on the IUCN Red List and is found in several water courses draining into to Moray Firth. It is a primary reason for the designation of several freshwater SACs in the region: the rivers Oykel, Evelix, Spey and Moriston. While it remains in freshwater for the duration of its life cycle, it spends its larval stage attached to the gills of diadromous salmonids such as Atlantic salmon and is therefore reliant upon them for survival. The larvae attach themselves to the gills of salmonids around mid-late summer, before dropping off the following spring to settle in riverbed gravels where they grow to adulthood.

5.5.4 Cephalopods

Cephalopods are mainly short-lived, fast growing molluscs such as squid, octopus and cuttlefish. In the Moray Firth, cephalopods form an important part of the diet for several top predators; the grey seal (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*) have a preference for octopus (*Eledone cirrhosa*), while squid are regularly found in the stomach contents of bottlenose dolphin (*Tursiops truncatus*), harbour porpoise (*Phocoena phocoena*) as well as cod (Boyle & Pierce 1994; Tollit & Thompson 1996; Daly *et al.* 2001; Santos *et al.* 1994; Santos *et al* 1995).

The veined squid, *Loligo forbesii*, is thought to be present in the Moray Firth in all seasons but occurs in greatest numbers between January and March (BEIS, 206; Pierce *et al.* 1994; Pierce *et al* 1998). There are *L. forbesii* spawning grounds within the Moray Firth, with spawning beginning in the winter months and small squid first appearing in July/August (Young *et al.* 2006, Hastie *et al.* 2009, Viana *et al.* 2009, Oesterwind *et al*. 2010).

5.5.5 Marine Mammals

Marine mammals include mustelids (otters), pinnipeds (seals) and cetaceans (whales, dolphins and porpoises). Marine mammals are vulnerable to the direct effects of oil and gas activities such as noise, contaminants and oil spills. They may also be affected indirectly by activities that affect prey availability.

5.5.5.1 Mustelids

The European otter (*Lutra lutra*) is a semi-aquatic mammal, which occurs in a wide range of ecological conditions, including inland freshwater and coastal areas (particularly in Scotland). Populations in coastal areas utilise shallow, inshore marine areas for feeding but also require fresh water for bathing and terrestrial areas for resting and breeding holts. Coastal otter habitat ranges from sheltered wooded inlets to more open, low-lying coasts. Inland populations utilise a range of running and standing freshwaters. These must have an abundant supply of food (normally associated with high water quality), together with suitable habitat, such as vegetated river banks, islands, reedbeds and woodland, which are used for foraging, breeding and resting (JNNC, 2010).

Historically, otters occur over most of the UK although the majority of the current population are found in Scotland, with a significant proportion found in the north and west of the country. They are an Annex II species and in Scotland are also designated as a PMF. Figure 5-14 shows the distribution of SACs, with otter as an interest feature, in the vicinity of Beatrice. For the majority of these sites, the otter population within the SAC has been classified as "non-significant", with the exception of the Dornoch Firth and Morrich More SAC and the upper River Spey SAC in which otter are a primary reason for their designation (see Section 5.6.1).

The Dornoch Firth and Morrich More SAC is the only specifically estuarine site designated as a SAC for otter (breeding ground) on the east coast of Scotland. The site comprises sand dunes, woodlands and lochans which provide an excellent habitat for otters, as do the Rivers Evelix and Oykel (also SACs), which feed into it.

The River Spey maintains a large population of otters. Evidence of breeding, including breeding holts, cub tracks and sightings of family groups (Strachan 2007). The lochs, and ditches of the nearby Insch Marshes, provide ideal sites for feeding, resting and shelter for otters.

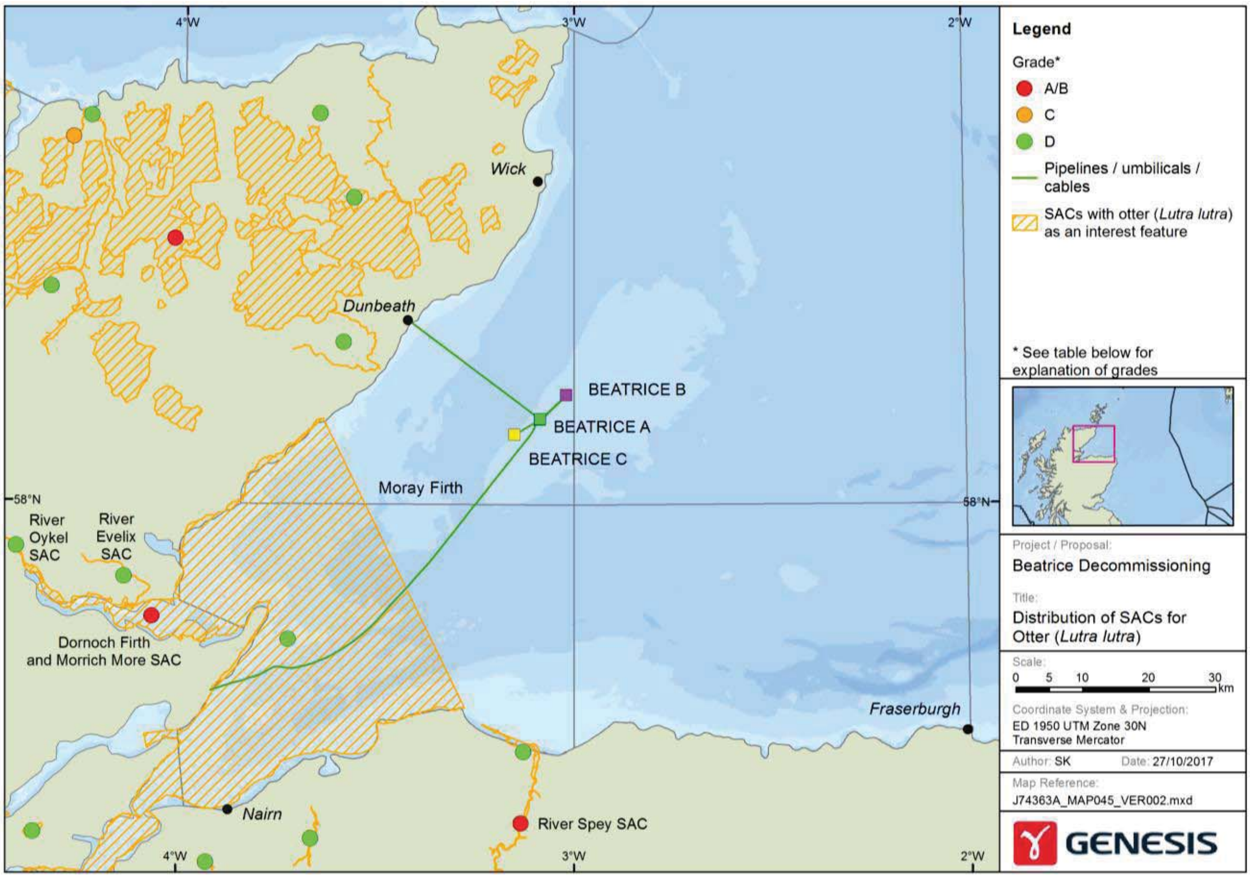


Figure 5-14 Distribution of SACs around the Moray Firth with European otters as a protected feature (JNCC, 2010).

Table 5-3 Description of grades shown in Figure 5-14.

Grade	Explanation
A	Outstanding examples of the feature in a European context.
B	Excellent examples of the feature, significantly above the threshold for SSSI/ASSI notification but of somewhat lower value than grade A sites.
C	Examples of the feature which are of at least national importance (i.e. usually above the threshold for SSSI/ASSI notification on terrestrial sites) but not significantly above this. These features are not the primary reason for SACs being selected.
D	Features of below SSSI quality occurring on SACs These are non-qualifying features ("non-significant presence"), indicated by a letter D, but this is not a formal global grade.

5.5.5.2 Pinnipeds

Two species of seal live and breed in UK waters: the grey seal (*Halichoerus grypus*) and the harbour seal (also called common seal) (*Phoca vitulina*). Both species occur widely around the UK coast with significant populations occurring along the east coast of Scotland.

The Habitats Directive identifies both species as an Annex II species and both been assessed by SNH and JNCC to be PMFs in Scottish waters (see Section 5.6.6.3). There are no SACs designated specifically for grey seals within the Moray Firth area whilst the Dornoch Firth and Morrich More SAC is designated for harbour seal. Seal haul-out sites are shown in Figure 5-15.

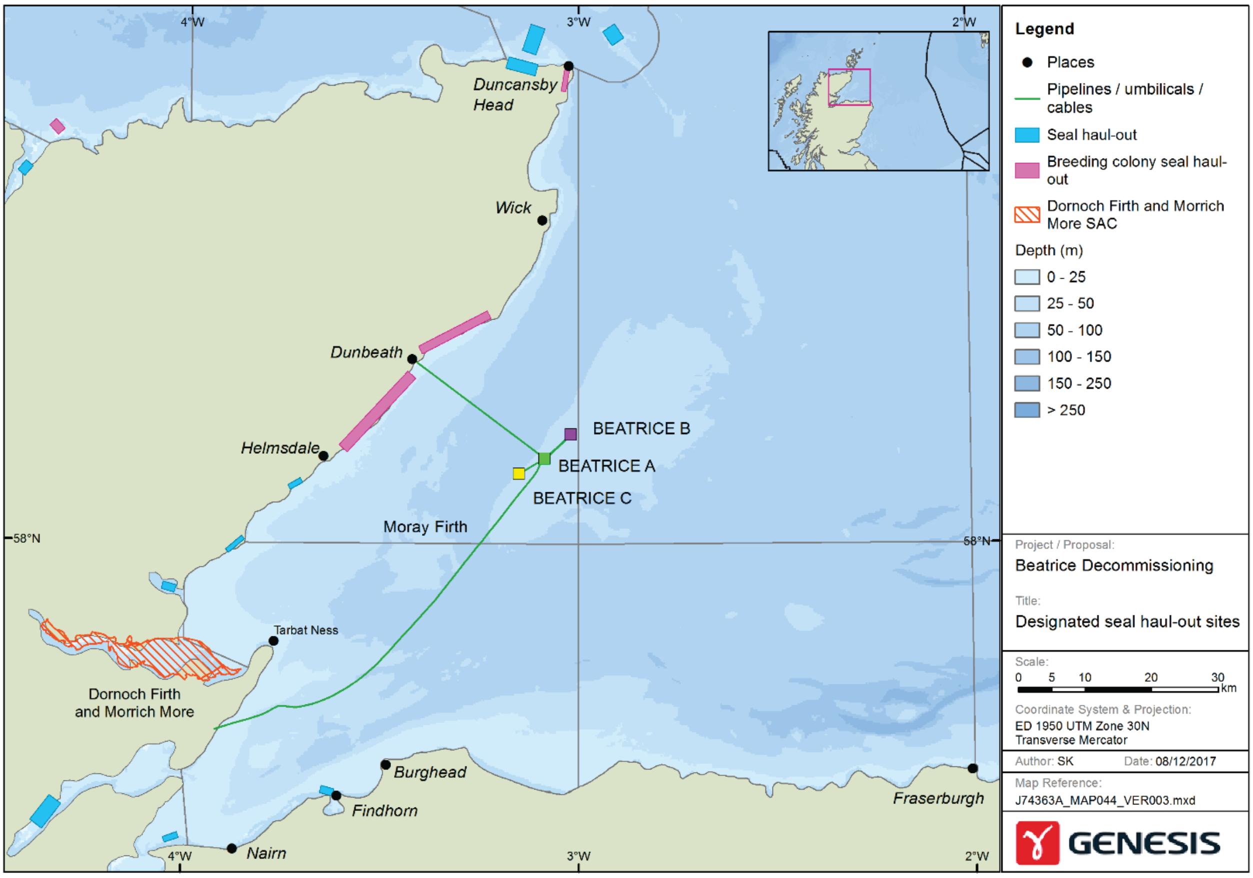


Figure 5-15 Designated seal haul out sites in the Moray Firth (Marine Scotland, 2014).

Harbour seals haul out on tidally exposed areas of rock, sandbank or mud throughout the Moray Firth, with the greatest concentration found in the inner Moray Firth particularly during June, July and August (breeding season and moult) (Thompson *et al*. 1996). Following a period of decline, harbour seal counts in the Moray Firth have stabilised, while general declines have continued across several other areas, in particular Shetland, Orkney and the Firth of Tay; research into the causes of the decline is ongoing (SCOS, 2015).

Harbour seals typically forage within 40-60 km of their haul out sites (Marine Scotland, 2013, Thompson *et al*. 1996) with larger seals traveling further out into the Moray Firth to forage than smaller seals. During the pupping season (June and July) adults remain closer to shore than other periods. Recent studies of harbour seal foraging distribution using satellite telemetry have revealed this species to occasionally forage much further offshore than previously thought, and to display a large degree of individual variation in foraging patterns and behaviour (Hammond *et al*. 2004, Sharples *et al* 2009, Sharples *et al*., 2012). In addition to seals from local haul-out sites, tagging studies have shown the Moray Firth to be part of the foraging range of seals from Orkney (Sharples *et al*., 2012). Maps displaying estimates of at sea usage by harbour seals (Jones *et al*. 2013; Jones *et al*. 2015), show low to moderate harbour seal density in the area, with an average density of 1 – 50 animals within the vicinity of the Beatrice infrastructure (Figure 5-16).

Grey seals breed on rocky beaches and in caves on the Moray Firth coast north of Helmsdale and also use haul out sites in the Dornoch Firth and on the south coast, particularly near Culbin forest and Findhorn village with the numbers of seals at haul out sites being generally highest from June-September. Extensive telemetry information from British grey seals at sea shows that they are widely distributed throughout the Moray Firth (Russell & McConnell 2014), particularly outside the pupping season in October-November and the moulting season in February-April (Matthiopoulos *et al*., 2004).

Tracking of individual grey seals has shown that they can feed up to several hundred kilometres offshore although most foraging tends to be within approximately 100 km (Sparling *et al*., 2012; Thompson and Duck, 2010). Tagging studies indicate that the density of grey seals in the vicinity of the Beatrice area is moderate, with an average density of 5 – 50 animals (Jones *et al*., 2013) (Figure 5-16). Grey seals foraging in the Moray Firth are likely to include many individuals breeding across North Scotland (especially on Orkney) and the Hebrides (Russell *et al*. 2013).

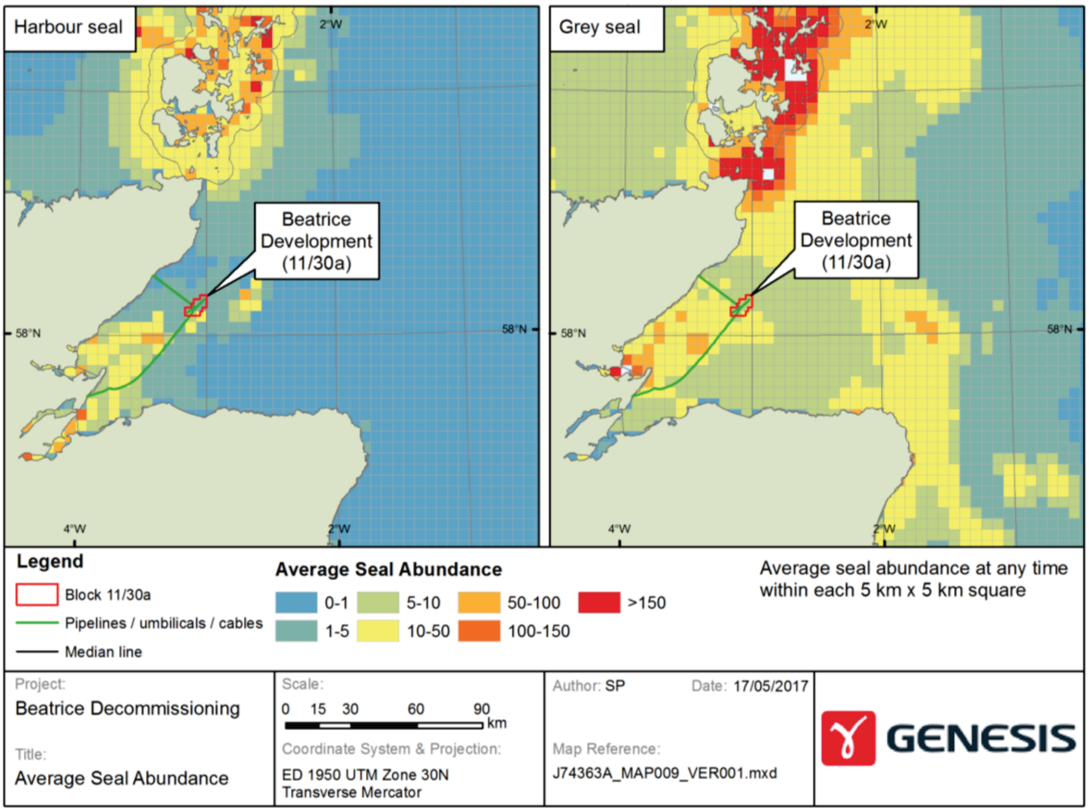


Figure 5-16 Harbour and grey seal distribution in the North Sea (Jones et al., 2013)

5.5.5.3 Cetaceans

The Moray Firth is an important area for several cetaceans, with a population of resident bottlenose dolphins and high numbers of harbour porpoises, white beaked dolphins (*Lagenorhynchus albirostris*) and minke whales (*Balaenoptera acutorostrata*) sighted regularly (Reid *et al.*, 2003). Reid *et al.* (2003) provides a summary of the distribution of cetacean sightings in northwest European waters (Figure 5-17). The data suggest that moderate to low numbers of harbour porpoise, white-beaked dolphin and minke whale occur in the area of the Beatrice development and power cable/export pipeline routes, and high densities of bottlenose dolphin occur within the area of the Nigg export pipeline. Fin whale, humpback whale, killer whale and long-finned pilot whale also occur in the outer Moray Firth in the vicinity of the Beatrice facilities. Atlantic white sided dolphin, common dolphin and Risso's dolphin have also been recorded within 100 km of the Beatrice development.

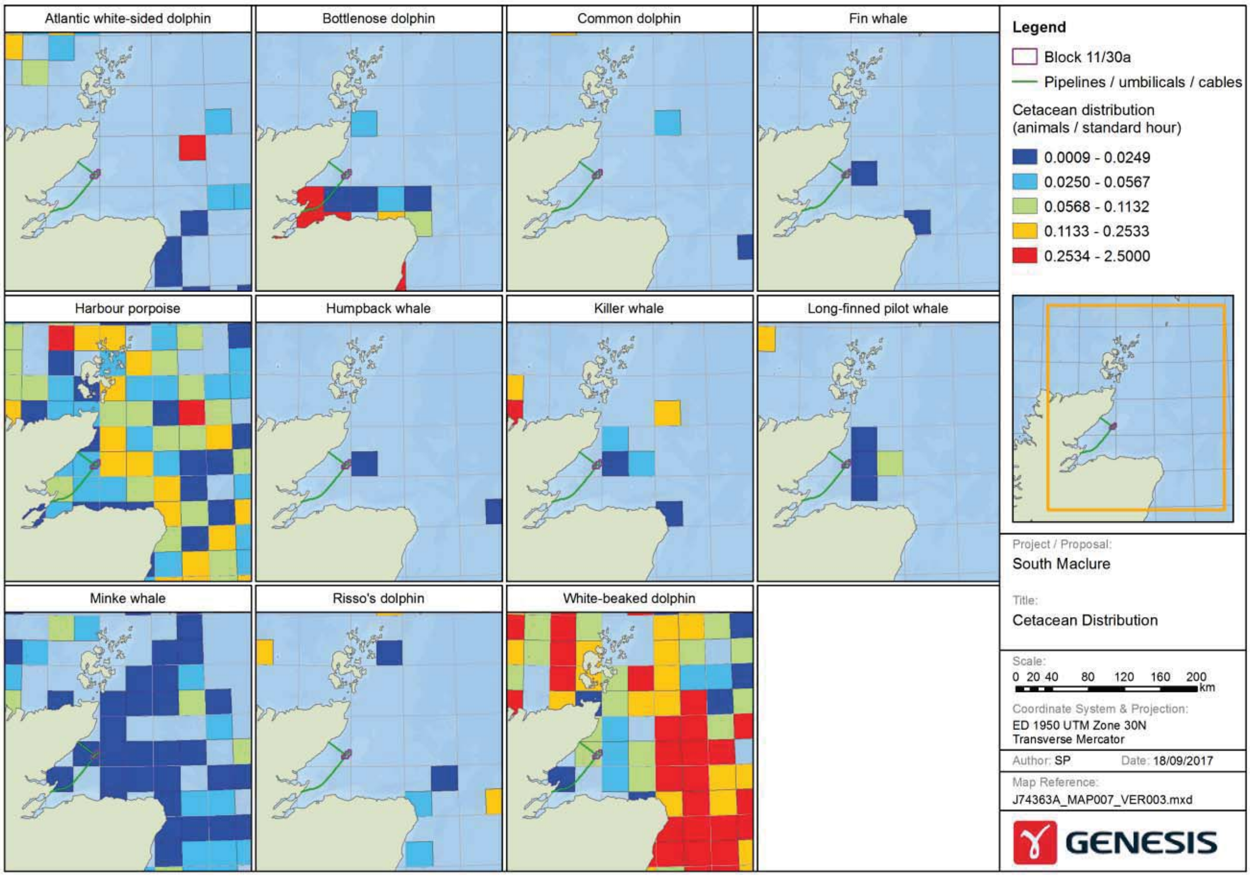


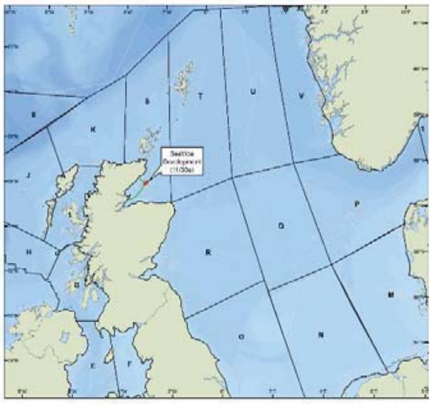
Figure 5-1□□ oray Firth distribution of cetacean species (Reid et al., 2003).

A series of Small Cetacean Abundance in the North Sea (SCANS) surveys have been conducted to obtain an estimate of cetacean abundance in North Sea and adjacent waters in the summers of 1994, 2005 and 2016 (SCANS, SCANS-II and SCANS-III, respectively). The results of these surveys are presented in Hammond *et al.* (2002); Hammond *et al.* (2013) and Hammond *et al.*, (2017).

The Beatrice Field is located within SCANS-III survey block area "S". Aerial survey estimates of animal abundance and densities (animals per km^2) within this area are provided in Table 5-4. The data confirms that harbour porpoise, bottlenose dolphin, white-beaked dolphin and minke whale may occur in the area of the development.

Table 5-4 Cetacean Abundance in SCANS-III Survey Block S (Hammond et al., 2017).

Species	Animal Abundance	Animal Density (per km²)
Harbour porpoise	6,147	0.152
Bottlenose dolphin	151	0.004
White-beaked dolphin	868	0.021
Minke whale	383	0.01



The JNCC have published 'regional' population estimates for the seven most common species of cetacean occurring in UK waters (Inter-Agency Marine Mammal Working Group IAMMWG, 2015). Divided into Management Units (MUs), the estimated abundance of animals in these MUs are currently considered the reference populations for cetacean species in the North and Celtic Seas. Phase III of the Joint Cetacean Protocol (JCP) provides abundance estimates (adjusted average summer density surfaces from 2007-2010) which can be used to scale the MU populations to provide a reference population estimate for any given area (Paxton *et al.*, 2016). These abundance estimates provide an indication of the spatial scale and the relevant populations at which impacts should be assessed. The relevant populations are presented in Table 5-5.

Table 5-5 MU cetacean abundance scaled to relevant area (IAMMWG, 2015; Paxton et al., 2016).

Species	MU Population	The Moray Firth	
		% Area of relevant MU	Scaled abundance to relevant area
Bottlenose Dolphin	195	Data not available from Paxton *et al.*, 2016	n/a*
Harbour Porpoise	227,298	1.3	2,955
Minke Whale	23,528	0.7	165
White-beaked Dolphin	15,895	0.7	111
*There are *c.* 130 resident bottlenose dolphins in the Moray Firth (Moray Firth Partnership, 2017).			

A brief description of the species detailed in Table 5-5 is provided below:

Bottlenose Dolphin

Bottlenose dolphins occur across a large part of UK waters, in coastal inshore areas, on the continental shelf and further offshore but for this species there is evidence for sub-population structuring. Offshore dolphins are likely part of a wide-ranging large oceanic population but inshore dolphins are thought to be part of semi-resident and much smaller populations for which separate MUs have been agreed (IAMMWG 2015); the relevant unit to the Moray Firth is the Coastal East Scotland MU covering inshore waters from Orkney to the Firth of Forth, 195 individual animals are known to occur within this area (IAMMWG, 2016).

In the Moray Firth, bottlenose dolphins are regularly observed throughout the year, with a clear preference for areas within 15 km of the coast and with highest densities in the inner Moray Firth and along the southern coast (Thompson *et al*. 2013). This species is listed in Annex II of the Habitats Directive, and the importance of this population, and the Moray Firth, is reflected in the designation of part of this area as a SAC.

Annual estimates over the period 1990-2013; show considerable inter-annual variability (range 43-134), in the number of bottlenose dolphins thought to use the SAC (Cheney *et al*. 2014).

Harbour Porpoise

The harbour porpoise is the most common cetacean in the North Sea. It is widely distributed throughout the Moray Firth, with frequent sightings in nearshore and offshore waters. Although seen throughout the year, sightings are most frequent and widespread in this region between April and September.

Passive acoustic monitoring during late summer/autumn at the Beatrice Field showed harbour porpoise to be frequently present, with short visits recorded several times per day (Talisman, 2006). Widespread distribution and regular presence across the Moray Firth was confirmed in more recent studies (Thompson *et al.*, 2013). The Smith Bank and Outer Moray Firth have been identified as persistent summer high density areas (Heinänen & Skov, 2015).

Minke Whale

Minke whales are found throughout much of the Moray Firth during summer months, with sightings recorded across the outer Moray Firth, the southern coast and occasionally the inner Moray Firth. Minke whales in this area appear to have a strong preference for water depths between 20 and 50m, steep shelf slopes and sandy-gravel sediment type, and as a consequence, are a feature of the proposed Southern Trench MPA (see Section 5.6.4).

White-beaked Dolphin

Along with harbour porpoise, white-beaked dolphins are the most commonly occurring cetaceans in the Central and Northern North Sea. They are frequently sighted in the Moray Firth, primarily in offshore waters of the outer firth. Although sightings are made throughout the year, the species is most frequently observed between June and October.

5.5.6 Birds

5.5.□.1 Seabirds

The waters of the outer Moray Firth and the nearshore waters off the Moray coast are important feeding grounds for seabirds (Tasker 1996). This is reflected in the designation of several Special Protection Areas (SPAs) around the Moray coast for the protection of migratory, vulnerable and rare seabird species, as described in Section 5.6.2.

Breeding seabirds including kittiwake, guillemot and razorbill at colonies along the coastline commute offshore to feed, particularly over Smith Bank. Cormorants, shags, gulls and terns tend to feed closer to shore. During the breeding season, the foraging ranges of adult seabirds is restricted by their need to return to their breeding sites to protect nests and eggs or feed young. During this period the majority of breeding birds occur within 50 to 100 km of the coast and are likely to occur within the Beatrice area. Following the breeding period, adult and juvenile auks move offshore where the adults moult. The waters around Smith Bank also support important concentrations of shags, while coasts along the southern Moray Firth are of particular year round importance for herring gulls. Outside the breeding period, seabirds are not restricted to breeding colonies and occur more widely across the North Sea. Many species, e.g. terns (*Sterna* spp.), overwinter out with the area, whilst other seabirds e.g. little auks (*Alle alle*), move to the area from more northerly breeding grounds to overwinter.

Using seabird density maps from European Seabirds at Sea (ESAS) data collected over 30 years, the predicted maximum monthly abundance of seabird species in the Beatrice area is summarised in Table 5-6 (Kober *et al*., 2010)

The data show that a number of seabird species are likely to occur in the area over the summer breeding season and winter months. For all species combined, a maximum of 125 seabirds are predicted to occur per kilometre square during the breeding season (April to September), whilst during the winter months (November to March) a maximum of 27 seabirds are predicted to occur per kilometre square.

Table 5-[illegible] Predicted monthly seabird surface density in the Beatrice area (maximum number of individuals per km²) (Kober et al., 2010).

Species	Season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arctic Skua	Breeding					<1							
	Other									<1			
Arctic tern	Breeding					<1							
Black legged kittiwake	Breeding					15							
	Winter										7		
Common Guillemot	Breeding					35							
	Winter										5		
	Other								106				
Common gull	Breeding					<1							
	Winter									<1			
Cormorant	Winter				<1								
European Shag	Breeding				6								
	Winter										2.5		
Gannet	Breeding					3							
	Winter										<1		
Glaucous gull	Winter										<1		
Great black-backed gull	Breeding				<1								
	Winter									<1			
Great skua	Breeding					<1							
	Winter									<1			
Herring gull	Breeding				3								
	Winter									3			
Lesser black-backed gull	Breeding					4							
	Winter									4			
Little auk	Winter											<1	
Manx shearwater	Breeding					3.7							
Northern fulmar	Breeding			16									
	Winter								7				
Pomarine Skua	Other			<1									
	Other								<1				
Puffin	Breeding				5								
	Winter								<1				
Razorbill	Breeding					22							
	Winter										2		
	Other								64				
Sooty shearwater	Summer							<1					
All species combined	Breeding				125								
	Summer							75					
	Winter											27	

Key	0	0 - 10	10-20	20 - 50	50 - 100	>100

For the Beatrice Wind Farm Demonstrator Project and the Beatrice Offshore Wind Farm (BOWL) project, seabird surveys were conducted from the Beatrice AP platform in 2005 and from a survey boat in 2009-2011, respectively. Surveys were conducted in all months of the year, although with variable effort between months in the 2005 survey (Talisman, 2006). The most frequently observed birds from both surveys are listed below:

- Kittiwake (*R. tridactyla*)
- Auk (all species combined - includes guillemot, black guillemot, little auk, puffin and razorbill).
- Fulmar (*F. glacialis*)
- Gannet (*Morus bassanus*)
- Great black-backed gull (*Larus marinus*)
- Herring gull (*L. argentatus*)
- Great skua (*Stercorarius skua*)
- Shag (*P.aristotelis*)
- Meadow pipit (*Anthus pratensis*)
- Sooty shearwater (*Ardenna grisea*)
- Arctic tern (*Sterna paradisaea*)
- Arctic Skua (*Stercocarius parasiticus*)

Auk species showed clear peaks in abundance in April and June whilst kittiwake abundance peaked in July, but was fairly high throughout spring-summer. Fulmar were abundant throughout the majority of the year, although notably less abundant from September-December. Gannet abundance was elevated from May-November, with peak numbers during October. Great black-backed gull were most abundant during autumn and winter months (Talisman, 2006).

Six pre-construction digital aerial surveys were undertaken between May and August 2015 covering the BOWL site and an area extending westwards to the East Caithness cliffs covering an area of 1,142 km^2 (BOWL, 2016). Densities of seabirds on the water and in flight were estimated for gannet, guillemot, kittiwake, puffin, razorbill, great black-backed gull, and herring gull were found to be comparable to those for the boat-based surveys undertaken in 2009 and 2011; showing these species abundances are generally typical of the area.

Seabird Vulnerability

Seabirds are generally not at risk from routine decommissioning operations however, they may be vulnerable to pollution from less regular activities (for example from accidental hydrocarbon discharges). Using survey data from 1995 – 2015 a Seabird Oil Sensitivity Index (SOSI) has been published. The purpose of the index 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. Data was collected from a wide survey area extending beyond the UK Continental Shelf using boat-based, visual aerial, and digital video aerial survey techniques.

This seabird data was combined with individual seabird species sensitivity index values. These index values are based on a number of factors which are considered to contribute towards the sensitivity of seabirds to oil pollution. Factors such as:

- Habitat flexibility (a species ability to locate to alternative feeding sites);
- Adult survival rate;
- Potential annual productivity; and
- The proportion of the biogeographical population in the UK (classified following the methods developed by Certain *et al*., (2015).

The combined seabird data and species sensitivity index values are subsequently summed at each location to create a single measure of seabird sensitivity to oil pollution. This is presented as a series of fine scale density maps for each month that show the median, minimum and maximum seabird sensitivity to oil pollution, and an indication of data confidence. The index is independent of where oil pollution is most likely to occur; rather, it indicates where the highest seabird sensitivities might lie if there were to be a pollution incident.

The mean sensitivity SOSI data for the Beatrice area is shown in Figure 5-18 and Table 5-7. For blocks with 'no data', an indirect assessment has been made based upon guidance from JNCC (JNCC, 2017a) where possible. In May there were two blocks (17/6 and 17/7) where it was not possible to fill the data gap.

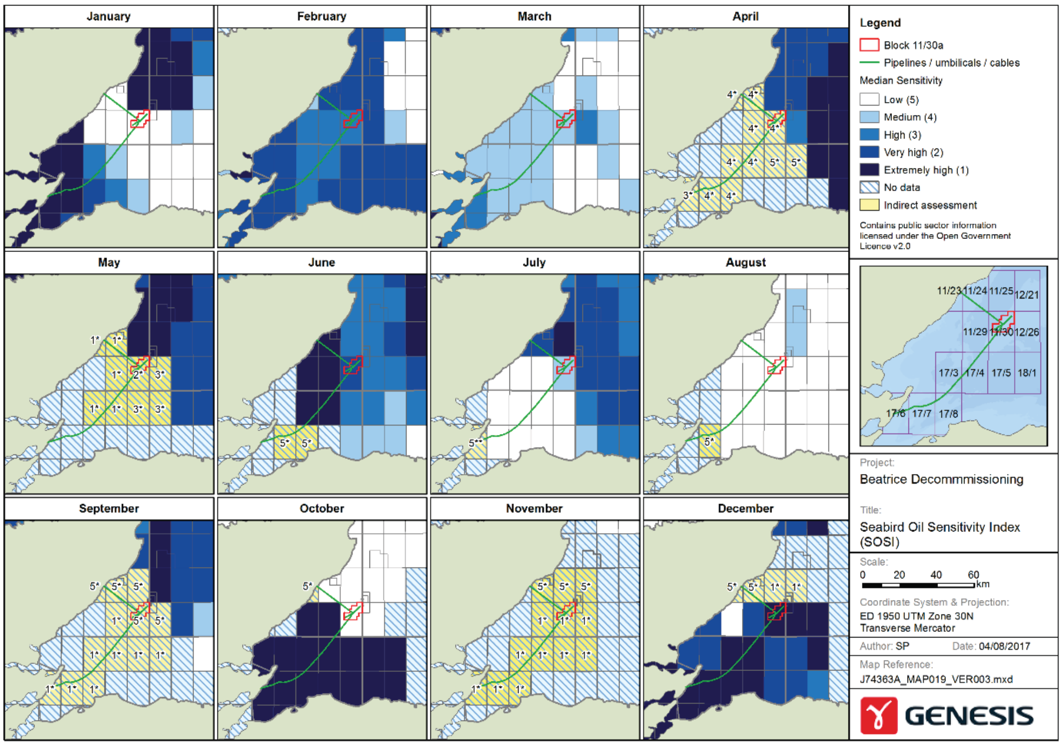


Figure 5-18 Median seabird oil sensitivity index in the vicinity of the Beatrice infrastructure.

Table 5-7 Revised Median seabird oil sensitivity index following JNCC guidelines (JNCC, 2017a).

Block	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
11/23				4*	1*				5*	5*	ND	5*
11/24				4*	1*				5*		5*	5*
11/25									5*		5*	1*
12/21											5*	1*
11/29				4*	1*				1*		1*	
11/30				**4***	**2***				**5***		**1***	
12/26					3*				5*		1*	
17/3				4*	1*				1*		1*	
17/4				4*	1*				1*		1*	
17/5				5*	3*				1*		1*	
18/1				5*	3*				1*		1*	
17/6				3*	ND	ND	5**	ND	1*		1*	
17/7				4*	ND	5*		5*	1*		1*	
17/8				4*	ND	5*			1*		1*	
KEY	1 - Extremely high			2 - Very high		3- High		4 - Medium		5 - Low	ND - No Data	

Indirect Assessment – data gaps have been populated following guidance provided by the JNCC (JNCC, 2017a).
** Data gap filled using data from the same block in adjacent months, or*
*** Data gap filled using data from adjoining blocks from same month.*

As can be seen from the data available and the indirect assessment, the sensitivity of seabirds to surface pollution in Block 11/30a and adjacent blocks varies throughout the year. In the Inner Moray Firth, sensitivity is generally; high to very high from September through to February, and in May and June; medium in March and April; and low in July and August. For Block 11/30a, sensitivity is high to very high in February, May, June, November and December and low to medium for the remaining months. Sensitivity for blocks falling between Block 11/30a and the East Caithness Coast is highest in February, May to July and October, and low to medium for the remaining months.

5.5.6.2 Waterbirds

Although waterbirds are not expected to occur within the Beatrice Field area, the firths, bays and other coastal areas of the Moray Firth basin are of great importance waders and other waterbirds on migratory passage, during the breeding season and over winter; several SPA sites (designated for the protection of seabirds of European importance) and Ramsar sites (designated at wetlands of international importance) occur around the Moray coast (see Sections 5.6.2 and 5.6.3).

Several sites in the Moray Firth area have such high numbers of birds (5yr average of >20,000 birds) to be consistently included in the UK list of principal sites for non-breeding waterbirds. These include the Inner Moray and Inverness Firth, the Dornoch Firth, the Cromarty Firth as well as the Loch of Strathbeg (Austin *et al.* 2014). The area is of considerable importance for a number of species including seaducks, divers, grebes and wintering geese.

5.6 Habitats and Species of Conservation Concern

The EU Habitats Directive (92/43/EEC) and the EU Birds Directive (79/409/EEC) are the main driving forces for safeguarding biodiversity in Europe. Through the establishment of a network of protected sites, these directives provide for the protection of animal and plant species of European importance and the habitats which support them.

The EU Habitats Directive and the EU Birds Directive have been enacted in the UK by the following legislation:

- **The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)**: These regulations transpose the Habitats and Birds Directives into UK law. They apply to land and to territorial waters out to 12 nm of the coast and have been subsequently amended several times.
- **The Conservation of Habitats and Species Regulations 2010**: These regulations consolidate all the various amendments made to the Conservation (Natural Habitats, &c.) Regulations 1994 in respect of England and Wales. In Scotland, the Habitats and Birds Directives are transposed through a combination of the Habitats Regulations 2010 (in relation to reserved matters) and the 1994 Regulations.
- **The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended 2009 and 2010)**: These regulations are the principal means by which the Birds and Habitats Directives are transposed in the UK offshore marine area (i.e. outside the 12 nm territorial limit) and in English and Welsh territorial waters.
- **The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended 2007)**: These regulations apply the Habitats Directive and the Birds Directive in relation to oil and gas plans or projects wholly or partly on the UKCS and adjacent waters outside territorial waters (i.e. outside the 12 nm territorial zone).

Figure 5-19 shows the protected areas in the vicinity of the Beatrice infrastructure.

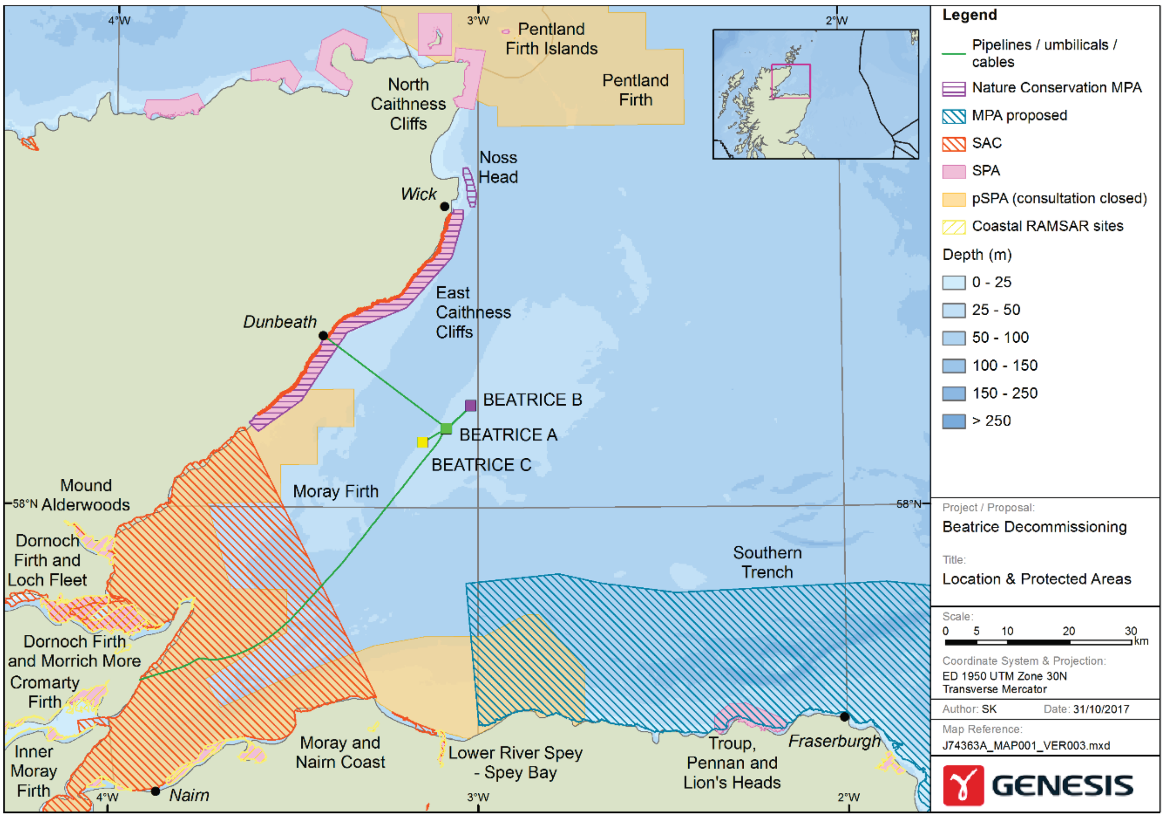


Figure 5-19 Location of the Beatrice Field in relation to protected areas.

5.6.1 Special Areas of Conservation/Sites of Community Importance

The EU Habitats Directive (92/43/EEC) lists habitats and species (Annex I and II respectively) whose conservation requires the designation of special areas of interest. These habitats and species are protected by a series of SACs / Sites of Community Importance (SCI).

Of the Annex I habitat types listed as requiring protection in the Habitats Directive, four potentially occur in the UK offshore waters (European Commission, 2007):

- Sandbanks which are slightly covered by seawater at all times;
- Reefs;
- Submarine structures made by leaking gases; and
- Submerged or partially submerged sea caves.

Four of the species listed in Annex II of the Habitats Directive occur in relatively large numbers in UK offshore waters:

- Grey seal;
- Common seal;
- Bottlenose dolphin; and
- Harbour porpoise.

All four of these species are likely to occur within the Beatrice area. Cetaceans are further protected from disturbance under Annex IV of the Habitats Directive, and seals are protected from injury under the Marine (Scotland) Act 2010.

A number of SACs designated for Annex I marine habitats and/or Annex II marine species occur within 30 km of the Beatrice Field (Figure 5-19). The nearest SACs are the East Caithness Cliffs SAC and the Moray Firth SAC which are intersected by the Beatrice A to Dunbeath power cable and the Nigg export pipelines, respectively (Table 5-8).

Table 5-8: SACs with coastal and marine components in closest proximity to the Beatrice infrastructure (JNCC 2012b)

SAC	Qualifying features	Approximate distance from the nearest Beatrice infrastructure
East Caithness Cliffs	<u>**Annex I habitat:**</u> vegetated sea cliffs of the Atlantic and Baltic coasts.	The Beatrice A to Dunbeath power cable route intersects the SAC *c.*20 km from the Beatrice platforms
Moray Firth	<u>**Annex I habitat:**</u> subtidal sandbanks (sandbanks which are slightly covered by sea water all the time). <u>**Annex II species:**</u> bottlenose dolphin (*T. truncatus*).	The Nigg export pipelines intersect the SAC *c.*24 km from nearest Beatrice platform (C)
Dornoch Firth and Morrich More	<u>**Annex I habitats:**</u> estuaries; mudflats and sandflats not covered by seawater at low tide; Salicornia and other annuals colonizing mud and sand; Atlantic salt meadows; embryonic shifting dunes; shifting dunes along the shoreline with marram grass *Ammophila arenaria* (white dunes); fixed coastal dunes with herbaceous vegetation (grey dunes); decalcified fixed dunes with crowberry (*Empetrum nigrum*); Atlantic decalcified fixed dunes; humid dune slacks; coastal dunes with Juniper species; subtidal sandbanks (sandbanks which are slightly covered by sea water all the time); and reefs. <u>**Annex II species:**</u> European otter and harbour seal.	*c.*20 km from Nigg export pipelines *c.*53 km from nearest Beatrice platform (C)
Lower River Spey – Spey Bay	<u>**Annex I habitat:**</u> perennial vegetation of stony banks	*c.*24 km from Nigg export pipelines *c.*48 km from nearest Beatrice platform (C)
River Spey	<u>**Annex II species:**</u> European otter (*L. lutra*)	*c.*24 km from Nigg export pipelines *c.*48 km from nearest Beatrice platform (C)

5.6.2 Special Protection Areas

The EU Birds Directive (2009/147/EC) requires member states to identify and nominate sites as Special Protection Areas (SPAs) for the protection of birds listed in Annex I of the Directive or sites that hold significant populations of regularly occurring migratory species. SPAs are also designated as SSSIs. Together with adopted SACs, the SPA network forms the 'Natura 2000' network of protected areas in the EU.

There are a number of SPAs along the east and northeast Scottish coast, those in nearest proximity to the Beatrice development are listed in Table 5-9. The nearest SPA is the East Caithness Cliffs which is intersected by the Beatrice A to Dunbeath power cable route c.20 km west of the Beatrice platforms and the nearest pSPA is the Moray Firth pSPA which is intersected by the Nigg export pipelines, *c.* 4 km south of the Beatrice A to Dunbeath power cable and *c.*11 km south of the Beatrice platforms (Figure 5-19).

Table 5-9 Coastal SPAs with marine components in closest proximity to the Beatrice infrastructure (JNCC, 2016).

SPA	Qualifying features	Approximate distance from the nearest Beatrice Infrastructure
East Caithness Cliffs SPA	Annex I species of international importance during the breeding season: Peregrine falcon (*Falco peregrinus*) Migratory breeding seabirds of European importance: Guillemot (*Uria aalge*) Kittiwake (*Rissa tridactyla*) Herring gull (*Larus argentatus*) Razorbill (*Alca torda*) A seabird assemblage of international importance regularly supporting over 20,000 seabirds with the following species during the breeding season: Puffin (*Fratercula arctica*) Great black-backed gull (*Larus marinus*) Cormorant (*Phalacrocorax carbo*) Fulmar (*Fulmarus glacialis*) Razorbill (*A. torda*) Guillemot (*U. aalge*) Kittiwake (*R. tridactyla*) Herring gull (*L. argentatus*) Shag (*Phalacrocorax aristotelis*)	The Beatrice A to Dunbeath power cable route intersects the SPA *c.*20 km from all Beatrice platforms
Moray Firth pSPA	Non-breeding wetland species population on European importance Migratory duck species of European importance	The Beatrice A to Nigg export pipeline route intersects the pSPA *c.*11 km from nearest Beatrice platform (C)
Cromarty Firth SPA	Annex I species of international importance during the breeding season: Common Tern (*Sterna hirundo*) Osprey (*Pandion haliaetus*) Annex I wetland species of international importance over winter Migratory wintering wetland species of European importance A wetland of international importance regularly supporting 20,000 waterfoul	*c.*10 km from Nigg export pipelines *c.*68 km from nearest Beatrice platform (C)
Inner Moray Firth SPA	Annex I species of international importance during the breeding season: Common Tern (*S. hirundo*) Osprey (*P. haliaetus*) Annex I wetland species of international importance over winter: Migratory wintering wetland species of European importance: A wetland of international importance regularly supporting 20,000 waterfoul	*c.*16 km from the Nigg export pipelines *c.*74 km from nearest Beatrice platform (C)
Dornoch Firth and Loch Fleet SPA	Annex I species of international importance during the breeding season: Osprey (*P. haliaetus*) Annex I wetland species of international importance over the winter Migratory wintering wetland species of European importance A wetland of international importance regularly supporting 20,000 waterfoul	*c.*20 km from all Beatrice platforms *c.*25 km from the Nigg export pipelines
Moray and Nairn Coast SPA	Annex I species of international importance during the breeding season: Osprey (*P. haliaetus*) Annex I wetland species of international importance over winter Migratory wintering wetland species of European importance A wetland of international importance regularly supporting 20,000 waterfoul	*c.*30 km from Nigg export pipelines *c.*46 km from nearest Beatrice platform (C)
Pentland Firth pSPA	Annex I species of international importance: Arctic tern (*Sterna paradisaea*) Migratory species of European importance Common guillemot (*U. aalge*) Arctic skua (*Stercocarius parasiticus*)	*c.*44 km from all Beatrice infrastructure

5.6.3 Ramsar Sites

The Ramsar Convention is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The convention entered into force in the UK in 1976, and there are currently 174 sites designated as Wetlands of International Importance (Ramsar Sites), a number of which are around the Moray coastline. The sites in closest proximity to the Beatrice facilities are detailed in Table 5-10.

Table 5-10 □amsar sites with marine components in closest proximity to the Beatrice infrastructure (JNCC, 201□c).

Ramsar Site	Qualifying features	Approximate distance from the nearest Beatrice Infrastructure
Cromarty Firth	• Extensive intertidal flats with eelgrass beds (Zostera spp.); • Seabird assemblages of international importance (over winter peak counts: 30,200 waterfowl).	*c.* 10 km from Nigg export pipelines *c.* 68 km from nearest Beatrice platform (C)
Inner Moray Firth	• Intertidal flats with eelgrass beds (Zostera spp.), saltmarsh, and a sand/shingle spit; • Seabird assemblages of international importance (over winter peak counts: 25,740 waterfowl).	*c.* 16 km from the Nigg export pipelines *c.* 74 km from nearest Beatrice platform (C)
Dornoch Firth and Loch Fleet	• A variety of wetland features including floodplain alder (*Alnus glutinosa*) woodland and coastal dunes. Nationally scarce aquatic coastal plants/animals; • Seabird assemblages of international importance (over winter peak counts: 28,692 waterfowl).	*c.* 20 km from all Beatrice platforms *c.* 25 km from the Nigg export pipelines
Moray and Nairn Coast	• Intertidal flats, saltmarsh and floodplain alder (*A. glutinos*) woodland. Nationally scarce aquatic coastal plants/animals: sea centaury (*Centaurium littorale*), Baltic rush (*Juncus balticus*), oysterplant (*Mertensia maritima*) and eelgrasses (*Zostera noltei*, *Z. angustifolia* and *Z. marina*) beetle (*Ochthebius lenensis*) and snail-killing fly (*Tetanocera freyi*); • Seabird assemblages of international importance (over winter peak counts: 22,609 waterfowl).	*c.* 30 km from Nigg export pipelines *c.* 46 km from nearest Beatrice platform (C)

5.6.4 Marine Protected Areas (MPAs)

Under the Marine (Scotland) Act and the UK Marine and Coastal Access Act (2009) the Scottish MPA Project led by Marine Scotland in partnership with SNH, the JNCC and others, designated 30 Nature Conservation Marine Protected Areas (NCMPAs) in July 2014. These NCMPAs were chosen based on:

- The contribution of existing protected area analysis;
- Contribution of other area-based measures; and
- Contribution of least damage / more natural locations.

The closest NCMPAs and proposed NCMPAs to the Beatrice infrastructure are presented in Table 5-11.

Table 5-11 NCMPAS in closest proximity to the Beatrice infrastructure (SNH, 2016).

NCMPA	Qualifying features	Approximate distance from the nearest Beatrice Infrastructure
East Caithness Cliffs NCMPA	• Guillemots and their nearshore feeding grounds	The Beatrice A to Dunbeath power cable intersects the NCMPA *c.* 20 km from nearest Beatrice platform (A)
Southern Trench proposed NCMPA	• Burrowed mud • Fronts • Minke whale • Shelf deeps • White-beaked dolphin • Quaternary of Scotland - sub-glacial tunnel valleys and moraines • Submarine Mass Movement - slide scars	*c.* 17 km from the Nigg export pipelines *c.* 25 km from nearest Beatrice platform (A)
Noss Head NCMPA	• Horse mussel beds	*c.* 30 km from the Beatrice A to Dunbeath power cable *c.* 32 km from nearest Beatrice platform (B)

5.6.5 Potentially Sensitive Habitats

5.6.5.1 Annex I Habitats

The Nigg export pipeline intersects the Moray Firth SAC designated for 'Subtidal sandbanks (sandbanks which are slightly covered by sea water all the time)' and passes *c.*2 km from a known sandbank (see Figure 5-20), however sandbanks are noted to be transient over time.

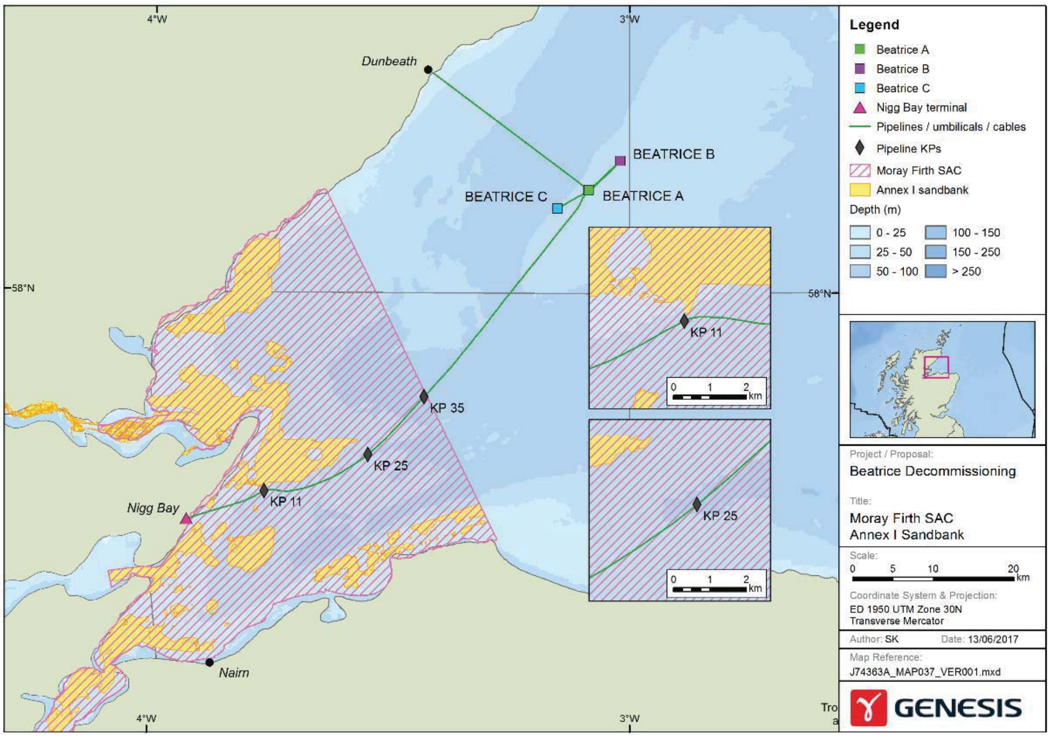


Figure 5-20 Annex 1 habitat 'Subtidal sandbanks within the Moray Firth SAC.

This habitat is defined as consisting of soft sediment types that are permanently covered by shallow seawater generally in waters up to 20 m below chart datum. Sandbanks are elevated, elongated, rounded or irregular topographic features, permanently submerged and predominantly surrounded by deeper water. There are four sub-categories, two of which occur in the Moray Firth: gravelly and clean sands; and muddy sands (the others are eelgrass and maerl beds) (Moray Firth SAC Management Group, 2009).

Sandbank habitats are typically spawning grounds and nursery areas for juvenile fish species and may support large populations of sandeels (which are an important food source for marine mammals and seabirds such as puffins, guillemots and razorbills) and flatfishes and roundfishes (which are important species for offshore commercial fishing). Sandbanks also support commercial fisheries for scallops or other bivalve shellfish.

Fugro (2017a) assessed two areas for their potential for the Annex I 'Stony reef' habitat, and found that although the areas did reach 'medium' reefiness, the patchy nature of the cobbles and boulders indicated these areas are unlikely to meet the Annex I habitat 'Stony reef'.

Horse mussel (*Modiolus modiolus*) beds are known to be found in the inner Moray Firth and northern side of the outer Moray Firth. The pre-decommissioning surveys found no evidence of the presence of the Annex I habitat 'Biogenic reefs' formed by horse mussel beds within the survey areas (Fugro,2017a and 2017b). Similarly, there was no evidence of submarine structure made by leaking gases were not identified in the Beatrice survey area (Fugro, 2017b).

5.6.5.2 □ SPA□ □abitats an□ □□ Bio□i□ersity Action Plan (□□BAP) □abitats

The pre-decommissioning survey detected the UKBAP habitat 'Subtidal sands and gravels' throughout the survey area (Fugro, 2017a). The EUNIS biotope complex 'Circalittoral fine sand' and 'Circalittoral muddy sand' are both included in the list of habitats known to represent this priority habitat.

Burrows were observed at some sampling stations and were investigated further to determine if they were representation of 'Mud habitats in deepwater' including 'Burrowed mud' and OSPAR Habitat 'Sea-pens and burrowing megafauna communities'. The burrows were generally observed as 'common' abundance, although appeared to be small and were unlikely to have been created by key indicator species, such as *Cerianthus* or *Pachycerianthus* anemones and the Norway lobster (*Nephrops norvegicus*). The phosphorescent sea-pen was observed throughout one station, although burrows appeared small.

5.6.6 Potentially Sensitive Species

5.6.6.1 Annex II Species

The following fish and marine mammal species listed under Annex II of the Habitats Directive occur or potentially occur in the Beatrice area: Atlantic salmon, sea lamprey, Allis shad (*Alosa alosa*), twaite shad (*Alosa fallax*), grey seal, harbour seal, bottlenose dolphin, harbour porpoise and European otter.

5.6.6.2 European Protected Species (EPS)

In addition to the cetaceans identified in Section 5.5.5 (all of which are considered to be EPS) EPS identified in the vicinity of the Beatrice Field include the European otter and the Atlantic sturgeon (*Acipenser sturio*).

Under the Habitats Regulations, it is an offence to deliberately disturb any European Protected Species (EPS), or to capture, injure or kill an EPS at any time. The planned decommissioning activities must not significantly disturb an EPS in a way that will affect:

- the ability of the species to survive, breed, rear or nurture its young or affect its hibernating or migration patterns (termed the injury offence); or
- the local distribution or abundance of any protected species (termed the disturbance offence).

5.6.6.3 Priority Marine Features

In addition to the list of features of nature conservation importance for which it is deemed appropriate to use area-based mechanisms (MPAs) as a means of affording protection, as part of the Scottish MPA Project, SNH and JNCC have compiled a separate list of 80 habitats and species, termed PMFs which are considered to be of particular importance in Scotland's seas. The purpose of this list is to guide policy decisions regarding conservation in Scottish waters.

The following PMF species are assessed to be of relevance to the Beatrice area (Tyler-Walters, 2016):

- Atlantic salmon (*S. salar)*
- Sea lamprey (*P. marinus*)
- Sea trout (*S. trutta*)
- Anglerfish (*Lophiiformes spp.*)
- Herring (*Clupeidae* spp.)
- Mackerel (*S. scombrus*)
- Ling (*M. molva)*
- Blue whiting (*M. poutassou*)
- Cod *(G. morhua)*
- Horse mackerel *(Trachurus trachurus*)
- Saithe *(Pollachius virens)*
- Sandeels *(Ammodytes spp.)*
- Whiting *(Merlangius merlangus)*
- Basking shark *(C. maximus)*
- Spurdog *(S. acanthias)*
- Ocean quahog *(A. islandica)*

Fugro (2017a) report the occurrence of two adult *A. islandica* specimens at survey stations close to Beatrice A and Beatrice C. A total of 128 juveniles were also identified across all the survey area.

The following PMF habitats are assessed to be of relevance to the Beatrice area (Fugro, 2017a):

- 'Subtidal sands and gravels' – observed throughout the survey area; and
- 'Seapens and burrowing megafauna communities' and 'burrowed mud' – none of the stations were considered to meet the Annex I habitat criteria.

5.6.6. Protected Species Summary

The designation of fish species requiring special protection in UK waters is receiving increasing attention with particular consideration being paid to large slow growing species such as sharks and rays. A number of international laws, conventions and regulations as well as national legislative Acts have been implemented which provide for the protection of these species. They include:

- **The UK Biodiversity Action Plan (BAP) priority fish species**;
- **The OSPAR List of Threatened and/or Declining Species & Habitats**;
- **The IUCN (International Union for Conservation of Nature) Red List of Threatened Species**;
- **The Wildlife and Countryside Act 1981** (which consolidates and amends existing national legislation to implement the Convention on the Conservation of European Wildlife and Natural Habitats (**Bern Convention**) and the Birds Directive in Great Britain). The Wildlife and Countryside Act makes it an offence to intentionally kill, injure, possess or trade any animal listed in Schedule 5 and to interfere with places used by such animals for shelter or protection.
- **The EC Habitats Directive** (transposed into UK law through the Conservation of Habitats and Species Regulations 2010 in England and Wales and also the 1994 Regulations in Scotland).

The fish species which are listed under the above protection regulations and are likely to occur in the area of the Beatrice infrastructure are shown in Table 5-12.

Table 5-12 Designation of fish species occurring in the vicinity of the proposed project.

Species	UK BAP	OSPAR	IUCN	Bern Convention	Habitats Regulations
Allis shad	✓	✓	Least Concern	✓	×
Twaite shad	✓	×	Least Concern	✓	×
Angel shark	✓	✓	Critically Endangered	✓ [1]	×
Atlantic salmon	✓	✓	Least Concern	✓ [2]	×
Common skate	✓	✓	Critically Endangered	×	×
Basking shark	✓	×	Vulnerable	✓	×
Porbeagle shark	✓	✓	Vulnerable	✓	×
[1] = Applies in the Mediterranean only. [2] ▯ ▯oes not appl▯ in sea waters					

5.7 National Marine Plan (NMP)

As mentioned previously (Section 1.5) the Scottish NMP comprises plans for Scotland's inshore (out to 12 nm) and offshore waters (12 to 200 nm) as set out under the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009. The plan represents a framework of Scottish Government policies for the sustainable development of marine resources and is underpinned by strategic objectives:

- Achieving a sustainable marine economy;
- Ensuring a strong, healthy and just society;
- Living within environmental limits;
- Promoting good governance;
- Using sound science responsibly.

These objectives are to be achieved through the application of the 21 'General Planning Principles' as summarised in Table 5-13.

Table 5-13 Scottish NMP's General Planning Principles.

Scotland's National Marine Plan Principles
GEN 1 General planning principle: There is a presumption in favour of sustainable development and use of the marine environment when consistent with the policies and objectives of this Plan.
GEN 2 Economic benefit: Sustainable development and use which provides economic benefit to Scottish communities is encouraged when consistent with the objectives and policies of this Plan.
GEN 3 Social benefit: Sustainable development and use which provides social benefits is encouraged when consistent with the objectives and policies of this Plan.
GEN 4 Co-existence: Proposals which enable coexistence with other development sectors and activities within the Scottish marine area are encouraged in planning and decision making processes, when consistent with policies and objectives of this Plan.
GEN 5 Climate change: Marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change.

Scotland's National Marine Plan Principles
GEN 6 Historic environment: Development and use of the marine environment should protect and, where appropriate, enhance heritage assets in a manner proportionate to their significance.
GEN 7 Landscape/seascape: Marine planners and decision makers should ensure that development and use of the marine environment take seascape, landscape and visual impacts into account
GEN 8 Coastal process and flooding: Developments and activities in the marine environment should be resilient to coastal change and flooding, and not have unacceptable adverse impact on coastal processes or contribute to coastal flooding.
GEN 9 Natural heritage: Development and use of the marine environment must: a) Comply with legal requirements for protected areas and protected species. b) Not result in significant impact on the national status of Priority Marine Features. Protect and, where appropriate, enhance the health of the marine area.
GEN 10 Invasive non-native species: Opportunities to reduce the introduction of invasive non-native species to a minimum or proactively improve the practice of existing activity should be taken when decisions are being made.
GEN 11 Marine litter: Developers, users and those accessing the marine environment must take measures to address marine litter where appropriate. Reduction of litter must be taken into account by decision makers.
GEN 12 Water quality and resource: Developments and activities should not result in a deterioration of the quality of waters to which the Water Framework Directive, Marine Strategy Framework Directive or other related Directives apply.
GEN 13 Noise: Development and use in the marine environment should avoid significant adverse effects of man-made noise and vibration, especially on species sensitive to such effects.
GEN 14 Air quality: Development and use of the marine environment should not result in the deterioration of air quality and should not breach any statutory air quality limits.
GEN 15 Planning alignment A: Marine and terrestrial plans should align to support marine and land-based components required by development and seek to facilitate appropriate access to the shore and sea.
GEN 16 Planning alignment B: Marine plans should align and comply where possible with other statutory plans and should consider objectives and policies of relevant non-statutory plans where appropriate to do so.
GEN 17 Fairness: All marine interests will be treated with fairness and in a transparent manner when decisions are being made in the marine environment.
GEN 18 Engagement: Early and effective engagement should be undertaken with the general public and all interested stakeholders to facilitate planning and consenting processes.
GEN 19 Sound evidence: Decision making in the marine environment will be based on sound scientific and socio–economic evidence.
GEN 20 Adaptive management: Adaptive management practices should take account of new data and information in decision making, informing future decisions and future iterations of policy.
GEN 21 Cumulative impacts: Cumulative impacts affecting the ecosystem of the marine plan area should be addressed in decision making and plan implementation.

6. SOCIO-ECONOMIC BASELINE

6.1 Introduction

This section describes the socio-economic activities in the vicinity of the Beatrice Development, which primarily include fishing, shipping, oil and gas operations, renewable energy developments and military exercises. Other features, such as cultural heritage, tourism and recreation, and landscape/seascape are also discussed.

6.2 Fishing

In relation to potential fishing activity in the area of the Beatrice Field, fish species may be divided into three categories:

- Demersal: live on or near the seabed e.g. cod, haddock, whiting, plaice and monkfish.
- Pelagic – swim freely in the water column and often aggregate into large, shoals e.g. mackerel and herring.
- Shellfish – benthic species which live on or in the seabed. Shellfish include crustacea, such as prawns and crabs; and molluscs, which include mussels and scallops.

Fishing gear are specifically designed to catch different types of fish species which live in different habitats and which also exhibit behavioural differences. There are two broad groups of fishing gear used in UK waters:

- **Active gears** - towed through the water and along the seabed, herding or surrounding the fish,
- **Passive/static gears** - set on the seabed to catch/trap the fish.

The potential for interaction between commercial fisheries and oil and gas subsurface infrastructure is highest for those fisheries targeting fish species found on or near the seabed (demersal and shellfish).

Active gear used for demersal or bottom (shellfish) trawling include (Scottish Government, 2014):

- Demersal trawl (otter trawl);
- Seine netting;
- Twin beam trawling;
- Bottom trawling (single boat); and
- Scallop dredging.

Passive/static gear used for demersal and shellfish fishing in Scottish waters include:

- Longlining;
- Set nets; and
- Potting and creeling.

6.2.1 Fishing Activity in the Beatrice Field Area

The Moray Firth has both an offshore and inshore fishing industry. The offshore industry targets demersal whitefish and pelagic species whilst the inshore fishery mostly targets squid and *Nephrops*. The inshore industry is much smaller in volume and financial terms than the offshore industry, but is vital to many of the smaller ports in the Firth (Moray Firth Partnership, 2017). Scallop dredgers fish throughout the Moray Firth.

ICES collates fisheries information for area units termed ICES rectangles measuring 30 minutes latitude by 1 degree longitude. As can be seen in Figure 6-1, the Beatrice infrastructure is located within ICES rectangles 45E6 and 44E6. The export pipelines crosses ICES rectangles 45E6 and 44E6 whilst all other infrastructure (platforms, infield water injection and production pipelines, all power cables and the two WTGs) lie within ICES rectangle 45E6.

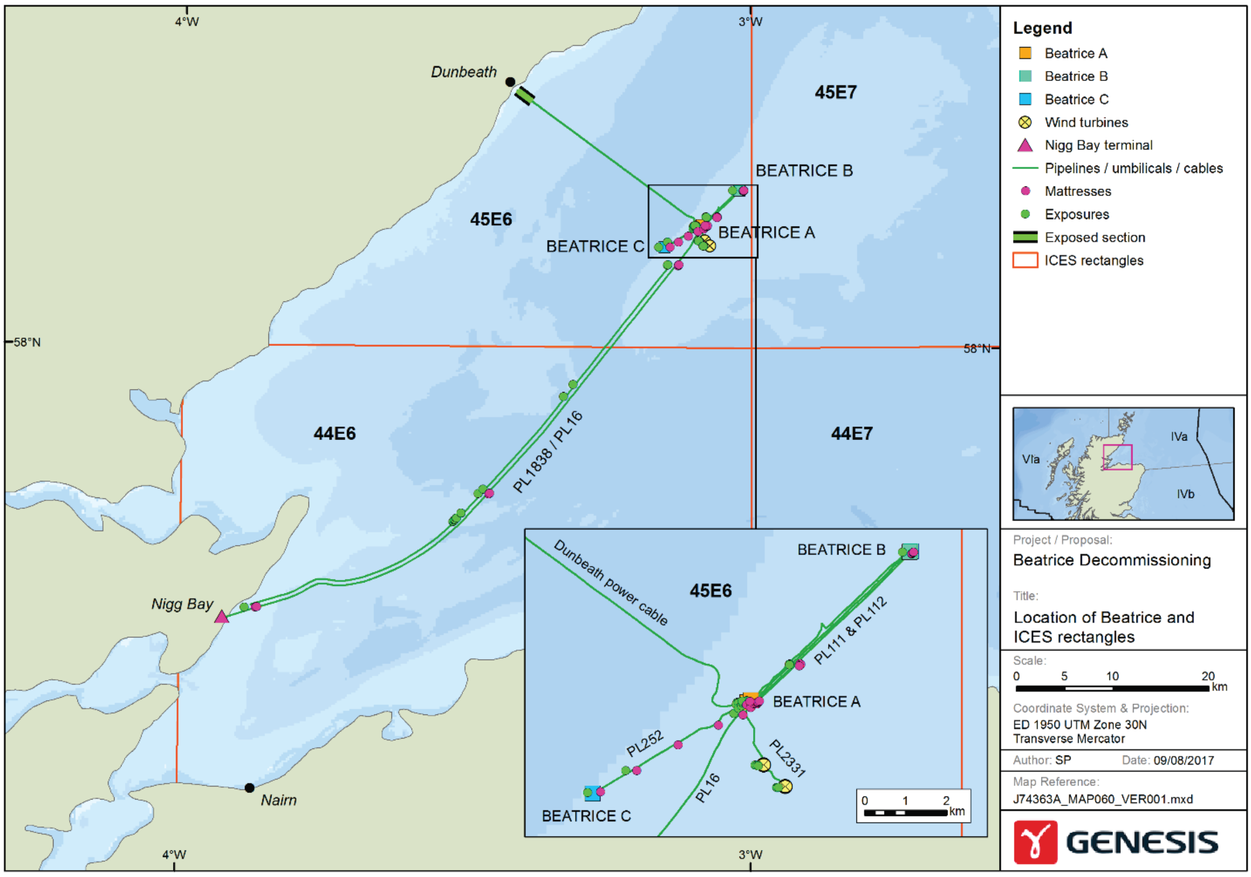


Figure 6-1: Location of Beatrice infrastructure in relation to ICES rectangles.

Effort and landings data for UK vessels greater than 10 m for each ICES rectangle are available from the Scottish Government (2017). No such statistical data could be sourced for vessels less than this size. However, the data collected by Kafas *et al.* (2014) provides spatial information on the fishing activity of Scottish-registered commercial fishing vessels measuring ≤ 15 m. VMS data made available for fishing vessels ≥ 15 m are also presented. Due to the differences in the sources of data and the spatial scale at which the data is collected it is not possible to provide a holistic numerical value in terms of vessel days and landings values for all vessel sizes operating in a particular area within the Moray Firth. Rather the information can be used to identify the type of fishing activity (and subsequently the types of gear) in the area and to provide an overall view of the relative importance of the area to the UK fishing industry.

6.2.1.1 Fishing Activity: Vessels ≥ 10 m

Using data provided by the Scottish Government fishing effort (vessel days), value and quantity data have been plotted for UK vessels ≥ 10 m in length. The summary descriptions provided below focusses on those rectangles within which the Beatrice infrastructure occurs or those in closest proximity i.e. ICES rectangle 45E6 (the Beatrice Field); ICES rectangle 45E7 (east of Beatrice); ICES rectangle 44E6 (the majority of the export line); and ICEs rectangle 44E7 (southeast of Beatrice). Adjacent rectangles to the north and east have also been included to show the wider regional context.

Fishing Effort: Vessels ≥ 10 m

Figure 6-2 shows the annual fishing effort for the years 2011 – 2015. Average fishing effort over the five-year period, measured in vessel days per annum, is highest in rectangle 44E7 (1,929 days), and lowest in rectangle 45E6 (489 days). The average annual number of vessel days in rectangle 44E6 was 792 days. Gear types associated with this effort in 45E6 and 44E6 include seine nets, trawls and pots. For comparison the highest fishing effort recorded in 2015 from a single ICES rectangle is 6,543 days from ICES rectangle 37E4 in the Irish Sea.

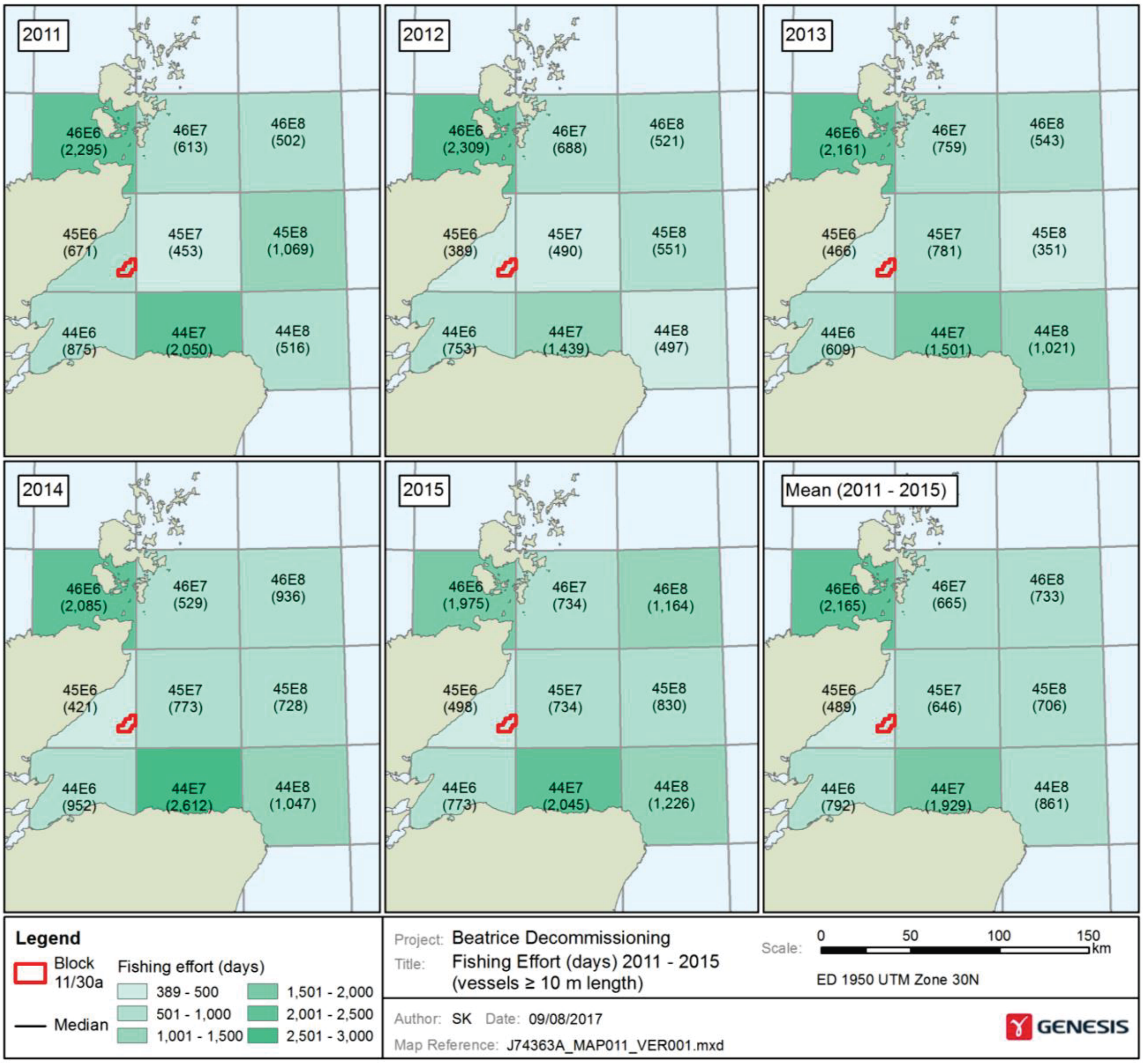


Figure 6-2: Annual fishing effort per ICES rectangle, 2011-2015 (Scottish Government, 2016).

Fish Landings by Value (£) and by Weight (te): Vessels ≥ 10 m

Figure 6-3 shows the reported annual fish landings (by value) for the years 2011 – 2015 for each species type (demersal, pelagic and shellfish). Over the five-year period, the value of fish landed from 44E6 and 45E6 is highest for shellfish, followed by demersal, with no pelagic species being targeted.

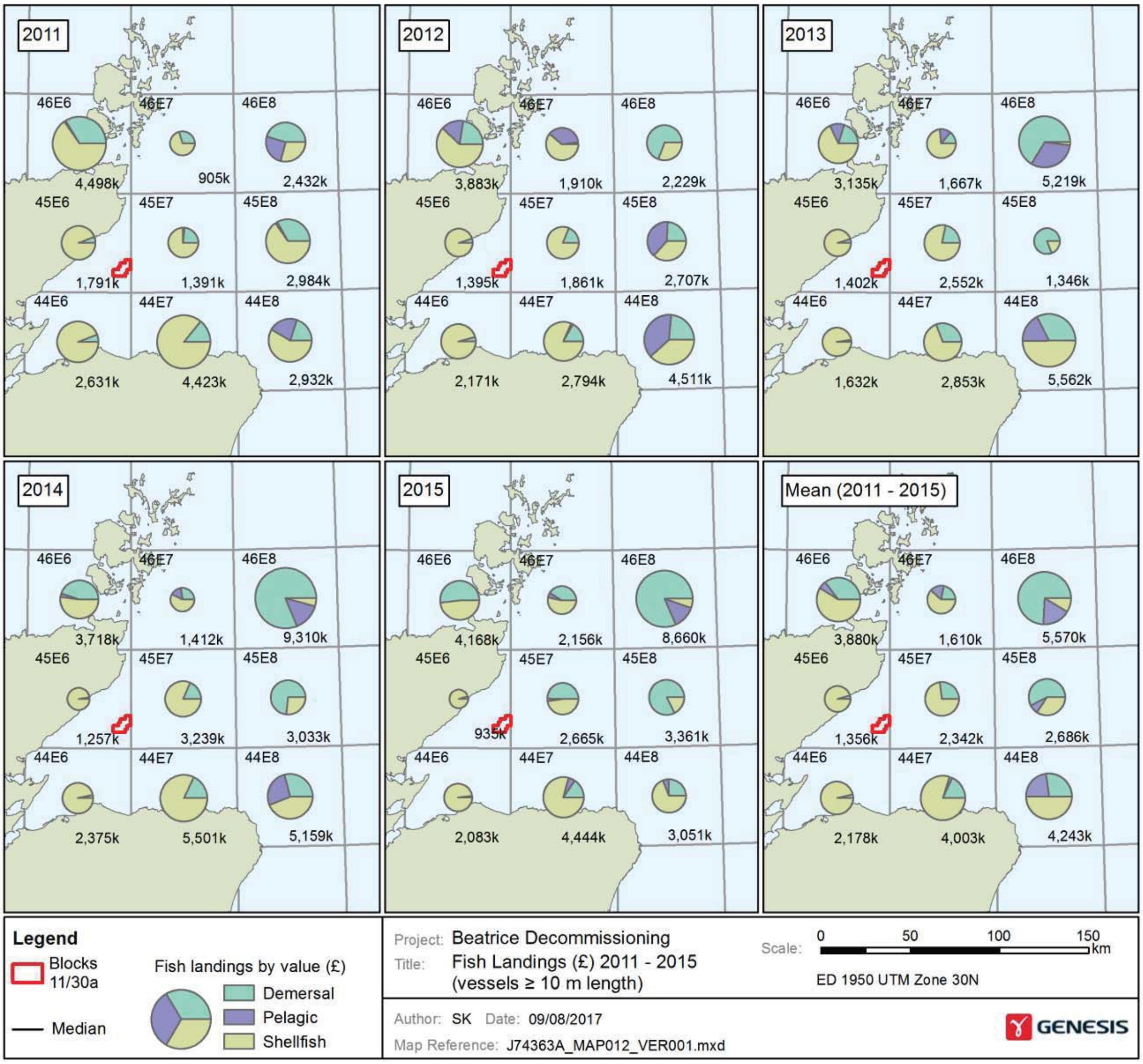


Figure 6-3: Annual fish landings by value (£) per ICES rectangle, 2011-2015 (Scottish Government, 2016).

Similarly, Figure 6-4 shows the annual reported fish landings by weight (te) for the years 2011 – 2015 and for each species type (demersal, pelagic and shellfish). The average total weight of fish landed by these larger vessels from 45E6 and 44E6 are relatively low. Over the five-year period, the weight of fish landed is highest for shellfish, followed by demersal, with no recorded landings of pelagic species from these ICES rectangles.

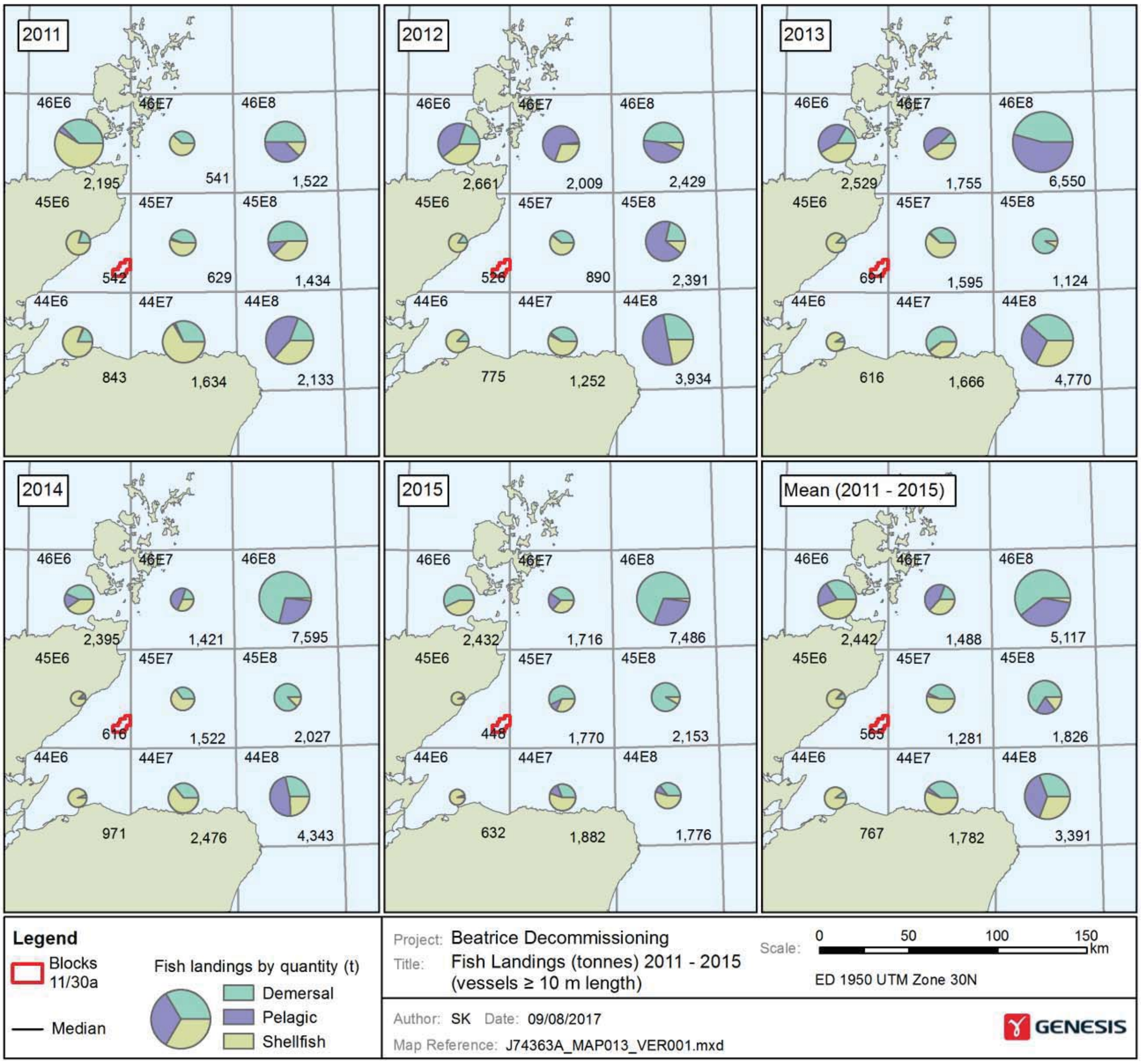


Figure 6-4: Annual fish landings by weight (t) per ICES rectangle, 2011-2015 (Scottish Government, 2016).

6.2.1.2 Fishing Activity: Vessels ≤ 15 m

ScotMap (Kafas *et al*. 2014) provides a spatial dataset (using grid cells ranging in area from 3.89 km² – 4.51 km²) of fishing intensity and fishing value in inshore Scottish waters by vessels ≤ 15 m for the period 2007 – 2011. The data provided is an annual average across the five years.

Fishing Intensity: Vessels ≤ 15 m

Figure 6-5 provides an indication of the fishing intensity in each grid cell. The number of vessels presented captures those vessels associated with active gear e.g. trawls and scallop dredges in addition to static gear e.g. crab and lobster pots. A relatively large number of fishing vessels are active along the length of the export pipelines. Activity appears to be generally less along the length of the Dunbeath power cable and in the vicinity of the Beatrice platforms though fishing activity is still recorded in these areas. Trawl vessels ≤ 15 m targeting squid, demersal species and *Nephrops*, in addition to scallop dredges operate in the area of the Beatrice infrastructure. Vessels using static fishing gear to target crabs, lobster and *Nephrops* are more active within 6 nm of the coastline. Crab and lobster pots dominate the area closer to the nearshore section of the Dunbeath cable whilst *Nephrops* pots tend to be laid in the area around the nearshore end of the export lines.

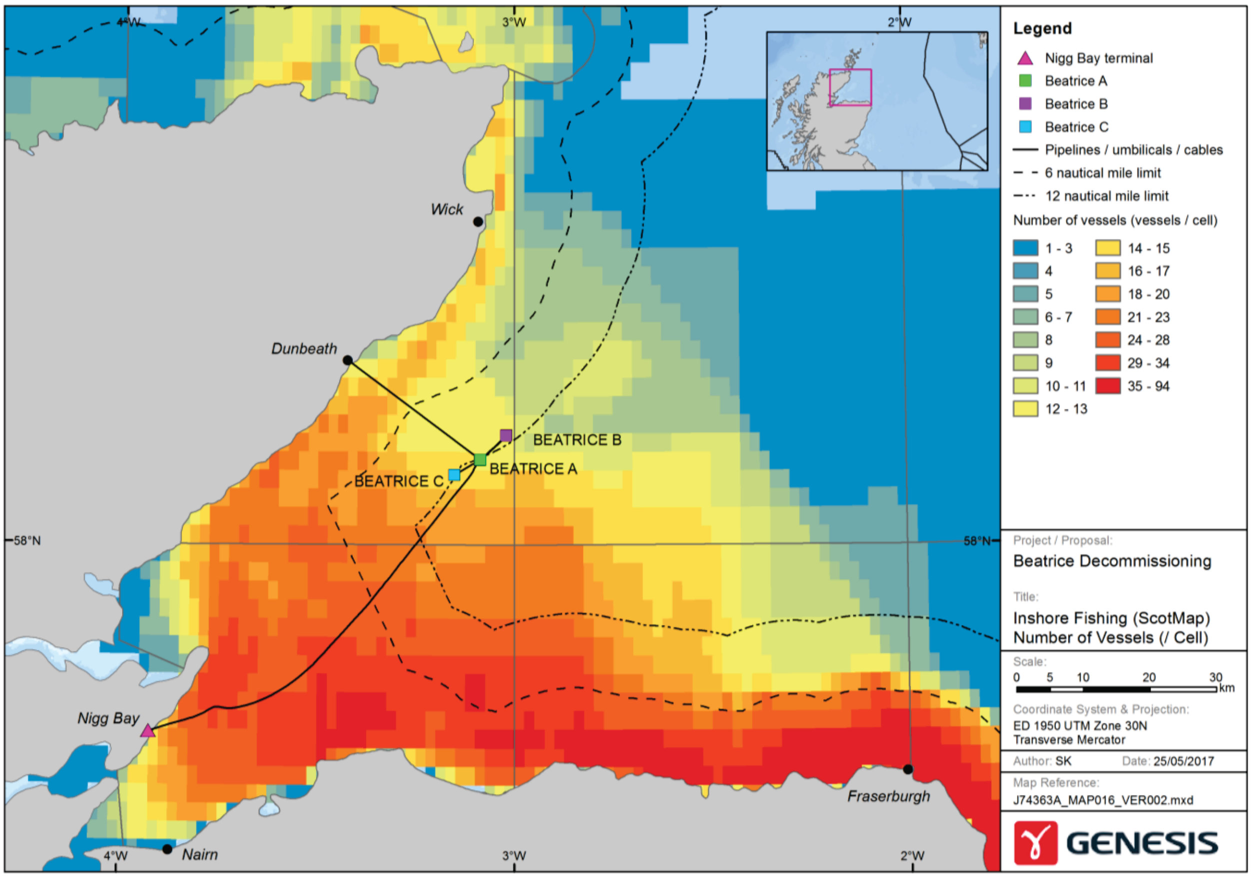


Figure 6-5: Fishing intensity by Scottish vessels ≤ 15 m (ScotMap: 2007 – 2011: vessels/cell) (Kafas et al., 2014).

Fish Landings by Value: Vessels ≤ 15 m

Figure 6-6 shows the value of landings by vessels ≤ 15 m. The value of landings by these smaller vessels is highest within 6 nm of the coastline. Landings by fish type suggest that the higher values associated with the nearshore section of the Dunbeath power cable and the nearshore section of the export pipeline are associated with the crab and lobster fishery and the demersal fishery respectively.

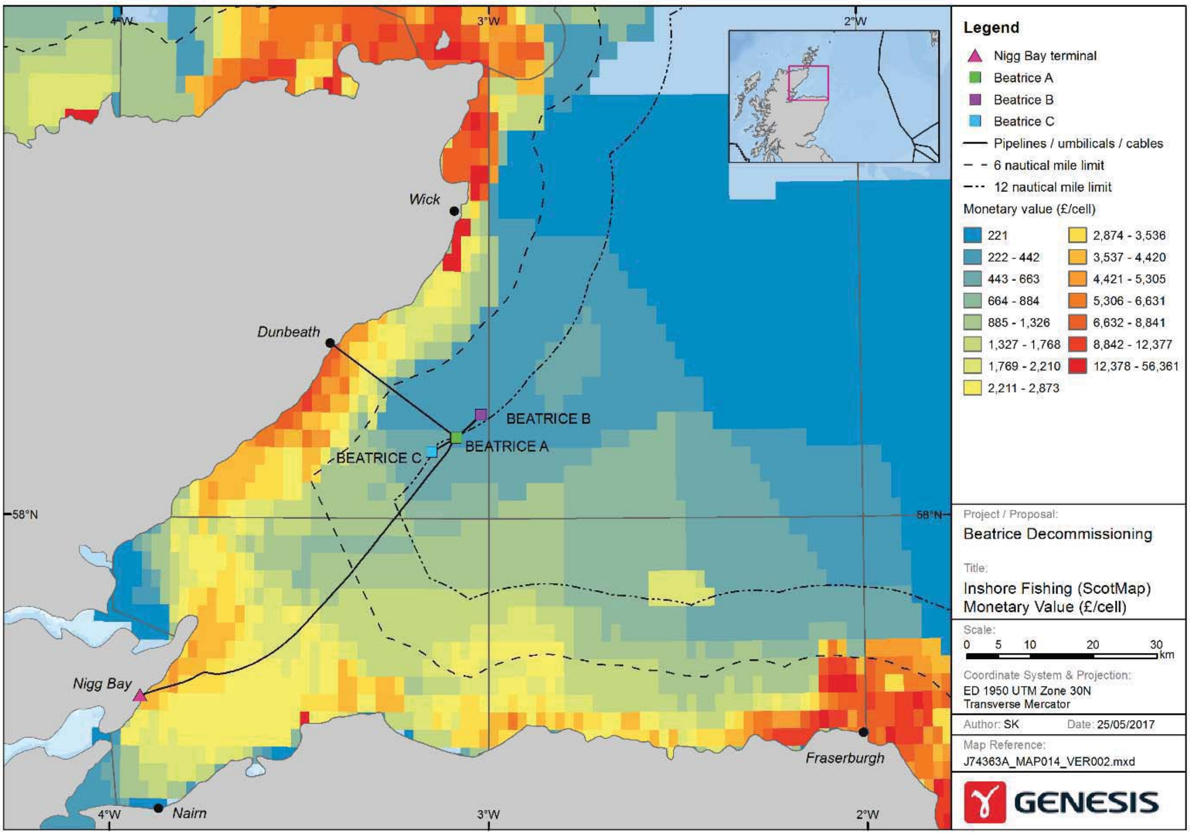


Figure 6-6: Landings value (£/cell) by Scottish vessels ≤ 15 m (ScotMap: 2007 – 2011: vessels/cell) (Kafas et al., 2014).

6.2.1.3 Fishing Activity: Vessels ≥ 15 m

Amalgamated VMS data (2009 – 2013) for vessels ≥ 15 m have been combined with landings data to develop GIS layers describing the spatial patterns of landings by the Scottish fleet. The data suggest that in general, larger trawl vessels targeting demersal species do not operate in high numbers near the Beatrice infrastructure. Larger scallop fishing vessels do operate along the power cable to Dunbeath, with relatively high intensity of scallop dredging being evident at intermittent points along the export pipelines (Figure 6-7). The data also show that some *Nephrops* fishing takes place along sections of the export pipeline (Figure 6-8). Though associated with a different subset of vessels (in terms of size), these observations are supported by the data presented in Section 6.2.1.1. which show that most landings by vessels ≥ 10 m from ICES rectangle 45E6 and 44E6 comprise shellfish.

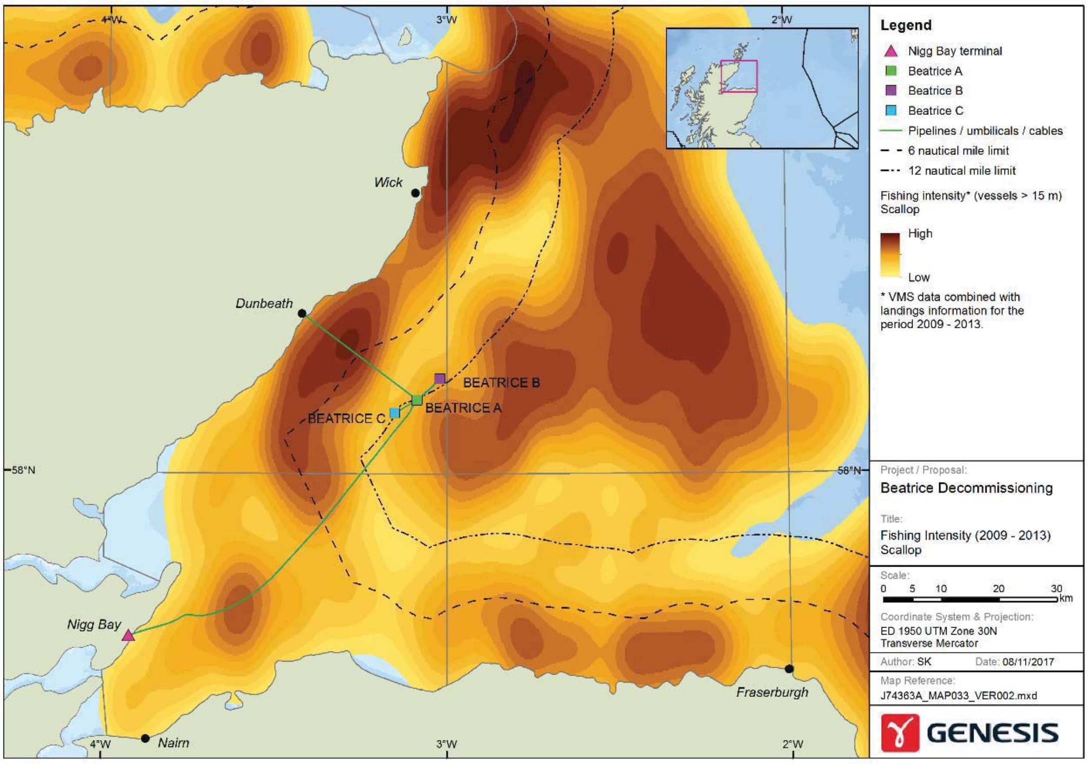


Figure 6-7: VMS and landings data showing fishing intensity by Scottish scallop vessels ≥ 15 m (2009-2013 amalgamated data) (Kafas et al., 2012).

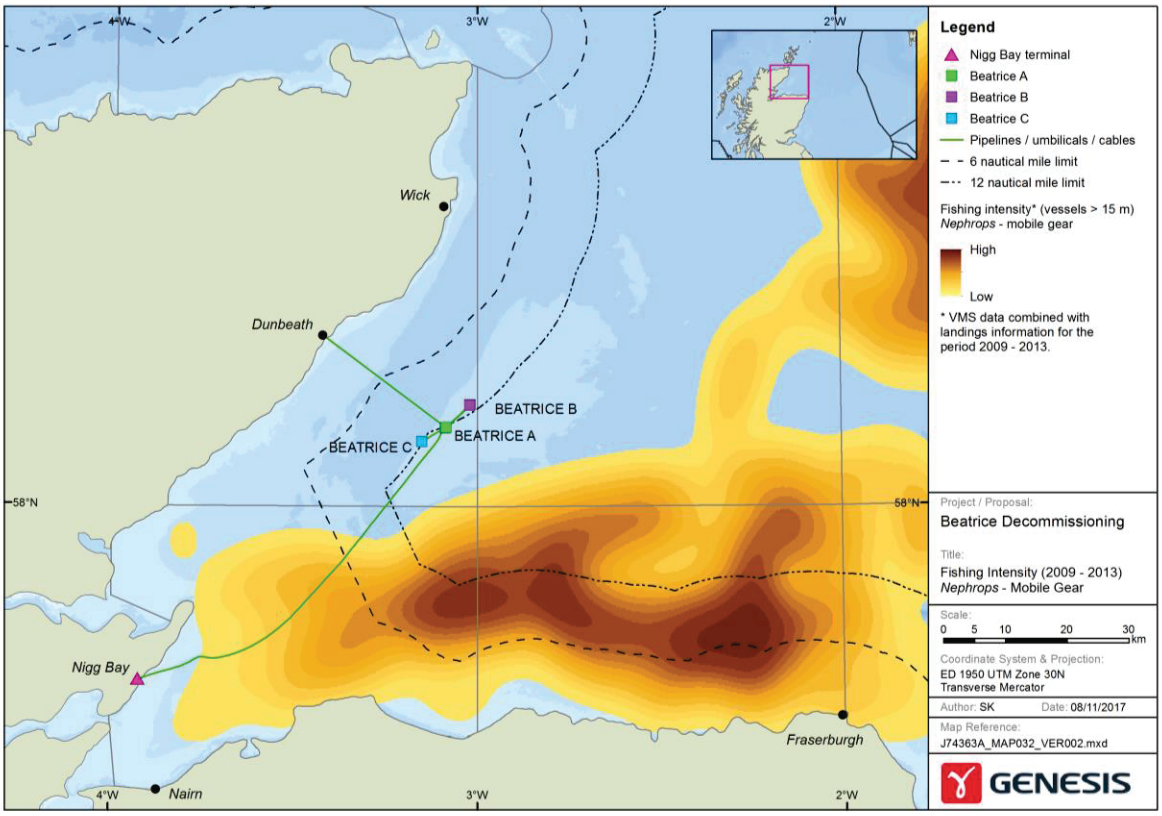


Figure 6-8: VMS and landings data showing fishing intensity by Scottish Nephrops vessels ≥ 15 m (2009-2013 amalgamated data) (Kafas et al., 2012).

6.2.2 Summary of Fishing Activity in the Project Area

A number of gear types are active in the area of the Beatrice infrastructure including seine nets, demersal trawls, *Nephrops* trawls, scallop dredges and pots. Given the different sources of data available it is difficult to draw conclusions on the relative value of the area to the UK or Scottish fishing industry as a whole. However, it can be seen that the area is an important fishing ground for smaller vessels whilst in terms of effort and landings it is of less importance to larger vessels.

For both larger and smaller vessels, shellfish comprise the most valuable landings and these are targeted with a mixture of static and mobile gear.

6.3 Shipping

There are several important ports in the Moray Firth for fish landings, the transport of oil industry supplies and products, as well as general cargo. Fraserburgh and Buckie are important fishing ports and were the base for 284 vessels in 2015 (Marine Scotland, 2016). The port of Inverness, located in the Beauly Firth, is of strategic importance to the north of Scotland supporting cargo, cruise ship and renewable energy industry related activities. Slightly further north in the Cromarty Firth, the port of Invergordon receives c. 100,000 cruise ship passengers between March/April and October each year. Shipping activities in the North Sea are categorised by the Oil and Gas Authority (OGA) (2016) to have either: very low; low; moderate; high; or very high shipping density. Figure 6-9 shows the level of shipping activity in Block 11/30 and the surrounding area. In Block 11/30 and adjacent blocks for which data is available, shipping density is categorised as being very low despite te number of ports in the region.

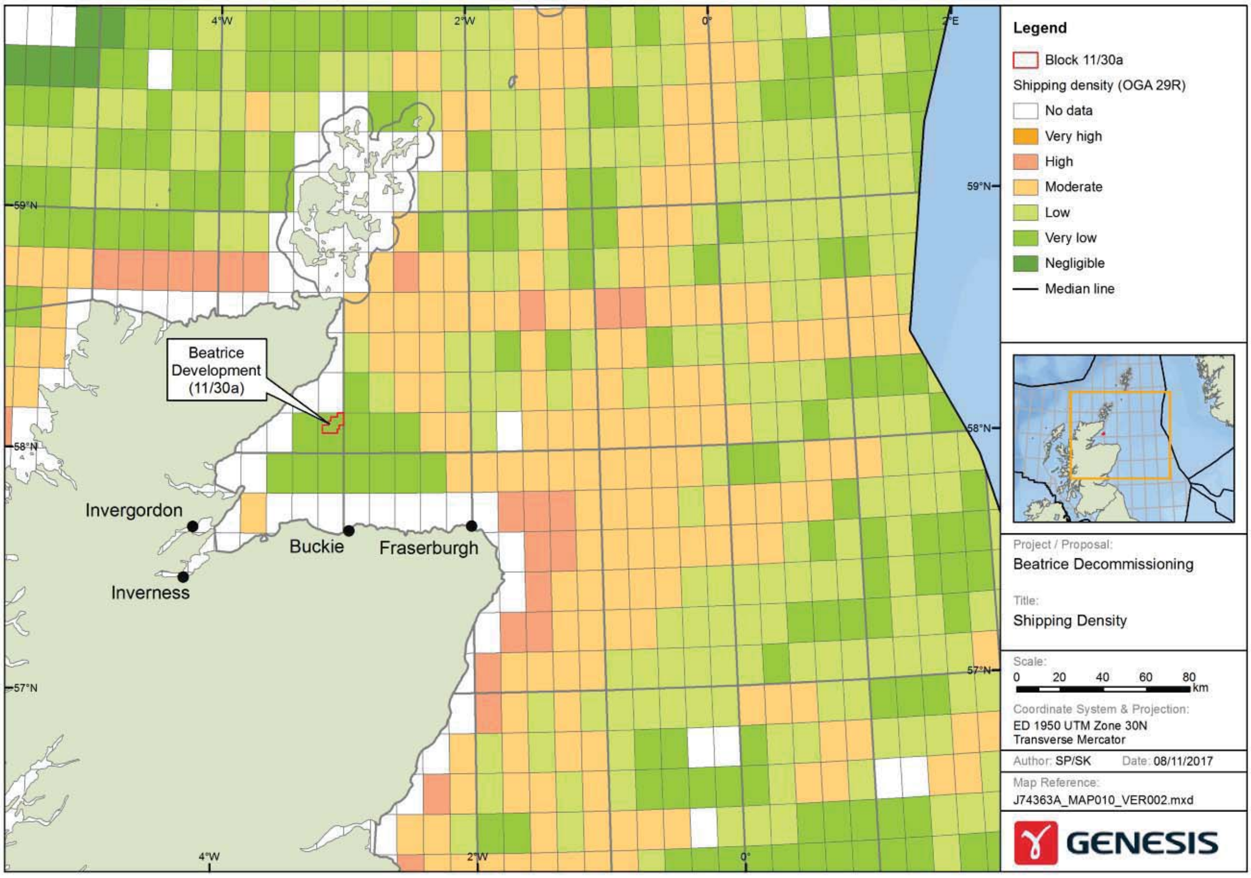


Figure 6-9: Shipping density in the vicinity of the Beatrice Development area as categorised by OGA (OGA, 2016).

There are no International Maritime Organisation (IMO) routes close to the Beatrice Field area or in the wider Moray Firth. A number of primary navigation routes are identified in ship Automatic Identification System (AIS) data along the southern and outer Moray Firth. Lower levels in the area are associated with 'non-route-based' traffic such as fishing vessels, naval vessels, tugs, dredgers, yachts, supply vessels to mobile drilling installations and non-routine traffic.

6.4 Surrounding Oil and Gas Infrastructure

The Beatrice field is adjacent to the Jacky oil field (Block 12/21) operated by Ithaca, which comprises a normally unmanned wellhead platform (WHP) tied back to Beatrice Alpha complex (Figure 6-10). The next closest oil and gas infrastructure is located at the Captain and Ross Fields, *c.* 75 km and 93 km east of Beatrice (Table 6-1).

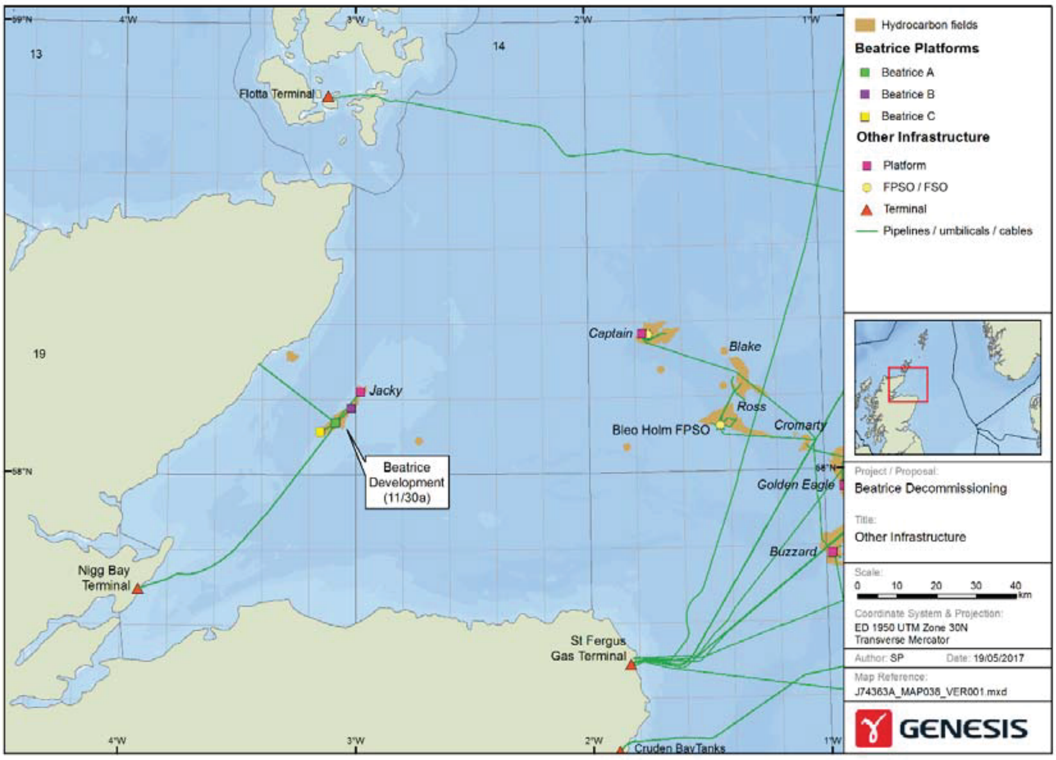


Figure 6-10: Oil and gas installations within the vicinity of the proposed development.

Table 6-1: Approximate distance of neighbouring installations from the Beatrice Bravo.

Installation	Approximate distance from Beatrice B (km)
Jacky platform	4.7
Captain	75
Bleo Holm FPSO	93

6.5 Other Industries

There are a number of nearby windfarm developments, these are shown in Figure 6-11. The Beatrice A platforms and the two WTGs the associated subsea infrastructure are located within the Western Moray Firth Round 3 windfarm zone, which to date has been subject to scoping for a development of up to 90 turbines. Initial proposals for development were published in 2016 and 2017 (Moray Offshore Renewable Power, 2017; Scottish Government, 2017). The Moray Firth Round 3 windfarm zone also contains a consented Eastern Development Area, located *c.* 10 km east of Beatrice B, (Figure 6-11). The Eastern Development was granted consent in 2014 and comprises the Telford, Stevenson and MacColl offshore windfarms. Construction is expected to commence once the appropriate contracts have been awarded.

Beatrice B is located *c.* 4 km from the Beatrice Offshore Windfarm Limited (BOWL) development and the export cable agreement area is located *c.* 1.3 km east of WTGB (Figure 6-11). The BOWL development was granted consent in March 2014, a final investment decision was made in 2016, and construction began in August 2017.

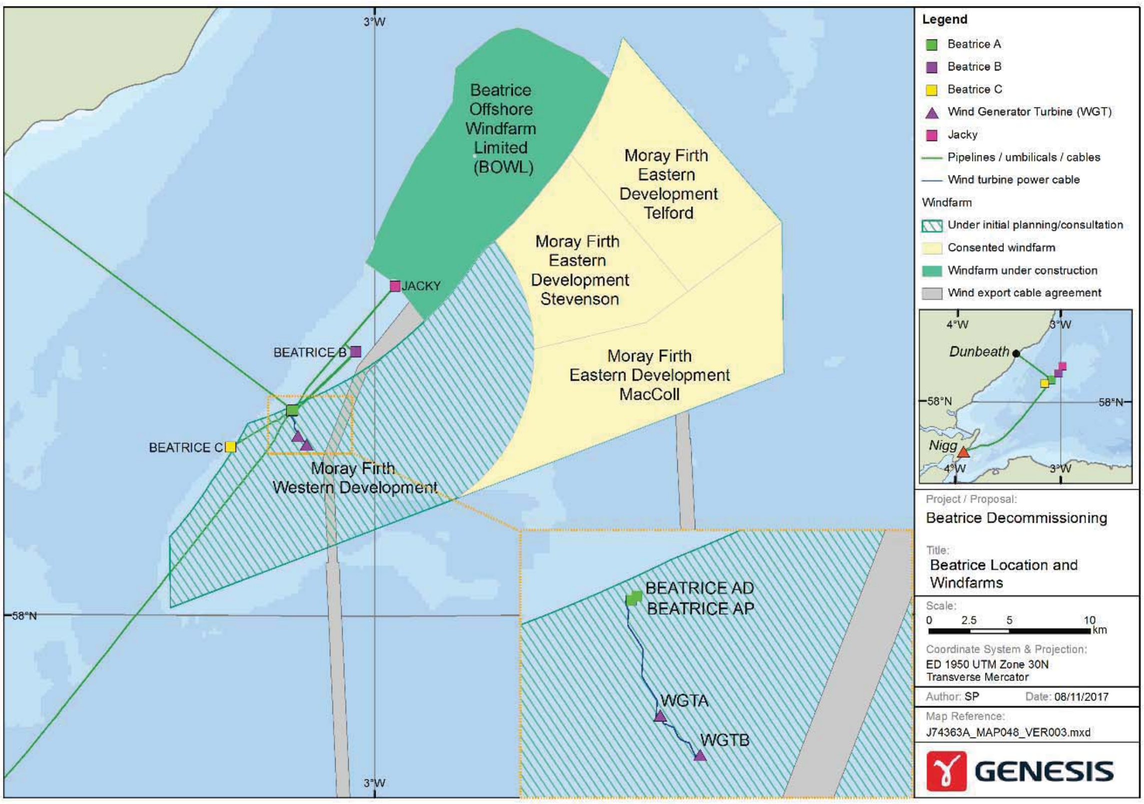


Figure 6-11 Beatrice facilities in relation to offshore windfarm developments in the Moray Firth (Crown Estate Scotland, 2017).

6.6 Submarine Cables and Pipelines

Cable export agreement areas are in place for the Beatrice and Moray Firth wind farm zones which both have their landfall on the southern Moray Firth coast at Portgordon and near Banff respectively.

There are no telecommunications or subsea power cables in the Beatrice area. The nearest telecommunications cables are the Shefa-2 telecommunications cable which terminates in Banff and the proposed Caithness-Moray high-voltage, direct current (HVDC) transmission project cable. These are located *c.* 27 km and 26 km to the east of Beatrice, respectively. The latter is due to be completed by 2018.

6.7 Military Exercise Areas

Several areas of the inner and outer Moray Firth are used by the Royal Air Force for radar training, high and low-angle gunnery and air to sea ground firing. The "danger areas" are shown in Figure 6-12. It is of note that the Beatrice Field area, along with the majority of the Moray Firth, lies within the large Air Force Area D712D, used for air combat training and high energy manoeuvres. The offshore area of the Moray Firth is not used by the Royal Navy.

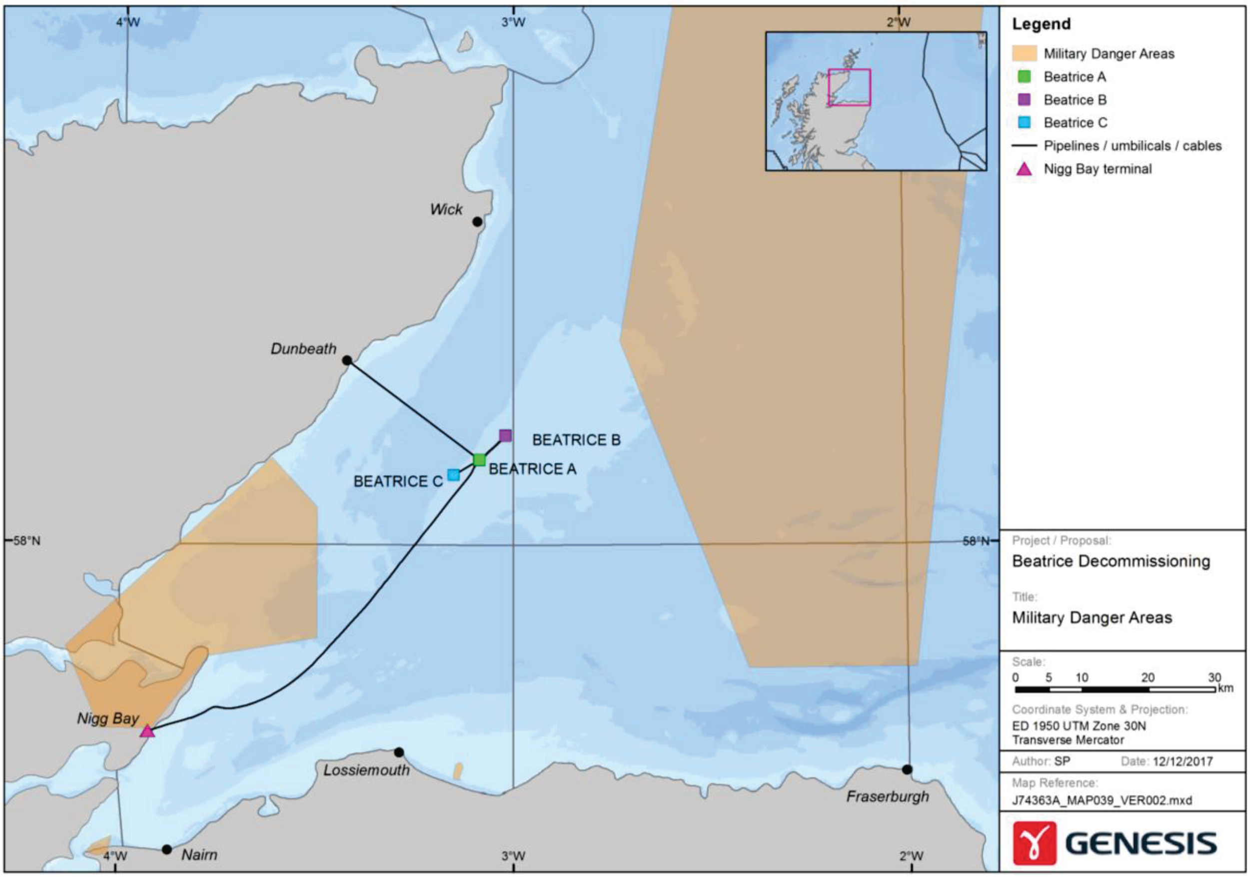


Figure 6-12: Military danger areas in the vicinity of the Beatrice infrastructure (Marine Scotland, 2014b).

6.8 Cultural Heritage

The Moray Firth has a number of coastal sites of archaeological interest, particularly within the inner, more sheltered, Beauly and Cromarty firths and Inverness area. Archaeological features include Mesolithic shell middens, marine crannogs dating from the late Bronze and Iron Age, cist cemetery sites from the Bronze Age and a number of fishtraps dating from the 17th-19th century (Hale & Cressey 2003). Additionally, the Canmore database records a large number of monuments around the coast of the Moray Firth, and a number of marine wreck sites (Scottish Government NMPi, 2017).

The shipwrecks in closest proximity to the Beatrice infrastructure are shown in Figure 6-13 and include: the San Tiburcio (steam tanker) wreck *c.* 300 m from the export pipeline; the Gretafield (steam tanker) wreck *c.* 0.5 km from the Dunbeath power cable landfall; and the possible Sunbeam (schooner) wreck *c.* 1 km from WGTB. In the Moray Firth there are also three shipwrecks protected under The Protection of Military Remains Act 1986 - these sites are shown in Figure 6-13 and also detailed in Table 6-2.

The strategic importance of the North Sea area during WWI and WWII; the concentration of much of the North Sea fishing fleet in coastal ports; the importance of maritime trade routes in the region and the treacherous nature of nearshore waters, have led to a large number of ship and aircraft wrecks. While many of the locations of these wrecks have been identified and recorded the locations of many more remain uncharted.

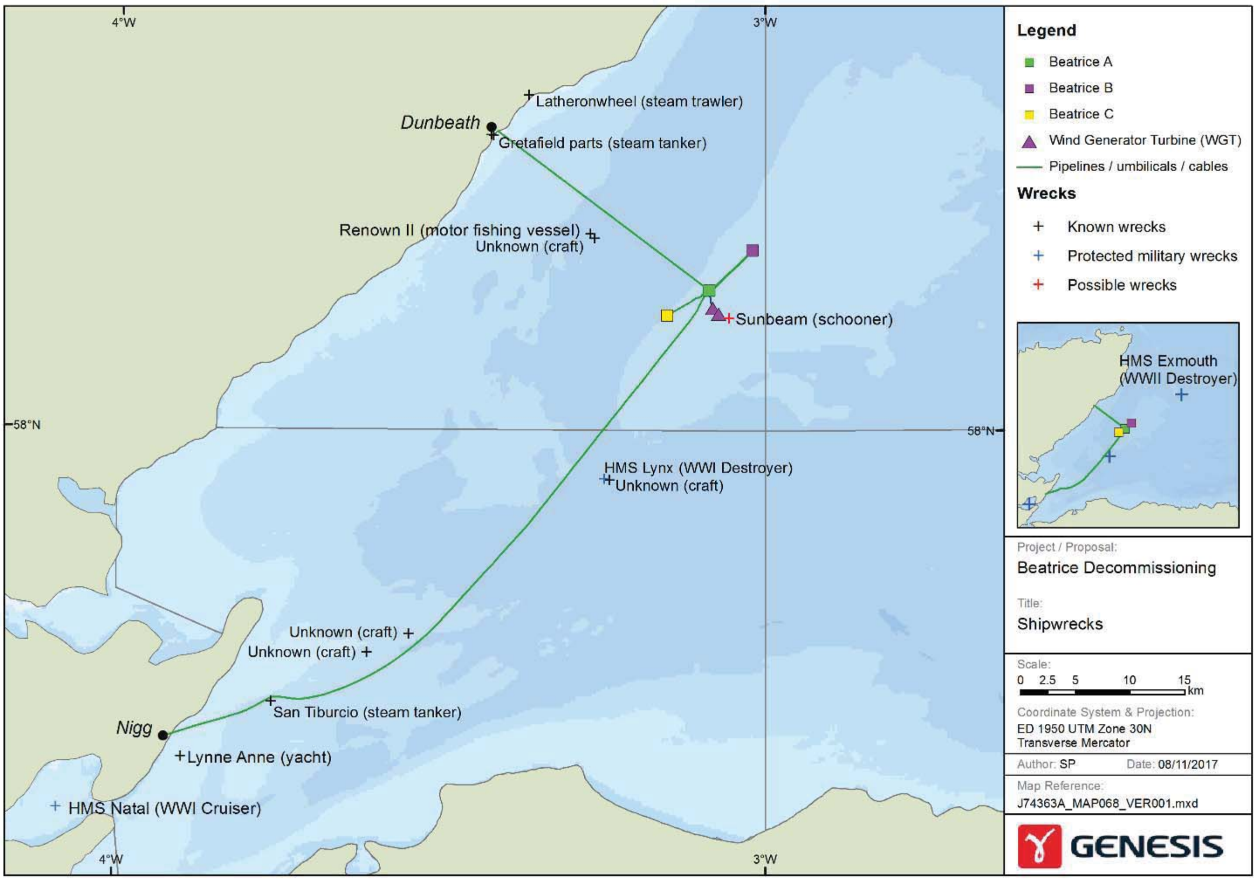


Figure 6-13: Known wrecks Relevant to the Beatrice Area.

Table 6-2: Known wrecks in the Moray Firth Protected under The Protection of Military Remains Act 1986.

Wreck	Protected location	Closest distance to Beatrice surface or subsurface infrastructure
HMS Lynx (WWI Destroyer)	Moray Firth, approximately 57°57'35.8"N 3°14'39.5"W	3 km
HMS Natal (WWI Cruiser)	Cromarty Firth, an area 100 m radius around 57°41'244"N 4°05'310"W	15 km
HMS Exmouth (WWII Destroyer)	Northeast outer Moray Firth, an area 750 m radius around 58°18'467"N 2°28'938"W	36 km (see inset map)

6.9 Tourism and Recreation

The Moray Firth coastline and adjacent land and waters provides for a variety of recreational activities which make tourism and leisure an important contribution to the local economy (LUC, 2016). In 2015, *c.* 700,000 visitors to the Moray area contributed £106 million to the local economy. There are a large number of easily accessible beaches in the area, several of which are designated by the Scottish Environment Protection Agency (SEPA) as bathing water sites under the Bathing Water Directive (Directive 2006/07/EC) (SEPA, 2016). Sailing is popular in the area with Moray Firth harbours being home to several hundred recreational vessels. In addition to this, boat-based dolphin watching attracts many tourists to the Moray Firth, with numerous boats operating cruises during summer months (Moray Firth Partnership, 2011). Angling is important in the area with several rivers (e.g. River Spey) supporting internationally important populations of Atlantic salmon. Other popular activities include land-based wildlife watching, cycling, walking/hiking, sea kayaking/canoeing, scuba-diving and surfing (Moray Firth Partnership, 2011; LUC, 2016).

6.10 Land and Seascape

There are relatively few landscape designations within the Moray Firth. The Dornoch Firth National Scenic Area (NSA) is the closest designated site with policy protection (52 km to the west of the Beatrice surface facilities). Additionally, there are a number of non-statutory local landscape designations, including on the south coast of the Black Isle and inner Moray Firth, and along the east Caithness coastline. Such sites are designated at a local level, are shown on local development plans, and have associated policies to safeguard their valued features.

7. IMPACT AND RISK ASSESSMENT METHODOLOGIES

This section presents the Environmental and Socio-Economic Impact Assessment (ESIA) and the Environmental and Socio-Economic Risk Assessment (ESRA) matrices used to determine the impact of the planned and accidental activities (respectively) associated with the Beatrice Field Decommissioning Project.

In addition, it presents the approach used to categorise the level of confidence for each assessment. This approach follows the guidelines produced by the Institute of Ecology and Environmental Management (IEEM, 2010).

7.1 Receptors and Aspects

Prior to carrying out the ESIA / ESRA the potential receptors likely to be impacted were identified (Chapter 5 and 6), and the ways in which the activities may interact with the environment, i.e. the "aspects"(Chapter 3) were ascertained.

7.1.1 Environmental and Socio-Economic Receptors

Receptors to be considered in the ESIA and ESRA include:

Environmental receptors:

- Air quality;
- Climate;
- Water quality;
- Sediment quality;
- Plankton;
- Benthic communities (including flora and fauna);
- Fish;
- Marine mammals;
- Seabirds;
- Coastal marine communities;
- Designated areas;
- Landfill.

Social receptors:

- Resource availability (e.g. diesel, landfill sites etc.);
- Fisheries;
- Shipping;
- Local communities (including other users e.g. tourism and persons living/working near the decommissioning yards, ports etc.);
- Cultural heritage (e.g. wrecks).

7.1.2 Identification of Aspects

Aspects to be considered include:

- Energy use and emissions to air;
- Physical presence of vessels and drilling rig;
- Physical presence of infrastructure decommissioned *in situ;*
- Discharges to sea;
- Disturbance to the seabed (including disturbance to the cuttings piles);
- Underwater noise;
- Visual impacts;
- Waste generation;

- Resource use;
- Unplanned events; and
- Yard activities e.g. noise, odour etc.

The aspects associated with each activity were assessed in terms of their impact on the receptors in the area. For example, the use of vessels will result in emissions to air, discharges to sea, underwater noise, physical use of space and, if anchored, disturbance to the seabed. Receptors potentially impacted by these aspects include air quality, climate, marine mammals, seabirds, other users of the sea, seascape and benthic communities (if anchored).

7.2 ESIA for Planned Activities

The significance of the environmental/social impact of planned activities on each of the susceptible receptors is derived by considering the 'Receptor Sensitivity' in relation to the 'Magnitude of Effect' of the aspect.

7.2.1 Receptor Sensitivity

Four categories of Receptor Sensitivity are applied ranging from 'Low' to 'Very High' as shown in Table 7-1.

Table 7-1: Receptor Sensitivity.

Category	Environmental Definition
(a) Low	**Flora/Fauna/Habitats - within the impacted area** • Population sizes are considered to be of little to no geographical importance. • Species do not have designated conservation status and are of IUCN 'Least Concern'. • No designated habitat/sites. • Impacted species are widespread in the North East Atlantic region. **Air quality:** Emissions may impact on other nearby installations. **Water quality**: Open offshore water body. **Cultural heritage sites**: Site integrity is already compromised. **Resource availability:** (e.g. landfill sites, diesel use) Renewable and/or abundant. **Third party users:** have capacity to absorb change without impact.
(b) Medium	**Flora/Fauna/Habitats – within the impacted area** • Significant numbers of at least one receptor of national importance (e.g. PMFs). • Significant numbers of a species which is listed as IUCN 'Near Threatened'. • Nationally designated habitat/sites (e.g. PMFs). • Species may be of regional value. **Air quality**: Populated areas nearby. **Water quality**: Semi-enclosed water body with good flushing. **Cultural heritage sites:** Site is of local heritage importance. **Resource availability**: (e.g. landfill sites, diesel use) Renewable and/or available. **Third party users:** have capacity to absorb change without significant impact.
(c) High	**Flora/Fauna/Habitats – within the impacted area** • Significant numbers of at least one receptor of regional (European) importance (e.g. Annex II / IV species and OSPAR designations). • Significant numbers of a species which are listed as IUCN 'Vulnerable'. • Regionally designated habitats/sites (e.g. OSPAR designations and Annex I habitats: SACs and SPAs). • Locally distinct sub-populations of some species may occur. **Air quality:** Densely populated areas nearby. **Water quality:** Semi-enclosed water body with limited flushing. **Cultural heritage sites:** Site is of regional heritage importance. **Resource availability:** (e.g. landfill sites, diesel use) Not renewable and/or limited availability. **Third party users:** have low capacity to absorb change and significant impact is likely to occur.

Category	Environmental Definition
(d) Very High	**Flora/Fauna/Habitat – within the impacted area** • Significant numbers of at least one receptor of international importance. • Significant numbers of a species which are listed as IUCN 'Endangered' or 'Critically Endangered'. • Internationally designated habitats/sites (e.g. Ramsar sites). • At least one receptor is endemic (unique) to the area. **Air quality:** Very densely populated area with sensitive receptors such as schools and hospitals. **Water quality:** Enclosed water body with no flushing. **Cultural heritage sites:** Site is of international heritage importance. **Resource availability:** (e.g. landfill sites, diesel use) Not renewable and/or scarce availability. **Third party users:** have no capacity to absorb change e.g. unemployment due to long term closure of fisheries.

7.2.2 Climate Change

With respect to the emission of greenhouse gases, climate is considered a global receptor rather than a local receptor. The categories identified in Table 7-1 do not capture definitions for climate change. This is because the sensitivity status of climate is considered to be 'Very High' in line with the 2014 Climate Change Report produced by the Intergovernmental Panel on Climate Change (IPCC, 2014).

7.2.3 Magnitude of Effect

Definitions for the Magnitude of Effect on the receptors are presented in Table 7-2. Prior to determining the Magnitude of Effect, industry recognised 'base case' mitigation measures were assumed to be applied e.g. on mobilisation of vessels to carry out the work Repsol Sinopec Resources UK will notify other sea users e.g. SFF. Additional Repsol Sinopec Resources UK or Project specific measures would include having a fisheries liaison officer on board any reel lay vessels that may be mobilised. These additional mitigations are considered prior to identifying the residual impact.

Table 7-2: Magnitude of Effect.

Magnitude Level		Description	
		Environmental Impact	Social Impact
0	**Positive/No effect** *Regulatory compliance or Company goals are not a concern.*	**No environmental concerns** • Positive environmental impact e.g. retaining a 500 m zone resulting in a 'protected area'. • No significantly negative environmental effects.	**No public concerns** • Possible enhancement in the availability of a resource benefitting the persons utilising the area e.g. removal of 500 m zones results in return of access to fishing grounds. • No impacts on sites or features of cultural heritage. • No impact on resource or landfill availability.
1	**Negligible** *Regulatory compliance or Company goals are not breached.*	**Negligible environmental effects** • Any effects are unlikely to be discernible or measurable and will reverse naturally. • No beaching or transboundary impacts.	**Limited local public awareness and no concerns** • An intermittent short-term decrease in the availability of a resource which is unlikely to be noticed e.g. vessels working out-with existing 500 m exclusion zones could temporarily impact on a shipping route or fishing area. • Undiscernible changes to a site or feature of cultural heritage that do not affect key characteristics and are not above background changes. • Undiscernible use of a resource (e.g. diesel, rockcover or landfill).
2	**Minor** *Regulatory compliance is not breached.*	**Minor, localised, short term, reversible effect** • Any change to the receptor is considered low, would be barely detectable and at same scale as existing variability. • Recover naturally with no Company intervention required. • No beaching or transboundary impacts	**Some local public awareness and concern** • A temporary (<1 year) decrease in the availability or quality of a resource e.g. access to fishing grounds may temporarily be inhibited due to presence of vessels. • Minor changes to a site or feature of cultural heritage that do not affect key characteristics. • Minor use of a resource (e.g. diesel, rockcover or landfill).
3	**Serious** *Possible minor breach of regulatory compliance.*	**Detectable environmental effect within the project area** • Medium localised changes to the receptor are possible. • Localised Company response may be required. • No beaching or transboundary impacts.	**Regional / local concerns at the community or stakeholder level which could lead to complaints** • Medium decrease in the short-term (1-2 years) availability or quality of a resource affecting usage e.g. bring a rig on site for 1-2 years. • Nuisance impacts e.g. marine growth odour coming from yards. • Partial loss of a site or feature of cultural heritage. • Moderate use of a resource (e.g. diesel, rockcover or landfill).

Magnitude Level		Description	
		Environmental Impact	**Social Impact**
4	**Major effect** *Possible major breach of regulatory compliance.*	**Severe environmental damage extending beyond the project area** • High, widespread mid-term (2-5 years) degradation of the receptor. • Company response (with Corporate support) required to restore the environment. • Possible beaching and / or transboundary impacts.	**National stakeholder concerns leading to campaigns affecting the Company's reputation** • High mid-term (2-5 year) decrease in the availability or quality of a resource affecting usage e.g. closure of fishing grounds. • Substantial loss or damage to a site or feature of cultural heritage. • High use of a resource (e.g. diesel, rockcover or landfill).
5	**Critical effect** *Major breach of regulatory compliance resulting in project delays and prosecution.*	**Persistent severe environmental damage** • Very high, widespread long-term (>5 years) degradation to the receptor that cannot be readily rectified. • Major impact on the conservation objectives of internationally/nationally protected sites. • Full Corporate response required. • Major beaching and/or transboundary impacts.	**International public concern and media interest affecting the Company's reputation** • Very high decrease in availability of a resource and potentially livelihood of users for > 5 years e.g. *hydrocarbons on beaches affecting tourism or tainting of fish resulting in the long-term closure of fishing grounds.* • Total loss of a site or feature of cultural heritage. • Significant use of a resource (e.g. diesel, rock cover or landfill).

7.2.4 Cumulative Impacts

The EIA sets the activities and potential impacts in the context of all other activities taking place in the Beatrice Field area to determine the additional cumulative effects of the new activities. The potential cumulative effects are discussed in the impact assessment chapters e.g. cumulative impacts on climate change.

7.2.5 Environmental / Socio-Economic Impact Significance

The 'Receptor Sensitivity' and the 'Magnitude of Effect' were combined using the matrix presented in Table 7-3 to determine the level of impact for planned activities.

Table 7-3: ESIA matrix for planned activities.

		Receptor Sensitivity			
		(a) Low	(b) Medium	(c) High	(d) Very high
Magnitude of Effect	(0) Positive/No effect				
	(1) Negligible				
	(2) Minor				
	(3) Serious				
	(4) Major				
	(5) Critical				

(i) Positive / No effect significance	• Positive or no environmental or social impact. • No public interest or positive public support.
(ii) Low significance	• No/negligible environmental and social impact. • No concerns from consultees.
(iii)Moderate significance	• Discernible environmental and social impacts. • Requirement to identify project specific mitigation measures. • Concerns by consultees which can be adequately addressed by the Company.
(iv)High significance	• Substantial environmental and social impacts. • Serious concerns by consultees requiring Corporate support. • Alternative approaches should be identified.

7.2.6 Transboundary Impacts

Where relevant, transboundary impacts of each aspect on the receptors is discussed in the impact assessment chapters e.g. the impact of emissions on climate change.

7.3 ESRA for Unplanned Events

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

7.3.1 Environmental and Social Significance of an Unplanned Event

The ESIA approach described in Section 7.2 for determining the environmental and social impacts of planned activities was also used to determine the significance of impacts that may result from unplanned events.

7.3.2 Likelihood of an Unplanned Event

Five categories of 'likelihood' have been identified as presented in Table 7-4.

Table 7-4: Likelihood of an unplanned event.

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

7.3.3 Environmental Risk of an Unplanned Event

Combining the significance of the environmental/social impact with the 'likelihood of the unplanned event occurring' allows the level of environmental risk to be determined using the matrix presented in Table 7-5. Note the potential for a beneficial impact significance has been removed as it is not expected that an unplanned event would lead to a beneficial environmental or social impact.

Table 7-5: ESRA matrix for unplanned activities.

		Environmental significance of unplanned event*		
		(ii) Low	(iii) Moderate	(iv) High
Likelihood of event	Extremely remote	Low	Low	Low
	Remote	Low	Low	Medium
	Unlikely	Low	Medium	Medium
	Possible	Low	Medium	High
	Likely	Low	High	High

*Note the numbers associated with each significance level range from (ii) to (iv) in keeping with assignment in Table 7-3.

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

7.4 Confidence Level

In support of the impact significance or environmental risk ranking assigned, a confidence level has been assigned to each ranking. The method applied is based on guidelines produced by the Institute of Ecology and Environmental Management (IEEM, 2010). The level of confidence that can be placed on the impact and risk significance predictions in the ESIA and ESRA assessments are highly dependent on the degree of uncertainty associated with the basis for the assessment, including the adequacy of available data, knowledge and understanding of the environmental component being assessed, the proposed technology, the nature of the project-environment interaction and the efficacy of the proposed mitigation. Applying a level of confidence allows for identification of those activities that are poorly understood and may require the impacts/risks to be analysed further throughout the project.

Three categories of confidence are applied: High, Medium and Low as defined in Table 7-6.

Table 7-6: Level of confidence.

Level of Confidence	Definition
High	Activity is clearly defined and Receptor Sensitivity is well understood. Nature of the impact is well understood.
Medium	Activity is defined, though may be subject to change. Nature of the impact is understood but some data gaps exist e.g. modelling may make assumptions; sufficient survey data may not be available.
Low	Activity is poorly defined and subject to change. Receptor Sensitivity is not understood. Large data gaps. Nature of impact is poorly understood.

7.5 ENVID Workshop

The results of the ENVID workshop are presented in Appendix A. For each activity assessed, a sensitivity ranking for each receptor, taking into account the baseline data presented in Chapters 5 and 6 and the definitions presented in Table 7-1 has been assigned. Using experience of the personnel in attendance (subsea engineers, topside and jacket engineers, environmental engineers and safety engineers) and the definitions provided in Table 7-2 a Magnitude of Effect was assigned. The subsequent environmental and/or socio-economic Impact Significance was assigned taking into account the highest level of receptor sensitivity.

The following Chapters (chapters 8 to 15) provide further assessment of the Impact Significance of planned events and the Environmental Risk (Chapter 15) of unplanned events. It should be noted that the receptor sensitivity and magnitude of effect are not discussed separately for each activity, rather the reader is advised this information is available in the ENVID table (Chapter A).

8. PHYSICAL PRESENCE

Using the assessment methodology described in Chapter 7, this chapter discusses the potential environmental and socio-economic impacts on other sea users and animals other than the benthic species, associated with the physical presence of:

- The vessels associated with the proposed Beatrice Decommissioning Project;
- The pipelines and power cables to be decommissioned *in situ*;
- The worst case scenario whereby 10 % of the flexible concrete mattresses and all of the grout filled mattresses and large grout bags (as summarised in Table 3-7) are decommissioned *in situ* with rock cover added to mitigate snagging by fishing gear; and
- The Beatrice AD cuttings pile management option whereby it is decommissioned *in situ*

The impacts on the seabed and the local benthic communities are discussed in Chapter 11 'Seabed Disturbance'.

8.1 Activities (Cause of Impact)

Specific vessels will be used for the different decommissioning activities and could include a jack-up drilling rig, HLVs, ROVSVs, survey vessels, trawl vessels and possibly a rock dump vessel. The physical presence of these vessels in the Beatrice area could potentially result in navigational hazards, a restriction of fishing operations and disturbance to marine mammals and birds.

In line with the results of the CA, Repsol Sinopec Resources UK propose to decommission all the pipelines and cables *in situ*. The end sections and exposed mid-line sections of the buried pipelines and power cables will be trenched and buried. The surface laid section of the Dunbeath power cable will be decommissioned *in situ* with no remedial activity.

The Project's base case is full recovery of all stabilisation features, though as described in Section 3.3.9 the EIA assesses a worst case whereby 10 % of the flexible concrete mattresses and all of the grout filled mattresses and large grout bags are rock covered and decommissioned *in situ*.

As described in Section 3.3.6, Repsol Sinopec Resources UK are continuing to investigate the optimal approach to managing the Beatrice AD cuttings pile. This EIA assesses the impacts associated with decommissioning the cuttings pile *in situ* following recovery of the Beatrice AD jacket, conductor guide frame and drilling template.

8.2 Impact of the Physical Presence of Vessels on Receptors

When taking Receptor Sensitivity and the Magnitude of Effect into account the ENVID determined that the Impact Significance of the presence of the vessels (associated with the proposed offshore activities) on other sea users, marine mammals and birds will be low (see Appendix A). These impacts are therefore only discussed briefly here. Note the impact of accidental spills of fuel during bunkering or as a result of a total loss of fuel inventory are discussed in detail in Chapter 15 'Accidental Events'.

8.2.1 Impact on Other Sea Users

Shipping activity in the area is considered very low (see Chapter 6). In terms of effort and landings the area is of relatively low significance to larger fishing vessels; however, it is a more important fishing ground for smaller vessels (see Chapter 6).

Most of the offshore activity associated with the proposed decommissioning activities will take place within the five existing 500 m exclusions zones. Except for the seabed clearance and over trawl trials (if required), activity out with the exclusion zones will be limited to the pipeline ends and exposed mid-line sections and to the lengths of lines covered in protective structures. Across all the pipelines and power cables, the trenching and burying activities and the decommissioning activities associated with the protective structures (i.e. mattresses, grout bags and concrete tunnels) are anticipated to last around 60 to 70 days (see Section 3.3.10).

A number of mitigation measures have been identified to minimise the impact of vessel activity in the area on other sea users. These are captured in the ENVID table (Appendix A) and summarised in Section 8.5.

Combining the mitigation measures identified with the fact that most of the offshore activities will take place within existing exclusion zones the Impact Significance of the vessels on other sea users is considered Low. This ranking takes into account available information on shipping and fishing activities such that the Confidence Level in the ranking is considered High.

8.2.2 Impact on Marine Mammals

As discussed in Section 5.5 a number of marine mammals occur in the Beatrice Field area. An increase in vessel traffic at a location occupied by marine mammals could cause disturbance and increase the risk of injury through vessel strikes. However, the evidence for lethal injury from boat collisions to marine mammals suggests that collisions with vessels are very rare (CSIP, 2011).

Given that marine mammals in the Moray Firth have coexisted with shipping, fishing and tourist activities for many years, they can be considered to be habituated to the physical presence of vessels. The Impact Significance, on marine mammals, of the additional vessels associated with the proposed decommissioning activities is, therefore, considered Low (note this relates to impacts associated with physical contact with the vessels. Impacts associated with underwater vessel noise are discussed in Chapter 12). The Confidence Level in the ranking is considered to be High as it is based on the fact that there have been no reports of significant levels of marine mammal/vessel collisions within the Moray Firth.

8.2.3 Impact on Birds

As described in Section 5.5 a number of bird species are found in the Beatrice area. Many of these birds will travel to the area from the SPAs that are found along the Moray Firth coast (see Section 5.6).

Disturbance from vessels has the potential to cause displacement of seabirds from foraging habitat and may cause flying birds to detour from their flight routes. For example, auks (guillemot, razorbill and puffin) are believed to avoid vessels by up to 200 to 300 m but gulls (e.g. kittiwake, herring gull and great black-backed gull) are attracted to the presence of them (Furness & Wade 2012). Auks and gulls are known to occur in the area (see Section 5.5); however, any short term behavioural responses associated with avoidance of / attraction to vessels is not considered significant.

Given the existing vessel activity in the Moray Firth, the close proximity of the Beatrice Field to the coastline and the fact that the existing platforms have navigation lights associated with them, it is expected that any impact the additional vessel activity could have on birds is negligible. Therefore, the Impact Significance of the vessels associated with the offshore activities on birds is considered Low and the Confidence Level in the ranking is considered to be High

8.3 Presence of Items to be Decommissioned *In Situ*

This section only considers the impact on other sea users. The impact on benthic species in considered in Chapter 11 ‘Disturbance to the Seabed’. It is possible for fishing gear to interact with subsea oil and gas infrastructure. Chapter 6 provides details of the types of fishing gear associated with the Beatrice Field area which includes demersal and *Nephrops* trawls and scallop dredges.

When taking Receptor Sensitivity and the Magnitude of Effect into account the ENVID determined that the socio-economic Impact Significance of the pipelines and power cables to be decommissioned *in situ* will be Low (see Appendix A). As the base case is to recover all stabilisation features, the socio-economic impact of decommissioning them is also considered Low.

Depth of burial surveys (since 1998) have found the burial status of the pipelines and power cables to be very stable (see Section 3.1). It is therefore expected that when the pipeline and power cable ends and exposed mid-line sections have been trenched and buried to a depth ensuring the safety of third party users of the sea, subsequent depth of burial surveys will result in similar findings on these lengths of lines. Trawl and scallop gear currently working in the area, traverse the buried sections of the pipelines and power cables without any interaction. It is anticipated that once the trench and bury activities are completed the over-trawl trials will show that the end and exposed sections are over trawlable.

Decommissioning the nearshore section of the Dunbeath power cable *in situ* is not expected to impact on other sea users. This section of the pipeline is laid on rocky seabed (see Section 3.3) that is not accessible by scallop dredges or demersal trawls.

Section 3.3.9 summarises the volume of rock cover that would be required assuming a worst case whereby 10% of the flexible concrete mattresses and all of the grout filled mattresses and large grout bags were rock covered and decommissioned *in situ*. It is anticipated this rock would result in a total footprint of *c*. 0.0051 km^2. In the event that any rock cover is laid, the rock size selected will be in accordance with industry best practice and SFF recommended practice such that demersal trawl gear would be expected to be able to access the area. However, it should be noted that the addition of rock cover is likely to restrict access by scallop dredges.

In the event that some of the grout filled mattresses cannot be recovered and subsequent consultation with BEIS identifies decommissioning *in situ* without rock cover as being the optimal option, there is potential for interaction with fishing gear. This interaction could include fishing gear snagging on sections of line under the grout filled mattresses that may become exposed should the mattresses break up over time. However, if the line was to become exposed it is expected that this would be identified during the future pipeline route surveys. In addition, the sections of line covered with these mattresses did not have spans associated with them, rather the mattresses were used to cover exposed sections such that it is expected that fishing gear could be trawled over them, though scallop dredges would likely be excluded.

As discussed in Section 3.3 recovery of the jackets has been assumed for the EIA to involve cutting the piles externally. Following removal, this could result in a seabed depression at each jacket leg location with a diameter of *c*. 4 m and depth of 3 m based on a worst case whereby the piles are cut 3 m below the seabed. Repsol Sinopec Resources UK are investigating methods of excavating such that following removal of the jacket, the excavated material can be used to fill in the hole created. As a worst case this EIA assesses the use of rock cover to fill in the holes. It is estimated that 80 te of rock cover would be required to fill each hole if piles were severed externally at a 3 m depth. Across all locations: Beatrice A, B, C and at the WTGs, it is expected that scallop dredges would be excluded from an area of around 0.0028 km^2 .

Repsol Sinopec Resources UK are still investigating the optimal approach for decommissioning the Beatrice AD cuttings pile. Should it be decommissioned *in situ* it is unlikely that scallop vessels would be able to dredge in the area of the pile. The footprint of the cuttings pile is around 0.002 km^2.

Combining the maximum footprint associated with (i) rock covering 10% of the flexible concrete mattresses and all of the grout filled mattresses and large grout bags; (ii) backfilling the jacket leg holes with rock and (iii) the footprint of the Beatrice AD cuttings pile suggests that scallop dredgers would continue to be excluded from an area of less than 0.01 km^2, whilst trawl gear would have to fish these areas with care.

Following decommissioning activities, it is estimated that a total footprint of around 3.9 km^2 will be returned to the fishing industry. This includes the area within the five existing exclusion zones (less the area not accessible to scallop dredges), and the areas along the pipelines and cables that will be trenched and buried. When the area that will continue to not be accessible to scallop dredges (c 0.01 km^2) is compared to the area to be returned to the fishing industry it represents around 0.25%.

Following decommissioning activities independent verification of the seabed state will be obtained for the pipeline areas and installation locations and evidence of clearance will be provided to all relevant governmental and non-governmental organisations. This could involve side scan sonar surveys and/or over trawl sweeps and/or over trawl trials. This EIA assumes the worst case disturbance of over trawl sweeps and over trawl trials. If carried out the trawl sweeps will be carried out using a chain mat (Figure 8-1) and will serve to recover debris and to break up any clay berms that could result from the trenching and burying activities. It should be noted that clay berms are not expected to occur in this area.

Figure 8-1: Photograph showing a chain mat using for trawl sweeps (courtesy of SFF).

The social Impact Significance of decommissioning the pipelines and power cables *in situ* following trenching and burying of the ends and exposed sections is considered Low. The Confidence Level of this ranking is considered High, given the stability of the seabed in the area, and Repsol Sinopec Resource UK's adherence to the requirement for a seabed clearance certificate and to an agreed pipeline survey plan (i.e. agreed with BEIS) following completion of the decommissioning activities.

Though the area of seabed that will remain inaccessible to scallop dredges is significantly less than that returned, Repsol Sinopec Resources UK acknowledges there will be a socio-economic impact and therefore consider the Impact Significance to be Moderate. The Confidence Level in the ranking is considered Medium as it is understood that some of the smaller fishing vessels active in the area do not have access to FishSafe, and it is therefore unclear how they will be made aware of (i) the presence of any stabilisation features and associated rock cover that may be decommissioned *in situ*, (ii) the cuttings pile if decommissioned *in situ* and (iii) if used, the rock added to fill the depressions resulting from removal of the jackets.

8.4 Transboundary and Cumulative Impacts

Given the distance from the nearest transboundary line (*c*. 265 km), unless transported to a non UK yard there are no transboundary impacts anticipated as a result of the activities captured in this Chapter.

Should some of the stabilisation features be rock covered and decommissioned *in situ* and should the Beatrice AD cuttings pile be decommissioned *in situ*, they will lead to some cumulative impacts with other projects e.g. the different wind farm projects in the Moray Firth area. This primarily pertains to the areas that can be accessed by fishing gear. However, given the base case of full recovery of all stabilisation features and the relatively small area associated with the Beatrice cuttings pile, this cumulative impact when considered in relation to the approved wind farm projects in the Moray Firth is not considered significant.

8.5 Mitigation Measures

The following mitigation measures are proposed to minimise the environmental and socio-economic impacts associated with the physical presence of the vessels and the items to be decommissioned *in situ*.

Proposed Mitigation Measures

- Ongoing consultation with SFF;
- Notice to mariners will be circulated;
- A Vessel Traffic Survey will be undertaken to support a CtL application;
- A Collision Risk Management Plan will be produced if required;
- Vessel use will be optimised and Repsol Sinopec Resources UK will continue to explore synergies, e.g. the potential to share supply boats, with wind farm developers in the area;
- All vessels engaged in the project operations will have markings and lightings as per the International Regulations for the Prevention of Collisions at Sea (COLREGS) (International Maritime Organisation, 1972).
- If used rock cover will be optimised and carefully managed. A fall pipe will be used to ensure accuracy of the rock dumping. Size of rock cover will be in accordance with industry practice which is also the preferred SFF / industry best practices.
- Locations of remaining materials (could possibly include unrecovered stabilisation features, rock cover and the Beatrice AD cuttings pile) will be marked on FishSafe.

8.6 Conclusion

Given the presence of shipping, fishing vessels and recreational craft in the Moray Firth; the exclusions zones at the Beatrice platforms and WTGs; and the extended schedule for the proposed decommissioning activities, the physical presence of the vessels required to complete the activities is not considered to have a significant environmental or socio-economic impact.

Depth of burial studies along the Beatrice pipeline and power cables show the seabed in the area to be very stable such that decommissioning the buried infrastructure *in situ* and trenching and burying the ends and exposed mid-line sections is not expected to have a significant impact.

The base case is to recover all stabilisation features, however, should this not be possible any rock cover that may be added will be in accordance with industry practice such that the impact on fishing activity in the area will be minimised. Following completion of the decommissioning activities, the five exclusion zones will be surrendered (c. 3.9 km^2) and the area will be accessible to the fishing industry.

The activities assessed in this chapter will not contradict the NMP objectives (see Section 5.7) and as the project progresses Repsol Sinopec Resources UK will ensure they comply with the NMP policies that have been introduced.

9. ENERGY USE AND ATMOSPHERIC EMISSIONS

Using the assessment methodology described in Chapter 7 this section discusses the potential environmental impacts associated with the energy use and atmospheric emissions produced as a result of the proposed decommissioning activities. Mitigation measures intended to achieve optimum energy efficiency and reduce emissions are also considered.

The Energy Institute (formerly the Institute of Petroleum) produced Guidelines for the Calculation of Estimates of Energy Use and Gaseous Emissions in the Decommissioning of Offshore Structures (IoP, 2000).

9.1 Activities (Cause of Impact)

Activities considered likely to consume energy and lead to emissions to atmosphere include:

- Offshore operations;
- Recycling and recovery of materials; and
- Manufacture of materials to replace those decommissioned in-situ.

It should be noted that onshore transportation of recovered materials is not expected to be carried out at a scale that would lead to significant additional emissions when considered in the wider context of general onshore transportation activities. They are therefore not considered further in this report. This is in line with the approach taken in the Energy Institute Guidelines cited above.

9.1.1 Offshore Operations: Vessel Activity

The principal emissions local to the Beatrice complex and associated subsea activities will be the releases of combustion gases from the jack-up drilling rig and the vessel engines. The assumed drilling rig and vessel requirements and anticipated fuel use for the proposed decommissioning activities are presented in Table 3-12 whilst Table 9-1 presents the anticipated emissions associated with this fuel use.

Table 9-1 Energy use and emissions associated with vessel activity.

Activity	Total fuel use (te)	Energy use (GJ)	Te						
			CO_2	NO_x	N_2O	SO_2	CO	CH_4	VOC
P&A activities (drill rig and supporting vessels)	24,813	1,057,034	79,401	1,474	5.5	99	390	4.5	50
Decommissioning activities: recovery, trenching / burying and over trawls	18,840	802,584	60,288	1,119	4	75	296	3.4	38
Post decommissioning survey	720	30,672	2,304	43	0.3	2.9	11	0.13	1.4

Assuming a worst case scenario whereby all the decommissioning activities associated with platform, WTG and subsea decommissioning occurs within a 36 month period then the maximum annual CO_2 emissions would comprise around 0.2 % of total UKCS domestic and international shipping emissions for 2014 (9,900,000 te; Committee on Climate Change, 2016). Should there be an overlap of the P&A and the decommissioning activities the total maximum CO_2 emissions anticipated in any one year would be *c.* 50,000 te which represents *c.* 0.3 % UKCS domestic and international shipping emissions (this assumes the P&A campaign is split over seven years and decommissioning activities split over three years).

9.1.2 Recycling and Manufacture of Replacement Materials

Recycling and recovery of materials from the structures to be returned to shore will have an energy demand and associated emissions. These will primarily be associated with the recovery of the steel. Whilst leaving materials *in situ* has no energy use or associated emissions to atmosphere, the energy use and emissions used to replace those "lost" materials can be calculated using the Institute of Petroleum (IoP) guidelines. The consideration of these allows the energy use and emissions from the other activities to be put into context.

The estimated emissions associated with the recycling of the Beatrice infrastructure to be recovered, as well as those associated with producing equivalent volumes of steel that will be decommissioned *in situ* have been estimated (Table 9-2) using the IoP Guidelines (IoP, 2000). It is anticipated that recycling of recovered metals other than steel will not be undertaken on a scale that will lead to significant additional emissions, so they are not considered further. Recovered concrete (e.g. from mattresses) may be crushed for reuse, an activity considered to have a relatively low energy demand and therefore are also not considered further.

Table 9-2: Estimates of energy use and emissions from recycling and replacement of steel.

Infrastructure	CO_2 (te)	Energy use (GJ)
Energy and emissions associated with recycling of recovered steel	38,000	422,000
Energy and emissions associated with production of steel to replace that decommissioned *in situ*	31,500	335,000
Total	**69,500**	**757,000**

When the total CO2 emissions associated with the onshore activities is compared against the 13 million te of carbon dioxide equivalent (CO_2e) emitted from the industry process across the UK (Scotland, England, Wales and Northern Ireland) in 2014 (DECC, 2016a) the anticipated CO_2 emissions represent *c*.0.5 % of total CO_2e industry emissions.[1]

9.2 Impact on Receptors

The energy consumption associated with the decommissioning activities for the Beatrice Field is expected to lead to the emission of combustion gases including CO_2, methane (CH_4), nitrogen oxides (NO_x), sulphur dioxide (SO_2) and volatile organic compounds (VOCs).

The direct impact of NO_x, SO_2 and VOC in the atmosphere is the formation of photochemical pollution in the presence of sunlight, comprising mainly low level ozone, but by-products may include nitric acid, sulphuric acid and nitrate-based particulate. The formation of acid and particulates may lead to a contribution to acid rainfall and the dry deposition of particulates. If such a deposition occurs at sea, it is possible that the substances will dissolve in sea water but the level of deposition is unlikely to lead to any significant impacts on local sea water composition due to the relatively small amount when compared to emissions from other vessels. In addition, the ultimate fate of atmospheric emissions can often be difficult to predict owing to the dependence on variable weather (especially wind), over quite short timescales.

CO_2 emissions contribute to greenhouse gas emissions and global warming impacts. The maximum annual estimates of vessel CO_2 emissions produced as part of the Beatrice decommissioning operations in relation to the total CO_2 produced from UK domestic shipping (Committee on Climate Change, 2015) is c.0.5 %. In addition, there will be a contribution to global warming from other gaseous emissions, the overall Global Warming Potential (GWP - a relative measure of how much heat a greenhouse gas traps in the atmosphere). The contribution will be proportional to the

[1] This 13 million te of CO_2e does not include emissions from energy supply, transport, business, residential, agriculture, waste management, public section, land use or forestry. The industrial process sector consists of emissions from industry except for those associated with fuel combustion.

volume of emissions, as for CO_2. Therefore, the overall GWP will also constitute a relatively small increase to existing emissions.

In general, environmental conditions offshore will lead to rapid dispersion and dilution of any emissions to atmosphere. The Beatrice facilities are located *c.*22 km from the nearest UK coastline. Offshore weather conditions will mean that impacts will be localised and short term. It is considered that the emissions to atmosphere from the Beatrice decommissioning activities are unlikely to lead to any significant impacts on either sea water quality or air quality and will not have a significant contribution to global warming.

When compared against emissions associated with the wider UKCS emissions and given that the activities are relatively short term (in comparison to those associated with new installations) the Impact Significance of emissions on climate change, air quality and seawater quality has been assessed as Low. The Confidence Level in this ranking is Medium as the estimates presented are based on assumptions about vessel types and an indicative schedule which could change as the project progresses.

9.3 Transboundary and Cumulative Impacts

Given the distance from the nearest transboundary line (*c.* 265 km), any transboundary impacts of atmospheric emissions arising from the decommissioning activities at Beatrice is expected to be of low significance owing to the rapid dispersion and dilution of emissions which will occur in offshore weather conditions and over distance.

In relation to the current levels of shipping traffic which already occur in the Moray Firth, the expected emissions from the decommissioning activities will represent a small incremental addition to emissions of combustion gases over a relatively short time period. Therefore, although the emissions to air will contribute to global warming, the cumulative impact on receptors from the atmospheric emissions generated by the decommissioning activities for Beatrice have been assessed to be of low significance.

9.4 Mitigation Measures

The following mitigation measures are planned to optimise energy consumption and reduce the environmental impacts associated with the discharge of emissions to air.

Proposed Mitigation Measures

- As part of the tendering process, proposed vessels will go through a detailed assurance process which will include a review of generator and engine maintenance which leads to better efficiency in line with manufacturer's specifications.
- Decommissioning vessel schedules will be planned to optimise (minimise) vessel use. Repsol Sinopec Resources UK will continue to investigate synergies with other projects in the area (e.g. wind farm developers) to optimise vessel use.
- Prior to the contract award, Repsol Sinopec Resources UK will audit the decommissioning yards to ensure suitable permits are in place and that atmospheric emissions are being managed.
- Activities will be carried out in line with Repsol Sinopec Resources UK's environmental policy which includes minimising emissions.

9.5 Conclusions

The principal energy use and generation of emissions to air offshore will arise from fuel combustion for propulsion and power generation by the vessels required for the proposed decommissioning activities. Onshore recycling and the manufacture of new materials to replace those decommissioned *in situ* will also have an energy demand and will result in emissions to air. These emissions will include components which have the potential to contribute to global warming, acid rainfall, dry deposition of particulates and photochemical pollution or cause impacts on local air quality. It is expected the impacts will have a low impact significance and will be relatively short term.

The activities assessed in this Chapter will not contradict the NMP objectives (see Section 5.7) and as the project progresses Repsol Sinopec Resources UK will ensure they comply with the NMP policies that have been introduced.

10. DISCHARGES TO SEA

Using the assessment methodology described in Chapter 7, this chapter discusses the potential environmental and socio-economic impacts associated with any discharges to sea resulting from the planned decommissioning activities. These discharges include:

- Routine vessel discharges;
- Pipeline discharges: inhibited seawater (and possibly very low concentrations of hydrocarbons) during pipeline decommissioning;
- Platform discharges: e.g. entrained fluids;
- Marine growth.

Unplanned/accidental releases are discussed in Chapter 15.

10.1 Activities (Cause of Impact)

Discharges to sea from the required vessels (including the drilling rig) will include:

- Ballast water;
- Bilge water;
- General shipboard drainage; and
- Treated sewage and grey water from accommodation and amenities.

At the time of decommissioning all of the pipelines will be filled with inhibited seawater. During decommissioning, inhibited seawater will be discharged during cutting/disconnection of the pipeline ends.

Should NORM be detected during engineering down and dismantling of the topsides, it may be discharged to sea in line with the platforms Certificates of Authorisation. Any remaining hydrocarbons or chemicals identified after cleaning operations will either be captured in tote tanks and sent to shore for disposal or will be returned to shore as part of the topsides removal.

10.2 Impact on Receptors

A number of receptors could be impacted by discharges associated with the planned activities. These are identified in the ENVID table (see Appendix A) and include water quality, plankton, benthic species, fish and marine mammals. When the Receptor Sensitivity and the Magnitude of Effect were taken into account the ENVID determined that the environmental Impact Significance of the different discharges identified is low. These impacts are therefore only discussed briefly here. No socio-economic impacts were identified in relation to the planned discharges.

10.2.1 Routine Vessel Discharges

As part of contract award, Repsol Sinopec Resources UK will undertake assurance work to ensure that all contractor vessels comply with MARPOL 73/78 requirements for the handling, treatment and discharge of liquid wastes. These requirements are set at levels to avoid environmental risk such that the environmental Impact Significance of routing vessel discharges is considered Low. The Confidence Level in this ranking is considered High due to the assurance process and adherence to the MARPOL 73/78 requirements.

At the time of ENVID it was not known where the contracted vessels will originate from. Therefore, consideration was given to the potential for bioinvasions as a result of biofouling (accumulation of organisms including plants, algae, or animals such as barnacles) on vessels. The Impact Significance was considered Low as Repsol Sinopec Resources UK will only award contracts to contractors signed up to the International Maritime Organisation (IMO) Convention and are therefore required to adhere to the IMO 2011 Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Species. As these Guidelines are recognised worldwide the Confidence Level in this ranking is considered High.

10.2.2 Pipeline Discharges

The inhibited seawater within the pipelines will contain traces of chemicals and hydrocarbons. When the pipeline ends are cut e.g. to disconnect from the risers: some of the inhibited seawater will be released into the water column. Similarly, should it be necessary to recover the exposed pipeline sections (i.e. should trench and bury not be an option) release of inhibited seawater at these locations is also possible. Prior to undertaking the activities, permit applications will be submitted under the Offshore Chemicals Regulations 2002 (as amended 2011) (OCR) for the discharge of inhibited seawater and under the Offshore Petroleum Activities (Oil Prevention and Control) Regulations 2005 (as amended) for the discharge of any trace quantities of hydrocarbons.

Given that: (1) the discharges will be into an open body of water; (2) the chemicals will have been selected on both their technical specifications and their environmental performance and (3) the pipelines have been flushed and cleaned to reduce their hydrocarbon content to ALARP, the Impact Significance is considered Low and the Confidence Level in this ranking is considered High.

10.2.3 Topsides Discharges

Though the platforms will have been cleaned following procedures that are considered BAT/BEP, it is possible that some hydrocarbons or chemicals remain trapped in 'dead leg' areas. An oil discharge permit and chemical permit for any hydrocarbon and chemical discharges which may occur during dismantling will be in place. During the topsides cleaning operations, equipment will have been checked for NORM such that at the time of decommissioning the topsides are clear. However, it is possible that some inaccessible areas may be contaminated. If detected during dismantling, this NORM may be discharged to sea in line with the platforms Certificate of Authorisation.

It is possible that small quantities of contaminants remain entrained in the topsides. However, as cleaning and flushing procedures will adhere to BAT/BEP requirements the Impact Significance of any discharges that may occur during lifting operations is considered to be Low and the Confidence Level in this ranking is considered High.

10.2.4 Jacket Discharges

The platforms and WTGs will have accumulated a coating of marine growth after being on location for between 11 and 38 years.

Estimated quantities of marine growth are presented in Chapter 14. The quantity of marine growth that could fall off or be removed to allow cutting/inspection of the structures during recovery and transport is not known. The rate of drying during recovery operations will impact the amount that will fall off and will be dependent on a number of factors including the method of transportation e.g. on deck or hanging from a crane hook and the prevailing weather conditions at the time e.g. temperature, wind and humidity. Nonetheless, marine growth is entirely organic in origin, therefore any marine growth which discharged into the sea during offshore activities is unlikely to lead to any impact other than a short term increase in suspended solids. This is likely to be rapidly dispersed by hydrodynamic conditions. Marine growth will naturally biodegrade within the normal ecosystem cycle and it is highly unlikely that it will lead to detectable impacts. The Impact Significance is therefore considered Low and the Confidence Level in this ranking is considered High.

10.3 Transboundary and Cumulative Impacts

Given the distance from the nearest transboundary line (*c*. 265 km) there are no transboundary impacts anticipated as a result of the anticipated discharges. In the unlikely event that a yard outside the North Sea is selected Repsol Sinopec Resources UK will audit vessels involved in transport to ensure that marine growth 'drop off' is contained.

Cumulative impacts are considered to be highly unlikely since the impacts arising from discharges are expected to be short term with rapid dispersion.

10.4 Mitigation Measures

The following mitigation measures are proposed to minimise the environmental impacts related to the planned discharges associated with Beatrice Field Decommissioning Project.

Proposed Mitigation Measures

- Repsol Sinopec Resources UK will carry out a detailed assurance process on all vessels prior to contract award.
- Work procedures will be in place to minimise offshore campaigns.
- Only MARPOL compliant vessels will be used.
- Flushing and cleaning of topsides and pipelines is completed in line with BAT/BEP requirements.
- All contracted vessels will be signed up to IMO and will adhere to their guidelines.
- Any associated discharges will be managed to minimise impact.

10.5 Conclusions

Repsol Sinopec Resources UK will only select contractors that are complaint with MARPOL such that the environmental impact of routine vessel discharges associated with the Beatrice Field Decommissioning Project is considered low.

There is the potential for small quantities of inhibited seawater (which will have residual chemicals and possibly small quantities of hydrocarbons) to be released during pipeline cutting operations. However, given that the pipelines are flushed and cleaned in accordance to BAT/BEP requirements, and the chemicals added were selected on their environmental performance the environmental impact of any discharges during pipeline decommissioning is considered low.

As for the pipelines, flushing and cleaning of the topsides will be in accordance with BAT/BEP requirements such that the environmental impact of any discharges during lifting operations is considered low. Some quantities of marine growth are expected to be removed during inspections and cutting operations and to 'drop off' during recovery. However as marine growth is entirely organic in origin, any discharge into the sea during offshore activities is unlikely to lead to any impact other than a short term increase in suspended solids.

All of these impacts will be localised and short term given the highly dynamic environment in the Beatrice Field area.

The activities assessed in this chapter will not contradict the NMP objectives (see Section 5.7) and as the project progresses Repsol Sinopec Resources UK will ensure they comply with the NMP policies that have been introduced.

11. SEABED DISTURBANCE

Using the assessment methodology described in Chapter 7, this chapter discusses the potential environmental impacts associated with any disturbance to the seabed resulting from the planned decommissioning activities. These activities include:

- Placement of a jack-up drilling rig and possibly vessel anchors;
- Recovery of the infrastructure including jackets and protective structures;
- Trenching and burying of the pipeline and power cable ends and exposed mid-line sections;
- Contingency rock cover over 10% of the stabilisation features; and
- Over trawl sweeps and over trawl trials.

11.1 Activities (Cause of Impact)

Repsol Sinopec Resources UK has commissioned a jack-up drilling rig (the ENSCO 80) to P&A the wells at the Beatrice B and Beatrice C platforms. The Ensco 80 is a three legged jack-up rig which requires the use of anchors to move it onto location. This EIA assumes a jack-up drilling rig similar to the ENSCO 80 will be used to P&A the Beatrice A wells. In addition, depending on the selected removal methodology it is possible that any accommodation vessels used could be anchored, whilst it is expected the HLVs will maintain station using anchors.

Seabed disturbance will result from the placement of the jack-up drilling rig legs on the seabed at the Beatrice AD, B and C platforms and from the placement of any anchors used to bring it on station (up to four anchors could be used at each location). Depending on the selected removal methodology it is possible that accommodation vessels brought alongside the Beatrice A, B and C platforms will maintain position using anchors. In all cases the jack-up legs, anchors and associated anchor chains will disturb the seabed. The EIA assumes a worst case whereby Repsol Sinopec Resources UK will commission over trawl sweeps and over trawl trials to ensure a clear seabed. At each of the platforms the disturbed area will be within the area disturbed by the over trawl trials, the total footprint of which is presented below. It is expected that vessels used to recover the WTGs will operate on DP, such that there should be no disturbance of the seabed in that area associated with the vessels. Similarly, the ROVSVs to be used for the trenching and burying activities and the rock dump vessel (if required) would operate on DP.

Recovery of any infrastructure from the seabed will result in disturbance to the sediments in the area. Should internal cutting of the jacket piles not be possible, excavation of the seabed around each jacket leg will be required. As a worst case the EIA assumes an area of *c*. 13 m^2 would be excavated to a depth of 3 m at each jacket leg.

Repsol Sinopec Resources UK will continue to explore available technologies that would allow the excavated material to be backfilled into the holes following jacket recovery. However, as a worst case this EIA assesses the use of rock to fill them. It is estimated that a maximum of 80 te of rock would be required to fill each hole such that the total volume of rock required across all seven jackets is estimated to be less than 2,500 te. The seabed area impacted by rock is estimated to be 0.0028 km^2 across the five jacket locations.

Disturbance to the seabed during recovery of the platform and WTG jackets, the conductor guide frame and the drilling template will occur within the existing 500 m exclusion zones and therefore is within the footprint expected to be disturbed by the over trawl sweeps and over trawl trials (if carried out). Similarly, recovery of the stabilisation features, the two steel protection frames on PL16 and the two concrete tunnels on the Dunbeath cable will cause some disturbance to the seabed, though again this will be within areas that would be impacted by any over trawl sweeps and over trawl trials that could be commissioned.

Recovery of the AD jacket, conductor guide frame and drilling template will cause disturbance to the Beatrice AD cuttings pile. As a worst case, whereby the jacket legs are cut externally, it is anticipated that up to 85% of the cuttings pile will be disturbed. The impacts of disturbing the cuttings pile is considered separately below.

During recovery operations, trenching and burying activities will cause sedimentation beyond the immediate area of the activities. Approximately 2 km of pipelines and power cables will be trenched and buried. Following trenching and burying over trawl sweeps may be carried out such that the area impacted by the trenching and burying activities will be within the footprint of the area impacted by the trawl trials.

Repsol Sinopec Resources UK propose to recover all flexible concrete mattresses, grout filled mattresses, and grout bags (25kg and larger 11.25 te and 22.5 te bags). However as discussed in Section 3.3.9.1 as a worst case the EIA assesses the scenario whereby 10% of the flexible concrete mattresses and all of the grout filled mattresses and larger grout bags are covered with rock and decommissioned *in situ*. As seen in Table 3-7 this rock is expected to impact on an area of *c*. 0.0051 km². This rock cover would have a very localised impact on individual benthic animals.

The areas of disturbance associated with the above activities are all located within the area that would be disturbed by over trawl trials if carried out. Assuming a worst case whereby the over trawl trials will be carried over the whole area of the five exclusion zones and the full length of the buried pipelines and power cables, a total footprint of disturbance of approximately 15 km² is anticipated (Figure 11-1). This assumes over trawl trials within a corridor width of 100 m along the length of pipelines and cables (50 m either side). Note no over trawl trials are expected on the nearshore surface laid section of the Dunbeath power cable.

These trawl trials would impact on *c*. 3.5 km² of the Moray Firth SAC which is equivalent to c. 0.23 % of the SAC. It should be noted the impact associated with the over trawl trials is similar to the impact associated with fishing gear used in the area.

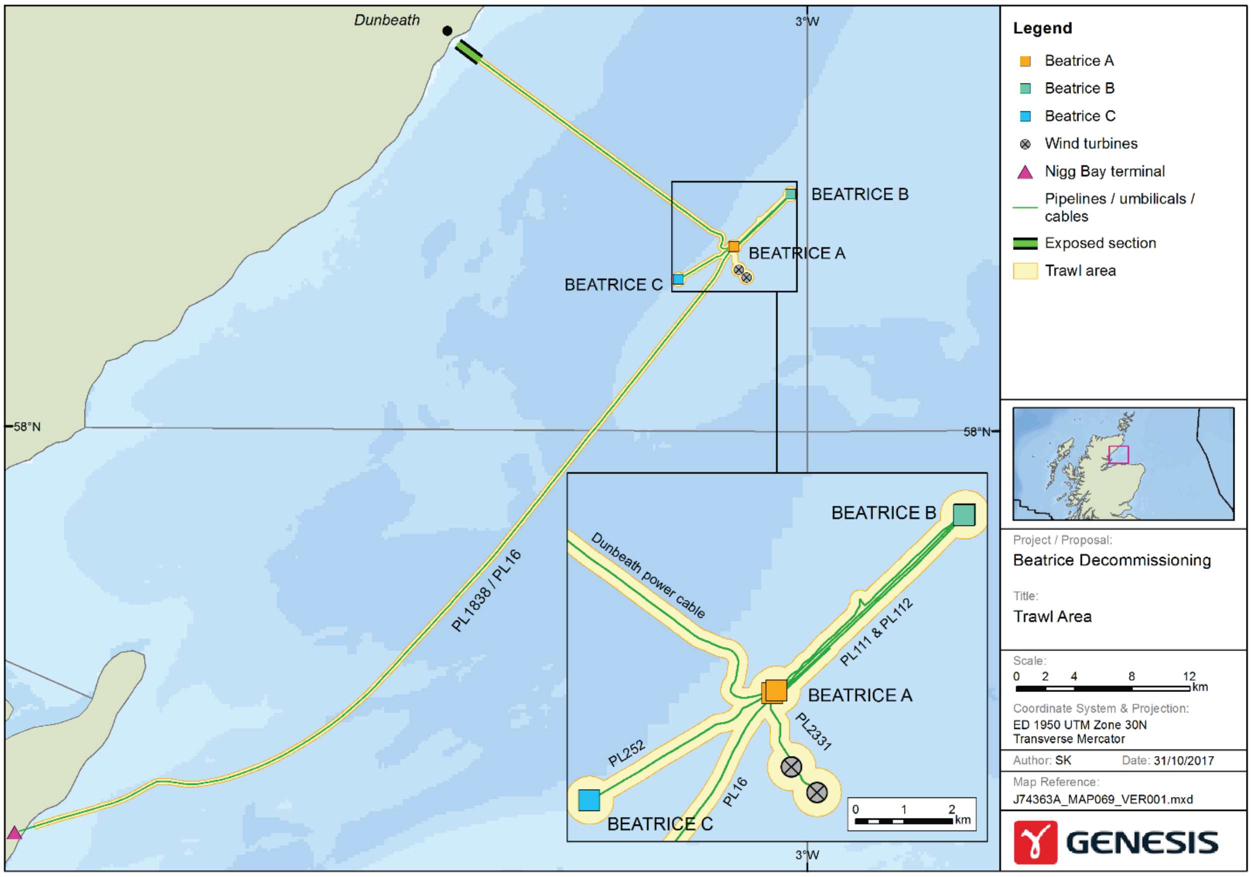


Figure 11-1: Maximum area expected to be covered by over trawl sweeps and over trawl trials.

11.2 Impact on Receptors

Maximum area of seabed disturbance associated with the proposed decommissioning activities is 15 km^2. However, this relates to an area impacted by the over trawl trials and may be less if for example side scan sonar surveys are used to obtain evidence of clearance. Impacts on this seabed area can be considered temporary because, following completion of activities, the seabed will begin to recover. Similarly, the impacts associated with the placement of the jack-up drilling rig, trenching and burying activities, recovery of structures etc. can be considered temporary.

The seabed area considered to be impacted permanently is limited to the areas where rock cover is deposited. For this assessment, it includes the potential worst case scenario of rock cover over 10 % of the flexible concrete mattresses and all of the grout filled mattresses and the larger grout bags, and the potential rock associated with the depressions formed when the jackets are recovered.

Trenching physically disturbs the benthic communities and their habitat within the area impacted and may cause some smothering in the wider region due to the re-deposition of excavated material. In addition, trenching can create a temporary plume of suspended solids. While some, mostly epifaunal, organisms are expected to be killed by the passage of the trenching machinery, the majority will be displaced, and are likely to survive. Some of the exposed organisms may not be able to re-bury before being predated upon while others may be relocated by water movements.

Given the nature of the sediment in the area it is possible that disturbed sediment particles may be transported via tidal currents for re-settlement over adjacent seabed areas. Sessile epifaunal species may be particularly affected by increases in suspended sediment concentrations as a result of potential clogging or abrasion of sensitive feeding and respiratory apparatus (Nicholls *et al*., 2003). In the case of filter feeders, such as the juvenile *A. islandica*, an increased suspended sediment concentration could impact the ability to feed. Larger, more mobile animals, such as crabs and fish, are expected to be able to avoid areas of deposition and elevated suspended solid concentrations. Evidence suggests that the sensitivity of fish to suspended sediments varies greatly between species and their life history stages, and depends on sediment composition (particle size and angularity), concentration and the duration of exposure (Newcombe and Jensen, 1996). Being the major organ for respiration and osmoregulation, gills are directly exposed to, and affected by, suspended solids in the water. If sediment particles are caught in or on the gills, gas exchange with the water may be reduced leading to oxygen deprivation (Essink 1999; Clarke and Wilber, 2000). This effect is greatest for juvenile fish as they have small easily clogged gills and higher oxygen demand (FeBEC 2010).

The ability for organisms to detect predators may also be reduced as a result of low visibility associated with suspended sediments. In instances of persistent and widespread suspended sediments there is the possibility of reduced feeding success among juvenile fish which may influence survival, year-class strength, recruitment and overall condition (Clarke and Wilber, 2000).

Any impacts from compression and sediment re-suspension are expected to be short lived since most of the smaller sedentary species associated with the area (such as polychaete worms) have short lifecycles and recruitment of new individuals from outside the disturbed area will be rapid. Recolonisation of the impacted areas 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 and burrowing species digging back to the surface. Recovery times for soft sediment faunal communities are difficult to predict, although some recent studies have attempted to quantify timescales. 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 assuming that recolonisation was through immigration into the disturbed area rather than from settlement or reproduction within the area. Recovery through immigration would be expected to take longer for the more extensive trawled areas, and larval recruitment or local reproduction by surviving individuals may be more important determining factors.

It should be noted the Beatrice infrastructure lies in an area that is targeted by scallop, *Nephrops* and demersal fishing gear and the temporary impacts of the decommissioning activities is considered to be within the envelope of the impacts associated with these gear types. The environmental Impact Significance of the temporary disturbance is therefore considered Low and the Confidence Level in this ranking is High.

The placement of rock cover will result in the loss of habitat and smothering of the benthos. Conversely, it creates habitats for benthic organisms that live on hard substrates leading to a change in the local seabed community and an increase in local habitat and community diversity. The environmental Impact Significance of any additional rock is considered Moderate and the Confidence Level in this ranking is considered High given the limited area to be impacted.

11.2.1 Disturbance within the Moray Firth SAC and Moray Firth pSPA

Following recovery of the mattresses, the length of pipelines within the Moray Firth SAC that would require to be trenched and buried is c. 577.5 m (173.5 m associated with PL1838 and 404 m associated with PL16: see Table 3-6). Assuming a worst case whereby trenching activity results in disturbance to a corridor width of 20 m (allows for some sedimentation impacts over wider area) these activities would have a temporary impact on an area of 0.011 km^2 which would equate c. 0.0007 % of the total area (1,513 km^2) of the Moray Firth SAC.

As a worst case if 10% of the flexible concrete mattresses located within the SAC could not be recovered, the rock cover added to mitigate snagging is expected to have a footprint of 0.011 km^2 (see Table 3.7). If this rock cover was laid within the Moray Firth SAC, this would equate to 0.0007 % of the total area (1,513 km^2) of the SAC. It should be noted that if a series of flexible concrete mattresses occurring within the Moray Firth SAC cannot be removed using a grab, Repsol Sinopec Resources UK would consult with BEIS and JNCC and if necessary would prioritise removal by basket over the use of rock cover.

Trawl trials would impact on c. 3.5 km^2 of the SAC which is equivalent to *c*. 0.23 % of the SAC. It should be noted the impact associated with the over trawl trials is similar to the impact associated with fishing gear used in the area.

The Moray Firth SAC is primarily designated for its bottlenose dolphin populations. In addition, subtidal sandbanks (sandbanks which are slightly covered by sea water all the time) are a qualifying feature but are not a primary reason for site selection. The trenching and burying and worst case rock cover placement activities will not have a significant impact on the bottlenose dolphins (see Chapter 12 for discussion on vessel noise). Sandbanks have inherently uncertain boundaries and therefore it is difficult to say with absolute certainty whether the pipelines cross them or not. The EIA has considered a worst case whereby these activities do occur within the boundary of the sandbanks. Based on the 'Natura 200 Standard Data Form' for the SAC (NATURA, 2015) the sandbanks occupy an area of 453.82 km^2. The trenching and burying activities within the sandbank boundaries would temporarily impact on 0.002% of this area. Given the low impact significance on the bottlenose dolphins and fact that the pipelines are out with the sandbank boundaries, the Impact Significance of the decommissioning activities on the SAC are considered Low.

As the Moray Firth pSPA covers a greater area (1,762 km^2) than the Moray Firth SAC the Impact Significance on the pSPA is also considered Low.

Note as the surface laid section of PL4331 (power cable from Dunbeath to Beatrice AP) will be decommissioned *in situ* with no remedial action being carried out, the impacts on the East Caithness Cliffs NCMPA/SPA/SAC are not considered significant.

11.2.2 Disturbance to the Beatrice AD Cuttings Pile

In order to recover the Beatrice AD jacket, conductor guide frame and drilling template it will be necessary to disturb a portion of the Beatrice AD cuttings pile. Should the base case of cutting the piles internally be feasible, it is estimated that approximately 30% of the pile will require to be relocated. However, this EIA assesses the worst case whereby cutting of the piles takes place externally such that 85% of the cuttings pile is relocated.

The total volume of cuttings was estimated to be 678 m^3 and the area of seabed covered by the cuttings pile was estimated to be 1,698 m^2. A detailed description of the cuttings pile is provided in Sections 5.4.2 and 5.4.3. Modelling of the disturbance to 85% of the cuttings pile was carried out to determine the environmental impact of relocating it to within 50 m of the conductor guide frame.

11.2.2.1 Summary of Modelling Results

A scenario whereby 576 m^3 (85%) of the pile was relocated to four locations (*c*. 144 m^3 to each location) *c*. 50 m from the conductor guide frame was modelled. The modelling was carried out using DREAM (Dose-related Risk and Effect

Assessment Model) (Sintef) part of the Marine Environmental Modelling Workbench (MEMW) suite of models which incorporates the ParTrack sub-model used for modelling the dispersion and settlement of solids. Full details of the methodology, model inputs, results and model uncertainties are provided in Appendix B. A summary of the results is provided here.

The maximum sediment deposition thickness resulting from moving the pile to each of the four release points is expected to be around 1.1 m within 10 m of the release point, diminishing rapidly with distance. The vast majority of the re-suspended material is predicted to be deposited within a limited distance, with thicknesses predicted to be less than 1 mm within 80 m of the discharge points, and less than 0.1 mm within 400 m of the discharge points.

The modelling results strongly indicate that the footprint-persistence of the re-settled pile would be well below the OSPAR thresholds. The oil would need to persist for over 15,000 years for the OSPAR 500 km^2.yr threshold to be exceeded. The leaching rate of the pile has not been estimated as it is not a straightforward output of the model. Previous studies have shown that for much larger piles, the leaching rate threshold of 10 te per year is not exceeded, and by inspection given the mass of oil remaining in the pile, it is not conceivable that the leaching rate criterion would be exceeded.

The results show that the area where the 50 mg/kg THC is exceeded shrinks significantly within 10 years of disturbance and re-deposition. Immediately after the end of the cuttings redistribution the model indicates that an area of 0.033 km^2 exceeds 50 mg/kg THC. This is reduced to an area of 0.0083 km^2 or about 25% of the original area of exceedance after 10 years.

The 50 mg/kg 'footprint' of the redistributed cuttings would largely lie within the existing footprint of sediments already contaminated above 50 mg/kg, although the redistributed contaminants would be present in the surface of the sediments versus deeper layers (Figure 11-2).

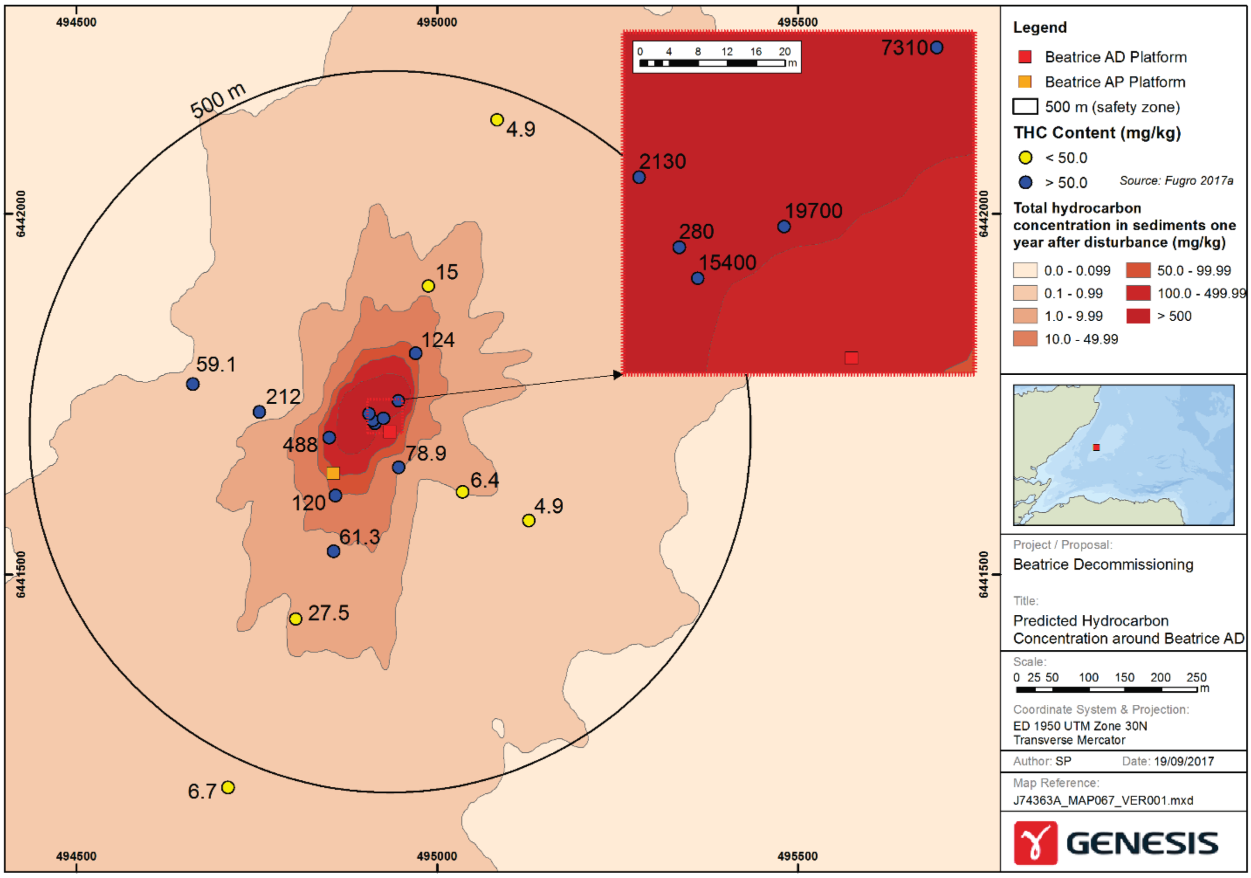


Figure 11-2: Hydrocarbon concentrations recorded in pre-decommissioning samples (Fugro, 2017a) and predicted concentrations resulting one year after disturbance.

The area of the seabed with a risk greater than 5% (a commonly recognised criterion for an acceptable level of environmental risk from aquatic discharges) is predicted to be around 11.7 km^2, shortly after the end of the relocation activities. However, this diminishes after discharge ceases, to 8.4 km^2 one year after the relocation of the cuttings and to 0.05 km^2 ten years after the end of the cuttings relocation. In spatial terms, this means that the area above 5% reduces from *c.* 2,000 m around the discharge point immediately after the redistribution of the cuttings, to within 100 m of the discharge point within 10 years. The core of the redistributed pile is predicted to be extremely persistent.

Within the sediment, the main mechanisms leading to risk to the environment are from the oil content of the sediments and to a lesser extent from the deoxygenation caused by biodegradation of these hydrocarbons. Grain size change and burial thickness are less significant factors. Risks due to the potential metals present in the barite fraction of the discharge are insignificant.

Risks to the water column are predicted to be significant within 6 km of the release and are predicted to persist above a 5% risk level in a water volume of around 0.0428 km^3 for the duration of the operations to relocate the cuttings pile. Once pumping stops, the water column concentrations in the vicinity of the pile are predicted to recover to normal conditions within 24 hours. Risks to the water column are predicted to be restricted to the bottom 10 m from the seabed and result from stress from fine particulates and from the toxicity of the oils liberated. The scale of these risks is similar to those from consented discharges e.g. similar to the risk to the water column from the discharge of WBM contaminated cuttings.

11.2.2.2 Impacts on Seabed Sediments

The sediments in the wider Beatrice area can be considered to be coarse silt, coarse sand, medium sand and fine sand (Fugro, 2017a). Only fine sediment types (silt to fine sand) were recorded within 100 m of the Beatrice A platform suggesting the presence of drill cuttings deposits (Fugro, 2017a).

Hydrocarbon concentrations within the wider Beatrice area are generally within expected background levels for the CNS, though concentrations are elevated close to the platforms.

Disturbance to the cutting pile at AD will result in cuttings material being relocating at depths less than 1 mm within 80 m of the discharge points and resulting in sediment concentrations exceeding 50 mg/kg within an area where this concentration is already exceeded such that the impact on the sediments is predicted to remain within the historic 'effect footprint' of the cuttings pile. The Significance Impact of the disturbance of the pile on the sediments is therefore considered Low. The Confidence Level in this ranking is considered Medium given the uncertainties with the modelling. These uncertainties are captured in Appendix B Section 6.

11.2.2.3 Impacts on Benthic Communities

The direct effects on benthic animals of disturbing the cuttings pile to facilitate recovery of the structures at AD could include mortality as a result of smothering, and possibly as result of suspended material (e.g. filter feeders) or habitat modification due to changed physio-chemical characteristics (such as sediment porosity and oxygenation). Disturbance could lead to leaching of hydrocarbon contaminants into the water column along with the suspension of particle bound contaminants that could assimilate in the gut of suspension feeders (Breuer *et al*. 2004).

As described in Section 5.5.2, surveys undertaken soon after LTOBM cuttings were discharged indicated the presence of a gradual ecological transition zone away from the platform (up to around 250 m) (Addy *et al*., 1984). Near the platform there were localised effects characterised by a significant reduction in the species diversity and abundance in comparison to natural background reference stations, and an abundance of the hydrocarbon tolerant opportunistic polychaete *Capitella capitate*. The pre-decommissioning survey (Fugro, 2017a) corresponded with the results of the earlier survey in that a limited abundance and diversity of benthic taxa were observed within 50 m of the Beatrice AD platform. Very low numbers (38 individuals) of the opportunistic polychaete *C. capitate* were detected in one of the four samples taken (Fugro, 2017a).

Oil and associated contaminants will continue to leach through the layers of the cuttings pile continually re-contaminating the surface layers of the pile as they start to degrade and therefore potentially causing toxic effects to demersal organisms. As a result, the environmental Significance Impact of the disturbance of the cuttings pile is considered Moderate and the Confidence Level in this ranking is considered Medium.

11.3 Transboundary and Cumulative Impacts

Given the distance from the nearest transboundary line (*c*. 265 km) there are no transboundary impacts anticipated as a result of the activities captured in this Chapter.

With regards to cumulative impacts, the Moray Firth area is targeted by scallop dredges and trawl gear and continues to be a healthy ecosystem. Therefore, the cumulative impacts associated with the activities described are not considered significant.

11.4 Mitigation Measures

The following mitigation measures are proposed to minimise the environmental impacts related to the planned seabed disturbance associated with Beatrice Field Decommissioning Project.

Proposed Mitigation Measures

- Pre anchor lay surveys to be carried out.
- Work procedures in place.
- Excavation methods at the jacket legs will be explored to identify how displaced material could be used to backfill any remaining depressions. Repsol Sinopec Resources UK will also explore use of fine rock particles to fill any holes that may remain.
- Should it not be possible to recover some of the stabilisation features, Repsol Sinopec Resources UK will consult with BEIS before an alternative approach to decommissioning them is applied.
- Ongoing discussions with BEIS and Marine Scotland regarding the optimal approach to managing the Beatrice AD cuttings pile.

11.5 Conclusions

The decommissioning activities associated with the Beatrice Decommissioning Project will result in disturbance to the seabed, however the environmental impact is not considered significant across most of the area.

Disturbance to the Beatrice AD cuttings pile, to allow recovery of the jacket, conductor guide frame, and drilling template will not extend the footprint where hydrocarbon concentrations are above 50 mg/kg. However, disturbance will likely cause slow leaching of contaminants such that it is possible that there will be an impact on benthic species. However, it should be noted this leeching rate is expected to be well below the OSPAR threshold given the relatively small volume of oil in the cuttings pile.

The activities assessed in this Chapter will not contradict the NMP objectives (see Section 5.7) and as the project progresses Repsol Sinopec Resources UK will ensure they comply with the NMP policies that have been introduced.

12. UNDERWATER NOISE

Using the assessment methodology described in Chapter 7, this Chapter discusses the potential environmental impacts associated with any underwater noise resulting from the planned decommissioning activities. The main sources of underwater noise include:

- Acoustic surveys;
- Vessels of various types, some of which will be using dynamic positioning (DP);
- Cutting tools: and
- Placement of rock cover.

Explosives will not be used and there are no piling activities associated with the project.

12.1 Activities (Cause of Impact)

All activities at sea generate underwater sound. The characteristics of the sound produced, in terms of the amplitude, range of frequencies and temporal features, varies with the type of activity and equipment. Sound levels in the marine environment diminish with distance from the source.

At the time of writing it was not known whether acoustic surveys would be required as part of the post decommissioning survey and monitoring programme. Potential impacts from acoustic surveying has therefore been included as a worst case scenario.

As discussed in Section 3.3 a range of specialist and support vessels (e.g, HLVs, ROVSVs, survey vessels etc.) will be required to undertake the proposed decommissioning activities.

Cutting activities will take place at the platforms, at the pipeline tie-in locations and possibly at the exposed pipeline and umbilical ends (should trench and burying not be an option).

Rock cover may be required at the pipeline ends and exposed sections should 'trench and bury or 'cut and remove' not be technically feasible. In addition, it is proposed to decommission the grout filled bag mattresses *in situ* and as a worst case contingency the addition of rock cover is being taken forward.

12.2 Impact on Receptors

Marine mammals and some fish species are known to be sensitive to underwater noise. Sound is important for marine mammals for navigation, communication and prey detection (Southall *et al*., 2007; Richardson *et al*., 1995). Introduction of anthropogenic underwater sound, therefore, has the potential to impact on marine mammals if it interferes with the ability of an animal to use and receive sound (OSPAR, 2009). The impact of sound on an animal depends on many factors including the level and characteristics of the sound, hearing sensitivity of the species and behaviour of the species.

Anthropogenic sound may interfere with acoustic communication, predator avoidance, prey detection, reproduction and navigation in fish (Slabbekoom *et al*., 2010). The effects of "excessive" sound on fish include avoidance reactions and changes in shoaling behaviour. Avoidance of an area may interfere with feeding or reproduction or cause stress-induced reduction in growth and reproductive output (Slabbekoom *et al*., 2010).

Harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale and seals are amongst the marine mammals that have been recorded in the Beatrice Field area (see Section 5.5). A range of fish species use the area for nursery and / or spawning grounds at different times of the year including haddock, lemon sole, mackerel, sprat and whiting (Coull *et al*., 1998). Further details are given in Section 5.5.

12.2.1 Acoustic Surveying Equipment

Seabed surveys carried out as part of decommissioning could employ acoustic surveying equipment such as side-scan sonar (SSS) and echo sounders to generate images of the seabed. Airguns are not expected to be used.

The impact of sound from acoustic survey equipment on marine mammals depends on frequency, pulse characteristics (e.g. duration, repetition rate and intermittency), source and received levels, directivity, beam width and receptor species. A review of the impact of acoustic surveying techniques on marine fauna in the Antarctic concluded that acoustic instruments such as SSS and many echo sounders are of sufficiently low power and high frequency as to pose only a minor risk to the environment. Airguns and low-frequency, high power transducers with a wide beam width are of greater concern (SCAR, 2005). This concurs with a review by Richardson *et al*., (1995), which found most evidence for a behavioural response to sonar operating at frequencies around 3 kHz to 13 kHz and no obvious response to pingers, echo sounders and other pulsed sound at higher frequencies unless the received levels were very high. Behavioural responses included avoidance and changes in swimming behaviour and vocalisation.

For echo sounders operating in shallow water depths such as at the Beatrice Field, the high-end frequencies outside the hearing range of marine species are used, these attenuate rapidly, and the operating power is lower than in deeper water (JNCC, 2010). Under these conditions JNCC considers that injury or disturbance would be unlikely. Similarly, JNCC consider the risk of injury or disturbance from SSS to be negligible because of the high frequencies that are outside the hearing range of marine mammals and attenuate rapidly and due to the short duration of this type of survey.

Very little information is available on the potential effects of SSS and echo sounders on fish (Popper, 2008 and ICES, 2005). Experiments exposing caged fish of various species to mid-frequency (2.8-3.5 kHz) sonar at a received sound pressure levels (SPL) of 210 dB re 1µPa root-mean-square (rms) found evidence of temporary hearing damage in fish with hearing sensitivity in the frequency range generated by the source but not those with lower frequency hearing. Hearing damage recovered within 24 hours and no evidence of pathology or mortality was found (Halvorsen *et al.*, 2012).

Unpublished work by the Norwegian Defence Research Establishment (Jorgensen *et al.*, 2005; presented in Kvaldsheim *et al.*, 2005) exposed larval and juvenile fish to simulated sonar signals at 1.5 kHz, 4 kHz and 6.5 kHz to investigate potential effects on survival, development and behaviour. The fish species used were herring, Atlantic cod, saithe and spotted wolfish (*Anarhichas minor*). Received sound levels ranged from 150 to 189 dB re 1 µPa. The only effects on fish behaviour were some startle or panic movements by herring for sounds at 1.5 kHz and there were no long-term effects on behaviour, growth or survival. There was no damage to internal organs and no mortality apart from in two groups of herring (out of over 40 tests) at received sound levels of 189 dB, for which there was a post-exposure mortality of 20 to 30%. Herring can detect higher frequencies than are detected by the other species in the study.

Given the results from studies to date the Impact Significance of any acoustic surveys that may be carried out as part of the decommissioning activities is considered Low and the Confidence Level in this ranking is High.

12.2.2 Vessels

The primary sources of sound from vessels are propellers, propulsion and other machinery (Ross, 1976 and Wales and Heitmeyer., 2002). In general, vessel sound is continuous and results from narrowband tonal sounds at specific frequencies and broadband sounds. Acoustic broadband source levels typically increase with increasing vessel size, with smaller vessels (< 50 m) having a source rms sound pressure level (SPL) of 160-175 dB re 1 µPa at 1 m, medium size vessels (50-100 m) 165-180 dB re 1µPa at 1 m and large vessels (> 100 m) 180-190 dB re 1 µPa at 1 m (Richardson *et al.*, 1995). However, sound levels depend on the operating status of the vessel and can vary considerably in time. Acoustic energy is strongest at frequencies below 1 kHz.

Some of the vessels will use DP systems to maintain and adjust their position when working. Sound levels can be louder during use of DP, which requires the operation of thrusters to control a ship's location. A study of drillship operations in deep water (> 480 m depth) in Baffin Bay, west Greenland, estimated source levels during different phases of the vessel's operation (Kyhn *et al.*, 2014). The vessel, *Stena Forth*, a drillship of 228 m length, had six DP thrusters. The highest noise was during periods of vessel maintenance, when the estimated source level was up to 190 dB re 1 µPa (rms). The source level during drilling was estimated to be 184 dB re 1 µPa (rms). The main peak of acoustic energy was below 5 kHz and vessel noise was discernible above ambient noise levels up to 38 km from the vessel. Additionally, the DP control system generated noise at around 100 dB re 1 µPa (rms) at frequencies between 20 – 35 kHz. Noise levels from the DP control system were not high but were clearly discernible above ambient levels, at frequencies audible to odontocete cetaceans (i.e. toothed whales that include dolphins, porpoises and whales possessing teeth) and seals.

Richardson *et al*. (1995) reviewed the effects of vessel noise on marine mammals. They noted that it is not always possible to distinguish between effects due to the sound, sight or even smell of a vessel to an animal but there is evidence that noise from vessels has an impact on marine mammals. Animals have been reported to display a range of reactions from ignoring to avoiding the noise. The latter can lead to temporary displacement from an area.

Vessel noise can mask communication calls between cetaceans, reducing their communication range (Jensen *et al.*, 2009). Exposure to low frequency ship noise may be associated with chronic stress in whales. Rolland *et al.*, (2012) reported a decrease in baseline levels of stress-related faecal hormones concurrent with a 6 dB reduction in underwater noise along the shipping lane in the Bay of Fundy, Canada, in 2001. The reported response of animals to received sound has been found to wane with repeated exposure in some studies (Southall, 2007).

Seals in the Moray Firth are known to experience elevated noise levels due to shipping, fishing and recreational traffic, however there has been no detectable relationship between declining seal populations and levels of co-occurrence between seals and vessels (Jones *et al.*, 2017).

Whilst the implications of behavioural responses to underwater noise are poorly understood, fish exhibit avoidance reactions to vessels and it is likely that radiated underwater noise is the cue. For example, noise from research vessels has the potential to bias fish abundance surveys by causing fish to move away (de Robertis & Handegard 2013; Mitson and Knudsen, 2003). Reactions include diving, horizontal movement and changes in tilt angle (de Robertis & Handegard, 2013).

As discussed in Chapter 6 fishing, shipping and recreational boating activities all take place within the Moray Firth. The vessels associated with the Beatrice Decommissioning Project will add to the background noise, however given the extended schedule of the proposed activities, the increase of vessel numbers in the area at any one time is not expected to exceed 2-3 and any impacts are anticipated to be short lived. The Impact Significance is therefore considered to be Low and the Confidence Level in the ranking is considered High.

12.2.3 Underwater Cutting

Mechanical methods of cutting underwater structures use hard cutting tools that produce a sawing or machining action. Examples include hydraulic shears, diamond wire and abrasive water jet cutters.

A recent paper reported that the noise from underwater diamond wire cutting, during the severance of a 0.76 m diameter conductor at a platform in the North Sea, was barely discernible above background noise levels including the noise of associated vessel presence (Pangerc *et al*., 2016). The cutting noise, an increase of 4 – 15 dB above background levels, was more discernible at higher frequencies, i.e. > 5 kHz, than at low frequencies, and was identifiable in recordings made 800 m from source. Anthony *et al.* (2009) present a review of published underwater noise measurements for various types of diver-operated tools. Several of these are underwater cutting tools, including a high-pressure water jet lance, chainsaw, grinder and oxy-arc cutter. Reported source sound pressure levels were 148-170.5 dB re 1µPa (it was not indicated whether these are rms or zero-peak). It is possible that larger, ROV operated cutting tools could generate louder sound levels but no published data are available.

There is no published information on the response of marine mammals or fish to sound generated by underwater cutting. However, reported source levels are relatively low compared with those generated by vessels such that any noise generated from cutting operations is not likely to cause significant disturbance to marine fauna. The environmental Impact Significance of underwater noise produced as a result of the offshore decommissioning activities is therefore considered Low and the Confidence Level in this ranking is High.

12.2.4 Placement of Rock Cover

No data are available on what the noise levels generated by the placement of rock cover might be, however it is believed that given the short duration of individual rock cover activities, there is only likely to be a low impact on marine mammals or fish associated with the noise generated (JNCC, 2008). The environmental Impact Significance is therefore considered to be Low and the Confidence Level in this ranking is considered High.

12.3 Transboundary and Cumulative Impacts

Given the distance from the nearest median line (c. 265 km) there are no transboundary impacts anticipated as a result of the underwater noise associated with the proposed decommissioning activities at the Beatrice Field.

Marine mammals and fish in the area are already exposed to anthropogenic back ground noise due to existing Beatrice and Jacky installations, vessels associated with shipping, fishing and recreational activities and the current wind farm development operations. The effects from the noise associated with the proposed decommissioning activities (vessels, cutting activities or rock placement) are not expected to cause a significant additional impact.

12.4 Mitigation Measures

The following mitigation measures are proposed to minimise the environmental impacts associated with any underwater noise that will result from the offshore activities.

Proposed Mitigation Measures

- Vessel use will be optimised. Repsol Sinopec Resources UK will continue to explore possible synergies with Ithaca and windfarm developers in the area e.g. sharing of supply boats.
- Procedures will be in place to minimise the number and duration of cutting operations.

12.5 Conclusions

Cetaceans, pinnipeds and fish are present in the area around the Beatrice Field, and these receptors have been identified to be sensitive to underwater noise. However, disturbance from noise resulting from the proposed decommissioning activities is expected to be low, and the likelihood of injury from underwater noise is negligible. The greatest potential disturbance is as a result of vessels using DP. However, marine mammals are likely to be accustomed to similar levels of noise from vessel movements in the region, such that any additional environmental impact significance is considered low.

The activities assessed in this Chapter will not contradict the NMP objectives (see Section 5.7) and as the project progresses Repsol Sinopec Resources UK will ensure they comply with the NMP policies that have been introduced.

13. ONSHORE ACTIVITIES

Cleaning, engineering down, dismantling, storage and transport of the structures when brought onshore have the potential to cause disturbance to the local community. Such disturbance could take the form of increased noise, odour, light, dust, gaseous emissions and visual disturbance. In addition, proximity to wildlife and habitats could result in disturbances caused by for example increased noise or traffic. Note the handling of waste is considered separately in Chapter 14 'Waste Management'.

Repsol Sinopec Resources UK will select an onshore contractor that operates an existing yard i.e. a new decommissioning yard will not be constructed to dismantle the Beatrice infrastructure. In selecting an appropriate contractor, Repsol Sinopec Resources UK will ensure the facilities are suitable for the required storage, dismantling and transfer of the expected quantities and types of waste. The scope of the assurance will include:

- Review of licences, consents and permits;
- Review of the facilities HSE management system, including environmental management procedures and waste management processes and planning;
- Assessment of the contractors HSE performance record;
- Review of the yard layout, storage areas, secondary containment, emissions and noise management, traffic management, drainage, and waste-water treatment; and
- Review of community engagement process.

The disposal yard will require to demonstrate that handling materials from the Beatrice Project will not breach the yard's environmental permits. Therefore, as an existing yard will be used, with the required licences to handle the recovered Beatrice materials the environmental and social Impact Significance of the onshore activities is considered Low and the Confidence Level in this ranking is considered High.

13.1 Transboundary and Cumulative Impacts

The Beatrice Decommissioning Project's preference will be to avoid moving the structures transboundary, however in the event the contract is awarded overseas, Repsol Sinopec Resources UK will complete assurance of the yard as described above and will only award to a yard with the correct licences in place such that any transboundary impacts of onshore activities are not considered significant.

Similarly, any cumulative impacts of the onshore activities are not considered significant as Repsol Sinopec Resources UK will ensure that the handling of the Beatrice materials will not result in a breach any of the consents and permits in place.

13.2 Mitigation Measures

The following mitigation measures are proposed to minimise the environmental and social impacts related to the onshore activities associated with the Beatrice Field Decommissioning Project.

Proposed Mitigation Measures

- Contract award will be to an established yard with appropriate experience, capability, licences, consents and community engagement in place.

13.3 Conclusions

Contract award will be to an established yard with appropriate experience, capability, licences, consents and community engagement in place such that the environmental and social impact of onshore activities is not considered significant.

14. WASTE MANAGEMENT

14.1 Regulatory Requirements

Once removed from its location the Beatrice infrastructure is effectively considered to be waste, treatment of which needs to take account of a number of Directives and Regulations including the Waste Framework Directive (WFD) (Directive 2008/98/EC). The overriding aim of the WFD is to ensure that waste management is carried out without endangering human health or harming the environment. Article 4 of the WFD also states that the waste hierarchy shall be applied as a priority order in waste prevention and management legislation and policy.

Other key EU waste management Directives and Regulations to be considered include (but is not limited to):

- Landfill Directive 99/31/EC;
- Waste Incineration Directive 2000/76/EC;
- Waste Electrical and Electronic Equipment Draft Directive;
- Ozone Depleting Regulations 2037/2000;
- The Fluorinated Greenhouse Gases Regulations 2015;
- Waste Shipment Regulations 259/93/EEC;
- Integrated Pollution Prevention and Control EEC/96/61.

Waste legislation for Scotland (The Waste (Scotland) Regulations 2012) covers controlled waste, duty of care, registration of carriers and brokers, waste management licensing, landfill, hazardous waste, producer responsibility, packaging waste, end-of-life vehicles, Waste Electrical and Electronic Equipment (WEEE).

Whether a material or substance is determined as a 'waste' is determined under EU law. The EU WFD (2006/12/EC) defines waste as:

"*any substance or object in the categories set out in Annex 1 of the Directive which the holder discards or intends or is required to discard*".

Materials disposed of onshore must comply with the relevant health and safety, pollution prevention, waste requirements and relevant sections of the Environmental Protection Act 1990. The waste management assessment should be based on the worst case scenario and follow the hierarchy shown in Figure 14-1, in line with relevant legislation, permits and consents.

Figure 14-1 Waste Hierarchy

Management of radioactive materials is governed under:

- Radioactive Substances Act 1993; and
- Trans-frontier Shipment of Radioactive Waste and Spent Fuel Regulations 2008.

The handling and disposal of radioactive waste requires additional authorisation. Onward transportation of waste or recycled materials must also be in compliance with applicable legislation, such as the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009, a highly prescriptive regulation governing the carriage of dangerous goods by road.

14.2 Activities (Cause of Impact)

The waste generated as a part of the decommissioning activities will be a combination of both hazardous (special: as defined in Scotland) and non-hazardous wastes.

Resources used by the decommissioning project include the use of vessels and equipment. The impacts of these have already been covered in the emissions to air, discharges to sea and underwater noise sections.

The inventory of Beatrice materials and re-use, recycling and disposal aspirations, of material recovered to shore are presented in Figure 14-2 and Figure 14-3 and Table 14-1. For consistency these tables are as stated in the draft DPs and include mattresses, grout bags and rock cover.

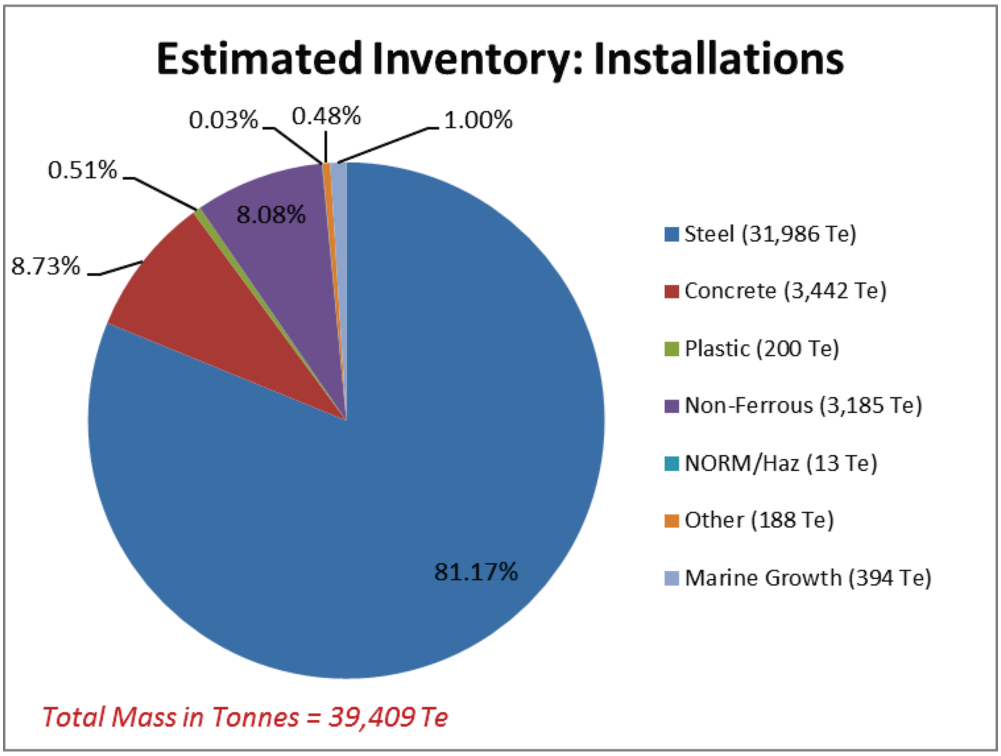


Figure 14-2 Pie Chart of Estimated Inventory (Installations).

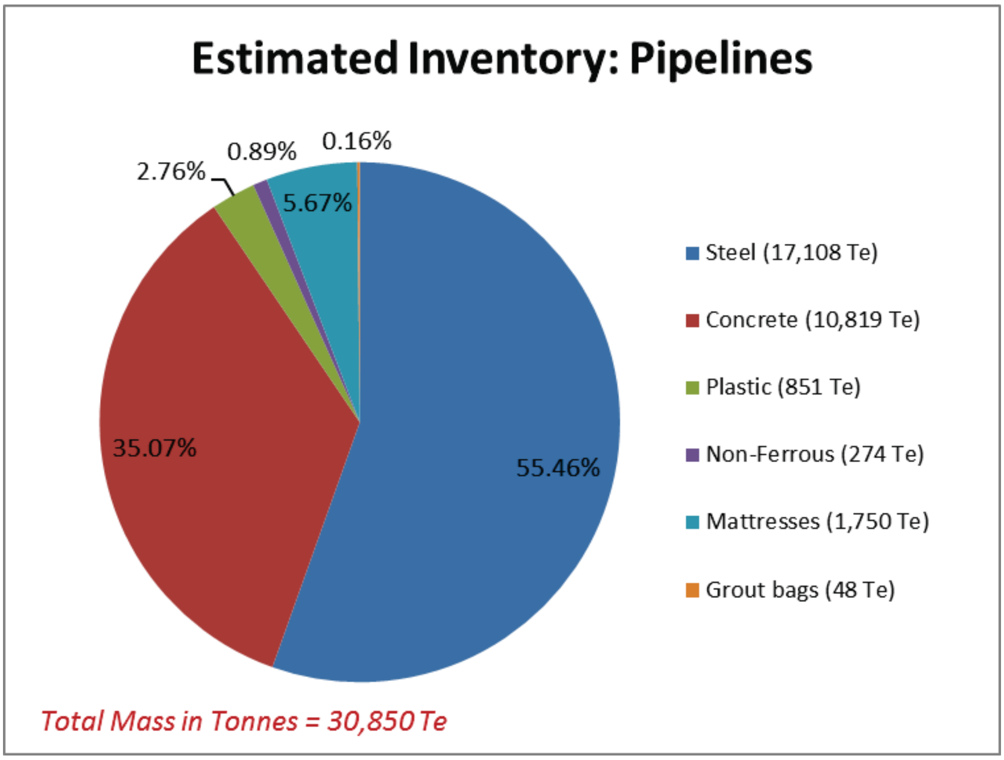


Figure 14-3 Pie Chart of Estimated Inventory (Pipelines).

Table 14-1 Waste Stream Management Methods

Waste Streams	Removal and Disposal method
Bulk liquids	Residual hydrocarbons will be removed from the topsides at all four platforms. At the Beatrice C and Beatrice B platforms it is anticipated that the residual hydrocarbons and associated flushing fluids will be recovered to shore in tote tanks for disposal. At the Beatrice Alpha complex, the residual hydrocarbons and any associated flushing fluids will be flushed into the export pipeline and returned to shore for disposal before the pipeline cleaning campaign takes place. All export pipelines will be flushed, cleaned and filled with inhibited seawater prior to decommissioning activities taking place.
Marine growth	Where necessary and practicable to allow access and inspection, some marine growth will be removed offshore. In addition, a portion is expected to 'drop off' during recovery operations. The remainder will be brought to shore for disposal should a recycling route (e.g. potential for use as a fertiliser) not be identified.
NORM/LSA Scale	Tests for NORM will be undertaken offshore and work will be carried out in full compliance with all relevant regulations.
Asbestos	The final disposal route will depend on the quantities found, but will be dealt with and disposed of in full compliance with all relevant regulations.
Other Hazardous wastes	Will be recovered to shore and disposed of in full compliance with all relevant regulations.
Onshore dismantling sites	Appropriate licensed sites will be selected. Dismantling sites must demonstrate waste stream management throughout the deconstruction process and the ability to deliver innovative reuse and recycling options. Existing sites would need a proven track record.

14.2.1 Material Fate

Overall, decommissioning puts resources back into use through re-use of equipment and recycling of materials such as steel. However, where infrastructure is left *in situ* (e.g. pipelines and power cables) this material is effectively "lost". The fate of the materials to be decommissioned is shown in Table 14-2.

Table 14-2 Inventory Disposition.

	Total inventory tonnage (te)	Planned tonnage to shore (te)	Planned tonnage left *in situ* (te)
Installations*	32,200	32,200	0
Installation Piles	7,209	3,976**	3,233
Pipelines*	30,850	2,822***	28,028
Total Inventory		38,998	31,261

**Note that pipelines PL2610 and PL2611 have been included in the "Installations" weight estimate as they are in integral part of the Beatrice Bravo jacket structure.*

*** Note that this weigh of piles includes weight of grout (3,274 te) which is assumed to be fully removed to shore.*

**** Planned tonnage to shore includes pipeline ends / mid pipeline exposures (where applicable) and mattresses / grout bags.*

Overall *c*. 38,998 te of material will be returned to shore and the majority of this is steel which will be recycled. In addition to the material identified in Table 14-2, marine growth will be returned attached to the jackets. Between 2011 and 2013, OGUK commissioned a series of reports including a review of marine growth estimates versus quantities processed by decommissioning yards. The 'worst case' estimate (by wet weight) of marine growth quoted is 10% of the jacket weight which was for the Miller platform located in the CNS in water depths of 103 m (BP, 2010). Based on this 10% estimate marine growth estimates across the seven jackets has been estimated at *c*. 830 te.

According to Tvedten (referenced in BMT Cordah 2011) the water content of marine growth is typically 70 – 90% of its total weight. The marine growth will start to dry out as soon as it is lifted out of the sea and therefore the weight of material to be disposed of onshore will depend largely on how much drying out takes place during recovery and transportation. As a worst case if water content is considered to be 70% and up to 20% falls off during recover and transport it is anticipated that a maximum of 200 te of marine growth will be returned to shore.

14.3 Impacts on Receptors

The onshore environmental impacts from waste disposal are principally associated with landfills and can include:

- Use of sometimes scarce landfill space (resource use);
- Degradation of local/regional air quality as a result of onshore transport;
- Potential degradation of the water environment if any leachate is produced by the landfill site and reaches surface water and/or groundwater;
- Nuisance to the local community from traffic, odour and visual impacts.

Where materials are recycled, impacts will be associated with existing processing plants:

- Degradation of local/regional air quality as a result of transport;
- Degradation of local/regional air quality as a result of plant emissions;
- Degradation of the water environment (surface water and groundwater) associated with any discharges from the processing plant;
- Nuisance to the local community from traffic and visual impacts.

As part of Repsol Sinopec Resources UK's Duty of Care, contract award will be to an established yard with appropriate experience, capability, licences and consents in place. As part of this the sites must demonstrate waste stream management throughout the deconstruction process.

The Beatrice Project will have in place a Waste Management Plan (WMP) developed to describe and quantify waste arising from decommissioning activities and identify available disposal options for those wastes. Where possible, materials will be recycled or sold and reused such that it is anticipated that less than 1 % of the total material returned will go to landfill. Waste management options will take into account the waste hierarchy (http://wastehierarchy.wrap.org.uk/) shown in Figure 14-1 with a reduction in volume of waste being the preferred option. Existing waste disposal routes and contractors will be used where possible.

NORM contaminated equipment will be handled, transported, stored cleaned and recycled/disposed of in a controlled manner. Procedures will be in place to ensure that equipment is not released or handled without controls to protect the worker and prevent contamination of the environment.

Application of the above mitigation measures e.g. the use of permitted facilities (including landfill sites) and adherence to the waste hierarchy means the environmental and social Impact Significance is considered to be Low and Confidence Level in this ranking is considered High.

14.4 Transboundary and Cumulative Impacts

The Beatrice Decommissioning Project's preference will be to avoid moving the structures transboundary, however in the event the contract is awarded overseas, Repsol Sinopec Resources UK will carry out assurance of the disposal yard and key subcontractor's disposal sites to ensure the correct licences are in place such that any impacts out with the UK are not considered significant.

Similarly, any cumulative potential impacts of the activities of waste management are not considered significant as Repsol Sinopec Resources UK will, as part of the assurance process, ensure that disposal of the Beatrice materials will not breach any of the consents and permits in place. In addition, it is anticipated that only *c*. 1% of returned material will go to landfill.

14.5 Mitigation Measures

The following mitigation measures are proposed to minimise the environmental and impacts related to the managing the waste associated with the Beatrice Field Decommissioning Project.

Proposed Mitigation Measures

- The Beatrice Project will have in place a WMP developed to describe and quantify waste arising from decommissioning activities and identify available disposal options for those wastes.
- Waste management options will take account of the waste hierarchy.
- As part of Repsol Sinopec Resources UK's Duty of Care, contract award will be to an established yard with appropriate experience, capability, licences and consents in place.

14.6 Conclusions

Any material recovered to shore as part of the Beatrice Decommissioning Project is considered to be waste. This material will be treated in line with the waste hierarchy such that it is estimated that only *c*. 1% will go to landfill. All requirements for segregation, transport and disposal, as set out in the project WMP, will be strictly adhered to and only fully permitted facilities will be used for recycling or disposal. The resulting environmental and social impacts from waste management are therefore expected to be low.

15. ACCIDENTAL EVENTS

15.1 Introduction

The accidental events identified in the ENVID (see Appendix A) are:

- Dropped objects during lifting activities;
- a loss of diesel fuel during bunkering; and
- total loss of fuel inventory due to vessel collision.

The environmental Impact Significance associated with dropped objects was considered Low whilst the environmental Risk was also considered Low. Any disturbance to the seabed would be within the footprint of the seabed disturbance assessed in Chapter 11 such that the Confidence Level in this ranking is High.

The offshore oil and gas sector activities have the potential for release of hydrocarbons, which may have detrimental impacts on the sea and associated marine ecosystems. The rest of this chapter considers the potential for large hydrocarbon releases (synonymous with unplanned discharges or accidental events) and the prevention measures to be adopted to reduce the probability of accidental events.

A loss of fuel during bunkering operations whilst unlikely to occur is still recognised as the most likely accidental diesel release. Should it take place it is expected the environmental Impact Significance would be Moderate and the environmental Risk would be Medium. A number of industry standard mitigation measures will be in place to minimise the likelihood of such an impact including the use of trained personnel, continuous radio contact between vessels and regular maintenance checks of the fuel transfer hose. The environmental impact associated with a bunkering diesel release would be less than that associated with a total loss of fuel inventory. As it is possible a total loss of fuel inventory could lead to a Major Pollution Incident (MPI), such a release has been modelled to determine its environmental impacts.

15.2 Loss of Fuel Inventory

A number of vessels will be involved in the decommissioning activities associated with the Beatrice Decommissioning Project. Diesel spill modelling was undertaken using the Oil Spill Contingency and Response (OSCAR) model developed by SINTEF to determine the environmental risk of such a loss. Two spill scenarios were initially considered:

- Scenario 1 - 7,000 m^3 spill from a HLV at the Beatrice Alpha complex; and
- Scenario 2 - 3,600 m^3 spill from a vessel working on the pipeline close to the shore.

Though the HLV would result in the largest loss of diesel, initial modelling was carried out to determine if a release of the smaller volume much closer to shore would actually result in a worse environmental and socio-economic impact significance. It was determined that the spill scenario resulting in the largest area of beaching represented the worst case scenario. The modelling found that there was a higher probability of beaching and a larger volume of beached hydrocarbons associated with the near shore release. It was therefore decided to further assess the smaller near shore release. Full details of the modelling including methodology, input parameters, results and a detailed impact significance assessment and risk assessment are provided in Appendix C.

In summary the sensitivity of a number of receptors (plankton, benthic species, fish, fisheries, birds, marine mammals, designated areas and local communities) to a spill was determined using the data presented in Chapters 5 and 6 and where possible published literature on the impacts of hydrocarbons on these receptors. The modelling outputs provided information on probability of beaching, concentrations of beached diesel on the coastline, and in the water column, surface areas impacted, volumes entrained in sediments etc. This information was used to determine the magnitude of effect on each of the receptors. The resultant environmental and socio-economic Impact Significance was subsequently found to vary for each receptor:

- Low: plankton.
- Moderate: benthos, fish and local communities.
- High: fisheries, seabirds, marine mammals and designated areas.

The likelihood of a full loss of diesel inventory from a vessel during decommissioning activities is considered remote, such that it is recognised that 'a similar event has occurred elsewhere but is unlikely to occur with current practices'. It should be noted that vessels are designed to minimise the possibility of a loss of total fuel inventory. In addition, the type of vessels to be used and their associated fuel inventories will be similar to other vessels regularly found throughout the Moray Firth and North Sea.

Combining the impact significance with the likelihood gives an environmental risk which was found to be either low or medium for each receptor considered:

- Low environmental risk: plankton, benthos, fish and local communities
- Medium environmental risk: fisheries, seabirds, marine mammals and designated areas.

The overall environmental Risk of a loss of total fuel inventory can therefore be considered Medium. OSCAR is regarded as a leading tool in predicting the fate and interpreting the effects of oil spills and is accepted in this capacity by environmental regulators. It has been shown to give reliable conclusions when viewed in context and when used in conjunction and with reliable environmental baseline data. However, there are some model uncertainties (detailed in Section 4 of Appendix C) such that the Confidence Level in this ranking is considered Medium.

Modelling outputs suggest that the probability of surface oiling > 3 µm extending much beyond the Moray Firth area is less than 5% (see Figure C-11 in Appendix C). Given the distance from the nearest median line (*c*. 265 km) there are no transboundary impacts anticipated as a result of a loss of diesel inventory at the Beatrice Field.

The assessment of the impacts of a total loss of diesel inventory from a vessel suggests that it could result in a Major Pollution Incident (MPI).

15.3 Mitigation Measures

The following mitigation measures are proposed to minimise the environmental risk associated with the potential accidental events identified.

Proposed Mitigation Measures

- Any infrastructure decommissioned *in situ* will be marked on FishSafe and communicated accordingly.
- Work procedures in place.
- Use of trained personnel to carry out bunkering operations.
- Bunkering operations would be manned continuously with radio contact between the vessels at all times.
- Regular maintenance checks of fuel transfer hose.
- Vessel assurance inspections.
- Pre-hire vessel audits.
- Emergency response plans in place including SOPEPs (shipboard oil pollution emergency plan).
- SIMOPS (simultaneous operations) will be managed through bridging documents and communications.

15.4 Conclusions

Diesel loss during bunkering operations has been known to occur in the industry such that the environmental Risk of such an event occurring during decommissioning is considered to be Medium. The Impact Significance of a total loss of fuel inventory is considered High for some receptors e.g. fisheries, seabirds, marine mammals and designated areas, however the environmental Risk is considered Medium given that the likelihood of such an event is considered remote due to vessel design and the application of industry standard mitigations.

16. ENVIRONMENTAL MANAGEMENT

Repsol Sinopec Resources UK are committed to conducting activities in compliance with all applicable legislation and in a manner that will minimise impacts on the environment. Environmental and social impacts identified through the impact identification processes (for example the ENVID workshop and the EIA) will be input to the projects risk register. A summary of key environmental and social impacts and risks shall be included within the projects decision documentation throughout all phases of the project.

Repsol Sinopec Resources UK has established a clear framework for the effective management of Health, Safety and Environmental (HSE) issues involving their oil and gas activities in the UK. The Company regards environmental management as being an integral part of our overall management responsibility, the fundamental aims being to support environmental protection, prevent pollution and comply with legislation and regulations. The principles of the International Standard for Environmental Management Systems (ISO14001) are incorporated within the Company's Safety and Environmental Management System (SEMS) which is an integral part of the company's overall management system.

Repsol Sinopec Resources UK's structure, roles and responsibilities are outlined in the SEMS. In addition, the SEMS provides the framework for a 'Plan-Do-Check-Act' approach to HSE management, which actively promotes continual improvement in all aspects of the organisation's activities.

Repsol Sinopec Resources UK's HSE Policy is a public declaration of the Company's commitment to create a working environment such that no harm is caused to people and where environmental impact is minimised. The Repsol Sinopec Resources UK HSE Policy is shown in Figure 16-1.

REPSOL SINOPEC
Resources UK

HEALTH, SAFETY & ENVIRONMENT POLICY

The Company Policy is to conduct our business in a manner that ensures we:

- cause no harm to people;
- minimise our impact on the environment;
- comply with regulatory requirements;
- choose safety over operational results;
- maintain a state of emergency preparedness.

The objectives of this Policy are to ensure we:

- always comply with the law or Company standards, whichever is of a higher standard;
- operate our business to ensure proactive risk mitigation and continuous improvement;
- set goals and targets, and measure performance against them;
- communicate openly with those who may be affected by our activities;
- strive to prevent all accidents and incidents, prevent pollution, use resources sustainably and capitalise on lessons learned;
- are able to respond to any foreseeable emergency.

SAFE OPERATIONS IN ALL COMPANY ACTIVITIES IS A CORE VALUE

If operational results ever conflict with this Policy, we all have a responsibility to choose compliance with this Policy over operational results and Repsol Sinopec Resources UK Limited will support that choice.

Bill Dunnett
Managing Director

Produced in-house by Document & Records Team
RSR-HSE-00-POL-COM-001.A01, Summary Extract of Company HS&E Policy
Effective January 2018

Figure 16-1 Repsol Sinopec Resources UK HSE Policy

17. CONCLUSION

The Beatrice Field is to be decommissioned by Repsol Sinopec Resources UK over the next 10 to 12 years. Included in the decommissioning activities is the complete removal of the Beatrice A complex, Beatrice B, Beatrice C, and the two WTGs. In line with the results of a comparative assessment all the pipelines and power cables will be decommissioned *in situ*. Pipeline and power cable ends and exposed mid-line sections will be trenched and buried. The base case is to remove all stabilisation features associated with the field.

17.1 EIA Results

The EIA process presented in this report considers the environmental and socio-economic impact significance of the planned and potentially unplanned activities associated with the decommissioning of the Beatrice Field. The impact significance was determined by considering the sensitivity of each receptor to the resultant aspect and the magnitude of the effect of each activity.

Receptors considered included: air, water and sediment quality, plankton, benthic species, fish, marine mammals, seabirds, designated area, coastal communities, fisheries, shipping, landfill resources, resource use, local communities and cultural heritage. The aspects considered are energy use and emissions to air, discharges to sea, seabed disturbance, underwater noise, and waste production. In addition, the physical presence of the vessels during operations and the items to be decommissioned in situ was considered.

For the majority of the planned activities the environmental and social impacts were considered to be of low significance when standard industry mitigation is applied. Only one environmental impact of significance (considered to be of moderate significance) was identified. This is associated with disturbance to the Beatrice AD cuttings pile during recovery of the substructures at Beatrice AD. The extent of disturbance depends on the method to be used to cut the jacket piles. The cuttings pile is below the OSPAR thresholds considered to be of environmental significance and given its small size (c. 1,420 te: 678 m^3) and relatively low hydrocarbon content (10 to 20 te) it will remain below these thresholds following disturbance. However, there is expected to be some slow leaching of contaminants into the water column such that the impact significance is considered to be moderate.

The base case is full recovery of all stabilisation features. The EIA assesses the worst case whereby 10% of the flexible mattresses and all of the grout filled mattresses and large grout bags are decommissioned *in situ.* Combining (i) the maximum footprint of this rock and (ii) rock used to backfilled jacket leg holes, and (iii) the footprint of the cuttings pile would result in scallop dredgers continuing to be excluded from an area of less than 0.01 km^2, whilst trawl gear would have to fish these areas with care. However, following recovery of the Beatrice facilities and the WTGs, Repsol Sinopec Resources UK will surrender the 500 m exclusions associated with them (five in total). In addition, trenching and burying of the pipeline ends and exposed mid line sections will allow fishing gear to access these areas such that it is estimated that around 3.9 km^2 will be returned to the fishing industry.

The impact significance of the planned activities on any designated areas in the Moray Firth is considered low. The export pipeline passes through the Moray Firth SAC. Trenching and burying activities will cause some sedimentation within in the SAC as will the over trawl trials (if carried out). However, this impact is well within the scope of the sedimentation resulting from ongoing trawling and dredging activities in the area such that it is not considered significant.

Given the location of the Beatrice Field and the proposed activities and mitigations, there are no transboundary impacts anticipated.

Two accidental events that have the potential to be a significant environmental risk were identified: a loss of diesel during bunkering operations and a loss of diesel due to vessel collision. When the impact significance and likelihood are taken into account for both incidents, the environmental risk was considered to be medium. This ranking reflects the sensitive nature of the Moray Firth and the potential impacts on the receptors rather than the likelihood of such incidents occurring. The assessment of the impacts of a total loss of diesel inventory from a vessel suggests that it would result in a MPI.

Assessment of compliance against the relevant NMP objectives has been achieved through the impact assessment process. The proposed decommissioning activities have been found not to contradict the NMP objectives and as the project progresses Repsol Sinopec Resources UK will ensure they comply with the NMP policies that have been introduced.

17.2 Summary of Mitigation Measures

Repsol Sinopec Resources UK will ensure routine environmental considerations are a key element of ongoing project decisions and assurance (e.g. vessels and yards) such that the environmental impact of the decommissioning activities will be minimised. Following the EIA process, it can be concluded that activities associated with the decommissioning of the Beatrice field are unlikely to significantly impact the environment or other sea users, for example shipping traffic and fishing, provided that the proposed mitigation and control measures are put in place.

Table 17-1: Decommissioning of Beatrice Field project specific commitments.

Aspect	Commitment
Physical presence	• Ongoing consultation with SFF; • Notice to mariners will be circulated; • A Vessel Traffic Survey will be undertaken to support a CtL application; • A Collision Risk Management Plan will be produced if required; • Vessel use will be optimised and Repsol Sinopec Resources UK will continue to explore synergies, e.g. the potential to share supply boats, with wind farm developers in the area; • All vessels engaged in the project operations will have markings and lightings as per the International Regulations for the Prevention of Collisions at Sea (COLREGS) (International Maritime Organisation, 1972). • If used rock cover will be optimised and carefully managed. A fall pipe will be used to ensure accuracy of the rock dumping. Size of rock cover will be in accordance with industry practice which is also the preferred SFF / industry best practices. • Locations of remaining materials (could possibly include unrecovered stabilisation features, rock cover and the Beatrice AD cuttings pile) will be marked on FishSafe.
Atmospheric emissions and energy use	• As part of the tendering process, proposed vessels will go through a detailed assurance process which will include a review of generator and engine maintenance which leads to better efficiency in line with manufacturer's specifications. • Decommissioning vessel schedules will be planned to optimise (minimise) vessel use. Repsol Sinopec Resources UK will continue to investigate synergies with other projects in the area (e.g. wind farm developers) to optimise vessel use. • Prior to the contract award, Repsol Sinopec Resources UK will audit the decommissioning yards to ensure suitable permits are in place and that atmospheric emissions are being managed. • Activities will be carried out in line with Repsol Sinopec Resources UK's environmental policy which includes minimising emissions.
Discharges to sea	• Repsol Sinopec Resources UK will carry out a detailed assurance process on all vessels prior to contract award. • Work procedures will be in place to minimise offshore campaigns. • Only MARPOL compliant vessels will be used. • Flushing and cleaning of topsides and pipelines is completed in line with BAT/BEP requirements.

Aspect	Commitment
	• All contracted vessels will be signed up to IMO and will adhere to their guidelines. • Any associated discharges will be managed to minimise impact.
Physical disturbance of the seabed and marine species	• Pre anchor lay surveys to be carried out. • Work procedures in place. • Excavation methods at the jacket legs will be explored to identify how displaced material could be used to backfill any remaining depressions. Repsol Sinopec Resources UK will also explore use of fine rock particles to fill any holes that may remain. • Should it not be possible to recover some of the stabilisation features, Repsol Sinopec Resources UK will consult with BEIS before an alternative approach to decommissioning them is applied. • Ongoing discussions with BEIS and Marine Scotland regarding the optimal approach to managing the Beatrice AD cuttings pile.
Nuisance (e.g. noise, odour)	• Vessel use will be optimised. Repsol Sinopec Resources UK will continue to explore possible synergies with Ithaca and windfarm developers in the area e.g. sharing of supply boats. • Procedures will be in place to minimise the number and duration of cutting operations.
Onshore activities	• Contract award will be to an established yard with appropriate experience, capability, licences, consents and community engagement in place.
Waste generation and resource use	• The Beatrice Project will have in place a WMP developed to describe and quantify waste arising from decommissioning activities and identify available disposal options for those wastes. • Waste management options will take account of the waste hierarchy. • As part of Repsol Sinopec Resources UK's Duty of Care, contract award will be to an established yard with appropriate experience, capability, licences and consents in place.
Accidental events	• Any infrastructure decommissioned *in situ* will be marked on FishSafe and communicated accordingly. • Work procedures in place. • Use of trained personnel to carry out bunkering operations. • Bunkering operations would be manned continuously with radio contact between the vessels at all times. • Regular maintenance checks of fuel transfer hose. • Vessel assurance inspections. • Pre-hire vessel audits. • Emergency response plans in place including SOPEPs (shipboard oil pollution emergency plan). • SIMOPS (simultaneous operations) will be managed through bridging documents and communications.

17.3 Overall Conclusion

To conclude, in relation to planned activities only one environmental impact of moderate concern was identified, relating to the disturbance of the cuttings pile at the Beatrice AD platform. Repsol Sinopec Resources UK are continuing to consult with BEIS and MSS to determine the optimal approach for managing the cuttings pile.

Repsol Sinopec Resources UK recognise that should any stabilisation features and the Beatrice AD cuttings pile be decommissioned *in situ* access by scallop gear will be restricted from a maximum area of 0.01 km^2. However, when compared to the area that will be returned to other sea users following surrender of the five exclusion zones and trenching and burying of exposed sections of pipelines (c. 3.9 km^2) it represents around 0.25 % and is therefore not considered significant.

Overall, the EIA concludes that the potential for significant impacts as a consequence of decommissioning the Beatrice facilities is low. Generally, the impacts identified were assessed as localised and short term with low potential for long term or transboundary and cumulative impacts.

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APPENDIX A: ENVID TABLE

(Note see Chapter 7 for definition of rankings applied to Sensitivity, Magnitude, Impact Significance and Likelihood).

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
Vessel Use																									
Vessel use	Emissions to air		a															Fuel combustion emissions (CO_2, CO, SOx, NOx, etc.) from vessels including jack-up drilling rig, cargo vessel, HLV, excavator vessel, ROVSV, rock dump and survey vessels. UK and EU Air Quality Standards not exceeded.	Minimise use of vessels through efficient journey planning and use of relevant vessels for each activity. Prior to contract award Repsol Sinopec Resource UK will review vessel Common Marine Inspection Documents (CMID) as part of vessel assurance (evidence of maintenance). All vessels will be in compliance with Repsol Sinopec Resources UK's Marine Assurance Standards (MAS). Vessels will be MARPOL compliant.	2	L	N/A		L	N/A

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
	Physical presence								b	c			a	a		a		Potential impact on multiple users especially commercial fisheries e.g. through collision with towed fishing gear.	Minimise use of vessels, through efficient journey planning. Notify other sea users - e.g. Kingfisher, Scottish Fishermen's Association (SFF) etc. Ongoing collaboration with SFF. All vessels engaged in the project operations will have markings and lightings as per the International Regulations for the Prevention of Collisions at Sea (COLREGS) (International Maritime Organisation, 1972). Navigational aids including radar, lighting and Automatic Identification Systems (AIS) will be used. A vessel Collision Risk Assessment (CRA) will be produced if required. Vessels associated with decommissioning of platforms and WTGs will	1	L	N/A		L	N/A

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
																			operate within existing 500 m exclusion zones.						
	Physical presence after activities						b											Potential anchor scars/depressions from jack-up drilling rig and HLV (if anchored).	Overtrawl trials after infrastructure has been removed. Remedial action if required following results of overtrawl trials and discussion with BEIS/SFF.	1	L	N/A		L	

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
	Disturbance to the seabed						b	b										Disturbance to the seabed from jack-up drilling rig. In addition, depending on removal option selected (and hence vessels type) for the platforms, there is potential for seabed disturbance from anchors. Localised seabed disturbance resulting in some lethal/sub-lethal effects on benthic and epibenthic fauna. Possible smothering of some organisms following settlement of re-suspended particles. Recovery dependent on type of seabed and species present. Area of impact is relatively small and out with any designated areas. Potential anchor scarring from anchors and depressions from spud cans. No impact on current fishing activity as disturbance will be within 500 m exclusion zones currently in place.	Jack-up drilling rig and anchor pattern will be designed to minimise/avoid disturbance of the drill cuttings pile at Beatrice AD. Overtrawl trials after infrastructure has been removed. Remedial action if required.	2	L	N/A		L	N/A

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
	Discharges to sea: vessel sewage			a		a		b	b									Discharge of sewage; grey and black water macerated to <6 mm prior to discharge and discharge of food waste to sea. Organic enrichment and chemical contaminant effects in water column and seabed sediments.	Minimise use of vessels, through efficient journey planning. Repsol will review vessel CMID as part of vessel assurance and all vessels will be compliant with Repsol's MAS. Vessels will be MARPOL compliant. In line with MARPOL Reg 9.1.2 there will be no discharge of treated sewage within 3 nautical miles (nm) of land.	1	L	N/A		L	N/A
	Discharges to sea: ballast water			a		a	b	b	b									Water quality in immediate vicinity of discharge may be reduced, but effects are usually minimised by rapid dilution in receiving body of water and non-continuous discharge. Possible introduction of invasive species depending on vessel routes.	Repsol audit procedures will ensure that the contracted vessels ballasting procedures are in line with the International Maritime Organisation (IMO) Convention aimed at preventing associated harmful effects. All discharges monitored and records maintained.	1	L	N/A		L	N/A

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
	Discharges to sea: biofouling					a	b	b										Bioinvasions as a result of biofouling (accumulation of organisms including plants, algae, or animals such as barnacles) on vessels.	Contracts will be awarded to contractors originating from countries signed up to IMO. As part of Repsol's auditing process, only vessels adhering to the IMO 2011 Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Species will be used. All member states of IMO are signed up to these Guidelines.	2	L	N/A		L	N/A
	Underwater noise							b	b									Vessels will use Dynamic Positioning (DP) and will have the potential to cause disturbance to marine mammals and fish in the form of temporary displacement from the area. Marine mammals and fish are expected to return once the vessel(s) has left the area.	Minimise use of vessels, through efficient journey planning.	2	L	N/A		L	N/A

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
	Visual impact									c						a		Potential to be seen by coastal communities, however not considered an issue given the frequency of vessels in the area and the temporary nature of the proposed operations. Given proximity to the coast (and therefore the lights associated with coastal communities) there is not considered to be an impact on bird migrations.		1	L	N/A	Stakeholder engagement	L	N/A
	Waste														b			General vessel waste.	Prior to contract award Repsol will review vessel Waste Management Plan (WMP). Repsol will ensure vessels are compliant with MARPOL and flag state requirements and, as such, meet Repsol's MAS.	1	L	N/A		L	N/A
	Resource use	a																Fuel use.	Minimise use of vessels, through efficient journey planning.	1	L	N/A		L	N/A

Activity	Aspect	Receptor Sensitivity															Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal											
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage							
	Unplanned event: loss of fuel during bunkering			a	a	a	a	b	c	c	b	d	c	a		c		Loss of fuel during bunkering.	Trained personnel to carry out bunkering operations using established work procedures; bunkering operations are manned continuously with radio contact between vessel and installation at all times. Regular maintenance checks of fuel transfer hose (identified as an environmentally critical element).	3	M	U		M	M
	Unplanned event: loss of vessel fuel inventory			a	a	a	a	b	c	c	b	d	c	a		c		Unforeseen event during operations for example a collision or fire resulting in a loss of fuel inventory (maximum 3,613 m3).	Vessel Assurance Inspection. Pre-hire vessel audit shall be used to establish nature of fire fighting systems. Emergency response plans in place including vessel SOPEPs. SIMOPs will be managed through bridging documents and communications.	4	H	R		H	M

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
Decommissioning of Pipelines and Power Cables (offshore activities)																									
Trench and bury activities	Disturbance to the seabed						a	b					b					Some resettlement of sediments during trenching and burying activities and during trawl sweeps and trawl trials (if carried out)		1	L	N/A		L	N/A
Length of pipelines and power cables left in situ	Physical presence						b						b					Low potential for additional exposures to occur. Pipeline status reports have found seabed to be stable over all trenched and buried pipelines and cables.	Post decommissioning pipeline status surveys to be carried out.	2	L	N/A		L	N/A
	Discharges to sea: flushing fluids			a		a	b	b	b			c						Discharge of flushing fluids (inhibited seawater containing corrosion inhibitors, biocides etc.) Only at pipeline ends as no cutting of mid line exposed sections. At the time of decommissioning all pipelines will be flushed and cleaned in line with BAT/BEP procedures to minimise oil concentrations remaining.	Chemicals used are PLONOR. Comply with OCRs.	1	L	N/A		L	N/A

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
	Discharges to sea: following pipeline degradation				b		b	b										Following pipeline degradation, will have exposure of wax remaining within the oil pipelines to the surrounding environment. Pipelines will be buried under sediment c. 0.6m deep, wax therefore not expected to become exposed to the seabed surface. Unlikely to be measurable in sediment, benthic communities or fish.	Majority of the pipeline will be buried under sediment to c. 0.6 m deep.	1	L	N/A		L	N/A
Additional impacts associated with first contingency option of cut and recovery of pipeline and power cable ends and exposed sections	Discharges to sea: flushing fluids			a		a	b	b	b			c						Discharge of flushing fluids (inhibited seawater containing corrosion inhibitors, biocides etc.) at pipeline ends and at mid line exposed sections. Flushing activities followed BAT/BEP approach to minimise oil remaining in the pipelines to ALARP.	Chemicals used are PLONOR. Comply with relevant regulations.	1	L	N/A		L	N/A

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
	Disturbance to the seabed						a	b					b					Jetting to access pipelines and power cables for cutting activities. Assume potential for use of baskets for ROV work as a worst case. Grapple may be used.	Optimise work procedures. Where required mechanical backfilling will be carried out.	1	L	N/A		L	N/A
Additional impacts associated with second contingency option of adding rock cover to pipeline and power cable ends and exposed sections	Physical presence: social receptors												b					Impact on fishing gear	Quantity of rock cover will be optimised. Consultation with SFF regarding rock cover profile. Over-trawlability survey. Follow up surveys. Location of rock added to FishSafe.	2	L	N/A		L	N/A

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
	Physical presence: environmental receptors (change in habitat type, impact on benthic animals).						b					c						Change in habitat type. Some mortality of benthic animals belonging to species which are generally considered widespread throughout the area. Though laying rock cover within designated sites, none will be laid on designated features.	Minimise quantity of rock to be laid. This is a mitigation option should trench and bury or cut and remove not be technically feasible.	2	M	N/A	Trench and bury or cut and recover of the pipeline ends and exposed sections will be selected over rock cover.	M	N/A
	Resource use	b																Use of rock and fuel. Around 14,000 te of rock would be required to cover the pipeline and power cable ends and exposed sections.	Pre planning of rock cover volumes required to be mobilised.	1	L	N/A		L	N/A

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
Decommissioning of Protective Structures: Mattresses, Grout Bags and Concrete Tunnels																									
Mattresses left on the seabed	Physical presence of flexible concrete mattresses						b						b					Potential snagging hazard. Prohibits access by scallop fishing gear.	Repsol Sinopec Resources UK's base case is to recover all concrete flexible mattresses. Rock cover may be added where there are a group of these mattresses that cannot be recovered using a grab. In this instance the rock covered mattresses will be marked on FishSafe. Overtrawlability trials will be carried out.	3	M	P	If individual mattresses cannot be recovered using grab, it is proposed to recover them using debris baskets. Review of ROV footage suggests there are no groups of mattresses that could not be recovered using a grab.	L	L
	Physical presence of grout filled mattresses and larger 11.25 te and 22.5 te grout bags: social impact												b					Potential snagging hazard. Prohibits access by scallop fishing gear. Repsol Sinopec Resources UK commissioned SFF to carry out over trawlability trials over some of these mattresses (Q4 2017). Results suggest that fishermen would need to trawl	Base case is to remove all grout filled mattresses and large grout bags. Where recovery is not possible, Repsol Sinopec Resources UK will consult with BEIS to identify an alternative option. Overtrawlability trials will be carried out.	3	M	P		L	L

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
																		carefully over the mattresses to prevent damage to the nets.	Locations of any remaining rock covered grout filled mattresses and grout bags will be marked on FishSafe and will be subject to a survey program.						
Possible contingency option: Impact of addition of rock cover on grout filled mattresses and larger grout bags (11.25 te and 22.5 te) not recovered	Physical presence: social receptors												b					Potential impact on trawl gear. Prohibits access by scallop fishing gear. Potential area to be impacted is small (0.005 km2).	Base case is full recovery. Quantity of rock cover will be optimised. Consultation with SFF regarding rock cover profile. Over-trawlability survey.	3	M	N/A	Follow up surveys to determine condition of rock cover.	L	N/A
	Physical presence: environment al receptors (change in habitat type, impact on benthic animals)				a		b											Change in habitat type. Some mortality of benthic animals belonging to species which are generally considered widespread throughout the area. These mattresses or grout bags do not occur in environmentally sensitive areas, hence any rock cover added will be out with sensitive areas. At time of writing, ranking	Base case is full recovery. Minimise quantities of rock cover to be laid.	2	L	N/A		L	N/A

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
																		was completed assuming worst case whereby none of the grout filled mattresses or larger grout bags could be recovered.							
	Resource use (rock)	b																Rock cover required to cover mattresses and larger grout bags that cannot be recovered.	Base case is full recovery. Minimise quantities of rock cover to be laid.	1	L	N/A		L	N/A
Recovery of grout bags (25 kg) and concrete tunnels	Disturbance to the seabed						b											Grout bags recovered using baskets. Possible that will be some mortality of benthic animals belonging to species which are generally considered widespread throughout the area. Concrete tunnels recovered using a grab.	Optimise work procedures to minimise basket deployments.	1	L	N/A		L	N/A
Unplanned events	Grout filled mattresses breaks down and exposes pipeline						b						b					Grout bag breaks down and exposes pipeline with pipeline potentially becoming a snagging hazard. However, considered extremely remote.	Base case is full recovery of these mattresses, if not possible Repsol Sinopec Resources UK will consult with BEIS to identify alternative approach.	3	M	R		M	L

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
Onshore activities associated with recovering mattresses grout bags and concrete tunnels.	Waste														a			Recovered mattresses, grout bags and concrete tunnels will only be put to landfill if an alternative use cannot be identified.	Waste management will follow the waste hierarchy: reduce, reuse, recycle. All waste will be handled and disposed of in line with regulations which will be detailed in the WMP.	2	L	N/A		L	N/A
Recovery of topsides, jackets, conductor frame, drilling template and wind generator turbines.																									
Recovery activities	Disturbance to the seabed out with the cuttings pile at AD.				a		b	b										Should internal cutting of the jacket legs not be technically feasible there will be disturbance to the seabed associated with excavation of material to allow access to the jacket piles below the seabed.Increased suspended solids in the water column and dilution and dispersion before settling on seabed.	A suitable tool will be selected for the cutting to ensure that impacts are minimised. Procedures will be in place for the activity. A lifting plan will be in place which will minimise the likelihood of dropped objects.	2	L	N/A		L	N/A

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
	Disturbance to the AD cuttings pile to allow recovery of the jacket, conductor guide frame and drilling template.			a	a		b	b										Assumes a scenario whereby 85% of the cuttings pile is relocated to allow access to infrastructure.	Ongoing studies to manage the cuttings pile e.g. exploration of all options to cut the jacket piles internally.	3	M	N/A		M	N/A
	Use of rock cover to fill depressions left on seabed: environmental impact				b		b											It is possible that should the jacket piles be cut externally depressions of up to 4 m diameter and 3 m deep may remain following jacket recovery. Rock cover could be used to fill the holes. Introduction of hard substrate to a generally sandy seabed area.	Repsol Sinopec Resources UK will continue to explore excavation technologies that allow excavated material to be used to backfill the holes.	2	L	N/A		L	N/A

Activity	Aspect	Receptor Sensitivity															Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal											
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage							
	Use of rock cover to fill depressions left on seabed: socio-economic impact												b					It is possible that should the jacket piles be cut externally depressions of up to 4 m diameter and 3 m deep may remain following jacket recovery. Rock cover could be used to fill the holes. Could result in exclusion of scallop dredges from the area.	Repsol Sinopec Resources UK will continue to explore excavation technologies that allow excavated material to be used to backfill the holes.	2	L	N/A	Consideration given to using finer 'rock' especially at the top of the depression that would allow ongoing access by scallop dredges.	L	N/A
	Increased suspended solids in the water column from cuttings activities (shavings)			a	a		b	b										Increased suspended solids due to metal shavings from the legs (SWARF)	Work procedures in place which include aim to minimise cutting operations.	1	L	N/A		L	N/A
	Underwater noise							b	b									Abrasive water jet cutting or diamond wire cutting. Studies suggest that there is no significant impact from the noise generated by cutting operations.	Number of cuts and therefore associated noise will be minimised.	1	L	N/A		L	N/A

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
	Discharges to sea: marine growth			a	a													Marine growth may fall off structure into sea and onto the vessels during transit. It will be naturally dispersed in the marine environment. Water quality in immediate vicinity of discharge will be reduced, but effects are usually minimised by rapid dilution in massive receiving body of water.	The Project preference will be to avoid any transboundary movement of recovered structures. However, in the unlikely event that a yard outside the North Sea is selected Repsol Sinopec Resources UK will audit vessels involved in transport to ensure that marine growth 'drop off' is contained.	1	L	N/A		L	N/A
Unplanned event	Dropped object						b											Potential of a significant dropped object during operations (e.g. a container or module)	Approved lifting plans in place. Experienced contractors will be used. PON2 reporting for dropped object into the sea. Would be recovered. Debris survey will be carried out.	1	L	P		L	L

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
	Liquid discharges from topsides during lifting			a														Possibility of small discharges of liquids entrained on the topsides.	Work procedures in place. All equipment flushed and cleaned as part of preparatory works.	2	L	N/A		L	N/A
Onshore/ yard activities	Emissions to air		b													b		Fuel combustion emissions (CO_2, CO, SOx, NOx, etc.) from lorries and cuttings tools and recycling operations.	Contract award will be to an established yard with appropriate experience, capability, licences, consents and community engagement in place.	2	L	N/A		L	N/A
	Noise and vibration															b		Lorries transporting the recovered infrastructure. Noise associated with the yard activities.	Contract award will be to an established yard with appropriate experience, capability, licences, consents and community engagement in place.	2	L	N/A		L	N/A

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
	Odour															b		Evidence of marine growth on the jackets.	Contract award will be to an established yard with appropriate experience, capability, licences, consents and community engagement in place.	2	L	N/A		L	N/A
	Waste														b			Estimated that c. 1% of recovered structures would go to landfill.	All waste will be handled and disposed of in line with regulations which will be detailed in the WMP. Offshore waste management procedure in place which should allow for effective management of the waste when it arrives onshore. Waste management will follow the waste hierarchy: reduce, reuse, recycle. Repsol Sinopec Resources UK to audit the disposal yard and key third party sites used.	2	L	N/A		L	N/A

Activity	Aspect	Receptor Sensitivity																Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Company or project specific mitigation	Residual Impact Significance	Environmental Risk (unplanned event)
		Environmental											Societal												
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage								
	Hazardous waste														b			Asbestos on all topsides. Lift transportation company may need certificate before lift to ensure not hazardous for transportation and proof before shipping.	Assessment of potential contaminants prior to arrival onshore. Possible quarantine of contaminated equipment on the barge/vessel for segregation If returned to shore it will be transported and disposed of in line with the relevant regulations which will be detailed in the WMP. The disposal yard selected will have all the required permits and consents in place to handle, store and dispose of the Beatrice waste. Repsol Sinopec Resources UK to audit the landfill site.	1	L	N/A		L	N/A

APPENDIX B – MODELLING OF DISTURBANCE TO THE BEATRICE AD CUTTINGS PILE

B.1. INTRODUCTION

B.1.1 Background

Drilling commenced at Beatrice AD in 1976 at which time Water Based Muds (WBM), Oil Base Muds (OBM) and Low Toxicity Oil Based Muds (LTOBM) were used to drill different sections of the wells. Up to 1996 all cuttings were discharged to sea. From 1996 only the WBM contaminated cuttings were discharged whilst OBM/LTOBM contaminated cuttings were skipped and shipped to shore for treatment and disposal. It should be noted that though diesel was widely used in the North Sea as a base oil, prior to being prohibited in 1984, it was never used at the Beatrice Field.

A total of 30 wells have been drilled at the Beatrice AD platform. Prior to the ban on the discharge of OBMs/LTOBMs, *c.* 17,869 m^3 of cuttings (WBM, OBM and LTOBM) had been discharged. The drilling of the final six wells after 1996 (between 1996 and 2001) resulted in the discharge of a further 682 m^3 of WBM contaminated cuttings.

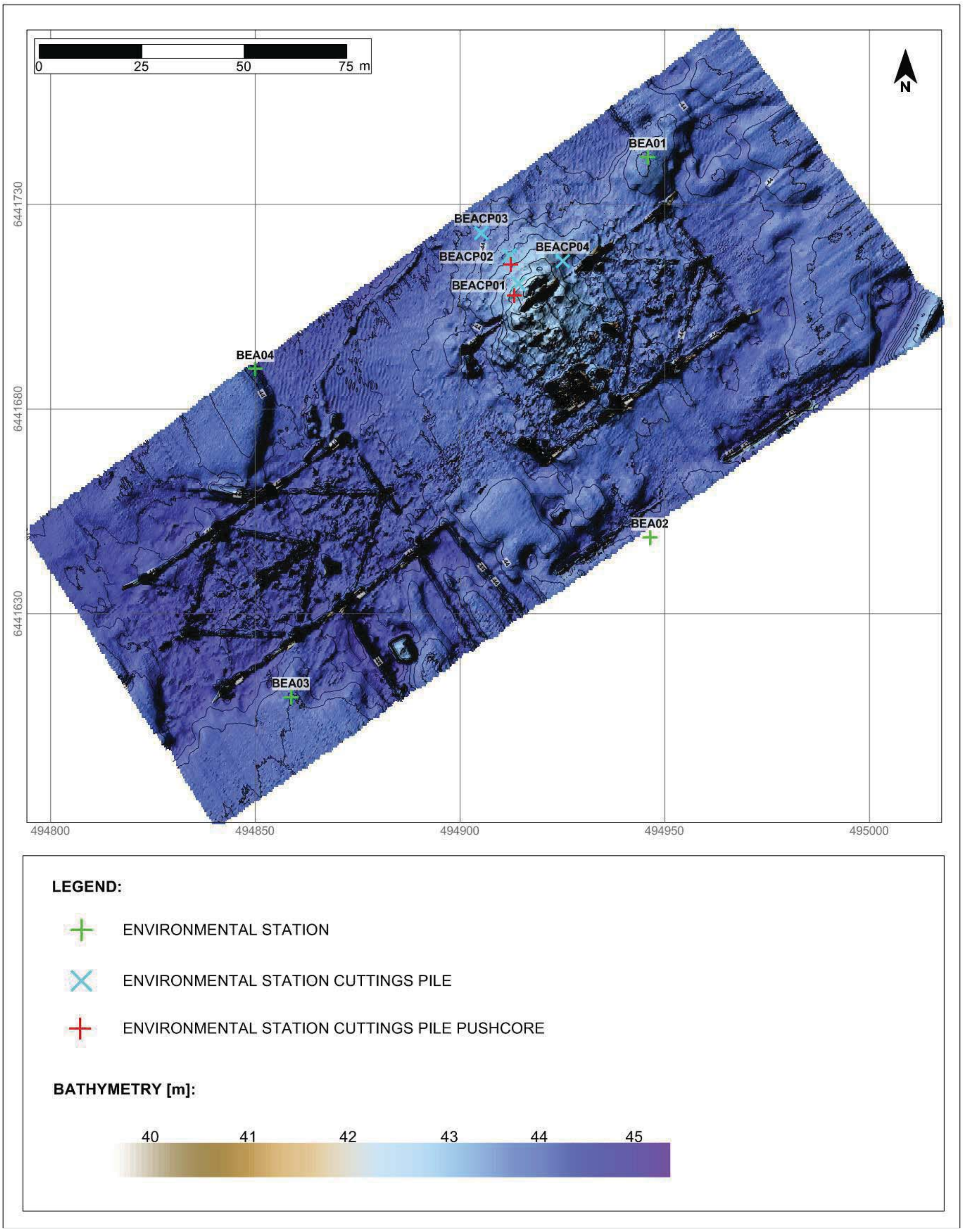
The 2016 survey (Fugro, 2017a) indicated that the current maximum depth of cuttings is *c.* 1.4 m with a volume of approximately 678 m^3. This suggests that there has been a high level of natural dispersion of the cuttings pile to date.

In order to recover the jacket, conductor guide frame and drilling template associated with the Beatrice AD installation it will be necessary to disturb part of the cuttings pile. It is estimated that should it be possible to cut the jacket legs internally, around 30% of the pile will require to be disturbed. In the instance that internal cutting will not be possible it is anticipated that up to 85% of the pile will need to be moved to allow external access to the jacket piles.

In order to determine the environmental impact significance of disturbing the cuttings pile, modelling was carried out assuming the worst case disturbance whereby 85% of the pile is moved to allow the recovery of the infrastructure.

DREAM (Dose-related Risk and Effect Assessment Model) (Sintef, part of the Marine Environmental Modelling Workbench (MEMW) suite of models) which incorporates the ParTrack sub-model used for modelling the dispersion and settlement of solids was used to model the fate of the disturbed cuttings. The model predicts the fate of materials discharged to the marine environment (their dispersion and physico-chemical composition over time) and it can also calculate an estimate of risk to the environment using a metric known as the Environmental Impact Factor (EIF). Further details on the EIF are provided in Section 3.2.

As part of the pre-decommissioning survey (Fugro 2017a and 2017b), samples were taken from the Beatrice AD cuttings pile as shown in Figure B -1. Samples BEACP01 to BEACP04 are surface sediment samples taken from within the area of seabed impacted by the cuttings pile. BEACORE1 and BEACORE2 are core samples taken to 0.65 m depth within the pile and were taken at the same location (though deeper) as BEACP01 and BEACP02. Sediments samples were also taken from the wider area of the seabed; numbered BEA01 to BEA17 (some of which are outside the boundary of the area shown in Figure B -1 but are detailed in the survey report: Fugro, (2017a)).



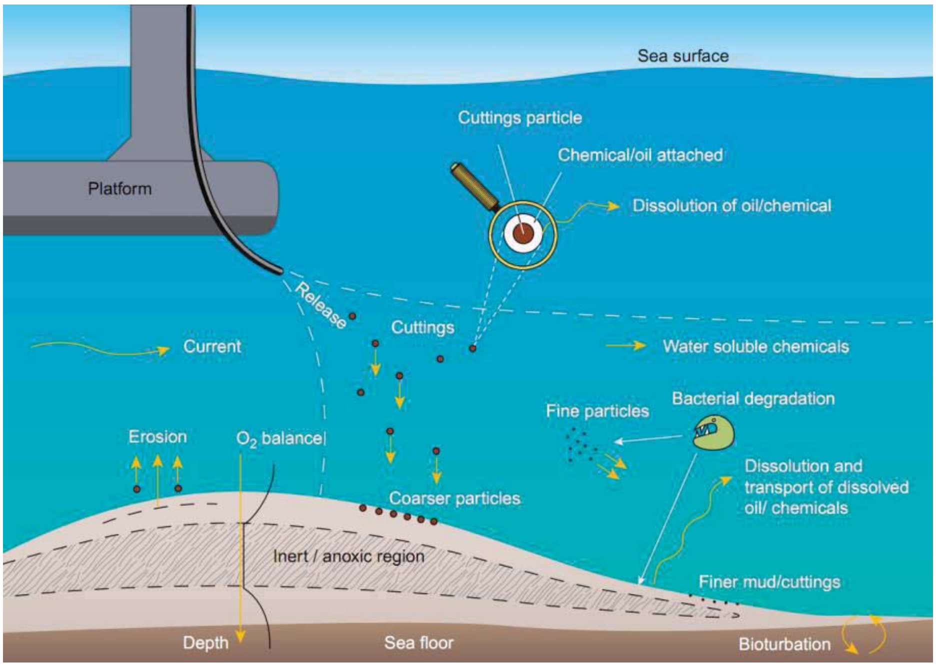
Note: Sample stations BEACP01 and BEACP02 include sampling surface samples BEACP01 and BEACP02 as wells as samples within 1 m core tubes, subsequently referred to as BEACORE1 and BEACORE2.

Figure B -1 : Cuttings pile topography and sampling locations (Fugro, 2017b).

B.2. MODELLING METHODOLOGY

B.2.1 Modelling Approach

The DREAM/ParTrack model has been developed to calculate the dispersion and deposition on the seabed of drilling mud and cuttings as well as the dispersion of chemicals in the free water masses. The calculations are based on the `particle' approach, combined with a near field plume model and the application of external current fields for the horizontal advection of the particles. The model consists of a plume mode and a far-field mode. The plume mode takes into account effects from water stratification on the near-field mixing, ambient currents and geometrical configuration of the outlet. Once plume advection ceases, particles fall out of the plume and deposit on the bottom. Downwards (or rise) velocity of the particles is dependent on size and particle density and also on agglomeration of solids in the presence of oil-related components. The far-field model includes the downstream transport and spreading of particles and dissolved matter, once the plume mode is terminated. The processes involved are illustrated in Figure B-2.



Note: the release shown at the base of the platform can represent either a discharge of new cuttings or as is this case the relocation of existing cuttings. The subsequent processes (solution, degradation etc.) are similar.

Figure B-2 : Processes involved in DREAM/ParTrack model.

Model predictions have been validated through field measurements at the Trolla field in 265 m water depth in the Norwegian Sea, where reasonably good correspondence was obtained between measured and simulated deposition of the cuttings on the sea floor (Rye, 2010 and Jødestøl and Furuholt, 2010). The observed deposition thickness was lower than was predicted by the ParTrack model which suggests that the modelling results are conservative. Validation was also achieved in Hayes and Galley (2013) where an existing large oily cuttings pile was recreated in the model using historic drilling records with a good degree of correlation between the known cuttings pile geometry and the modelled geometry.

B.2.2 Model Inputs

B.2.2.1 Grid Size

The DREAM/ParTrack model accurately disperses particles according to the prevailing currents, densities, etc. To report results, it places a grid over the particles and infers concentrations, thicknesses, etc. based on the properties of each particle and their area of influence. Grid sizes are user-defined and are chosen to reflect a desired resolution in the output. A range of grid sizes were used in order to optimise specific outputs whilst not resulting in unmanageable model run times. Three sizes were used:

- A 4 km by 4 km grid with cell sizes of 10 m by 10 m to calculate local deposition patterns;
- A 5 km by 6 km grid with cell sizes of 15 m by 15 m to calculate the extent of the environmental risk to the seabed; and
- A 10 km by 10 km grid with cell sizes of 25 m to calculate water column effects.

The grid size used does not affect where cuttings actually deposit in the model, only the resolution of the outputs and the overall run time. The number of particles modelled was set to 10,000. This was sufficient to minimise any approximation in assigning mass to particles. The initial plume formation was modelled using the PLUME3D sub-model within ParTrack as recommended by SINTEF and within this calculation a time step of 0.5 seconds was used to calculate initial plume characteristics. Beyond the initial plume, a time step of two minutes for calculating subsequent particle fates was used, which is as low (i.e. as accurate) as possible while maintaining model stability and the ability to run the model within reasonable timescales. By experience based on previous modelling of cuttings deposition including a study validated against observation (Hayes and Galley, 2013) and other observations in the field, and through training and consultation with SINTEF over a long period, these parameters are considered reasonable.

After the relocation of cuttings has ceased, the time development of the risk is calculated by the model. The model combines assumptions around biodegradation, bioturbation depths, oxygen profiles in the sediment, expected recovery times from burial and grain size change and changes in chemical and oil toxicity over time. This gives a forecast of the reduction in environmental risk to the sediments over time. This approach is discussed in more detail in Rye *et al.* (2006). Laboratory and field research validating the approach can be found at: http://www.sintef.no/projectweb/ERMS/Reports/.

B.2.2.2 Metocean Data

The current data used was the SINTEF six-hourly data for 1990 to 1992.

The wind data used was the SINTEF three-hourly data for a similar period, however, cuttings deposition is not expected to be affected by shallow surface conditions.

The model takes into account the thermocline and halocline. Background information on metocean data collected for the Beatrice windfarm (PhysE, 2007 and ABPmer, 2012) and surface temperature and salinity data collated by the Scottish Government (NMPi, 2016) were used to determine representative values of temperature and salinity. The PhysE report shows that there is little stratification in mean temperature in the Moray Firth (9.3°C at the surface going down to 9.0°C at 35 m). The Beatrice AD drill cuttings will be ambient temperature when redistributed. Given this, and the fact that the cuttings are mainly composed of dense materials such as rock and barite, it is not expected (or observed in the model) that there is significant upward motion of cuttings, and the vast majority of material remains near the seabed. Variations of temperature and salinity with depth are therefore not considered to influence the model results significantly such that a constant temperature of 9 °C and salinity of 35 ppt were used as representative parameters in the model.

B.2.2.3 Sediment Type and Particle Size Distribution

The sediment analyses around the Beatrice AD platform show the prevailing sediments to be silty sand with numerous shell fragments (Fugro, 2017a) and a prevailing reference particle size of 0.21 mm for seabed sediments has been taken (the mean particle size for sediment samples around Beatrice AD, but not including the samples taken from within the actual cuttings pile, see Figure B -1).

The model has a default Particle Size Distribution (PSD) for drill cuttings that was obtained from a review of data from drilling in Norwegian waters during the development of the DREAM/ParTrack model. However, since PSD data is available for the Beatrice pile (Fugro, 2017a), it was considered preferable to use this data.

There is no data regarding the proportion of barite and bentonite in the Beatrice AD cuttings pile. This has therefore been calculated from typical industry values for barite content in mud (IOGP, 2003) and a comparison of densities (density for cuttings combined with barite and bentonite (Fugro, 2017a) compared to known densities of barite and bentonite).

Of the samples taken, sample BEACORE2 (see Figure B -1) taken at a depth of 0.44 m was selected to be the most representative of the PSD of the pile as a whole (rather than surface samples). The PSD for sample BEACORE2 has been plotted in Figure B-3 alongside the default model data for barite and bentonite. The PSD for "Beatrice cuttings" was derived from the PSD for BEACORE2 cuttings minus the barite and bentonite fractions. This is the PSD that was inputted into the model to represent the cuttings.

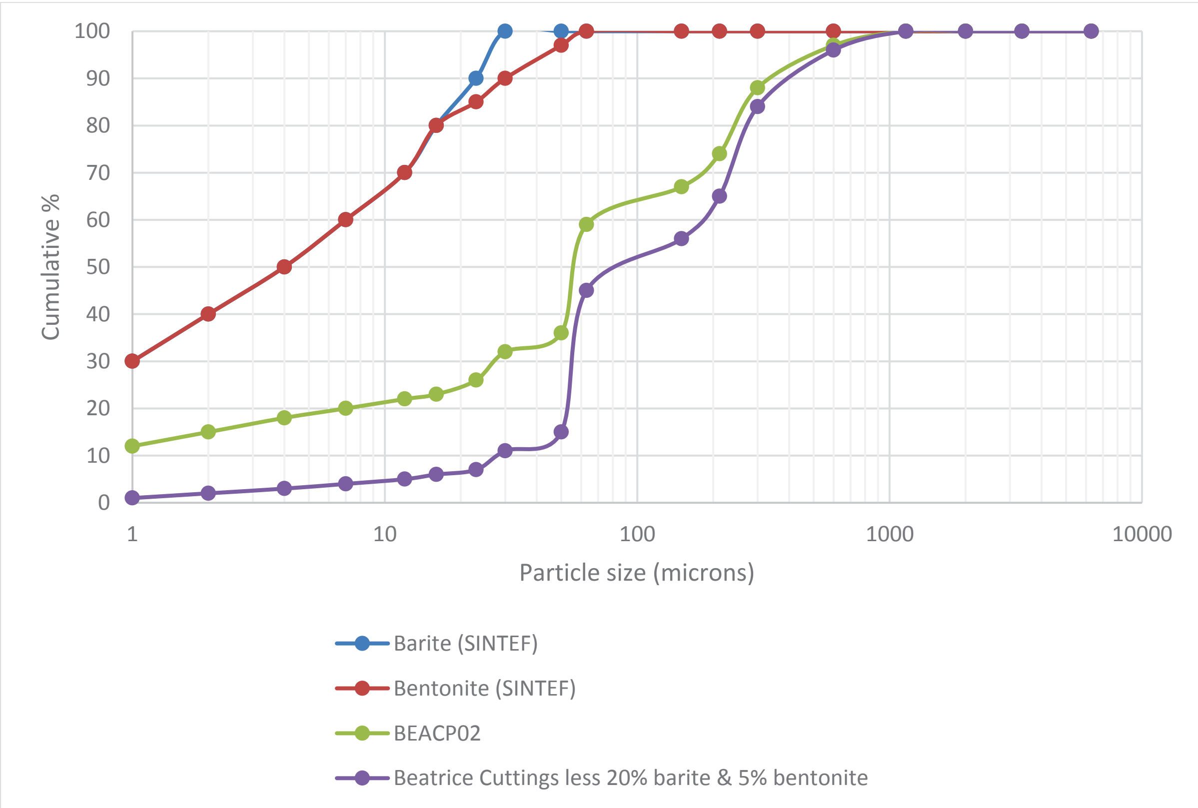
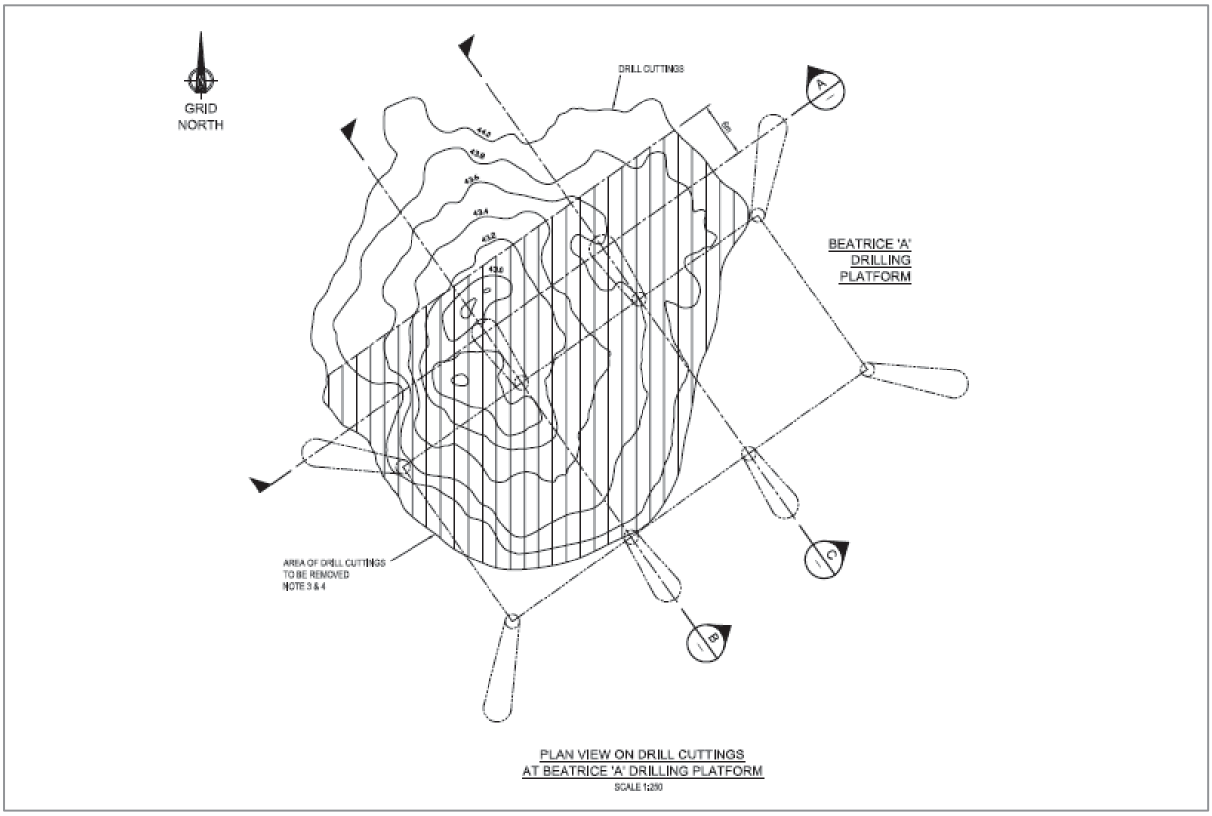


Figure B-3 : Particle size distribution.

B.2.2.4 Volume of Cuttings

The total volume of cuttings at Beatrice AD was estimated to be 678 m^3 and the area of the seabed covered by the cuttings pile was estimated to be 1,698 m^2 (Fugro, 2017a). The volume and area estimates were calculated by Fugro using the NaviModel and assuming a natural seabed depth around Beatrice AD of 44 m.

It is expected that a maximum of 576 m^3 (85%) would require to be moved to allow external access to the jacket piles, conductor guide frame and drilling template. Figure B-4 shows the area of cuttings which would need to be moved.



Note: area requiring removal is shown as hashed.

Figure B-4: Extent of cuttings pile and area requiring removal.

B.2.2.5 Structure and Composition of the Beatrice AD Cuttings Pile

Typically, cuttings piles are made up of three layers (UKOOA, 2002; Genesis, 2013):

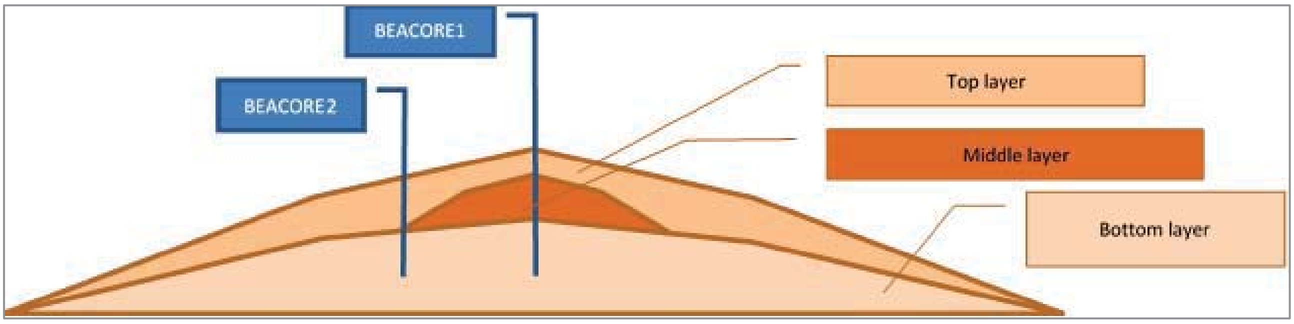
- Top layer: an oxygenated surface layer;
- Middle layer: an oil contaminated core; and
- Bottom layer: a less contaminated base layer.

The structure and composition of the pile used in the model was based on the recent survey data (Fugro, 2017a). The Beatrice AD cuttings pile is not in simple layers over the whole area as reflected by the differing contamination levels found in the samples from the two cores, BEACORE1 and BEACORE2 (Figure B-2). At BEACORE1 the three samples (top, middle and bottom) follow the pattern indicated above but at BEACORE2 the middle layer is virtually absent. The cuttings pile was assumed to be roughly conical with a base of 1,698 m^2 (Fugro, 2017a). It is also assumed that the middle layer (most contaminated layer) identified at BEACORE1 thins out and is therefore not present in the outer edges of the pile. Based on this, the volumes for each layer within the pile were calculated as shown in Table B -1 assuming the pile is structured similar to that shown in Figure B-5.

Table B -1 .Volumes of cutting by layer.

Layer	Max Depth (m)	Volume (m³)	Volume to be moved/relocated (m³)
Top layer	0.075	102	87
Middle layer	0.525	167	142
Bottom layer	0.4	408	347
Total		678	576

Notes: Volume to be moved based on 85% of total.



Source: Sampling data in Fugro, 2017a, sampling locations shown in Figure 2-2

Figure B-5 Schematic representation of pile structure inferred from survey.

Cuttings piles are made up of a solid fraction which in turn is made up of three fractions (cuttings/rock, barite and bentonite) and water. Typically, the solid fraction is made up of around 75% cuttings, 20% barite and 5% bentonite. The survey results provide a range for the proportion of water in the overall cuttings pile (29.5% to 49.1%), as well as the overall cuttings pile density (2.14) and the particle (i.e. rock fraction) density (2.6) for BEACORE1 (Fugro, 2017a). As the density of barite, bentonite and water are all known it was possible to estimate the proportion of water and rock that would be required to result in a calculated density similar to the measured one (see Table B-2). From this an estimate of the fraction of solids to water was obtained and the proportion of each fraction as a percentage of the total was calculated for each layer.

Table B-2: Profile composition (%).

Pure cuttings	Solids (59%)			Water[1]	Chemicals[2]	Overall
	Cuttings	Barite	Bentonite			
Split by type	75%	20%	5%			
Top layer	44%	12%	3%	41%	0.32%	100%
Middle layer	44%	12%	3%	36%	4.52%	100%
Bottom layer	44%	12%	3%	41%	0.19%	100%
Specific gravity	2.6	4.2	2.7	1.03	1.00	2.148
1:10 cuttings:water	**Cuttings**	**Barite**	**Bentonite**	**Water**	**Chemicals[2]**	**Overall**
Top layer	4.0%	1.1%	0.27%	94.6%	0.03%	100%
Middle layer	4.0%	1.1%	0.27%	94.2%	0.41%	100%
Bottom layer	4.0%	1.1%	0.27%	94.6%	0.02%	100%

Note 1: % water content is given in the Fugro survey report (Table 4.9) and ranges from 29.5% to 49.1%. The calculated range therefore correlates well with the measured range.

Note 2: Including oil-related components

B.2.2.6 Composition of the Discharges

B.2.2.6.1 Chemical Components

Historically, a variety of different drilling muds have been used to drill the Beatrice AD wells and these will have weathered over time. Typically, the oil components used in OBM can be categorised into groups with similar properties (e.g. IOGP, 2003 and 2016) including:

- Aliphatic oil, originally the principal component of the base oil;
- Benzene and alkylated benzene (Benzene, Toluene, Ethylbenzene and Xylene or BTEX)
- Naphthalenes (including C1-C3 alkyl homologues), phenanthrenes and dibenzothiophenes (NPD); and
- Other polycyclic aromatic hydrocarbons (PAH) (i.e. excluding NPDs).

The survey data (Fugro, 2017a) was used to establish concentrations of chemicals in different layers within the cuttings pile based on the samples from BEACORE1 and BEACORE2. The chemicals make up a very small percentage of the overall total and can be either attached to the cuttings and/or the barite and/or present as free chemicals.

The analysis of samples from the cuttings pile shows an oil content ranging from 0.19% and 0.32% for the upper and lower layers respectively, to 4.5% for the middle layer (Fugro, 2017a). This includes a very high fraction of Unresolved Complex Mixtures (UCM).

BTEX was not measured during the survey. However, BTEX chemicals have a very high biodegradation rate and therefore their concentration is expected to be negligible. This was confirmed in the Murchison cuttings pile (Genesis, 2013).

A wide range of metals were measured in the samples (Fugro, 2017a). However, to avoid an unnecessarily complex model, lead (Pb) was selected as it has the highest PEC/PNEC[1] ratio (predicted environmental concentration (PEC) to

[1] *The Predicted No Effect Concentration (PNEC) is the concentration of a chemical below which no adverse effects of exposure in an ecosystem are measure. PNEC values are intended to be conservative and predict the concentration at which a chemical will likely have no toxic effect. The PNEC is used in conjunction with the predicted environmental concentration value (PEC) to calculate risk.*

predicted no-effect concentration (PNEC)) and would therefore potentially have the worst impact, and would reflect whether metals as a whole were an important risk factor.

The behaviour of OBM contaminated cuttings in the water column is potentially complex and is discussed at some length in the SINTEF ERMS project reports (www.sintef.no/erms). In summary, the model applies algorithms to the overall discharge to agglomerate the particles according to the level of oleophilic compounds present (i.e. those with a high organic carbon water partition coefficient - K_{oc}). Further, assumptions need to be made as to whether different chemical components (including oil-related components) will be associated with cuttings, or other solids e.g. barite, or whether they may be 'free' in the liquid to disperse. OBM is designed as a cohesive mixture that resists separation into components, but it is unclear whether this behaviour would remain in an aged cuttings pile, or whether in fact new associations would form between chemicals and solids over time. Judgement has been applied as follows in order to prepare a chemical profile that can be modelled:

- components typically related to the base oil are treated in equal thirds as being attached to cuttings, barite and as a free component. This represents the original cohesive design of the mud mixture and its propensity to remain in contact with cuttings and solids, but also allowing for a component that is dispersed when resuspended by the dredge;
- components which are typically added chemicals (alkyl phenols, ethoxylates and tributyl tin (TBT)) are treated as being able to act freely. These are not normally associated directly with the drilling fluids and are more likely from another source and therefore are represented as being unattached to the mud; and
- metals are attached to barite, which relates to levels of metals known to be present in historic sources of barite.

All components can subsequently dissolve and partition into water and sediments according to the model chemistry.

While this is an approximation, the sum of contaminants released in the model in total are equal to those indicated by the cuttings samples. The separation made above is to match their dispersion behaviour more closely to expectations given their origins and general physical and chemical properties, and that they will be affected differently by the presence of solids and residual mud chemicals.

The main chemical compositional input parameters are summarised in Table B-3. It can be seen that UCMs form the main component.

PCBs, bis-phenol A (BPA), octyl and nony phenol and tributyltin (TBT) quantities are insignificant (205 g present in the whole pile for nonyl phenol and as low as 0.12 g present in the whole pile for PCBs). PAHs (polycyclic aromatic hydrocarbons) and NPDs (Naphthalene, phenanthrenes and dibenzo thiapenes) are mostly present in low concentrations but it was noted from the survey results (Fugro, 2017a) that naphthalene, phenanthrene and anthracene exceed the Effect Low Range (ERL)[2] concentration in most of the samples taken from the cuttings pile (BEACORE1 all depths, BEACORE2 all depths, BEACP03 and BEACP04). Pyrene and benzo (ghi) perylene only exceeded the ERL in the BEACORE1 mid core sample.

[2] *ERLs are values developed by the US Environmental Protection Agency and are defined as the lower tenth percentile of the data set of concentrations in sediment which were associated with biological effects. Adverse effects are rarely observed on organisms where concentrations fall below the ERL value.*

Table B-3: Main chemical inputs to model.

Chemical (te)	Chemicals attached in equal quantities to rock fraction, barite fraction and as free chemicals					
	UCM	n-alkane	PAH	NPD	PCB	BPA
Top layer	5.59E-02	2.07E-03	4.10E-05	7.04E-04	2.17E-08	1.62E-07
Middle layer	1.37E+00	1.97E-01	9.54E-04	3.75E-02	1.01E-08	8.78E-07
Bottom layer	1.38E-01	7.70E-03	1.87E-04	2.02E-03	8.86E-08	2.59E-06
Chemical (te)	**Chemicals only present as free chemicals**			**Chemicals attached to barite**		
	Octyl phenol	**Nonyl phenol**	**TBT**	**Lead**		
Top layer	6.81E-07	6.69E-05	1.13E-07	1.10E-02		
Middle layer	4.73E-06	5.55E-06	3.55E-09	2.22E-03		
Bottom layer	7.17E-07	1.33E-04	1.16E-07	1.74E-02		

The chemical groups listed in Table B-3 have been aligned with representative substances within the DREAM model substance database which contains physical, chemical and biological properties for a variety of substances including oils. PNEC values have been drawn from the OSPAR list of PNECs in produced water contained in OSPAR Agreement 2014/05 along with values from the OSPAR Environmental Assessment Criteria (EAC)[3] and ERL values (PCB and Pb) and the Norwegian Pollution Control Authority (NPCA) PNECs (bisphenol-A and TBT). There is no consistent source of applicable PNECs that can be applied to this scenario hence a number of sources have been used.

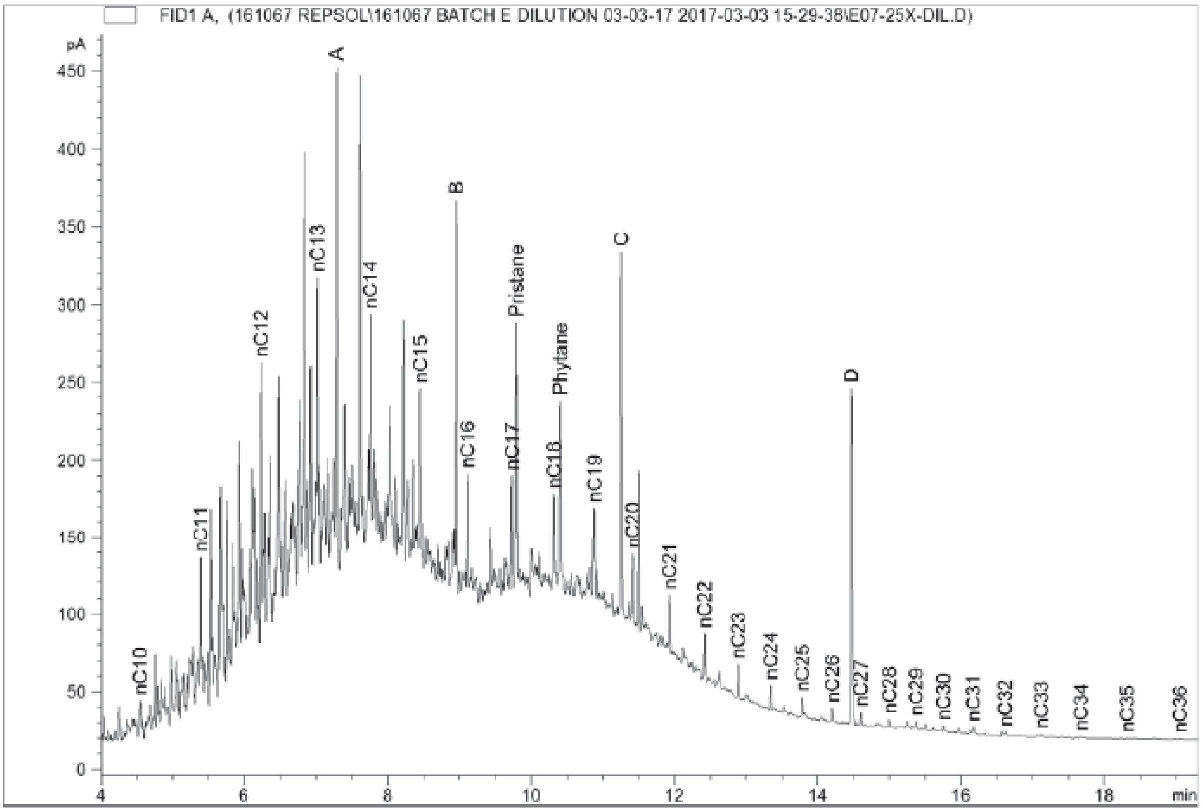
B.2.2.6.2 Unresolved Complex Mixtures

UCM is a term that encompasses a mixed breakdown of products of oil in the marine environment, especially over long periods of time in sediments. This material presents as a wide range of molecular masses and appears as a 'hump' in mass spectrometer results, in contrast to the distinct spikes that correspond to specific common reservoir hydrocarbons such as octane, decane, etc. (Figure B-6).

UCM composition in oil-contaminated sediments is discussed in a number of papers and a typical summary of characteristics is given in Brownawell *et al.* (2007) which references other studies, and also reviewed in Neff (2002). The components of the UCM include alkanes, branched alkanes, cycloalkanes, monoaromatics, multi-ring aromatics, heteroatomic aromatics, steranes and cyclic triterpenoids. When crude oil or refined fuels enter the marine environment evaporation removes the most volatile compounds; dissolution removes the more polar and water-soluble compounds; and biodegradation generally attacks the linear alkanes, branched alkanes, and then the cycloalkanes and aromatic compounds. The weathering processes produce UCM which persist in sediments and have often been used as a marker for petroleum contaminated sediments. Sediment concentrations can be present at much higher levels than other traditional organic contaminants such as PAHs. Recently research has shown that components of the UCM may be the cause of toxicity caused by weathered oils when the toxic effects are based upon a mass of known toxic components in oil (e.g. PAHs and phenols) (Neff *et al*., 2000). Studies performed have also shown that the monoaromatic components of the UCM (Rowland *et al*., 2001) amongst other components produce a toxic response in *Mytilus edulis* in aqueous exposures at concentrations found in polluted environments. The UCM is lipophilic and therefore can accumulate in the fatty tissues of benthic organisms like *Mytilus edulis* which are continuously exposed to it in the environment.

□ ***E□Cs are defined by □□P□□ and represent the contaminant concentration in the environment below which no chronic effects are expected to occur in mrine species□ includin□ the most sensitive species. Therefore□concentrations below the E□C are considered to present no si□nificant risk to the environment.***

Given the complex nature, there is a variety of data on environmental response levels for this material, and it is difficult to be certain of the relevance of UCM data in terms of its source – the oils present in the Beatrice cuttings pile are derived from drilling base oils which will differ from oils in e.g. harbour sediments on which other studies are based. The PNEC is found from LC50, which was set to 50 ppb for insoluble aliphatics with a carbon number higher than 10. Based on the biodegradation and octanol water partition coefficient (K_{ow}) value, an assessment factor of 10 has been used to find the PNEC as LC50 / 10. Further information on the PNEC derivation is given in Section B.4.3.



Note: A, B, C and D are laboratory reference standards used to calibrate the results

Figure B-6 : Mass spectrometer result for samples at BEACORE1 showing 'hump' of UCM.

B.2.2.7 Redistribution of the Pile to Adjacent Seabed

Data from previous studies and from technical data sheets for Oceaneering dredging systems (Oceaneering, 2012) were used to determine a representative pumping regime to allow 85% of the cuttings pile to be moved. A typical set up is shown in Figure B-7.

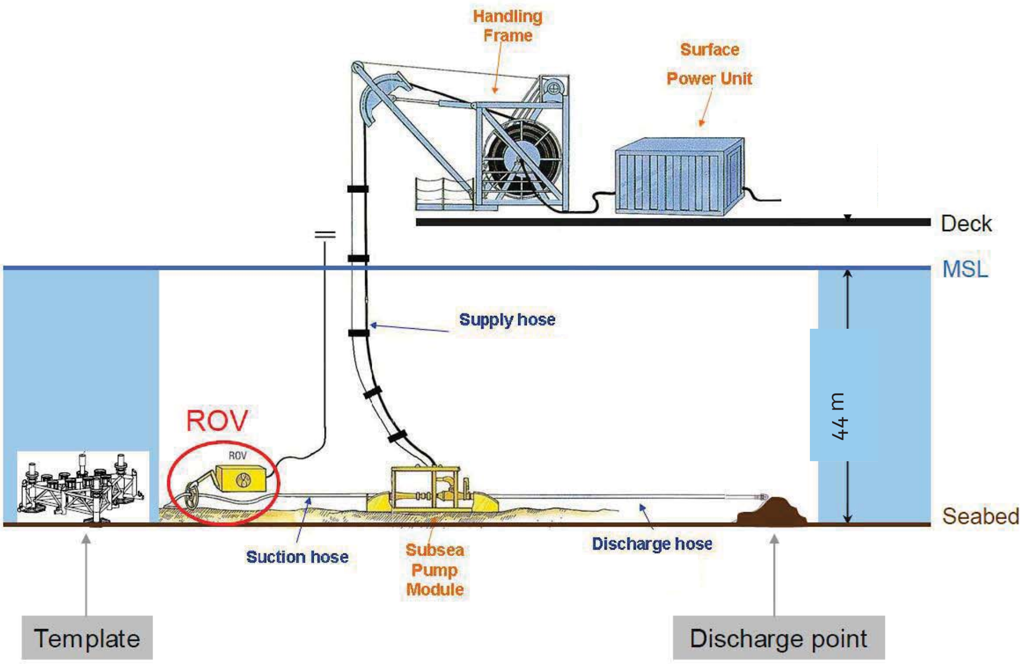


Figure B-7 : Schematic layout for redistribution of cuttings pile.

A single pumping regime was modelled to represent the portion of the cuttings pile being pumped to four separate locations, each, c. 50 m from the centre of the platform and spaced evenly in an arc from west to north (i.e. away from the existing platform, see Figure B-8).

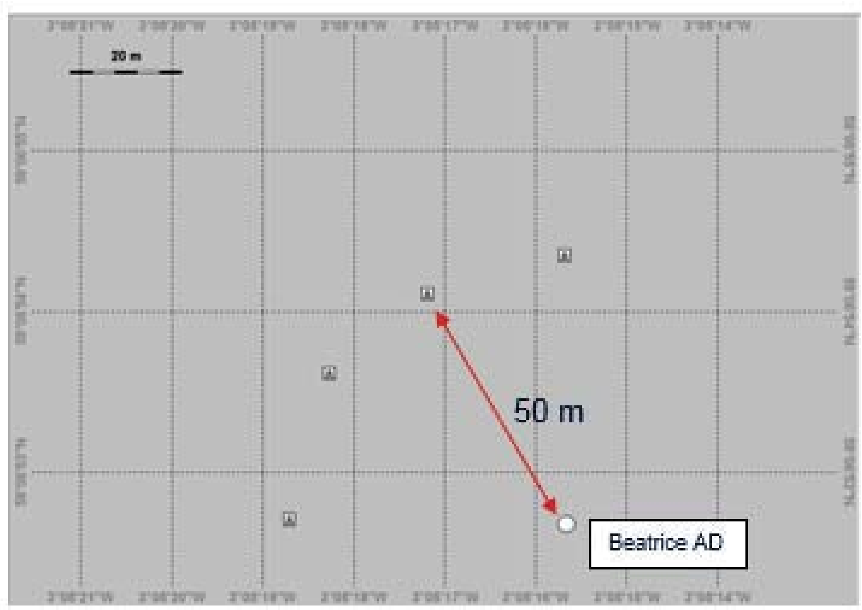


Figure B-8 : Location of discharges (Q) in relation to Beatrice AD.

In the model it was assumed that the three layers would be removed, pumped and discharged in sequence i.e. the surface layer, followed by the main oily layer, followed by the base layer. Volumes to be discharged at each location are captured in Table B-4.

A pumping rate of 10 m^3/hr was chosen based on pumping rates achieved during the Joint Industry Project (JIP) trial cuttings pile removal undertaken on the North West Hutton platform cuttings pile (UKOOA, 2002). Although design flow rates of 100 m^3/hr were described, only 10 m^3/hr flow rates were achieved during the trials. This appears to be borne out by work done by BP at Valhall (Norwegian Environment Agency, 2013) where pumping rates varied between 7 and 32 m^3/hr.

During the NW Hutton trials (UKOOA, 2002) the water to solids ratios varied between 10:1 and 20:1, very occasionally reaching 6:1. During modelling work undertaken at Murchison (Genesis, 2013) runs were undertaken using three different water to solids ratios (6:1, 15:1 and 20:1) but the model was found not to be particularly sensitive to the selected water to solids ratio. Therefore, for the Beatrice model a single water to solids ratio of 10:1 was selected. This was considered representative of ratios previously achieved.

Based on the volume of cuttings needing to be moved, the pumping rate and the water to solids ratio, the duration of each discharge was calculated. It is not expected that the pattern of deposition around the discharge points will vary significantly if a nearby location or slightly different orientation is used.

The discharge was assumed to be approximately 2 m above the seabed. This would ensure that the hose did not become blocked with cuttings piling up in front of the hose.

Cuttings volumes and likely durations of discharge at a single discharge point are shown in Table B-4 for each tranche of cuttings. It has been assumed that at each of the four locations a portion of each layer (top, middle, bottom) will be discharged. The calculated duration of the discharge assumes a 10 m^3/hr flow rate such that the relocation activities are expected to last *c*. seven days at each location.

Table B-4: Cuttings volumes and discharge duration at each of the four locations

	Cuttings volume (m^3)	Overall volume with water (m^3)	Discharge duration (days)	Modelled duration (days)
Top	22	239	1.0	1
Middle	36	391	1.6	2
Bottom	87	954	4.0	4
TOTAL (one location)	144	1,584	6.6	7
TOTAL (all four locations)	576	6,336	-	-

B.3. RESULTS

The model was used to produce three main outputs:

- Depositional thickness on the seabed and oil concentrations in the sediment (Section B.3.1);
- Environmental risk to the seabed and to the water column resulting from burial thickness, particle size change, toxicity and oxygen depletion (Sections B.3.2.1 and B.3.2.3); and
- Recovery of the seabed (Section B.3.2.2).

B.3.1 Impacts of Deposition on the Seabed

B.3.1.1 Predicted Sediment Thickness

Predicted deposition thicknesses over an area of approximately 3 km by 3 km from the four release points are shown in Figure B-9. This shows that only a small proportion of the solids discharged are expected to settle out locally, and finer solids will distribute over a wide area to a very low thickness. Within 400 m of the discharge points thickness is less than 0.1 mm along the dominant current axis.

The maximum thickness of deposition ranges from *c*. 800 to 1,100 mm (i.e. 0.8 to 1.1 m) for each of the four discharges. This maximum thickness is predicted to occur within 10 m of each discharge point. However, since the model averages the thickness over each grid cell, and each cell is 10 m by 10 m, it is possible that there will be local thicknesses greater than this immediately adjacent to the release point, which are balanced by local scale movement of solids downslope that is only represented in the model in a limited way. In practice, this resolution offers reasonable correlation with observations.

Thicknesses rapidly diminish with distance; and within 80 m, the maximum depositional thickness is predicted to be less than 1 mm. It is noted that a large proportion of the finer elements of the mud are transported away from the modelled area due to the fine particle size and will contribute to background levels of suspended solids. The environmental risk of the plume of these solids in the water column has been predicted, and the modelling extends sufficiently far to cover the area where effects in the water column are potentially significant as indicated by 5% level of risk as described in Section B.3.2.2. Such plumes are typical of ongoing consented drilling operations using WBM.

Consideration of the environmental risk resulting from the deposition thicknesses is also discussed in Section B.3.2.2.

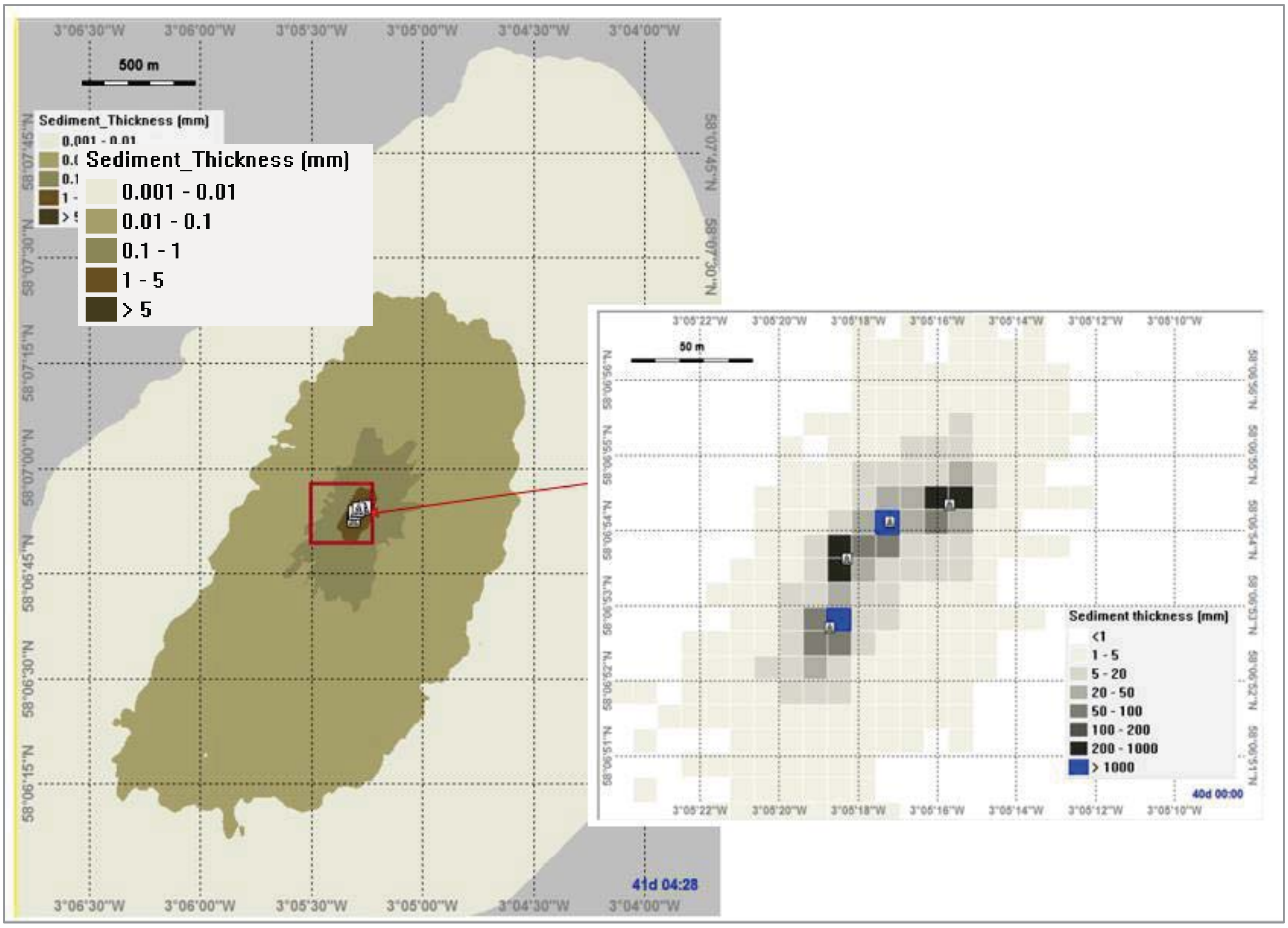
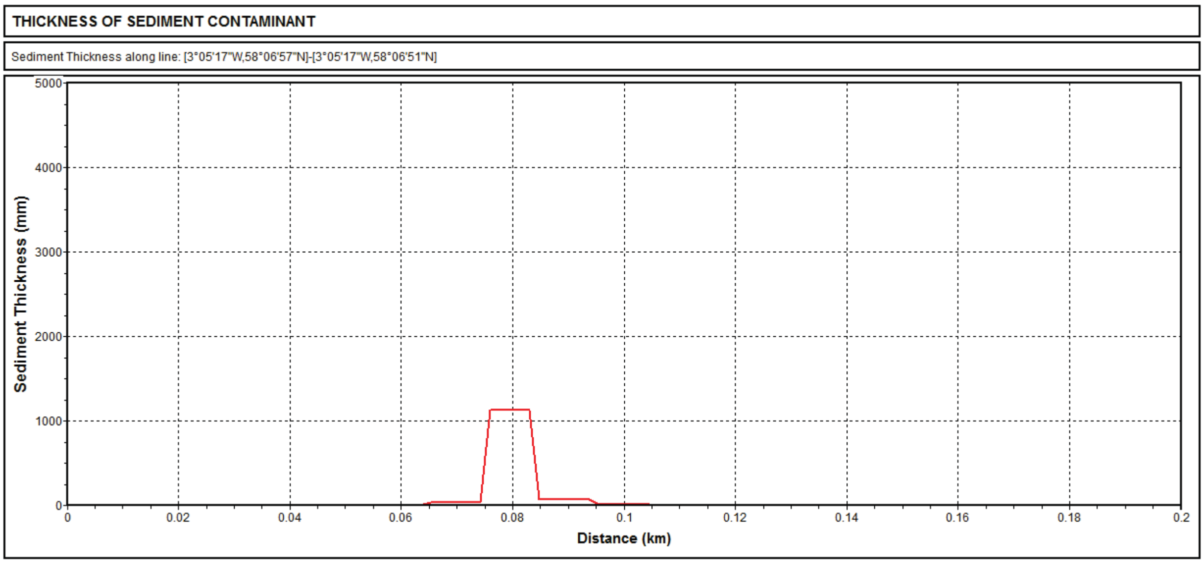


Figure B-9 : Deposition thickness of solids.

A cross section of thickness through the deposited pile is shown in Figure B -10 and clearly shows the rapid decrease of thickness with increasing distance from the discharge point.

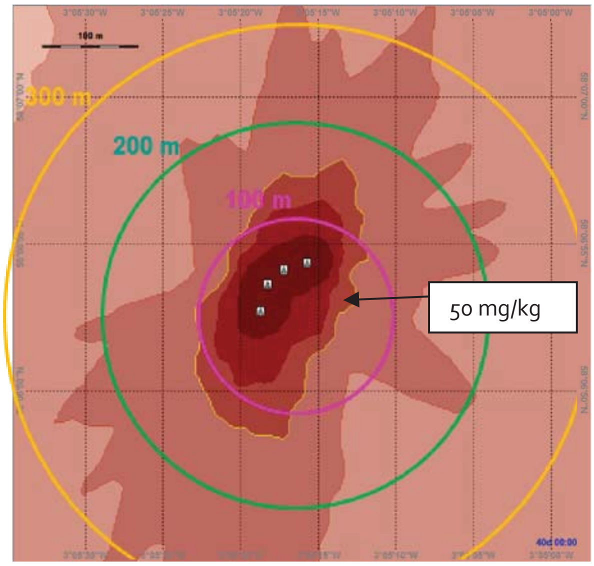


Note: Cross section north to south, through a single discharge point. Note difference in vertical (mm) and horizontal scales (km).

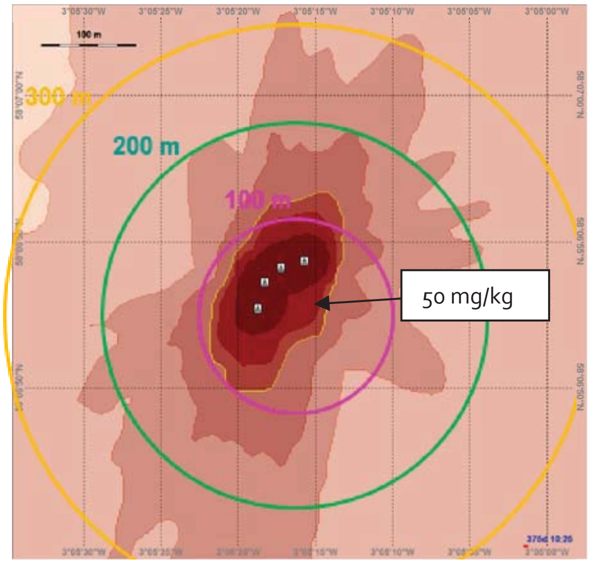
Figure B -10 Cross section showing deposition profile.

B.3.1.2 Oil in the Sediment

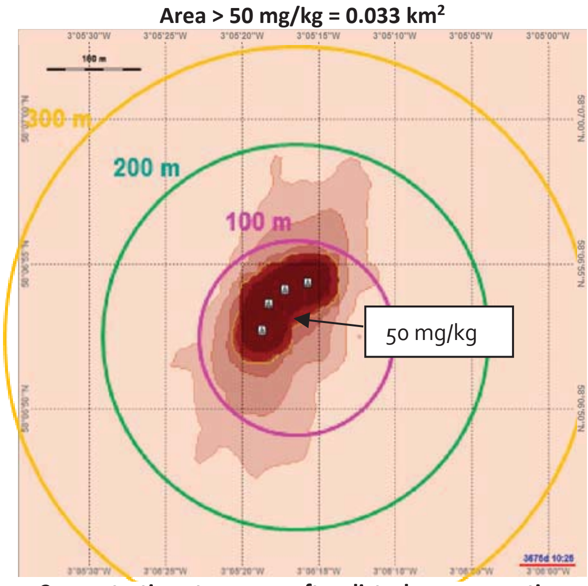
Modelled oil concentrations in the sediment, representing total hydrocarbons, are shown in Figure B-11. This includes concentrations shortly after the end of the cuttings disturbance, one year post-disturbance and 10 years post-disturbance.



Concentrations after disturbance operation
Area > 50 mg/kg = 0.033 km^2



Concentrations one year after disturbance operation
Area > 50 mg/kg = 0.020 km^2



Concentrations ten years after disturbance operation
Area > 50 mg/kg = 0.008 km^2

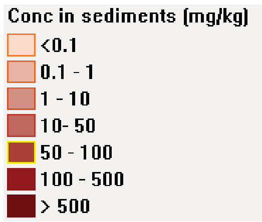


Figure B-11: Total hydrocarbon concentration in sediments over time.

The 50 mg/kg value is the concentration defined by □□□□□ (Oslo Paris Commission for the Protection of the Marine Environment of the North-East Atlantic) to aid the interpretation of the magnitude of environmental impacts of cuttings piles in the North Sea (OSPAR, 2006 and 2009□□ THC is used as the key parameter for biological effects from cuttings piles, and 50mg THC/kg in sediments has been suggested as the concentration where biological effects can be expected (e.g. Norwegian Oil and Gas, 2016, quoting multiple sources).

Figure B-11 clearly shows the area where the 50 mg/kg total hydrocarbon (THC) concentration is exceeded shrinking significantly within 10 years of disturbance and re-deposition. Immediately after the end of the cuttings redistribution the model indicates that an area of 0.033 km² exceeds 50 mg/kg THC. This is reduced to an area of 0.0083 km² or about 25% of the original area of exceedance after 10 years.

Based on the modelled area at the end of the cuttings relocation of 0.033 km², the oil would need to persist for over 15,150 years for the OSPAR threshold of 500 km².yrs to be exceeded. Given the ongoing degradation of the oil and the shrinkage of the area over time, it is concluded that the redistributed pile could not conceivably exceed 500 km².yrs of footprint-persistence.

The modelled results should also be put into the context of the existing cuttings pile and its footprint where oil is already greater than 50 mg/kg THC. THC as measured during the 2016 survey (Fugro, 2017a) are shown in Figure B- 12. This indicates that THCs exceed the 50 mg/kg threshold at distances of between c. 160 to 315 m from Beatrice AD. This would be equivalent to an area of between 0.08 km² and 0.31 km² which is an order of magnitude greater than the footprint predicted by the model following redistribution. Figure B-13 shows the total hydrocarbon concentrations in sediments one year after disturbing the cuttings pile superimposed on the hydrocarbon concentrations recorded in the survey.

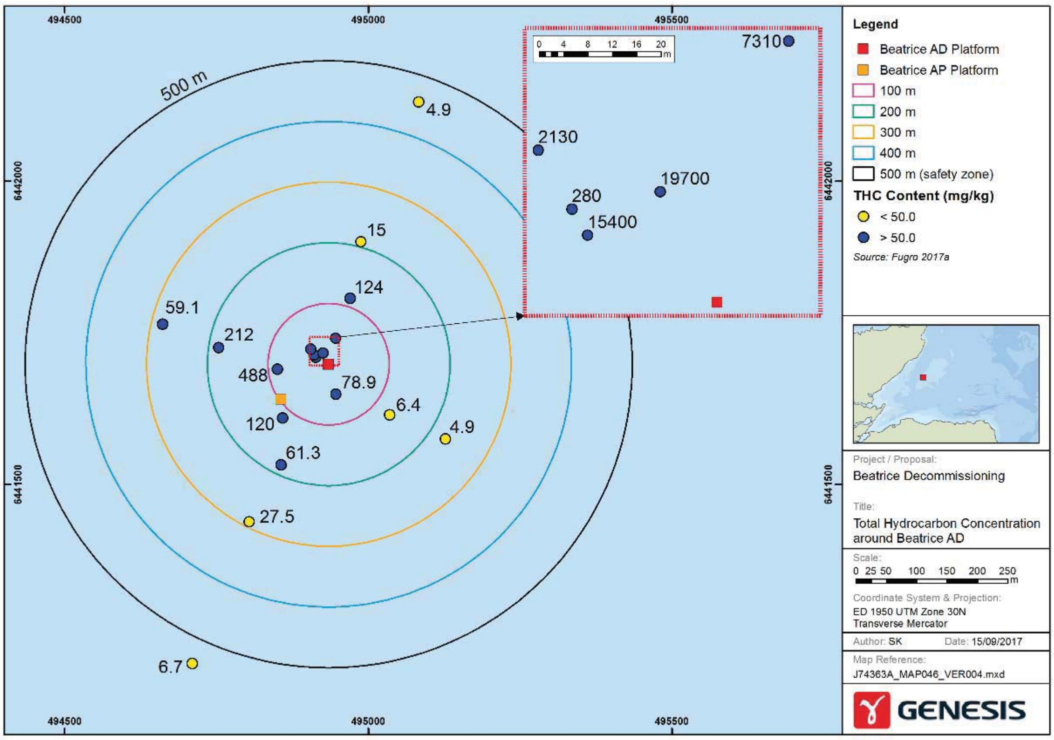


Figure B- 12: THC concentration (in mg/kg) around Beatrice AD from 2016 survey (Fugro, 2017a).

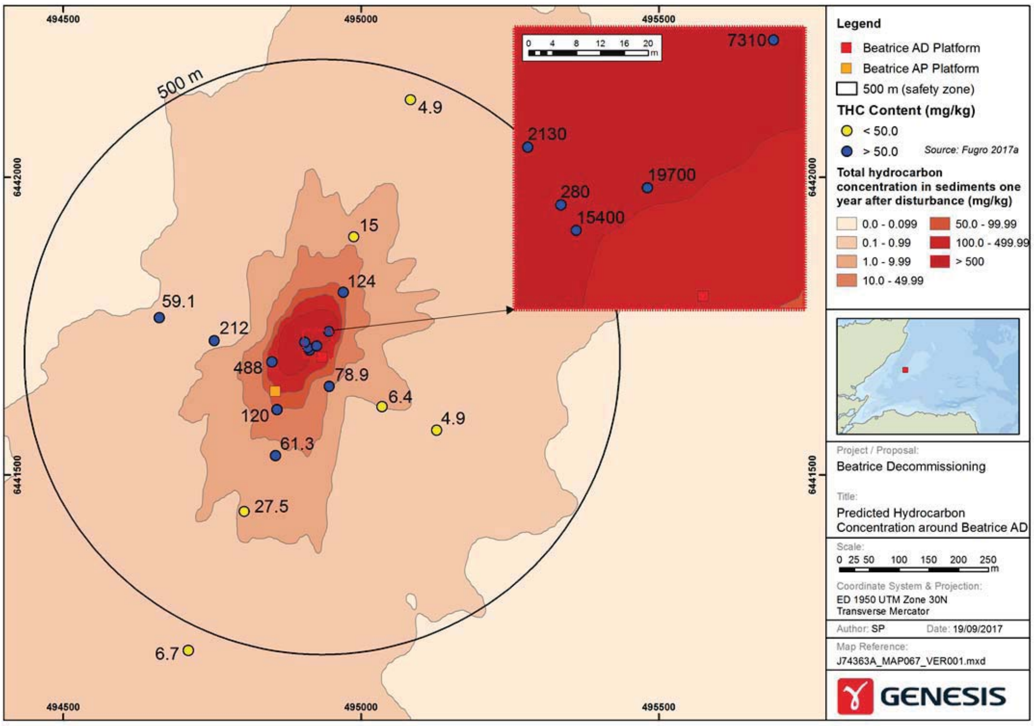


Figure B-13: Total hydrocarbon concentrations in sediments one year after disturbing the cuttings pile relative to current hydrocarbon concentrations.

B.3.1.3 Grain Size Change

Figure B-14 shows the percentage change in grain size. In the immediate vicinity of each discharge (within 10 m) there is more than a 100% increase in grain size, however, beyond *c.* 60 m of the discharge point, the percentage change in grain size is minimal (<3% change).

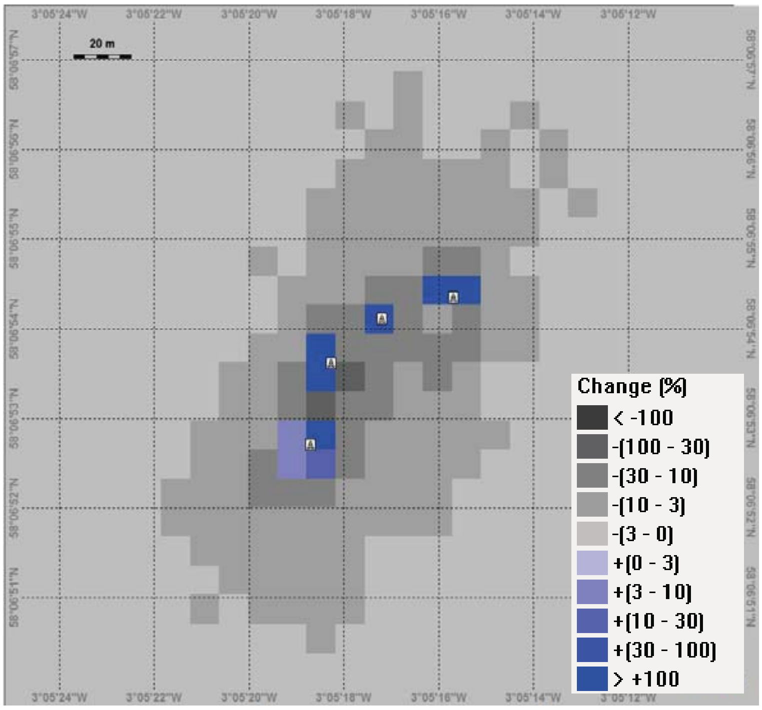


Figure B-14: % Change in grain size.

B.3.2 Environmental Risk

The framework for assessing drilling discharges follows internationally agreed principles for environmental risk assessment. This includes four key stages:

- Hazard Identification
- Exposure Modelling (predicting PECs)
- Effect Assessment (using PNECs)
- Risk Assessment

For Hazard Identification, relevant stressors were identified in the ERMS JIP as follows:

- Water column:
  - o Toxicity of chemicals; and
  - o Physical effects of suspended matter.
- Sediments:
  - o Toxicity of chemicals;
  - o Burial of organisms;
  - o Change in sediment structure (grain size); and
  - o Oxygen depletion.

The DREAM model carries out exposure modelling of drill cuttings and the components in drilling muds simultaneously in both the sediment and water column compartments.

The ERMS JIP involved a literature study in order to determine the means of Effect Assessment. This involved applying principles described by the European Union Technical Guidance Document (EC, 2003) to non-toxic stressors as well as toxic stressors. For all stressors, PNECs and species-sensitivity distributions were derived.

The risk assessment compares the PEC with the PNEC for each stressor (as listed above, calculated separately for the sediments and the water column). The outcome of the risk assessment is a combined risk probability or EIF. The spatial extent over which the EIF exceeds 5% is taken as a measure of overall risk to the environment, and can be used as a measure of significance. Sensitivity curves used to derive these 5% risk levels can be found in the technical reports at www.sintef.no/erms/reports and the risk levels are based on scientific studies of sensitivity to grain size change, burial thickness and other stressors such as described in Trannum (2004) and Kjeilen-Eilertsen (2004).

In most consenting regimes, risks below this level of 5% are considered acceptable, with limited effect and a high expectation of recovery, and changes in the ecosystem may in many cases be undetectable. Where the risk is greater than 5%, risks are potentially significant and should be investigated and justified further before consent is normally granted. It does not mean that actual harm to the environment is certain, or total, but its likelihood increases with the level of risk predicted. The risk corresponds to the percentage of most sensitive species present, which will often mean the smallest organisms with the least individual resources to respond to stressors; but at the same time such organisms are often numerous in the locality and have rapid reproductive cycles, e.g. plankton or polychaete worms. Larger animals are usually more robust, more mobile and better able to adapt to stresses in the environment and in general would be expected to tolerate levels of risk higher than 5%.

The main aim of the risk assessment process is to identify those stressors of most significance, and the characteristics of the discharge or the environment that contribute to the risk, and thereby identify (a) which parts of the environment are at a non-significant risk, and (b) for those parts at potentially significant risk, whether the proposals are justifiable and whether reasonable mitigation measures have been applied.

B.3.2.1 Environmental Risk to the Seabed

Risk to the seabed sediments from toxicity, oxygen depletion, grain size change and burial thickness have been modelled.

The total risk plot is presented at in Figure B-15 showing the main area of deposition, where the shape of the risk contours generally reflects the depositional pattern.

The maximum area of seabed predicted to be above a risk level of 5% is 11.8 km². This implies there could be impacts on certain organisms.

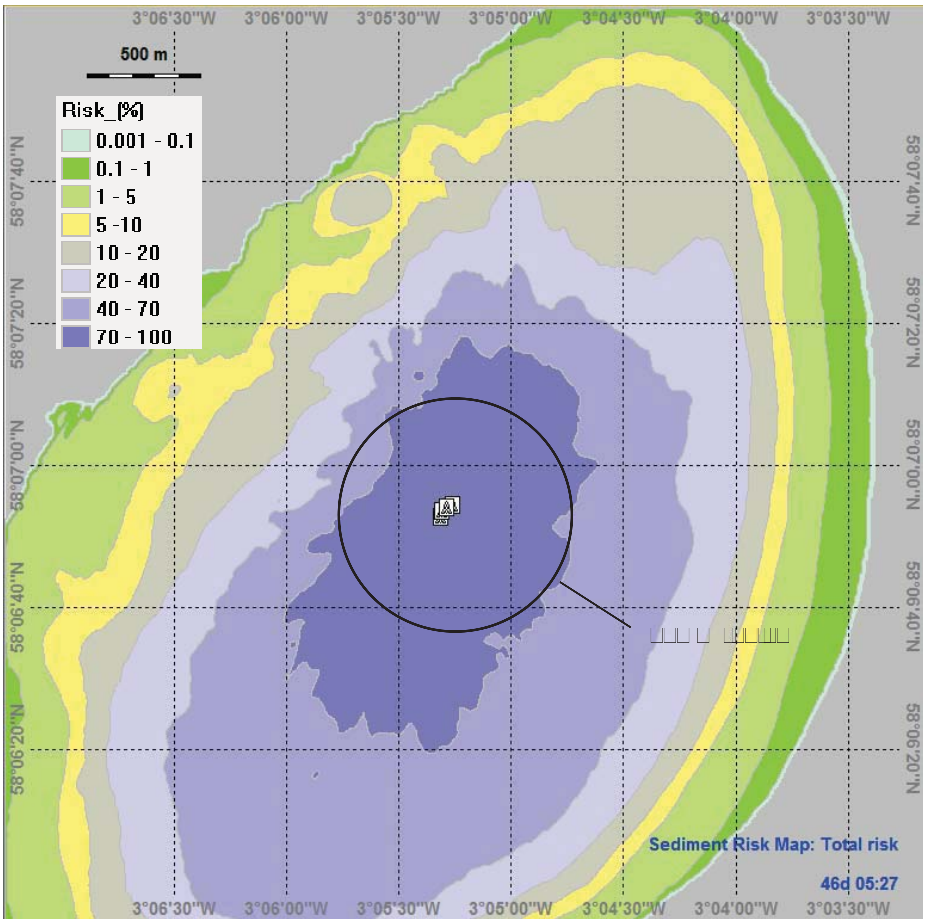


Figure B-15: Sediment risk after cessation of discharge.

The contributions to the risk from the various stressors are shown in Figure B-16. The largest contribution to the risk is from the oil-related components (UCMs and PAHs). The risk from deoxygenation only accounts for 6% of the total and the risk associated with grain size changes is less than 1% and therefore is not shown on the pie chart.

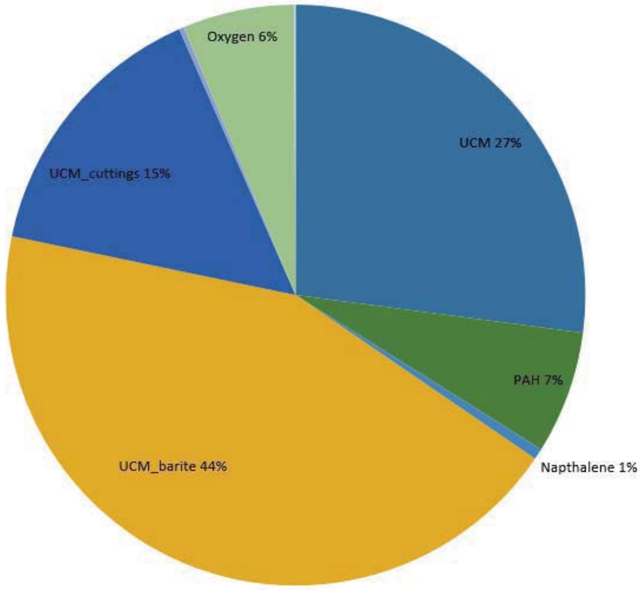


Figure B-16 Contributions to environmental risk to sediments

B.3.2.2 Predicted Recovery of the Seabed

Using the sediment sub-model to forecast the change in the stressors over time, a recovery of the seabed can be predicted; this is shown in Figure B-17. The area of seabed predicted to have a risk of over 5% decreases from 11.8 km^2 immediately after cuttings relocation, to 8.4 km^2, one year after cuttings relocation, shrinking to 0.046 km^2 10 years after cuttings relocation.

It is predicted that in spatial terms, the area affected by the 5% risk will shrink back to a 'core' of oil-contaminated sediments reducing to 40-110 m from the discharge point within 10 years.

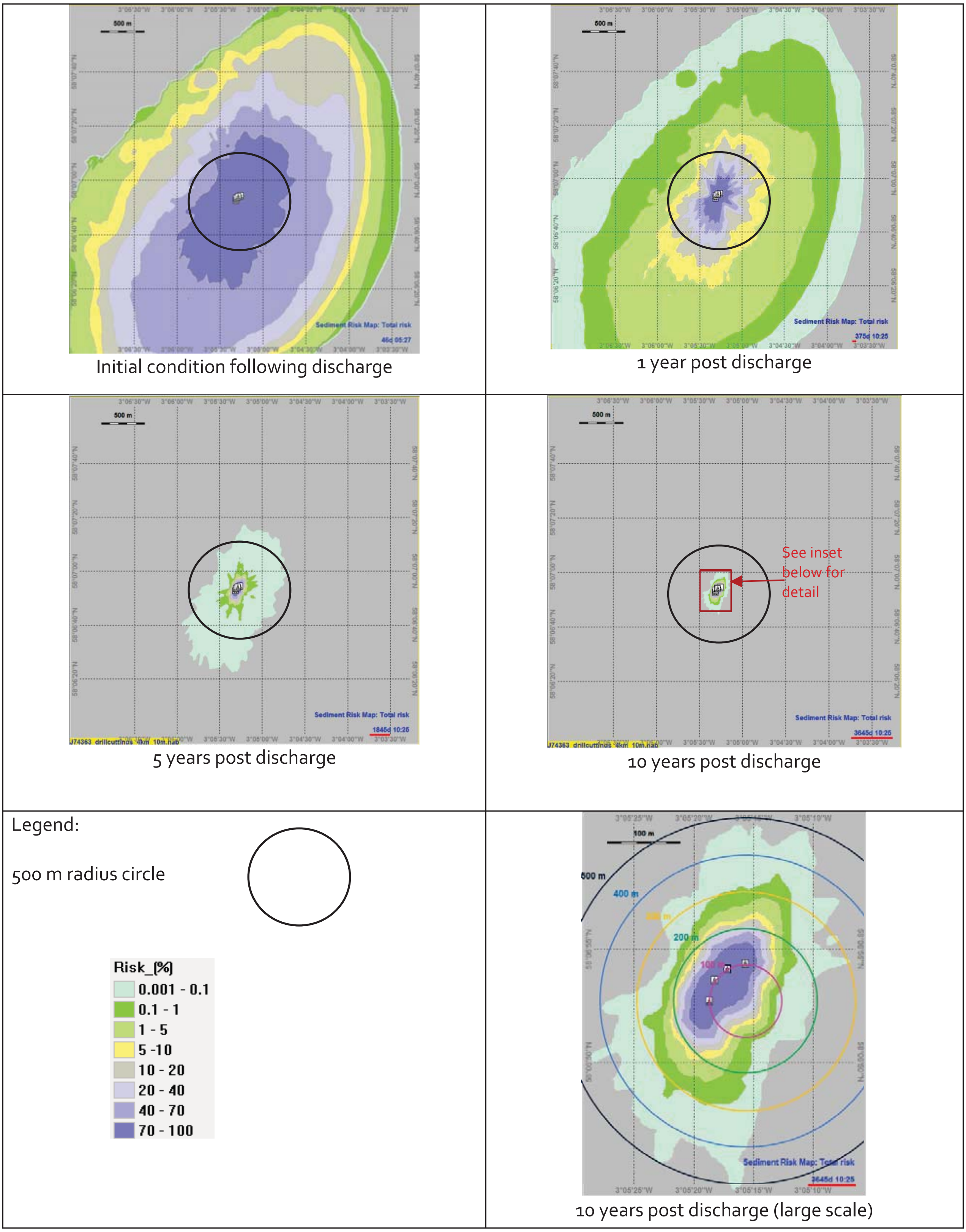


Figure B-17: Time development of risks to seabed.

The maximum risk levels can be plotted over time as shown in Figure B-18. By far the largest contributions to risk come from UCMs attached to the barite, present as free chemicals and attached to the cuttings, with a small contribution from PAHs and naphthalene. The risk from oxygen depletion is low initially but becomes significant after the first year. Other risk factors such as heavy metals, dispersed oils (aliphatics), PCBs and BPAs were found to be insignificant.

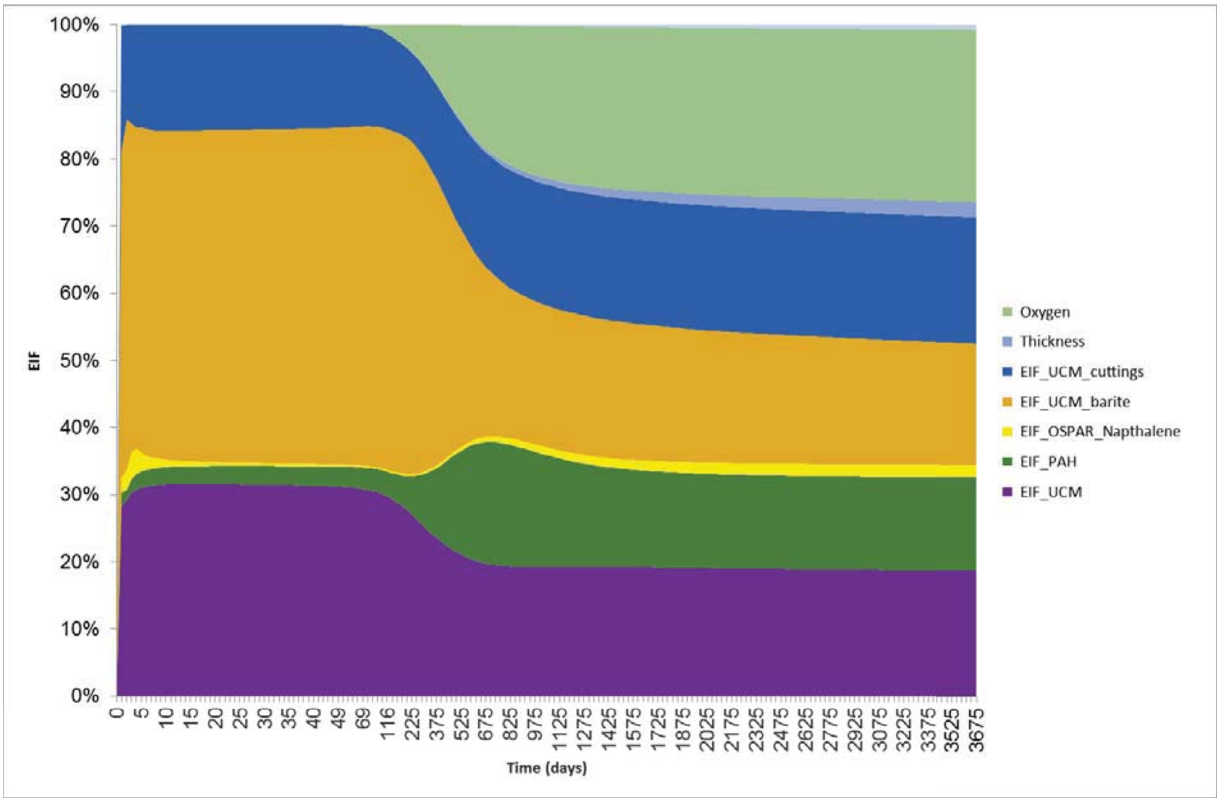


Figure B-18: Time development of maximum risk to seabed expressed as % EIF.

B.3.2.3 Environmental Risk to the Water Column

The model calculates risks to the water column from chemical toxicity and also from the particulates liberated into the water column.

The predicted plume is observed to move widely around the discharge point as a result of daily tidal and circulation currents. A plot of the total risk to the water column is shown in Figure B-19. The area at a risk of >5% extends to approximately 6 km of the modelled discharge. Areas of risk to the water column are predicted to remain within 10 m of the seabed and the upper water column would not therefore appear to be at risk. After discharge ceases, the water column within the modelled area is predicted to return to levels <5% risk within 21 hours (see Figure B-20).

It should be noted that the risk to the water column was only modelled around a single discharge point but the same pattern would be replicated around each relocation point. However, as the risk falls below 5% within 21 hours (see Figure B-20), there would be limited cumulative effect from all four discharges. It is possible that the plume from one discharge may still be present in the locality when the subsequent discharge begins, but this 'overlap' would be insignificant as the two plumes would be separated by the prevailing currents which will tend not to draw them together, i.e. the plumes are predicted to act independently.

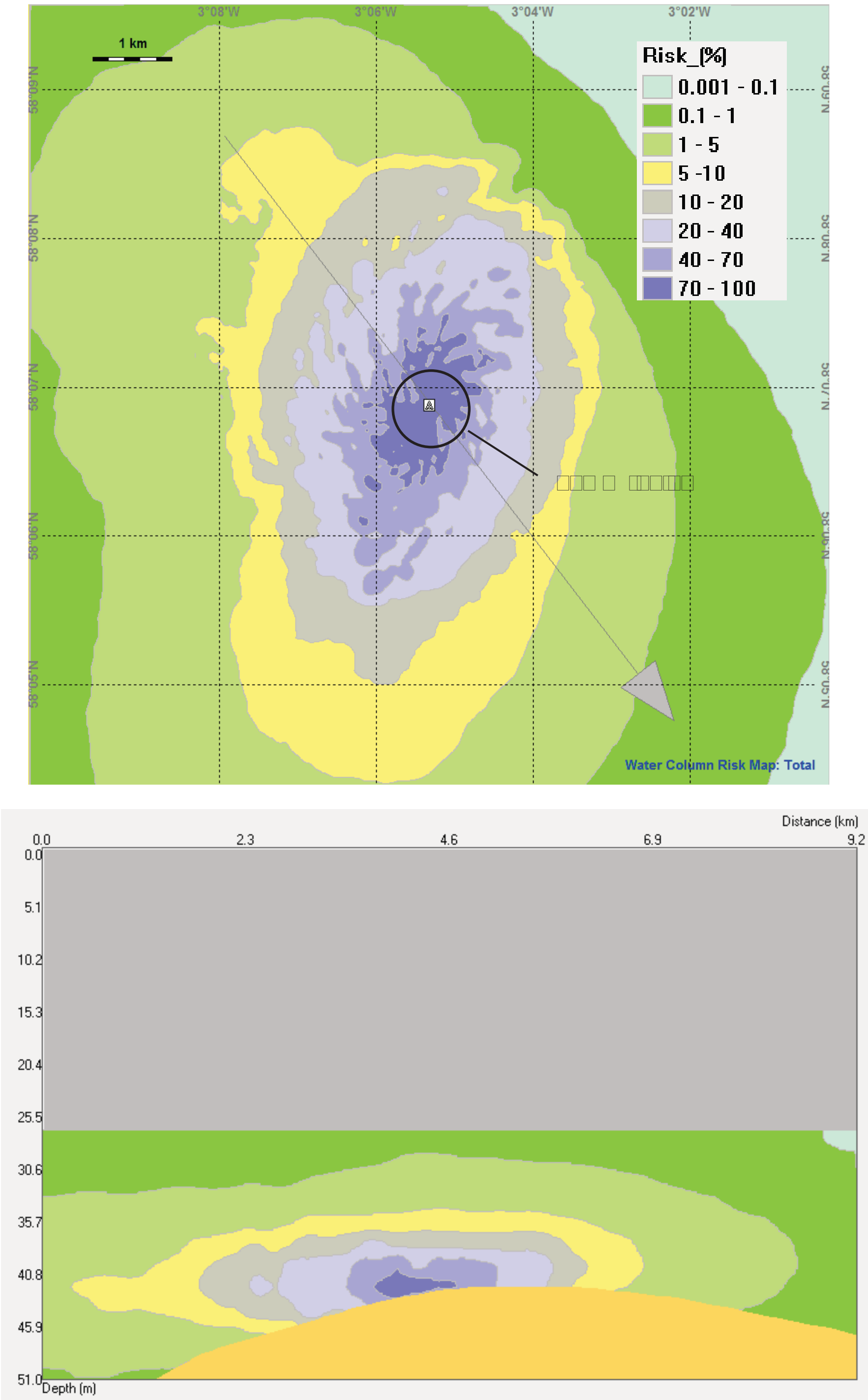


Figure B-19: Overall risk to water column (plan view and cross section).

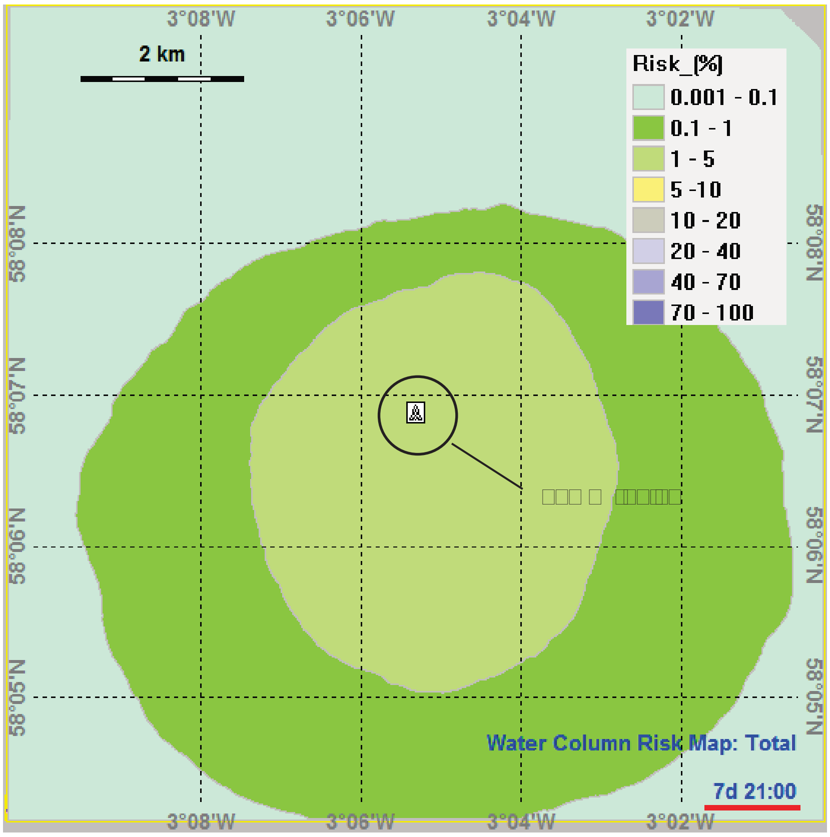


Figure B-20: Risk to water column 21 hours after cessation of discharge.

The sources of risk to the water column are predicted to be a mixture of toxicity risk from oils, but to a greater extent they result from the fine suspended solids. This is a feature that was built into the model to reflect the impact of non-natural fine particulates on plankton and zooplankton (Smit *et al.*, 2006) and observed in laboratory studies (e.g. Strachan, 2010).

The relative contributions to the risk are shown in Figure B-21. The largest fraction of the risk contribution is from the particulates barite and bentonite, though it can be noted that risks of this magnitude resulting from particulate stress in the water column are routine as a result of consented discharges of WBM and cuttings. The water column risks resulting from the toxicity of the oily discharges are predicted to account for approximately 16% of the total risk.

The maximum EIF modelled in the water column is 428. This is equivalent to a volume of 42,800,000 m^3 (100 m by 100 m over 10 m depth) or 0.0428 km^3. As a comparison, a 500 m safety zone around a platform at this depth (43 m) would occupy 0.034 km^3.

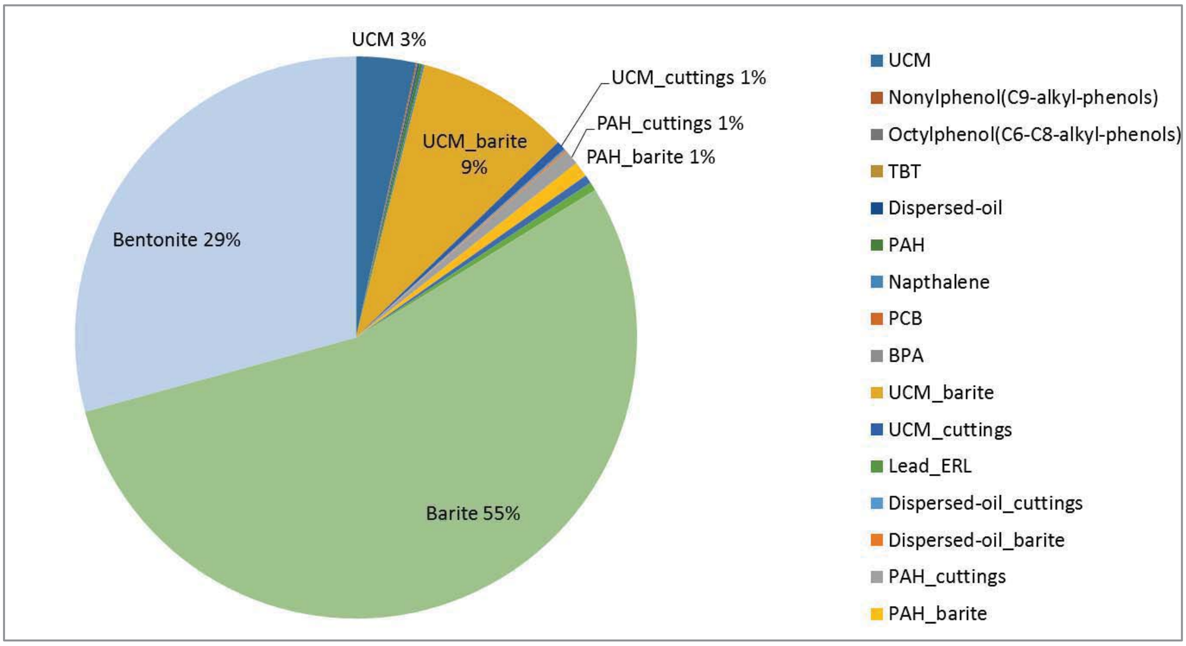


Figure B-21: Proportions of contribution to risk in water column.

B.4. MODEL UNCERTAINTIES

There are a number of uncertainties in an exercise of this type and conclusions should be drawn at a high level. The main uncertainties are presented here.

B.4.1 Particle Size Distribution

The PSD was based on a single sample from BEACORE2 (see Figure 2-2) as this was the only one available at depth (0.44 m). The surface samples are generally coarser (classified as sand rather than clay) but consistent across the area of the cuttings pile. Grain size is not a dominant seabed stressor in the risk calculations, and practically, cuttings are from relatively well-defined sources (barite, bentonite and rock from a small range of geologies and specific drill bits) so a large variation would not be expected. Therefore, while refining PSD may potentially affect the results it is unlikely to affect the overall conclusions.

B.4.2 Metocean Data

The SINTEF metocean data was used, which covers the years 1990-1992 at six-hourly intervals and at a single depth. Different years of metocean data, or a longer range of actual metocean data would possibly produce slightly different results. Such differences are, however, not expected to lead to any significant difference in the overall conclusions in the report, i.e. the currents chosen are consistent with obtaining high-level information.

B.4.3 Oil Composition and Content

The Fugro survey (2017a) presents detailed results of the cuttings pile sampling and the model has replicated these results as far as possible.

The biggest uncertainty lies around the fact that a very large proportion of the hydrocarbon fraction is classed as UCM i.e. unidentified hydrocarbons. The DREAM database contains physical and chemical properties for UCM, including a PNEC of 5 ppb which is very conservative. It is, however, uncertain as to how representative of the actual material these properties are.

The SINTEF chronic PNEC of 5 ppb is based on an acute LC50 of 50 ppb in the water column for relatively insoluble aliphatic oils with a carbon number higher than 10. Based on the biodegradation and K_{ow} value, SINTEF has applied an assessment factor of 10 to derive a PNEC of 5 ppb. This value is reflected in other varied data in circulation such as Wolfe (1976) and Environment Canada (2009) that point to a chronic PNEC of 5 ppb in pore water being relevant for aliphatic hydrocarbons, so this is considered a reasonable basis in the absence of specific toxicity data for the material at this site. There are also other sources such as OSPAR Agreement 2014/05 which reference a higher PNEC of 70.5 ppb, although the scientific panel responsible noted reported that only one reliable source was found for an aliphatic PNEC. Further, OSPAR Agreement 2014/05 is for the assessment of produced water where exposures are arguably relatively short term, versus chronic exposure in sediment pore-water, and chronic PNECs are often assumed to be an order of magnitude smaller than acute PNECs in the absence of other data.

More detail on the properties of the UCM would improve the quality of the results, but is unlikely to alter the conclusions around the OSPAR thresholds for cuttings piles, since the predictions are that the persistence of the pile would be well below the threshold levels.

There are a range of PNECs available in the literature for both water and sediments. Largely, PNECs in use for common substances tend to converge over time, and publications such as OSPAR Agreement 2014/05 resulted from a lengthy process of expert consultation and drew on further exhaustive work undertaken within the auspices of the Water Framework Directive and the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Regulation. Further iteration or sensitivity analysis of these PNECs would refine the outputs, but this is unlikely to change the finding relating to UCM as the key risk factor in sediments.

The PAH content is also highlighted. Levels of PAH in shellfish are regulated under European Commission Regulation (EC) No. 835/2011 and are monitored in inshore waters although it not certain whether offshore catches are tested.

B.4.4 Allocation of Contaminants to Solids

Over the life of the field, different contaminants have been released in different ways into the sediment, mainly in association with the drill cuttings and OBM, but also potentially from other platform discharges over field life, or from ships (a potential source of the TBT present). On discharge, contaminants may remain associated with the solids, and settle out quickly, or may be freely available to disperse in the water column. There is relatively little published data on the relocation of oily drill cuttings and the behaviour of specific contaminants, therefore, assumptions have been made regarding the proportions of contaminants associated with the different fractions (rock/barite/water).

Overall the total sum of contaminants released in the model is equal to the total measured in the cuttings samples so there is no 'loss' of contaminant. The majority of predicted risk is associated with UCM, which is thought to be related to the base oil (Fugro, 2017b) and which was originally designed to be a cohesive mixture associated with the fine drilling solids and able to transport cuttings in circulation.

Should some components be more closely associated with the solids, they will deposit closer to the release point, and conversely if some components were more freely dispersible then they would travel further.

The assumptions made are considered reasonable; further effort testing sensitivities would be disproportionate to the information gained and are not expected to alter the overall conclusions. Post-operation monitoring would confirm the 'final' contaminant levels and would be a useful contribution to knowledge.

B.4.5 Dredging Operations

At this stage it is not known exactly what equipment will be used to undertake the cuttings relocation. Assumptions regarding pumping rate and water to solids ratio have been made based on past experience at Valhall and NW Hutton and on technical data sheets for typical dredging equipment that could be used on the project. A conservative pumping rate of 10 m^3/hr was used as this was considered to represent a worst case – pumping and therefore cuttings disturbance over a longer period of time.

Previous modelling and sensitivity runs at Murchison (Hayes and Galley, 2013) showed that the model was not particularly sensitive to pumping rate or to the water to solids ratio. It is therefore considered that these parameters are sufficiently well defined for the purposes of the modelling study.

B.4.6 Overall Uncertainty of the Modelling Process

The underlying model has a well-documented basis in the way the particle mechanics are handled, the physical, chemical and biodegradation and bioturbation processes involved, the significant sediment stressors and the way in which they are evaluated. Field data was used to generate the majority of the features of the model, including via the UKOOA JIP on drill cuttings, Phases 1-3 and the ERMS Joint Industry Project. During model development, validation experiments were also conducted that tested aspects of the model. Input data for the model have been taken from known information or recognised industry sources and contain several conservative assumptions that would overestimate the outputs. Increasing the resolution of the modelling grid may slightly alter the exact boundaries shown in the outputs, but the results do not show any granularity that would indicate that grid size is affecting the outputs of leaching rate and footprint.

The model predictions of environmental persistence are significantly below the OSPAR threshold value of 500 km^2 yr.

B.5. CONCLUSIONS

Modelling was undertaken to simulate relocation of 85% of the cuttings pile using a suction dredge and redistributing the material to four separate areas located 50 m from the centre of the platform. Re-distribution of the cuttings at each location was modelled.

The maximum sediment deposition thickness resulting from moving the pile to each of the four release points is expected to be around 1.1 m within 10 m of the release point, diminishing rapidly with distance. The vast majority of the re-suspended material is predicted to be deposited within a limited distance, with thicknesses predicted to be less than 1 mm within 80 m of the discharge points, and less than 0.1 mm within 400 m of the discharge points.

The outputs strongly indicate that the footprint-persistence of the re-settled pile would be well below the OSPAR threshold. In fact, the 'footprint' of seabed that is predicted to be elevated above 50 mg/kg following pile redistribution is smaller than the corresponding predicted footprint for the existing pile. The oil would need to persist for over 15,000 years for the OSPAR 500 km^2.yr threshold to be exceeded. The leaching rate of the pile has not been estimated and is not a straightforward output of this model. Previous studies have shown that for much larger piles, the leaching rate threshold of 10 tonnes per year is not exceeded, and by inspection given the mass of oil remaining in the pile, it is not conceivable that the leaching rate criterion would be exceeded. The 50 mg/kg 'footprint' of the redistributed cuttings would largely lie within the existing footprint of sediments already contaminated above 50 mg/kg, although the redistributed contaminants would be present in the surface of the sediments versus deeper layers. The 2016 sampling suggests that existing contamination is predominantly (although not universally) present in the mid-depth of the pile.

The area of the seabed with a risk greater than 5% (a commonly recognised criterion for an acceptable level of environmental risk from aquatic discharges) is predicted to be around 11.7 km^2, shortly after the end of the relocation activities. However, this diminishes after discharge ceases, to 8.4 km^2 one year after the relocation of the cuttings and to 0.05 km^2 ten years after the end of the cuttings relocation. In spatial terms, the area above 5% reduces from approximately 2,000 m around the discharge point immediately after the redistribution of the cuttings, to within 100 m of the discharge point within 10 years. The core of the redistributed pile is predicted to be extremely persistent.

Within the sediment, the main mechanisms leading to risk to the environment are from the oil content of the sediments (primarily UCMs) and to a lesser extent from the deoxygenation caused by biodegradation of these hydrocarbons. Grain size change and burial thickness are less significant factors. Risks due to the potential metals present in the barite fraction of the discharge are insignificant.

Risks to the water column are predicted to be significant within 6 km of the release and are predicted to persist above a 5% risk level in a water volume of around 0.0428 km^3 for the duration of the operations to relocate the cuttings pile. Once pumping stops, the water column concentrations in the vicinity of the pile are predicted to recover to normal conditions within 24 hours. Risks to the water column are predicted to be restricted to the bottom 10 m from the seabed and result from stress from fine particulates and from the toxicity of the oils liberated. The scale of these risks is similar to those from consented discharges e.g. the discharge of produced water.

APPENDIX C - DIESEL SPILL MODELLING

C.1. INTRODUCTION

This appendix presents the modelling carried out to assess the environmental impact significance of a total loss of diesel inventory from a vessel during offshore activities. Modelling was undertaken using the Oil Spill Contingency and Response (OSCAR) model developed by SINTEF (Stiftelsen for industriell og teknisk forskning - The Foundation for Scientific and Industrial Research).

To support an EIA, the impacts associated with the maximum potential spill of diesel inventory are normally assessed. However, for this study it was deemed that the worst case in terms of volume (associated with the largest vessel to be used during offshore decommissioning operations) may not necessarily be the worst case in terms of impact, as a smaller release, nearer shore could result in greater impacts. Therefore, two spill scenarios were initially considered to determine the worst case environmental significance.

- Scenario 1 - 7,000 m^3 spill from a HLV at the Beatrice Alpha complex; and
- Scenario 2 - 3,600 m^3 spill from an ROVSV working on the pipeline close to the shore.

In this instance the worst case scenario was considered to be the release that resulted in the greatest impact on the shoreline in terms of spatial extent of oiling and volumes beached. Repsol Sinopec Resources UK consulted with BEIS who agreed with this approach.

C.2. MODELLING METHODOLOGY

C.2.1 Overview of the OSCAR Model

Modelling of potential spill scenarios has been undertaken using the OSCAR model developed by SINTEF.

The OSCAR software is a multifunction model that computes surface and subsurface transport, behaviour, weathering and fate of oil (used here to refer to a wide range of hydrocarbons including diesel), as well as potential ecological impacts. The model has been the subject of verification and calibration by numerous field experiments both on surface spills and subsea spills in offshore and nearshore locations, e.g. as described in Reed *et al*. (1995; 1996) and Johansen *et al.* (2001).

The model calculates and records transport and distribution of a contaminant in three physical dimensions, plus time, and provides outputs pertaining to oil on the water surface, along shorelines, in the water column, and in sediments. For subsurface spills the near field part of the simulation is conducted with a multi-component integral plume model that is embedded in OSCAR. The near field model accounts for buoyancy effects of oil and gas, as well as effects of ambient stratification and cross flow on the dilution and rise time of the plume.

OSCAR uses a Lagrangian (particle tracking) approach, enabling explicit tracking of each particle's location and behaviour through time. On the surface, the model employs spreading (gravitational and by shearing), advection, evaporation, water column entrainment (natural and facilitated by dispersant), emulsification, randomized dispersion and shoreline interaction to determine transport and fate. An Ekman model integrated into OSCAR computes a wind-driven current which transports near-surface oil. In the water column, currents, particle interactions and a random walk procedure control horizontal and vertical advection, dispersion of entrained and dissolved particles, interaction with suspended sediments, embedment of oil into the sediments, and degradation of oil at different rates whether dispersed, dissolved or in the sediments. Changes in state and compartment (such as interaction between water column and sediments) are controlled by solubility and partitioning coefficients. These processes are linked to an oil properties database and an intrinsic Oil Weathering Model based on the extensive experience of the SINTEF oil weathering laboratories (Daling *et al.*, 1997).

OSCAR supports two different types of model runs: stochastic modelling (also known as a Monte Carlo approach) and deterministic modelling. Both stochastic modelling and deterministic modelling have been conducted for this assessment and are explained in more detail in the following sections.

C.2.2 Stochastic Modelling

The stochastic modelling feature of OSCAR allows a single spill scenario to be run multiple times over different time periods (with different start and end times). This allows for the spill scenario to be modelled during different weather conditions. Results from all the individual stochastic simulations are then aggregated in order to report behaviour in a probabilistic or statistical sense. The stochastic model results that have been utilised in this assessment report are:

- Probability of hydrocarbons above a threshold thickness of 0.3 µm appearing on the sea surface;
- Probability of hydrocarbons above a concentration threshold of 25 parts per billion (ppb) being present in the water column; and
- Probability of any hydrocarbons (i.e. no threshold applied) reaching the shoreline.

Further information on these thresholds is given in Section C.2.4.

C.2.3 Deterministic Modelling

Deterministic model runs are conducted for a single spill scenario over a specified meteorological interval. They are therefore used to highlight hydrocarbon behaviour over a specific time frame and include worst case shoreline impacts. The deterministic model results used in this assessment are:

- The sea surface area impacted by hydrocarbons above a thickness threshold of 0.3 µm over time;
- The volume of water impacted by hydrocarbons above a concentration threshold of 25 ppb over time;
- The concentrations of hydrocarbons above a threshold of 50 mg/kg being deposited in the seabed sediment; and
- The worst case concentrations of hydrocarbons reaching the shoreline.

C.2.4 Hydrocarbon Threshold

The following thresholds have been adopted in the modelling:

- The model was run to determine the probability of a thickness of diesel at the surface of 0.3 µm. A surface thickness threshold of >0.3 µm is the minimum surface thickness identified by the Bonn Agreement Oil Appearance Code (BAOAC) capable of producing a visible rainbow surface sheen under good conditions. Whilst lower surface thicknesses may produce a visible sheen, this threshold value was chosen as that above which potential significant impacts on environmental sensitivities may begin to occur.
- A water column concentration threshold of 25 ppb was used to signify the level where potential impacts may start to be discernible. In context, 50 ppb is the lowest acute Predicted No Effect Concentration (PNEC) for any oil component in the OSCAR database, and is mid-range of the levels described as sub-lethal effects by Patin (2004).

  Although not applied as thresholds in the model, the following thresholds are used to guide the interpretation of the results:

- For sediment deposition, a mass of hydrocarbons of 50 mg per 1 kg of sediment (50 mg/kg) has been identified as the threshold above which toxic effects on benthic fauna may begin to be discernible. This threshold was adopted by OSPAR in the context of oil-based mud contamination of the seabed (OSPAR, 2009).
- Mass of hydrocarbons on the shoreline above 100 g/m^2. This was considered to be an impact threshold for oiling of birds by the US Army Corps of Engineers (2003). French McCay (2009) also notes that 100 g/m^2 would be enough to coat benthic epifaunal invertebrates living in intertidal habitats on hard substrates.

It should be noted that model predictions for shoreline and sediment hydrocarbons are approximate in that they assume a uniform coastline type and a uniform seabed type in this exercise. These assumptions can be refined but are considered adequate to arrive at an overall assessment of the environmental impact significance

C.2.5 Spill and Model Parameters

The spill scenarios initially considered included a total loss of diesel inventory from a HLV at the Beatrice Alpha complex location and the total loss of diesel inventory from an ROVSV closer to shore. These can be considered to be extreme, theoretical scenarios used to identify an outer envelope of impacts. Release parameters for these discharge scenarios are summarised in Table C-1 and model parameters that have been applied for all scenarios are presented in Table C-2. A near-ambient release temperature has been assumed.

Table C-1: Release parameter for modelled spill scenarios.

Scenario	Description	Spill volume	Release location	Release duration	Release temp.
1	Release form HLV, working at Beatrice Alpha	7,000 m^3	Sea Surface	1 hour	9.3 °C
2	Release from ROVSV or similar vessel working on pipeline, close to shore	3,613 m^3			

Table C-2: Model parameters for modelled spill scenarios.

Modelling parameter		Value
Duration of simulation		30 days
Model time step		20 minutes
Model output interval		2 hours
Number of stochastic runs		100
Model grid resolution	Longitude	500 m
	Latitude	500 m
	Depth	2.5 m
Number of particles	Liquid/Solid	20,000
	Dissolved	10,000

C.2.5.1 Diesel Profile

OSCAR holds a single profile for marine diesel the properties of which shown in Table C-3

Table C-3: Marine diesel properties.

Oil type	Oil type	Specific Gravity	Viscosity cP	Reference Temperature °C	Pour Point °C
Marine Diesel	Refined Distillate	0.843	3.9	13	-36

C.2.5.2 Environmental Input data

The OSCAR model takes into account various environmental parameters that affect the fate and behaviour of discharged hydrocarbons. Data has been obtained from a number of sources for use in the OSCAR model and is discussed in this section.

C.2.5.2.1 Ocean Currents

One of the main environmental factors that influences the transport and behaviour of discharged hydrocarbons is ocean currents. Current data supplied by Oil and Gas UK (O&G UK) covering the years 2011-2014, derived from the HYCOM global circulation model, was used in the simulations. The dataset contains surface ocean currents with a temporal resolution of one hour i.e. the currents change speed and direction at hourly intervals. For the Beatrice area, the longitudinal and latitudinal resolutions of the wind data set are *c.* 7 km and 8 km, respectively. A snapshot of current data is shown in Figure C-1.

Alternative 3-dimensional data are available but at a much lower spatial and time resolution (1 day). These data were assessed and judged to give less reliable results given the proximity to shoreline and therefore the importance of oil transport over short time periods and short distances. While the surface ocean data used is not 3-dimensional, the release is on the sea surface and the model predicts that the majority remains near the water surface when dispersed, so the surface ocean current dataset is considered more reliable.

The current data includes the effects of wind forcing. Given the relatively large resolution of the global datasets they do not resolve the local effects of Stokes Drift, whereby hydrocarbons are carried forwards on wave tops more rapidly than the overall wind-driven surface layer is moving. To account for this, a small wind forcing element is added in the model.

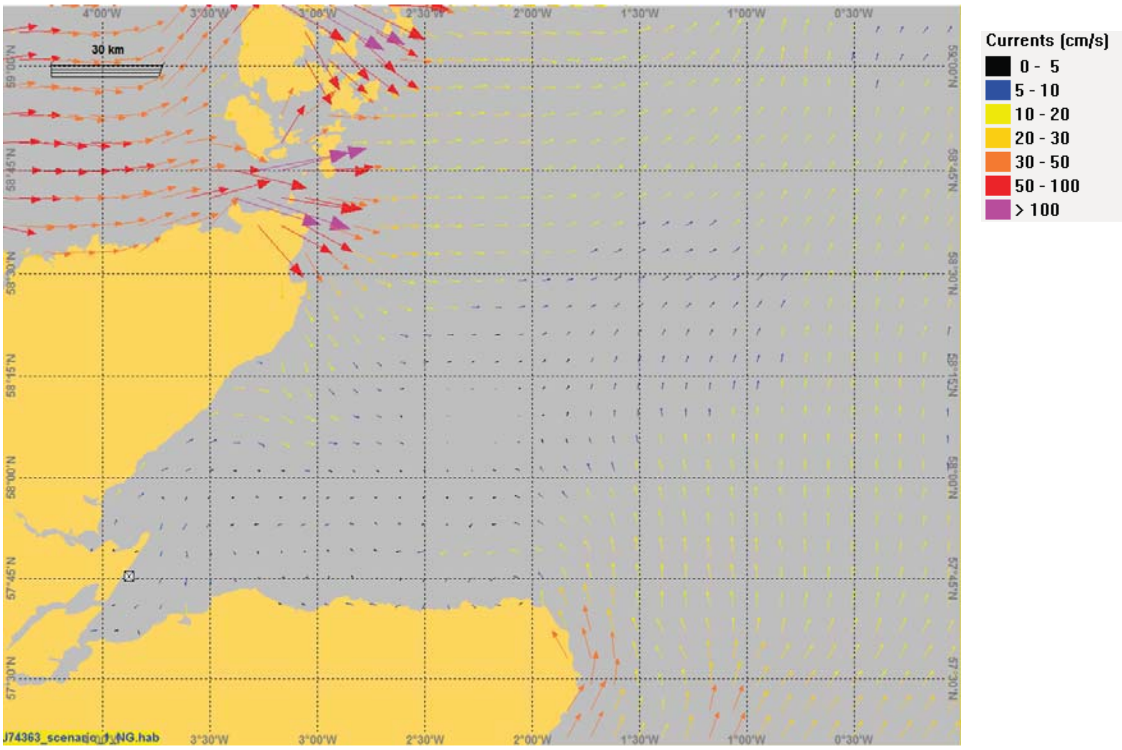


Figure C-1: Snapshot of current data in Moray Firth used in model.

C.2.5.2.2 Winds

To complement the 3D current data, wind data at 10 m above sea level, which is sourced from the European Centre for Medium Range Weather Forecasts (ECMWF), has been used in the modelling. The wind data is used in the OSCAR model to generate wave height and period information using a fetch calculation, which is subsequently utilised to calculate turbulent mixing in the sea surface layers. The data set includes winds over 'land' cells which is important at the local scale of hydrocarbons very close to the shoreline, where the resolution of the modelled currents does not exactly match the detailed shoreline profile. This helps to overcome some local anomalies where current data is absent in small areas near the coast, as the wind data generates a wave driven (Stokes Drift) component to continue moving the hydrocarbons particles.

For the Beatrice Field area, the longitudinal and latitudinal resolutions of the wind data set (wind data is available from 2008 to 2014) are *c*. 45 km and 84 km, respectively. The temporal resolution of the data is three hours i.e. the wind speed and direction change in the model every three hours.

C.2.5.2.3 *Bathymetry*

OSCAR models in a three dimensional spatial environment, with a water column with stratified temperature and salinity. A number of modelling parameters vary with depth, such that it is important to have accurate bathymetry data. The bathymetry data that has been used in the OSCAR modelling is obtained from the General Bathymetric Chart of the Oceans (GEBCO) 30 arc-second grid, which is a continuous terrain model for ocean and land with a spatial resolution of 30 arc seconds (GEBCO, 2014).

The GEBCO bathymetry grid was largely generated by combining quality-controlled ship depth soundings with interpolation between sounding points guided by satellite-derived gravity data. Data sets developed by other methods are also included to create a continuous terrain model for ocean and land.

C.2.5.2.4 *Water Column Temperature and Salinity*

The sea temperature was set to 9.3 °C and salinity of 34.5 ppt at the surface which are typical mean annual values for this part of the North Sea (Scottish Government, NMPI, 2016). It was assumed that the diesel release would be at ambient temperature as it is held in the vessels' tanks prior to release.

C.3. RESULTS

C.3.1 Stochastic Modelling Results

Stochastic modelling was initially carried out to determine which release Scenario would result in the greatest shoreline impact. The results of the modelling are summarised Table C-4 and illustrated in Figure C-2 and Figure C-3.

Table C-4: Summary of stochastic results for both scenarios.

Modelling results	Scenario 1 – release at Beatrice Alpha	Scenario 2 – near shore release
Maximum accumulated diesel mass on shore (Figure C-2)	2% of the total diesel released i.e. 140 te reaching the coastline.	19% of the total diesel released i.e. 685 te reaches the coastline.
Probability of shoreline contamination (Figure C-3)	Mostly less than 25% along southern Moray Firth coast west of Lossiemouth, 60 to 80% further east. Less than 5% in the inner firths.	60 to 80% along most of southern Moray Firth coast. Probabilities higher in the inner firths than for Scenario 1.

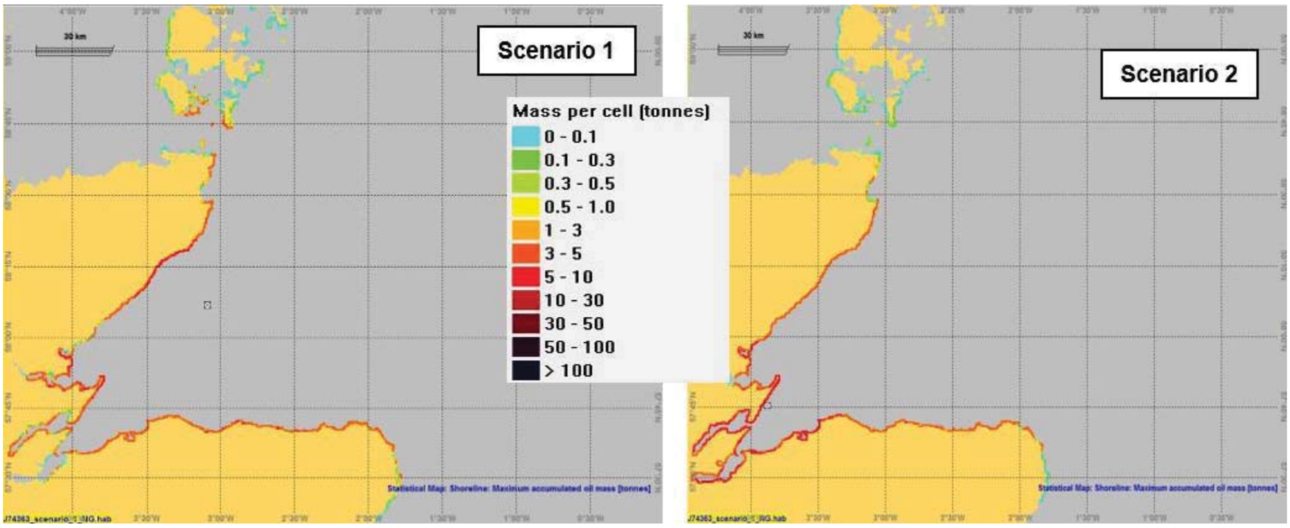


Figure C-2: Maximum accumulated diesel mass (te) on the shore.

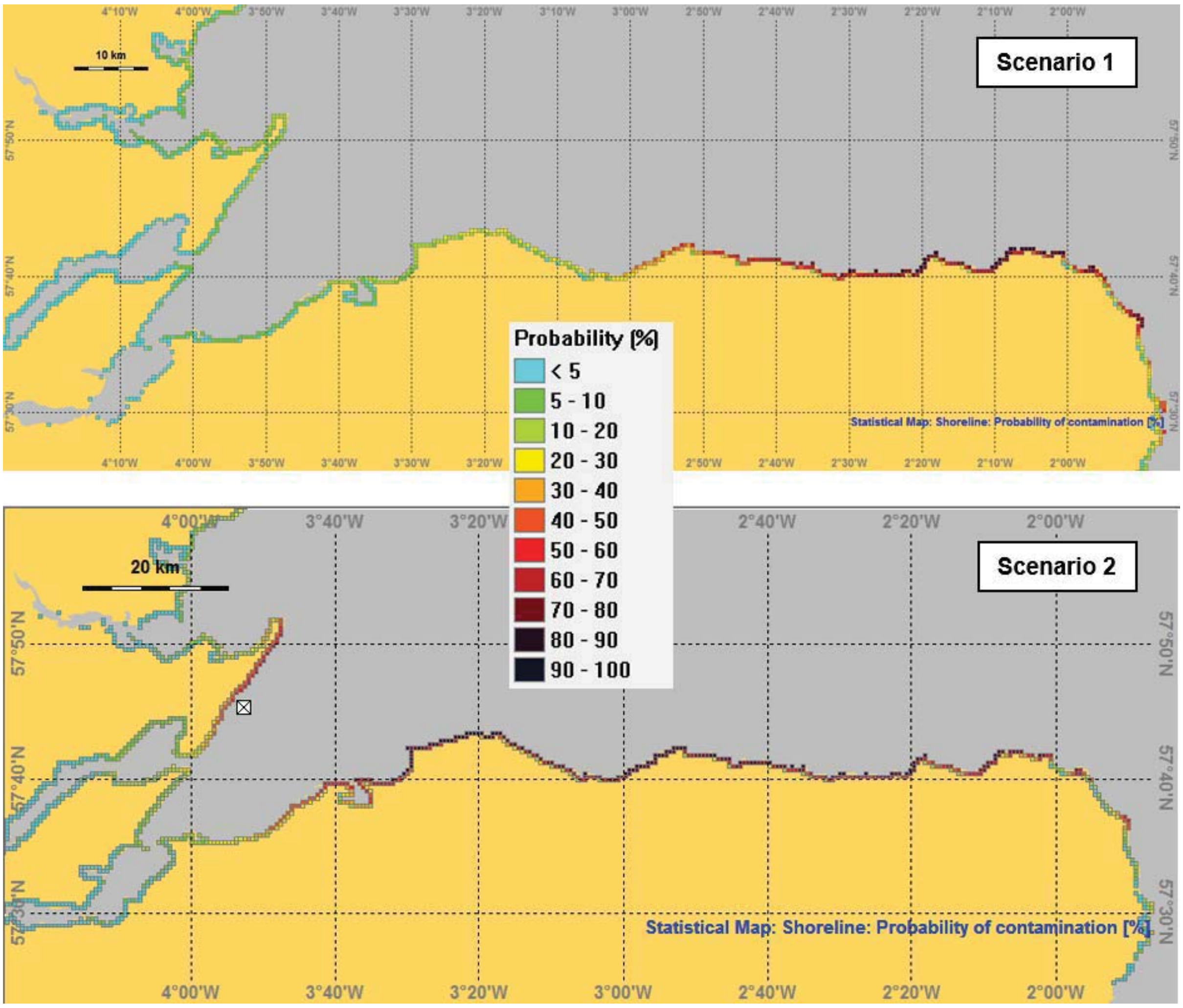
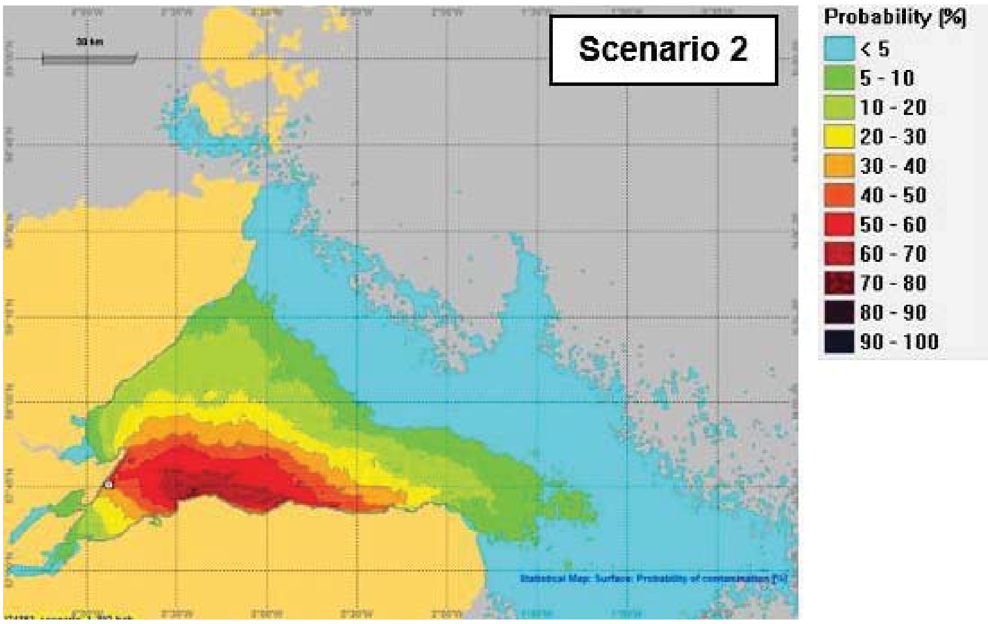
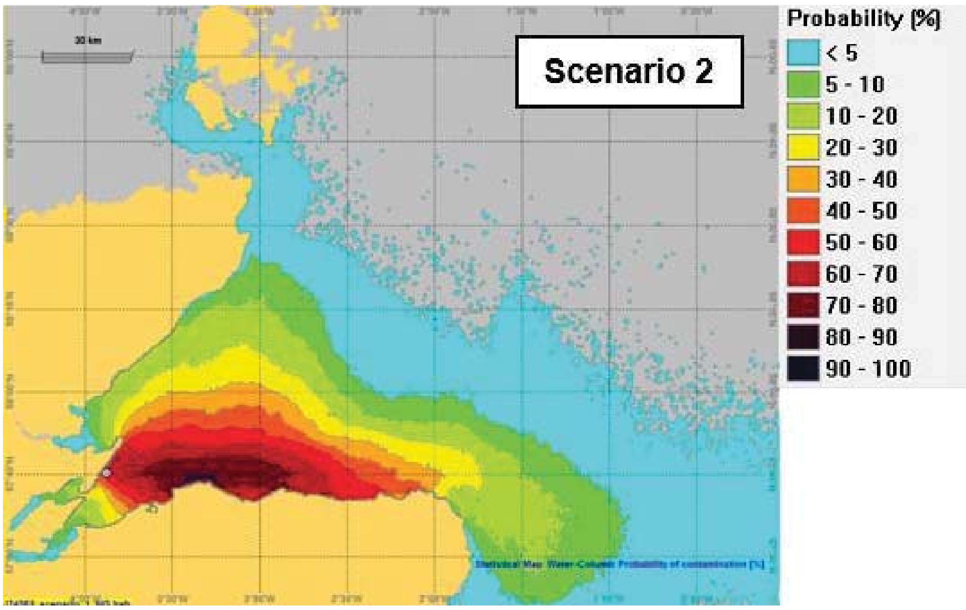


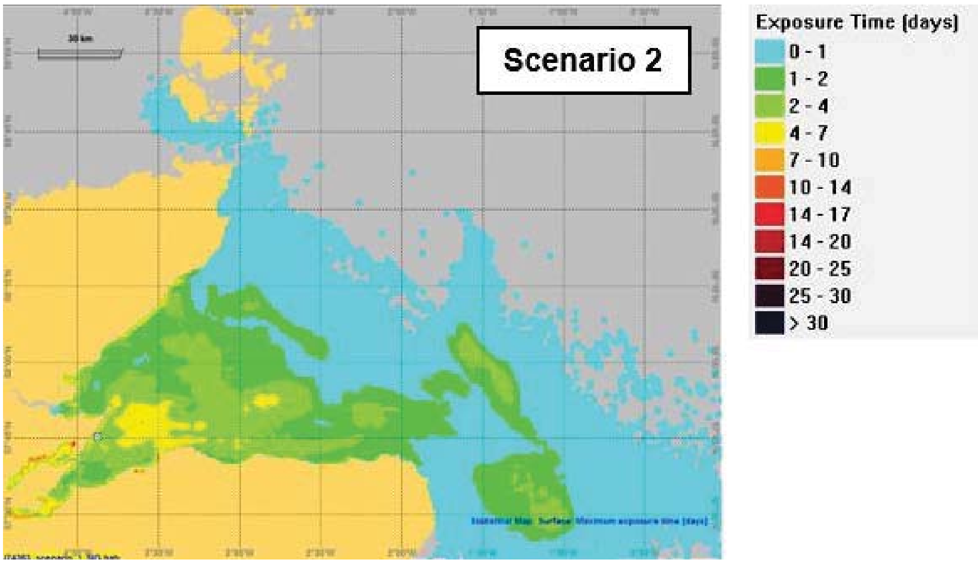
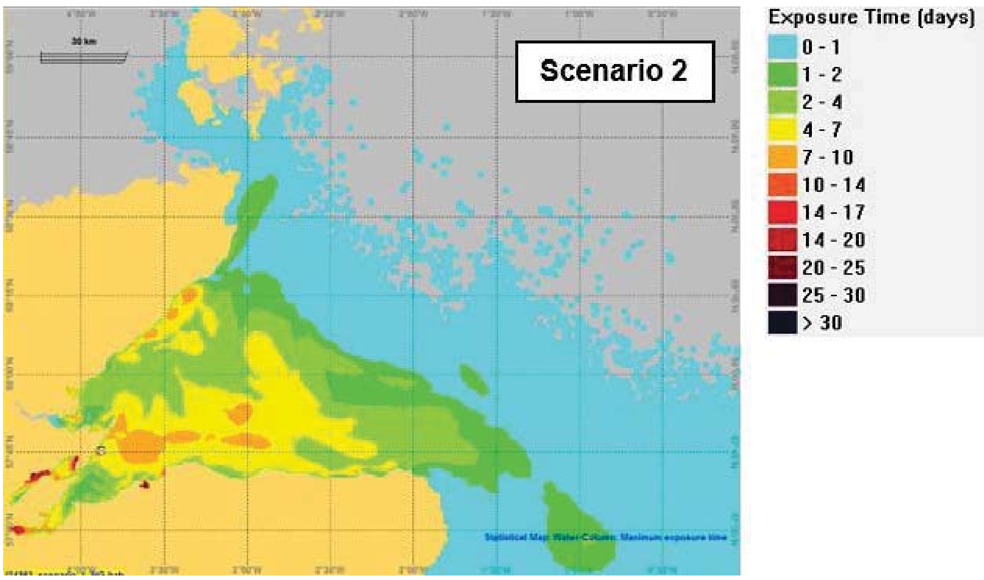
Figure C-3: Probability of shoreline contamination.

Given the larger volumes of beaching and the higher probabilities of shoreline oiling it was determined that the nearshore release (Scenario 2) represents the "worst case" in terms of potential environmental impacts and therefore it was this scenario that was examined in more detail.

Further stochastic modelling was carried out on Scenario 2 the results of which are presented in Table C-5.

Table C-5: Summary of stochastic modelling results.

Description	Model output
Probability of surface oiling with thickness > 0.3 µm Highest probabilities near Lossiemouth and to the west of Lossiemouth. Higher probabilities within inner firths (Dornoch, Cromarty and Inverness Firths). Maximum probability around 71%.	
Probability of diesel in water column at concentrations > 25 ppb Maximum probability of 82% near Lossiemouth on the southern Moray Firth coast. Area of probability of over 70% extends to the east and west of Lossiemouth along the Moray Firth coast. Probabilities along the Dunbeath coast are between 10 and 20%. Probabilities in the inner firths reach 50 to 60% in some parts.	

Description	Model output
Maximum exposure time at the surface Mostly less than 4 days but sections of the inner firths reach 15 to 23 days and along the southern Moray Firth coast exposure time reaches 15 to 20 days.	
Maximum exposure time in the water column at > 25 ppb Mostly less than 7 days with small areas less than 10 days. Along the Moray Firth coast less than 7 days but at Findhorn exposure time is 25 days and in the inner firths it reaches 15 to 20 days.	

C.3.2 Deterministic Modelling Results for Scenario 2

A single deterministic run was carried out for Scenario 2 (nearshore release) to investigate the worst case shoreline concentrations and sediment concentrations. The time period for the deterministic run was selected to correspond with the stochastic simulation that resulted in the highest mass of diesel arriving on shore. This was the stochastic simulation 17 days into the 30-day simulation which had 685 te of diesel modelled as reaching the shoreline.

Figure C-4 shows the maximum surface diesel thickness aggregated over the 30 days modelled. The total impacted area with an oil thickness of greater than 0.3 µm is 1,710 km². However, it should be noted that at any one time, the surface diesel occupies a much smaller area within this envelope. A snapshot of diesel thickness at the surface after 24 hours is shown in Figure: C-5.

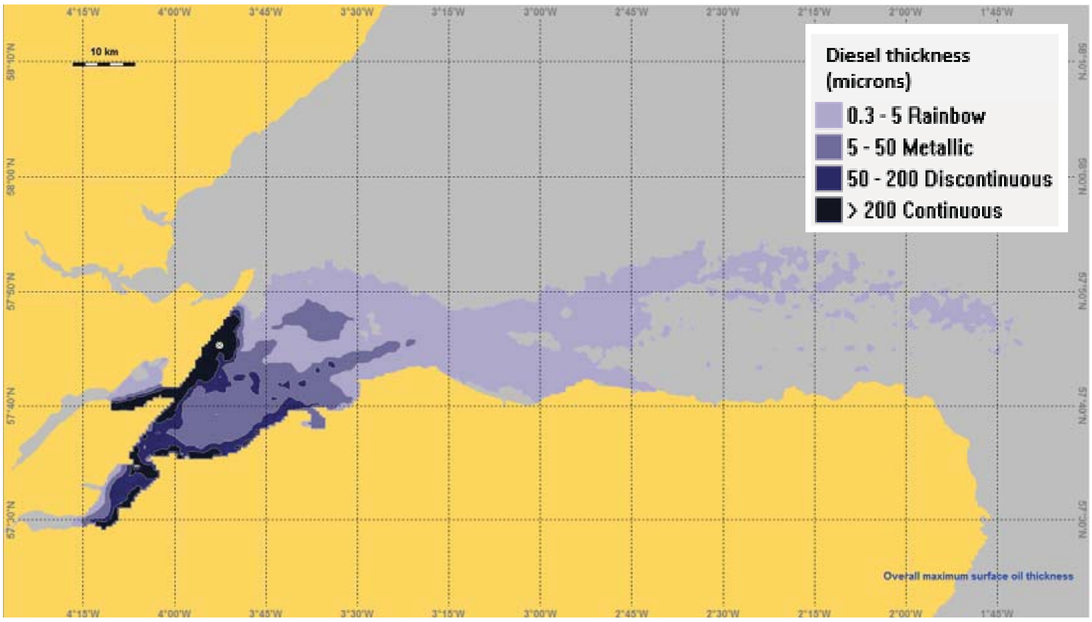


Figure C-4 : Overall maximum surface diesel thickness.

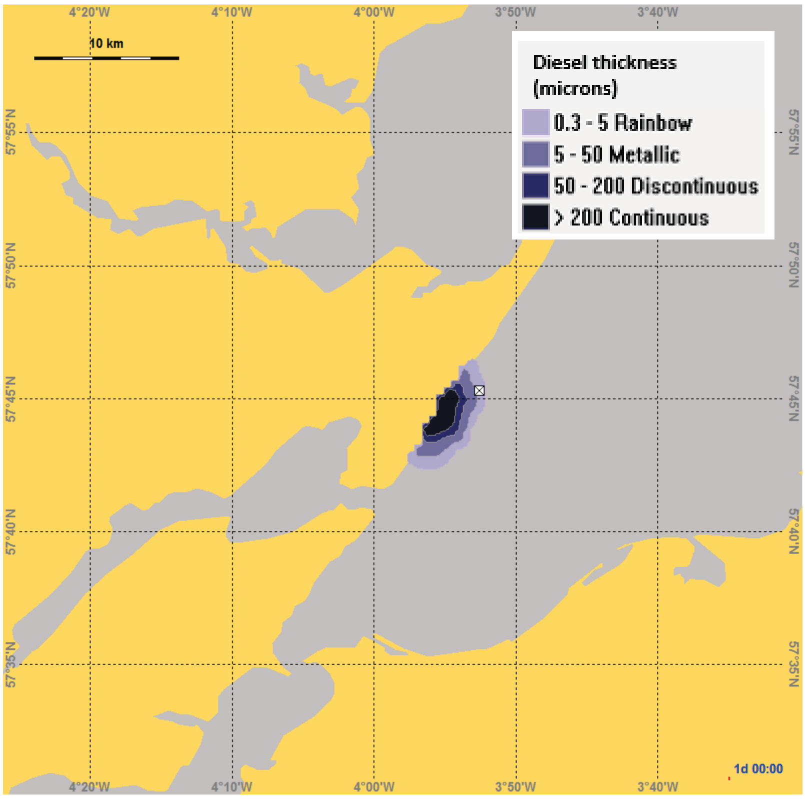


Figure: C-5: Surface diesel thickness after 24 hours.

Figure C-6 shows the overall diesel concentration in the water column aggregated over the 30-day modelling period and Figure C- 7 shows a snapshot of the diesel concentration in the water column 24 hours after the spill. Shoreline stranding results in elevated concentrations in parts of the inner Moray Firth. The total impacted water volume with a concentration > 25 ppb diesel is 9.71 km³.

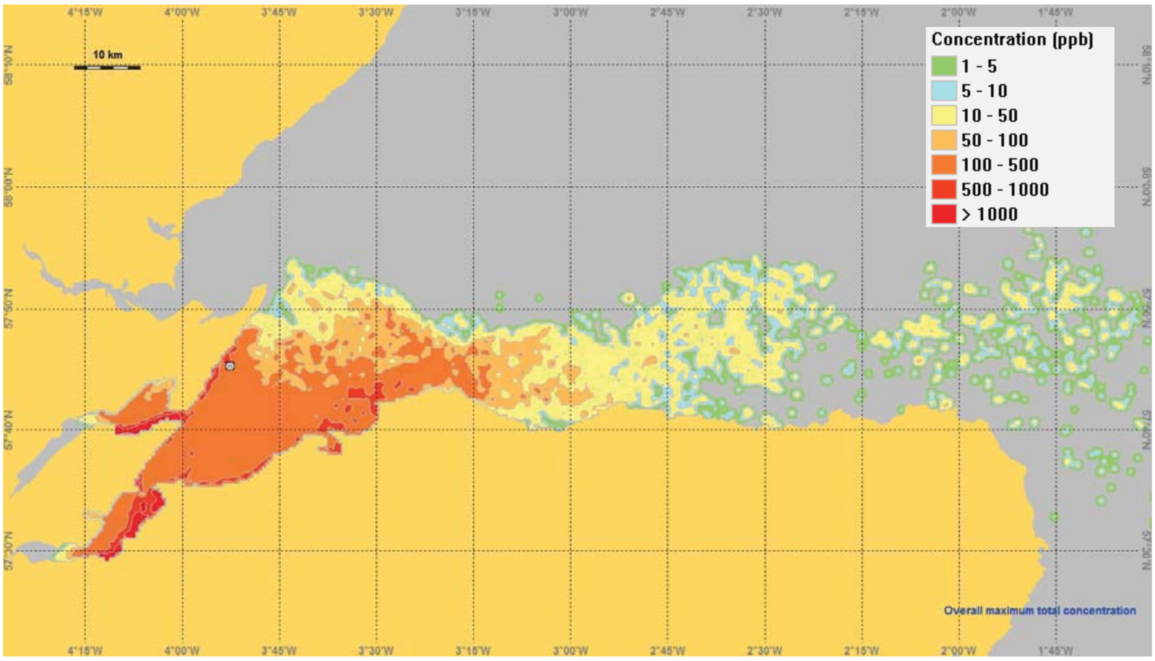


Figure C-6: Overall maximum total concentration of diesel in water column.

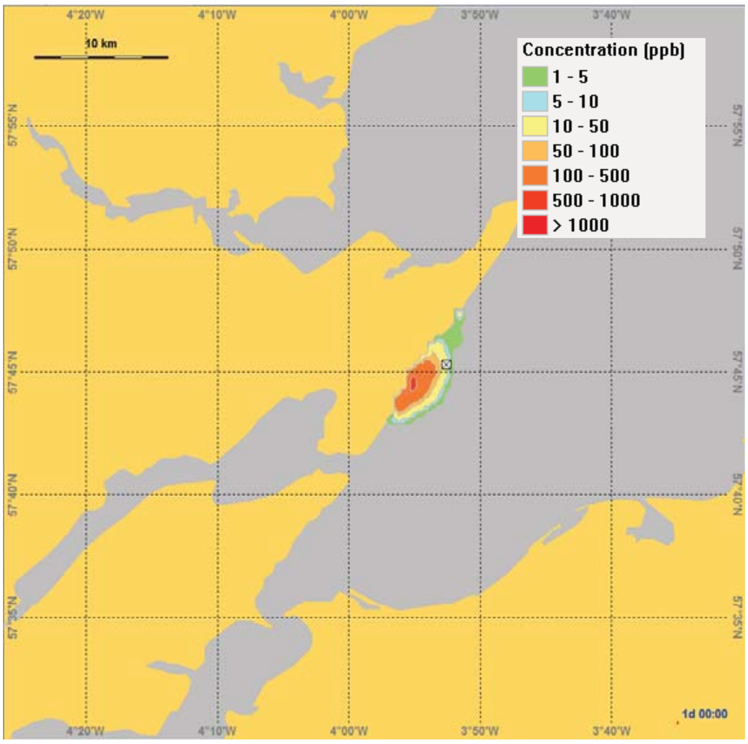


Figure C- 7: Total concentration of diesel in water column after 24 hours.

The concentrations of oil above a threshold of 50 mg/kg being deposited in the seabed sediment are shown in Figure C-8. The area of sediment where the concentration exceeds 50 mg/kg is predicted to be 33 km² and occurs primarily in the inner Moray Firth and along the coast towards Nairn and Findhorn.

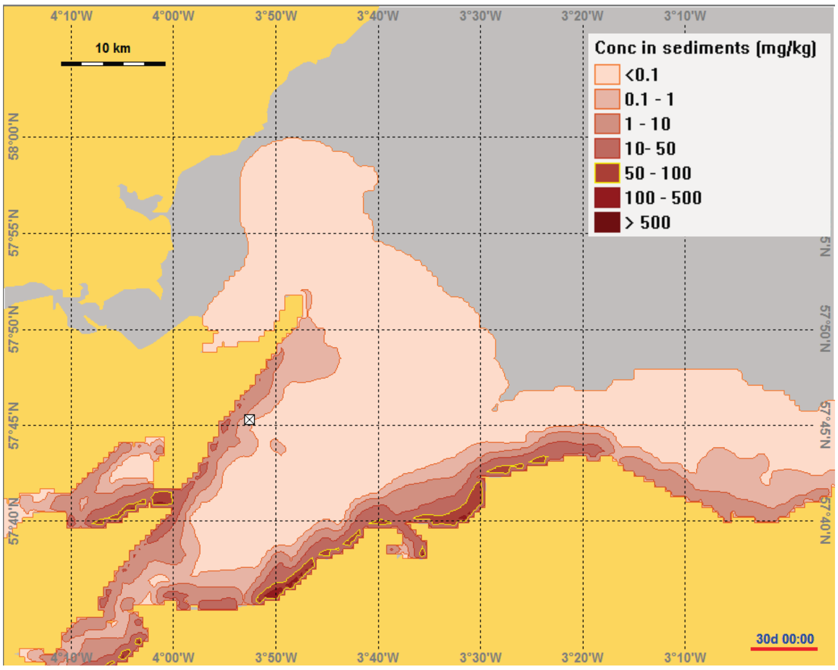


Figure C-8 : Predicted total concentration of diesel in sediment.

The worst case shoreline beaching occurs after 17 days and is shown in Figure C-9. Beaching is concentrated in the inner Moray Firth, predominantly on the southern shorelines (in a similar area to the elevated sediment concentrations).

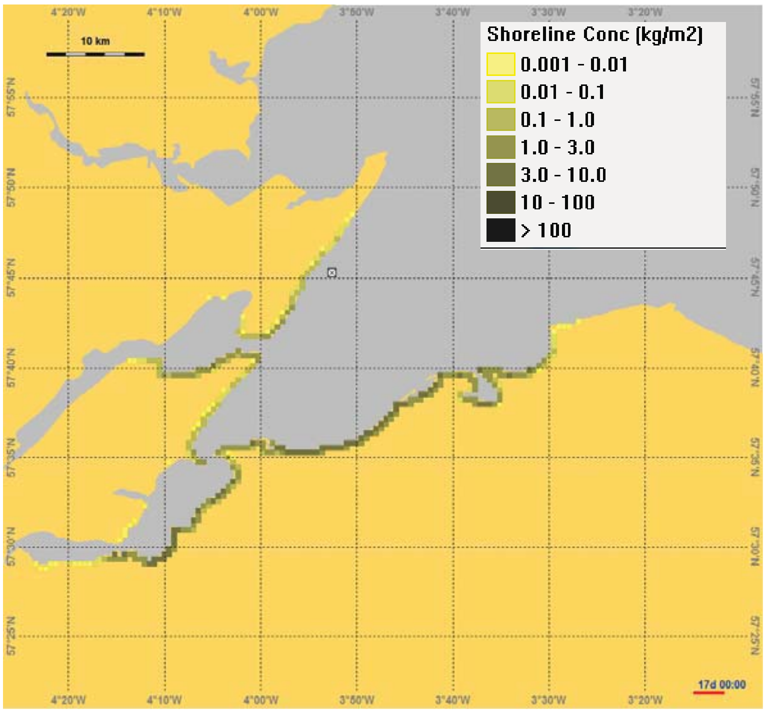


Figure C-9 : Worst case shoreline oiling.

When diesel is released at the sea surface, it is subjected to a number of processes including spreading, evaporation, natural dispersion, sedimentation and biodegradation. As shown in Figure C- 10 after 30 days, *c*. half the diesel has evaporated (1,648 te), a significant portion has biodegraded (539 te) and dispersed through the water column (47 te) with the remaining diesel found either in the sediment (528 te) or stranded on the shoreline (332 te). Only 43 tonnes are left at the surface after 30 days.

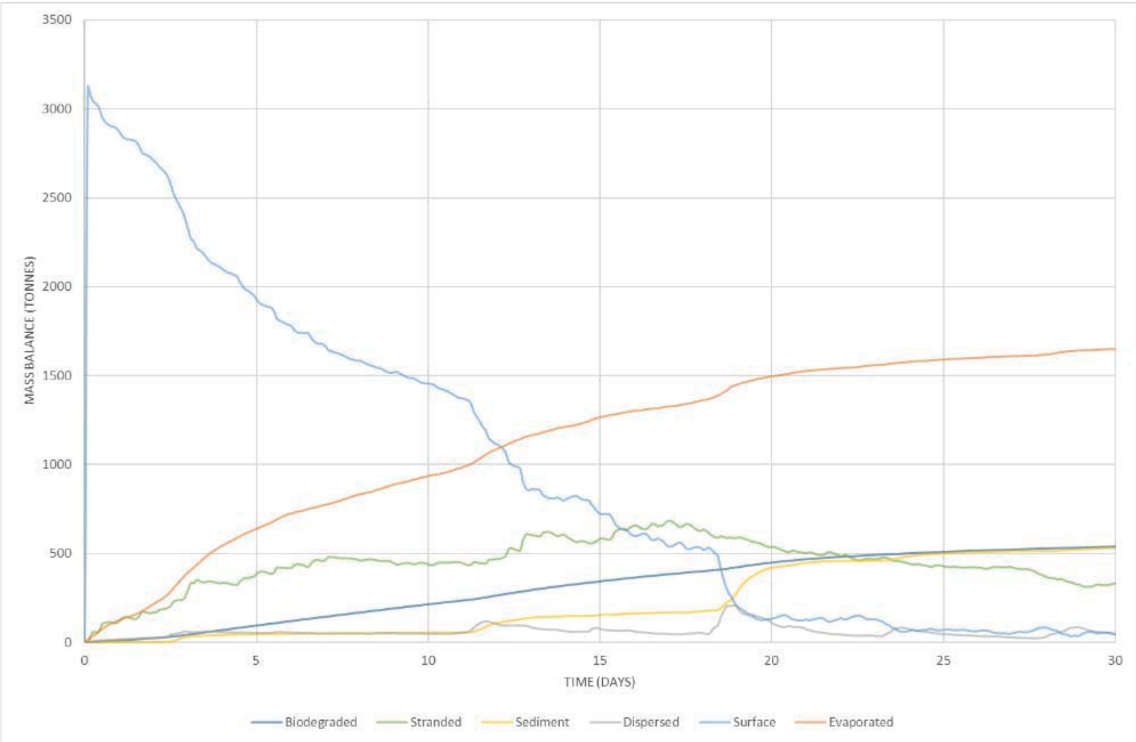


Figure C- 10: Diesel mass balance.

C.4. ENVIRONMENTAL IMPACT ASSESSMENT

C.4.1 Receptor Sensitivity

The key receptors in the Beatrice Field area and their sensitivity to a diesel spill (as defined in Table 7-1 of Chapter 7) are summarised in Table C- 6.

Table C- 6 : Receptor sensitivity.

Receptor	Key features	Receptor Sensitivity
Plankton	Similar to community found over a wide area of the central North Sea.	Low
Benthos	Limited diversity in the vicinity of the cuttings piles, otherwise typical of the wider area.	Low
Fish	Spawning and nursery activity: cod, haddock, herring, lemon sole, *Nephrops*, plaice, saithe, sandeel, sprat and whiting. Atlantic salmon and sea lamprey are present in the Moray Firth and are Annex II protected species. Infrequent sightings of basking shark.	Low
Fisheries	Area impacted is targeted primarily for demersal and shellfish species.	High
Seabirds	Extremely high seabird sensitivity during certain times of year. Several Ramsar (wetlands of international importance) and SPA sites occur along theMoray Firth.	High
Marine mammals	Dornoch Firth and Morric More SAC and River Spey SAC are designated for otters. Breeding colony seal haul out along Dunbeath coast and other seal haul out colonies along coast south of Dunbeath. Harbour seals and grey seals both Annex II species whilst harbour seals are a qualifying feature of the Dornoch Firth and Morric More SAC. Harbour porpoise, bottlenose dolphin, white-beaked dolphin and minke whale may occur in the area of the development. Bottlenose dolphins are the qualifying feature for the Moray Firth SAC.	High
Designated areas	Ramsar sites include Dornoch Firth, Cromarty Firth, Inner Moray Firth, Moray and Nairn Coast. Extensive areas designated as SACs, SPAs and NCMPAs	Very high
Local communities	Tourism and recreation are important sectors of the local economy including beaches, sailing, dolphin watching cruises, angling etc.	Medium

C.4.2 Magnitude of Effect

This section discusses the impact of oil on each of the key receptors in order that a Magnitude of Effect of the diesel release may be determined. It should be noted that much of the available literature focuses on impacts from oil rather than diesel.

C.4.2.1 Impacts of Hydrocarbons on Plankton

Oil and oil biodegradation can cause problems for phytoplankton in the immediate vicinity of a spill. Oil slicks can inhibit air-sea gas exchange and reduce sunlight penetration into the water, both essential to photosynthesis and phytoplankton growth (González *et al*., 2009). PAHs in the oil can also affect phytoplankton growth, with responses ranging from stimulation at low concentrations of oil (1 mg/l i.e. 1,000 ppb) to inhibition at higher concentrations (100 mg/l i.e. 100,000 ppb; Harrison *et al*., 1986).

Zooplankton at the air-sea interface are thought to be particularly sensitive to oil spills due to their proximity to high concentrations of dissolved oil and to the additional toxicity of photo-degraded hydrocarbon products at this boundary (Bellas *et al*., 2013). Following an oil spill zooplankton may suffer from loss of food in addition to the direct exposure of oil toxicity resulting in death from direct oiling as well as impaired feeding, growth, development, and reproduction (Blackburn *et al*., 2014 and references therein).

Johansson *et al*., (1980) documented short term impacts on zooplankton biomass in the month following the Tsesis oil spill off the coast of Sweden in 1977 (1,000 te of medium grade fuel oil) with biomass levels being re-established within five days.

Plankton generally have rapid doubling times and within the North Sea they have a continual exchange of individuals with surrounding waters (North Sea Task Force, 1993). Therefore, though hydrocarbons can cause problems for plankton, it is expected that the plankton communities would recover relatively quickly in the event of a diesel spill such that the magnitude of effect is considered minor.

C.4.2.2 Impacts of Hydrocarbons on Benthic Species

The area of seabed where the concentration exceeds 50 mg/kg is predicted to be 33 km^2 and occurs primarily in the inner Moray Firth and along the coast towards Nairn and Findhorn. In response to oil exposure, benthic animals can either move, tolerate the pollutant (with associated impacts on the overall health and fitness), or die (Gray *et al*., 1988; Lee and Page, 1997). The response to oil by benthic species differs depending on their life history and feeding behaviour as well as the ability to metabolise toxins, especially PAH compounds.

The response of polychaete populations to oil spills are complex and varied and are thought to differ depending on their different feeding strategies and trophic relationships in benthic environments. Some species decrease in abundance after an oil spill whilst others may be the first colonisers in the aftermath of oil-spill die-offs (Blackburn *et al*., 2014 and references therein). Some polychaetes contribute to biodegradation of oil in sediments whilst some have different abilities to metabolize contaminants (Bauer *et al*., 1988; Driscoll and McElroy, 1997).

Significant negative impacts have been observed on amphipod populations following oil spills. For example, amphipod populations in several families were suppressed for up to six years at sites impacted by the 1989 Exxon Valdez spill in Prince William Sound, Alaska (Jewett and Dean, 1997). After the 1977 Tseis oil spill in the Baltic Sea, amphipods (Pontoporeia spp) at oiled sites were reduced to less than 5 % of their pre-spill biomass. Surviving females produced significantly greater numbers of abnormal larvae and population recovery was not detected for almost three years after the spill (Elmgren *et al*., 1983). Amphipods are especially sensitive to the effects of local pollution because of their low dispersal rate, limited mobility and lack of a planktonic larval stage.

Filter feeders will ingest oil from the water column, however they tend to have a limited capacity to metabolize it. (Blackburn *et al*., 2014 and references therein). Toxic PAH compounds have been shown to accumulate in filter feeders (Menon and Menon, 1999) whilst cellular pathologies observed in the tissues of benthic bivalves may be linked to chronic oil exposure and to the uptake from contaminated sediments (Neff and Haensly 1982; Berthou *et al*., 1987).

Acute oil toxicity to echinoderms following major oil spills have resulted in significant starfish mortality e.g. a large number of starfish mortalities resulted from the grounding of the Morris J Bergman barge in Puerto Rico in 1994 and from the Erika oil spill off France in 1994 (Mignucci-Giannoni 1999; Joly-Turquin *et al*., 2009). Multiple sublethal impacts of oil pollution on starfish have also been documented in laboratory studies including detrimental effects on growth, locomotion, ability to detect prey and feeding behaviour (Ordzie and Garofalo 1981; O'Clair and Rice 1985; Temara *et al*., 1999). The magnitude of these effects differed depending on the type of oil and /or starfish species.

It should be noted that the examples provided above refer to the impacts of crude oils rather than diesel releases. As mentioned previously literature on the environmental impacts of a diesel spill are scarce. Woodin *et al*. (1972) examined the effects of a diesel spill on the invertebrates of a cobble beach in North America and found that many different taxa were killed. However, faunal repopulation did begin around eight months post-spill.

Given the area of sediment impacted and the potential impacts of diesel on benthic species the magnitude of effect of a spill on benthic species is considered serious.

C.4.2.3 Impact of Hydrocarbons on Fish and Fisheries

Exposure of fish to contaminants can occur either through uptake of dissolved fractions across the gills or skin or direct digestion of the pollutant. Fish spending the majority of their life-cycle in the water column are likely to receive the highest exposure to contaminants that remain in solution though some will also accumulate sediment bound contaminants indirectly through their diet (i.e. digestion of animals that have accumulated the contaminants in their tissues). Fish associated with the seabed (e.g. flatfish) are more exposed to particle bound contaminants with the main exposure route being either directly through ingestion of contaminated sediments or through their diet. Seabed dwelling organisms can also absorb contaminants through the surface membranes as a result of contact with interstitial water.

Test results following the Braer oil spill south of Shetland in 1993 showed that a spill of that size (c. 85,000 tonnes), in which the oil is rapidly dispersed through the water column, can quickly lead to highly contaminated and tainted fish and shellfish. This differs to the observations made following the Sea Empress spill off the southwest of Wales in 1996 (c. 72,000 tonnes) whereby hydrocarbon and PAH concentrations in all species of finfish, including migratory salmon and sea trout, remained low throughout the incident.

Once the oil disappears from the water column fish generally lose their oil content very quickly. This rapid loss of oil from fish tissue is linked to the fact that fish will metabolise accumulated hydrocarbons very rapidly (Krahn *et al*. 1993). Following the Braer incident it was observed that PAH levels in individual sandeels did not differ between samples taken from sites differing in exposure levels. This is presumed to indicate that the rate of metabolism is sufficient to control the accumulation of these substances in fish. Observations on sea bass following the Sea Empress oil tanker spill showed that in the first year sea bass recruitment was reduced, however this impact was short lived with recruitment returning to original levels the following year. Similarly, overall sandeel densities a year after the Braer incident were found to have returned to pre-spill densities. In both instances the finfish fisheries were reopened before the shellfish fisheries.

Following the Braer incident some shellfish (particularly crustaceans) were found to lose hydrocarbons from their tissue as quickly as finfish, while others (molluscs) lose their accumulated hydrocarbons much more slowly (Davies and Topping, 1997) due to relatively low depuration rates and lower metabolisation due to their limited ability to produce oil-specific enzymes dependent on the species (Neff, 2002). Crabs and lobsters retained significant levels of contamination (up to 225 µg/kg) for a longer period, while molluscs were found to accumulate the highest concentrations of PAHs e.g. levels detected in some scallop gonads were up to 20,000µg/kg wet weight. Lower concentrations were seen in whelks which are likely to be a result of the fact that they are carnivores rather than filter feeders, the latter ingesting dispersed oil droplets directly and also oil attached to solid particles (summarised in Wolfe, 1976 and National Academies, 1985).

Following the Exxon Valdez spill in 1989, fish embryos and larvae were chronically exposed to partially weathered oil in dispersed forms that accelerate dissolution of 3, 4- and 5-ringed hydrocarbons. Laboratory experiments showed that these multi-ringed PAHs from partially weathered oil at concentrations as low as 1 ppb are toxic to pink salmon eggs exposed for the months of development and to herring eggs exposed for 16 days (Marty *et al*., 1997; Heintz *et al*., 1999; Carls *et al*., 1999). This process explains the elevated mortality of incubating pink salmon eggs in oiled rearing streams for at least 4 years after the oil spill (Bue *et al*., 1998). This long term exposure had consequences for salmon and herring through indirect effects on growth, deformities, and behaviour with long term consequences on mortality and reproduction.

In conclusion, the Sea Empress, Braer oil and Exxon Valdez oil spills did have adverse effects on the fish communities in the areas of the oil spills. However, following a relatively short period, the fin fish fisheries were reopened with recruitment and densities of monitored stocks returning to pre-spill numbers a year later.

Although the oil content for most fish is likely to diminish quickly once the oil disappears from the water column (which is likely to take place within a few weeks of the spill), shellfish appear to take longer to recover. As a result, the magnitude of effect on fish is considered serious whilst it is considered major for fisheries given that some restricted areas may be closed to scallop and *Nephrops* fishing for a few years.

C.4.2.4 Impact of Hydrocarbons on Seabirds

Birds are vulnerable to oiling from surface oil pollution, which can cause direct toxicity through ingestion and hypothermia as a result of a bird's inability to waterproof their feathers and a loss of feather structure. Oil pollution can also impact birds indirectly through contamination of their prey, although experience from incidents such as the Braer suggests that food chain impacts are relatively low and unlikely to affect long term populations (Davies and Topping, 1997).

Species that spend a greater proportion of their time on the sea surface are considered to be more at risk from the effects of surface pollution; for example, puffins are more likely to be affected than the highly aerial petrels. Species that are wholly dependent on the marine environment for feeding and resting are considered more vulnerable to the effects of surface pollution than species that use offshore areas only seasonally or move offshore only to rest or roost. Additionally, the potential reproductive rate of a species will influence the time taken for a population to recover following a decline. Other factors such as mortality and migration rates, species abundance and conservation status (e.g. globally threatened) shall also determine the effects of an oil spill on seabird populations.

The Seabird Oil Sensitivity Index (SOSI) is a tool which aids planning and emergency decision making with regards to oil pollution. It identifies areas at sea where seabirds are likely to be most sensitive to oil pollution. It is based on seabird survey data collected from 1995 to 2015, from a wide survey area extending beyond the UKCS using boat-based, visual aerial, and digital video aerial survey techniques.

This seabird data was combined with individual seabird species sensitivity index values. These index values are based on a number of factors which are considered to contribute towards the sensitivity of seabirds to oil pollution. Factors such as:

- Habitat flexibility (a species ability to locate to alternative feeding sites);
- Adult survival rate;
- Potential annual productivity; and
- The proportion of the biogeographical population in the UK (classified following the methods developed by Certain *et al.*, (2015)).

The combined seabird data and species sensitivity index values are subsequently summed at each location to create a single measure of seabird sensitivity to oil pollution. This is presented as a series of fine scale density maps for each month that show the median, minimum and maximum seabird sensitivity to oil pollution, and an indication of data confidence. The index is independent of where oil pollution is most likely to occur; rather, it indicates where the highest seabird sensitivities might lie if there were to be a pollution incident.

Seabird vulnerability to surface pollution in the Moray Firth is extremely high at certain times of year (May, October and December). In addition, the whole of the Moray Firth is within the foraging range from the main seabird colonies within the SPAs.

Figure C-11 shows seabird sensitivity (for December) in the Moray Firth in relation to the probability of surface oiling following a diesel release at Beatrice. This shows that the area of highest probability of surface oiling (60%) potentially coincides with very high and extremely high seabird sensitivity and the minimum arrival time to these areas is less than two hours.

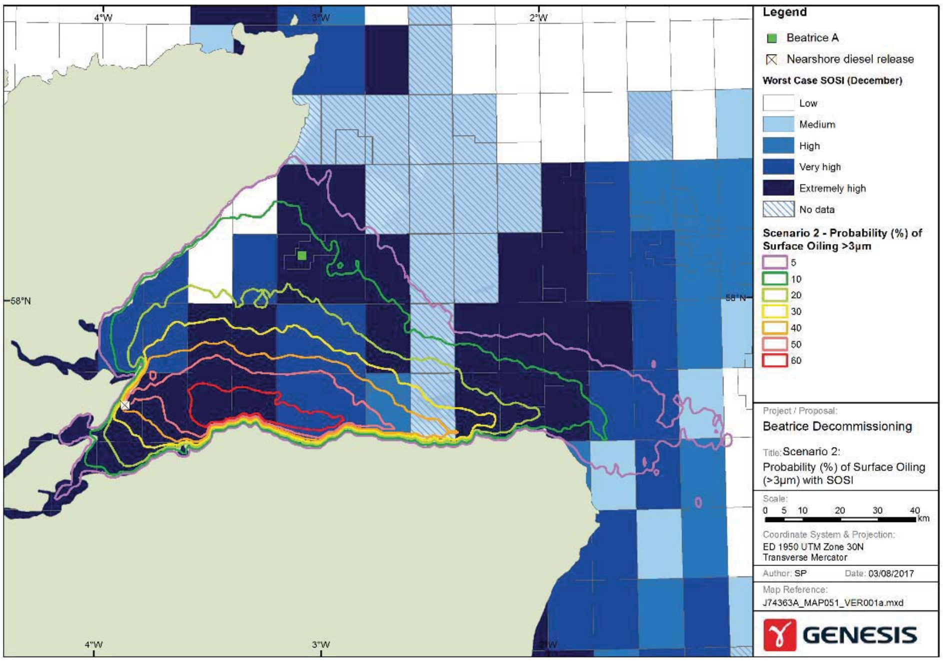


Figure C-11: Seabird sensitivity in relation to probability of surface oiling.

In the event of a spill the diesel would evaporate from the surface over a matter of days, (generally less than 10 days), and would be present in discrete patches rather than covering the whole area indicated in the plots. Nevertheless because of the initial extent of surface oiling and the relatively low exposure time needed to compromise a bird, the magnitude of effect is considered major.

C.4.2.5 Impact of Hydrocarbons on Marine Mammals

Marine mammals may be exposed to oil or diesel in one of two ways:

- Internally (swallowing contaminated water, consuming prey containing oil based chemicals, or inhaling of volatile oil related compounds); and
- Externally (swimming in oil or dispersants, or oil or dispersants on skin and body).

As marine mammals feed on fish and squid and/or plankton, contamination of the water column affecting this food source could have a negative impact on marine mammals, either directly as a result of lack of prey or indirectly as a result of bioaccumulation of contaminants.

The effects of oil on marine mammals are dependent upon species but may include:

- Hypothermia due to conductance changes in skin, resulting in metabolic shock;
- Toxic effects and secondary organ dysfunction due to ingestion of oil, congested lungs;
- Damaged airways;
- Interstitial emphysema due to inhalation of oil droplets and vapour;
- Gastrointestinal ulceration and haemorrhaging due to ingestion of oil during grooming and feeding;
- Eye and skin lesions from continuous exposure to oil;
- Decreased body mass due to restricted diet; and
- Stress due to oil exposure and behavioural changes.

The nature of the oil/diesel and how much it has weathered may also be an important factor in determining impacts on wildlife. Individuals oiled early in a spill may be exposed to the more toxic components of the oil by direct contact and ingestion and suffer greater toxicity than those affected by a more dispersed and weathered oil/diesel.

Pinnipeds

Seals are very vulnerable to oil pollution because they have to spend much of their time on or near the surface of the water. They need to surface every few minutes to breathe, and regularly haul out on to beaches. During the course of an oil pollution incident they are at risk both when surfacing and when hauling out. Seals have been seen swimming in oil slicks during a number of documented spills (Geraci and St Aubins, 1990).

Most pinnipeds scratch themselves vigorously with their flippers but do not lick or groom themselves so are less likely to ingest oil from skin surfaces. However, a pinniped mother trying to clean an oiled pup may ingest oil. The risk of oiling increases for pinniped pups. They spend much of their time in rocky shore areas and tidal pools where spilt oil can accumulate. Recent evidence suggests that pinniped pups are very vulnerable during oil spills because the mother/pup bond is affected by the odour and pinnipeds use smells to identify their young. If the mother cannot identify its pup by smell in the large colony it may not feed it and this could lead to starvation and abandonment.

Oil can also impact on the mucous membranes that surround the eyes and line the oral cavity, respiratory surfaces, anal and urogenital orifices. This can cause corneal abrasions, conjunctivitis and ulcers. Consumption of oil-contaminated prey can lead to the accumulation of hydrocarbons in tissues and organs. Spraker *et al*. (1994) found four types of lesions characteristic of hydrocarbon toxicity in the brains, principally the thalamus, in oiled seals collected months after the Exxon Valdez spill.

The probability of shoreline oiling at the seal haul out sites is low (< 10%), with the exception of the Findhorn site where the probability of shoreline oiling reaches 50 to 60%. If shoreline oiling were to take place, a maximum of 4 to 6 te of diesel per cell (500 m by 500 m) is predicted to accumulate onshore.

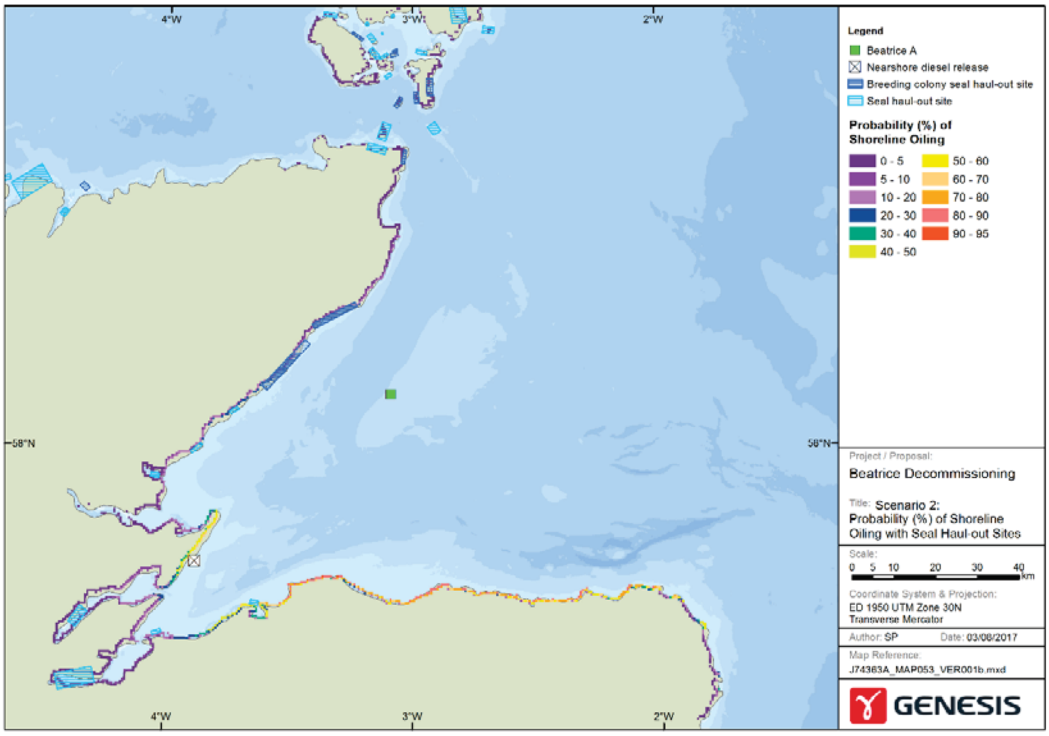


Figure C-12: Probability of shoreline oiling in relation to seal haul out sites.

Cetaceans

There is little documented evidence of cetaceans being affected by oil spills. Smultea & Wursig (1995) found that bottlenose dolphins apparently did not detect sheen oil and that although they detected slick oil, they did not avoid traveling through it. Evans (1982) observed that gray whales *Eschrichtius robustus* typically swam through oil seeps off California. Although the gray whales modified their swim speeds and breathing rates, there was no consistent pattern of behaviour regarding the presence of the oil. Lack of an olfactory system likely contributes to the difficulty cetaceans have in detecting oil.

Within 24 hours of the Exxon Valdez spill (42 million litres of crude) killer whales were observed within the slick which was several hundred kilometres long. Travelling whales e.g. killer whales, may spend three to ten minutes at a time under water and when they surface to breathe, they may have travelled hundreds of metres. Waves and darkness can reduce their visual ability at the surface and it is possible that individuals could resurface within a fresh slick and find it difficult to locate oil-free water (Matkin *et al*., 2008). In the months following the Exxon Valdez spill there were numerous observations of gray whales, harbour porpoises, Dall's porpoises and killer whales swimming through light to heavy crude oil sheens (Harvey and Dahlheim, 1994).

The way a cetacean consumes its food affects the likelihood of it ingesting oil. Baleen whales, which skim the surface are more likely to ingest oil than "gulp feeders" or toothed whales. Baleen whales are particularly vulnerable to oil while feeding, as oil may stick to the baleen while the whales "filter feed" near oil slicks. Geraci and St. Aubins (1990) estimated that a long-finned pilot whale *Globicephala melas* would need to ingest 30 l of oil over a period of weeks in order to suffer severe effects. Chronic ingestion of subtoxic quantities of oil may have subtle effects which would only become apparent through long-term monitoring. The transfer of petroleum hydrocarbons through the mother's milk to suckling young is another way oil may affect cetaceans.

Cetaceans have mostly smooth skins with limited areas of pelage (hair covered skin) or rough surfaces. Oil tends to adhere to rough surfaces, hair or calluses of animals, so contact with oil by cetaceans may cause only minor oil adherence.

Cetaceans can be susceptible to inhaling oil and oil vapour. This is most likely to occur when they surface to breathe. Several days after the Exxon Valdez spill, gray whales were observed swimming lethargically at the surface and oil fumes were recorded at an altitude of 200 m (references within Matkin *et al*., 2008). Inhaling oil and oil vapour may lead to damaging of the airways, lung ailments, mucous membrane damage or even death. A stressed or panicking dolphin tends to move faster, breathing more rapidly and therefore surfacing more frequently into oil and hence increases exposure. Following the Exxon Valdez spill a coated Dall's porpoise was observed to be stressed and remaining at the surface for extended periods of time (Harvey and Dahlheim, 1994).

Parts of the Moray Firth SAC for bottlenose dolphins falls within areas with a high probability of surface oiling (up to 60%, see Figure C-12).

Although there is little documented evidence of cetaceans being significantly affected by oil spills, given the extent of the area where surface oil and shoreline beaching is predicted to take place, and the potential impacts on seals the magnitude of effect of a diesel release on marine mammals is considered major.

C.4.2.6 Impact of Hydrocarbons on Designated Areas

Figures C-13 to C-15 show the probability of surface oiling, the probability of diesel reaching the coastline and the mass of accumulated diesel in relation to designated protected areas.

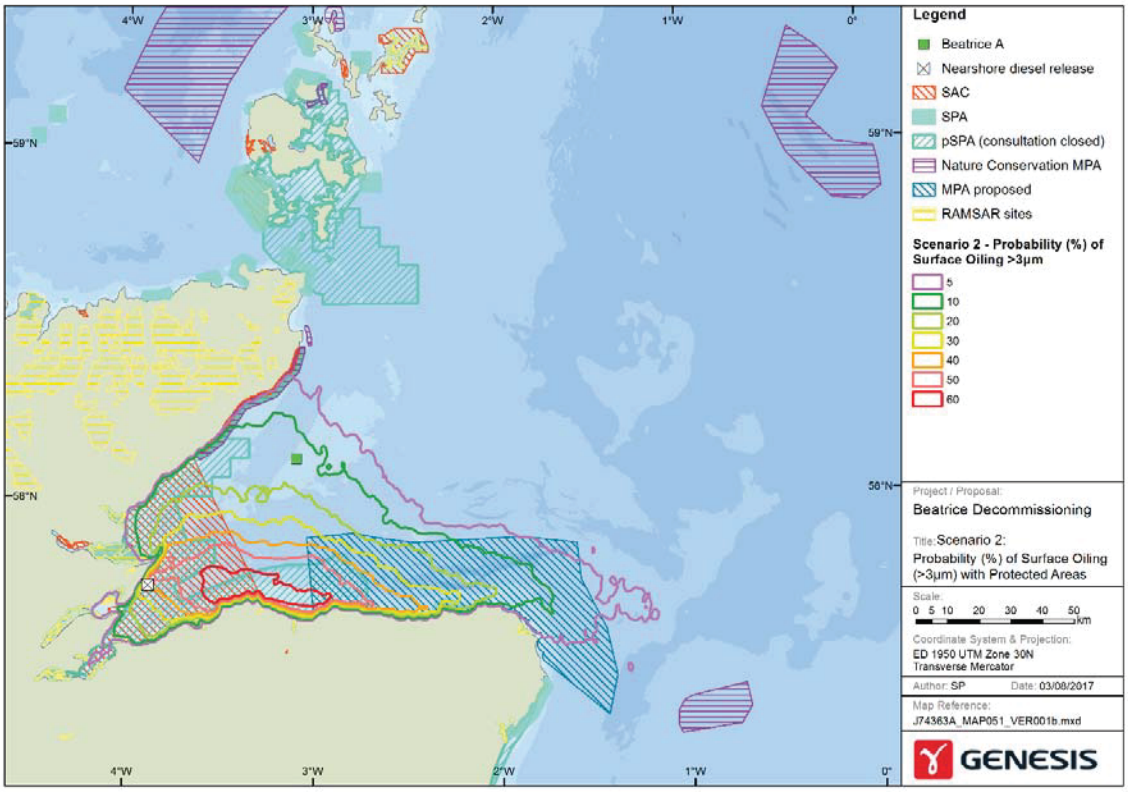


Figure C-13: Probability of surface oiling in relation to designated protected areas.

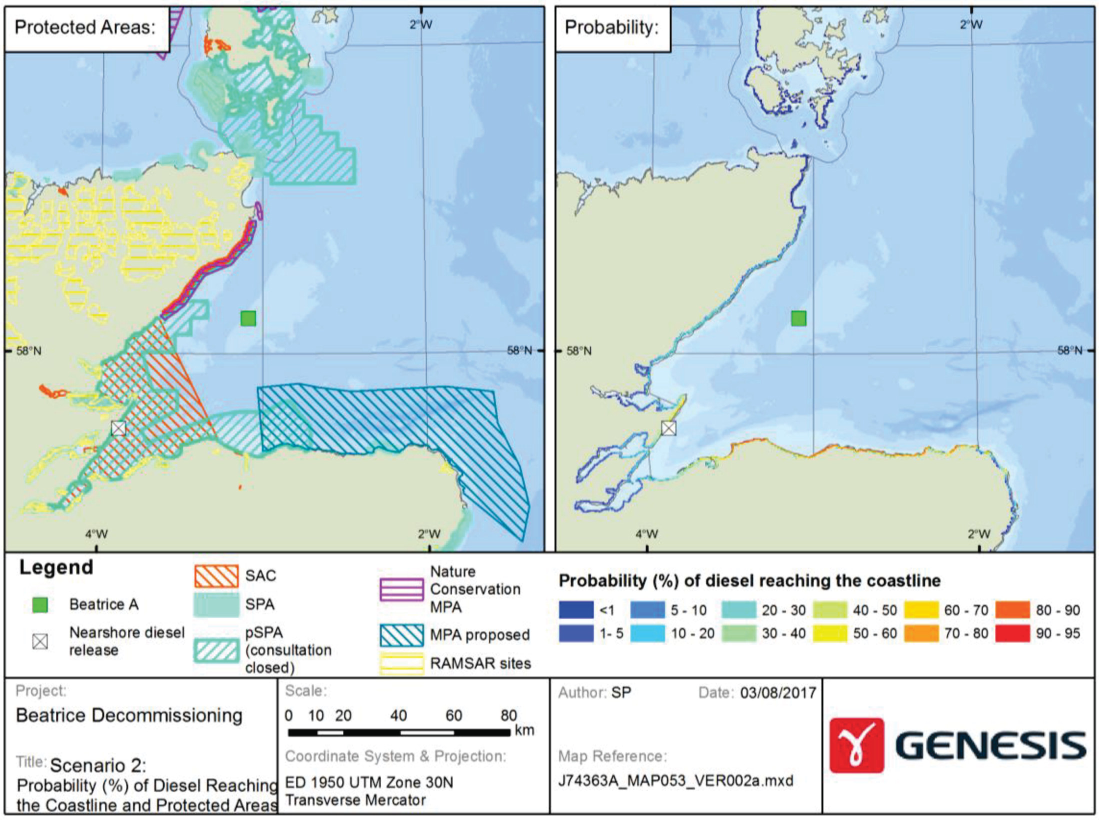


Figure C -14: Probability of diesel reaching the coastline in relation to protected areas.

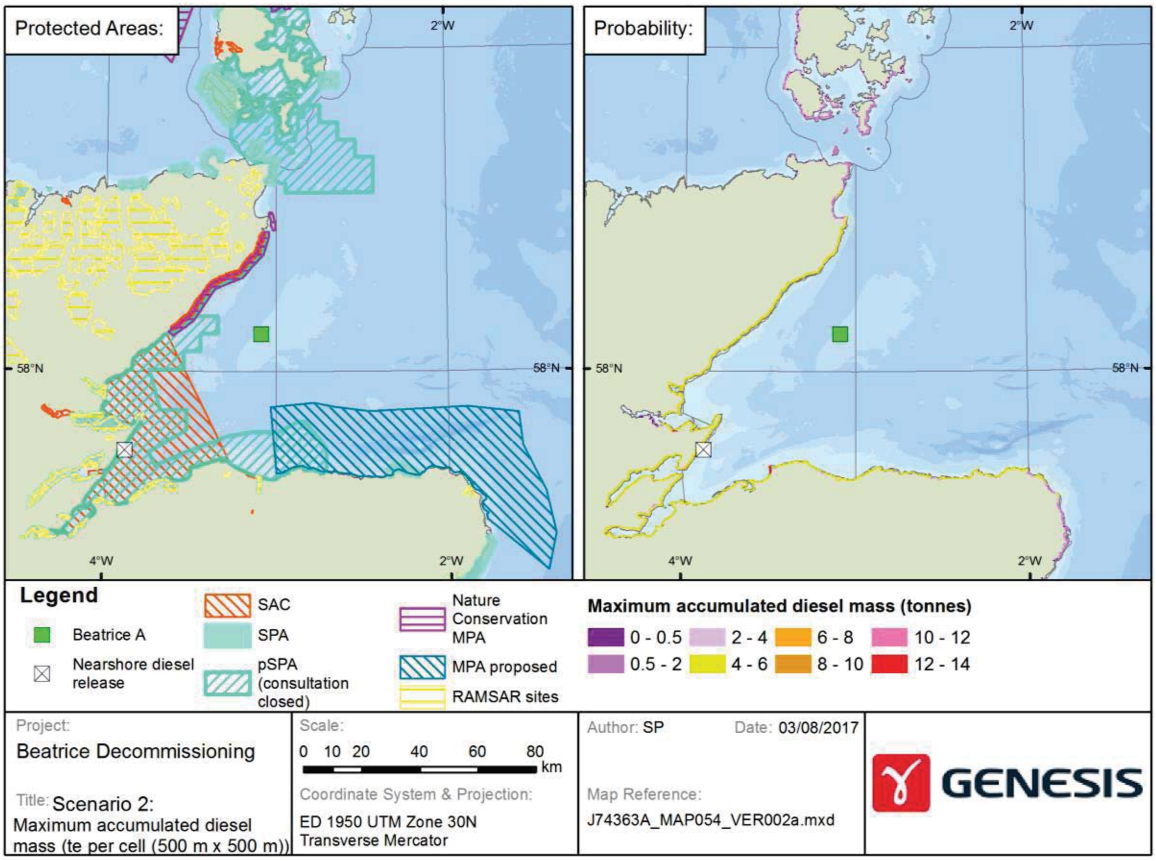


Figure C-15: Maximum accumulated diesel mass in relation to protected areas.

The modelling results suggest that areas of highest probability of surface oiling occur within the Moray Firth SAC, the proposed Southern Trench MPA and the Moray and Nairn coast pSPA. Probabilities of shoreline beaching are higher along the Moray Firth coast between Findhorn and Fraserburgh than along the section of coast between Inverness and Wick and therefore most Ramsar sites fall into areas of low probability, with the exception of the Moray and Nairn Coast Ramsar site which is designated for its coastal and riverine habitats, including intertidal flats, saltmarsh and sand dunes which support migrating waterbirds and wintering waders. Sediment concentrations of over 50 mg/kg are predicted in small parts of the Ramsar site (see Figure C-15).

Given the number of designated areas that would be impacted by a diesel release the magnitude of effect is considered major.

C.4.2.7 Impact of a Spill on Local Communities

In addition to having an active fishery the Moray Firth waters and adjacent land provides for a variety of recreational activities which make tourism and leisure an important contribution to the local economy (LUC, 2016). In 2015, *c.* 700,000 visitors to the Moray area contributed £106 million to the local economy. Further details are provided in Chapter 6.

A diesel spill resulting in beaching would possible result in a reduction in livelihood in the short term (1-2 years maximum) both through media reports and/or actual impacts such that the magnitude of effect is considered serious.

C.4.3 Impact Significance

Combining the receptor sensitivity and the magnitude of effect, using the methodology applied in Chapter 7 an environmental impact significance can be determined for the impact on each receptor as show in Table C- 7.

Table C- 7: Assessment of environment and socio-economic impact significance

Receptor	Sensitivity	Magnitude	Impact Significance
Plankton	Low	Minor	Low
Benthos	Low	Serious	Moderate
Fish	Medium	Serious	Moderate
Fisheries	High	Major	High
Seabirds	High	Major	High
Marine mammals	High	Major	High
Designated areas	Very high	Major	High
Local communities	Medium	Serious	Moderate

C.4.4 Environmental Risk

Given that the loss of diesel would be an unplanned event, an environmental risk ranking can be assigned by combining the 'impact significance' with the 'likelihood' of the spill taking place using the method set out in Chapter 7.

The Advisory Committee on Protection of the Sea (ACOPS) collates spill data for all of the North Sea, by region but it separates out statistics for the UKCS. Spills from installations are reported separately from spills from vessels within the UKCS. Between 2002 and 2014 (the last year for which data is currently available, ACOPS 2002 to 2014 surveys) there has been a total of 292 mineral oil spills from vessels in the UKCS, varying from zero in 2014 to 37 in 2012. Mineral oil includes crude, bunker, diesel, fuel, lubrication and other oil types. Only 16 of these spills fall into the bunker/diesel and fuel oil category. All of these spills were below 50 te with the exception of one (a spillage of 605 te by an unidentified vessel reported by the Tartan installation). The likelihood of a full loss of diesel inventory from a vessel during decommissioning activities is therefore considered remote, i.e. 'similar event has occurred elsewhere but is unlikely to occur with current practices'.

Combining the 'impact significance' identified for each key receptor with the assigned likelihood gives an environmental risk of low to medium dependent on the receptor (Table C-8) such that the overall environmental risk of a loss of diesel inventory is considered Medium.

Table C-8: Summary of environmental risk.

Receptor	Impact Significance	Likelihood	Environmental risk
Plankton	Low	Remote	Low
Benthos	Moderate		Low
Fish	Moderate		Low
Fisheries	High		Medium
Seabirds	High		Medium
Marine mammals	High		Medium
Designated protected areas	High		Medium
Local communities	Moderate		Low

C.5. MODEL UNCERTAINTIES

C.5.1 Metocean Data

Two-dimensional surface current data was supplied by O&G UK covering the years 2011-2014 and is the best data reasonably available. Alternative or better data could involve a longer range of metocean data, actual current data from the Beatrice location or specific three-dimensional current fields for the area, which would produce slightly different spatial results. Such differences are, however, not expected to lead to any significant difference in the overall conclusions in the report, which are representing a large release at one possible location out of many potential locations.

C.5.2 Shoreline and Sediment Type

A rocky shoreline and sandy seabed sediment were selected for use in the model. This is an approximation to the prevailing shoreline type and is reasonable where high-level conclusions are drawn on the fate and potential impacts of a large hydrocarbon release. Whereas for offshore areas, the seabed sediment is generally relatively uniform, this is not normally the case closer to shore. In the Moray Firth for example, although much of the sediment is sandy there are also areas of mudflats (e.g. near Findhorn). Similarly, there are areas of sandy, cobble or mud flat shoreline that could retain more hydrocarbons than implicit in the rocky shore assumption as hydrocarbons are adsorbed better onto finer grained sediment. However, hydrocarbons that are under-retained in these areas are available to contact and be retained in adjacent areas, so the overall proportions of hydrocarbons and large scale distribution is valid. Refinement of the seabed and shoreline types within the model would improve predictions, but the ERA has taken a worst case approach to ranking of magnitude of impacts and therefore it is not considered that this would alter the outcome of the study.

C.5.3 Overall Uncertainty of the Modelling Process

There are many variables and uncertainties present in such a modelling exercise and care should be taken in interpreting results within these uncertainties. Specific spatial or numerical details taken in isolation may be unrepresentative, particularly for unplanned discharges with large spatial ranges near coastlines. Modelling in these circumstances is intended to be used to draw overall and high-level conclusions on hydrocarbon transport, fate and effects.

The OSCAR model has undergone considerable scientific development over more than 30 years, and the results from field trials and incidents are regularly fed back into the model physics and features to bring predictions closer and closer to real observations. The model physics are largely shared by the model for dissolved components (DREAM) and solid components (ParTrack) and together there is a significant body of validation work (e.g. Daling *et al*., 1997, Durell, 1996, Reed *et al.*, 1996, Johansen and Durgut, 2006, Niu and Lee, 2013, De Susanne *et al.* 2015).

Overall OSCAR is held up worldwide as a leading tool in predicting the fate and interpreting the effects of oil spills and is accepted in this capacity by environmental regulators. It has been shown to give reliable conclusions when viewed in context and when used in conjunction with reliable environmental baseline data, empirical evidence from real world or laboratory studies and experienced judgment, as here.

C.6. CONCLUSIONS

Modelling using OSCAR was undertaken to determine the environmental and socio-economic risk of a worst case diesel spill during the proposed decommissioning activities associated with the Beatrice Field

To support the EIA, two spill scenarios were initially considered:

- Scenario 1 - 7,000 m^3 spill from a HLV at Beatrice Alpha; and
- Scenario 2 - 3,600 m^3 spill from an ROVSV working on the pipeline close to the shore.

Prior to commencement of the modelling it was recognised that the scenario resulting in the most shoreline oiling (volume and area) would represent the worst case scenario. Stochastic modelling showed that there were greater volumes of beaching associated with Scenario 2, and that a longer length of coastline would be impacted. Scenario 2 was therefore assessed in detail.

Receptor sensitivities were assigned using the environmental and socio-economic base data provided in Chapters 5 and 6 respectively. The results from the deterministic modelling (carried out for Scenario 2) were used to define the magnitude of effect of the release on each receptor. Combining receptor sensitivity and the magnitude of effect showed the impact significance to vary for different receptors:

- Low impact significance: plankton.
- Moderate impact significance: benthos, fish and local communities.
- High impact significance: fisheries, seabirds, marine mammals and designated areas.

The likelihood of a full loss of diesel inventory from a vessel during decommissioning activities is considered remote, such that it is recognised that 'a similar event has occurred elsewhere but is unlikely to occur with current practices'.

Combining the impact significance with the likelihood gives an environmental risk which was found to be either low or medium for each receptor considered:

- Low environmental risk: plankton, benthos, fish and local communities
- Medium environmental risk: fisheries, seabirds, marine mammals and designated areas.

Therefore, taking the remote likelihood of a total loss of diesel inventory and the impact significance on all receptors into account the environmental risk of a diesel spill is considered Medium. Given that the experimental basis for model has been validated by SINTEF via a number of experiments including real oil spills (Reed *et al.* 1999 etc.) the Confidence Level in this ranking is Medium.