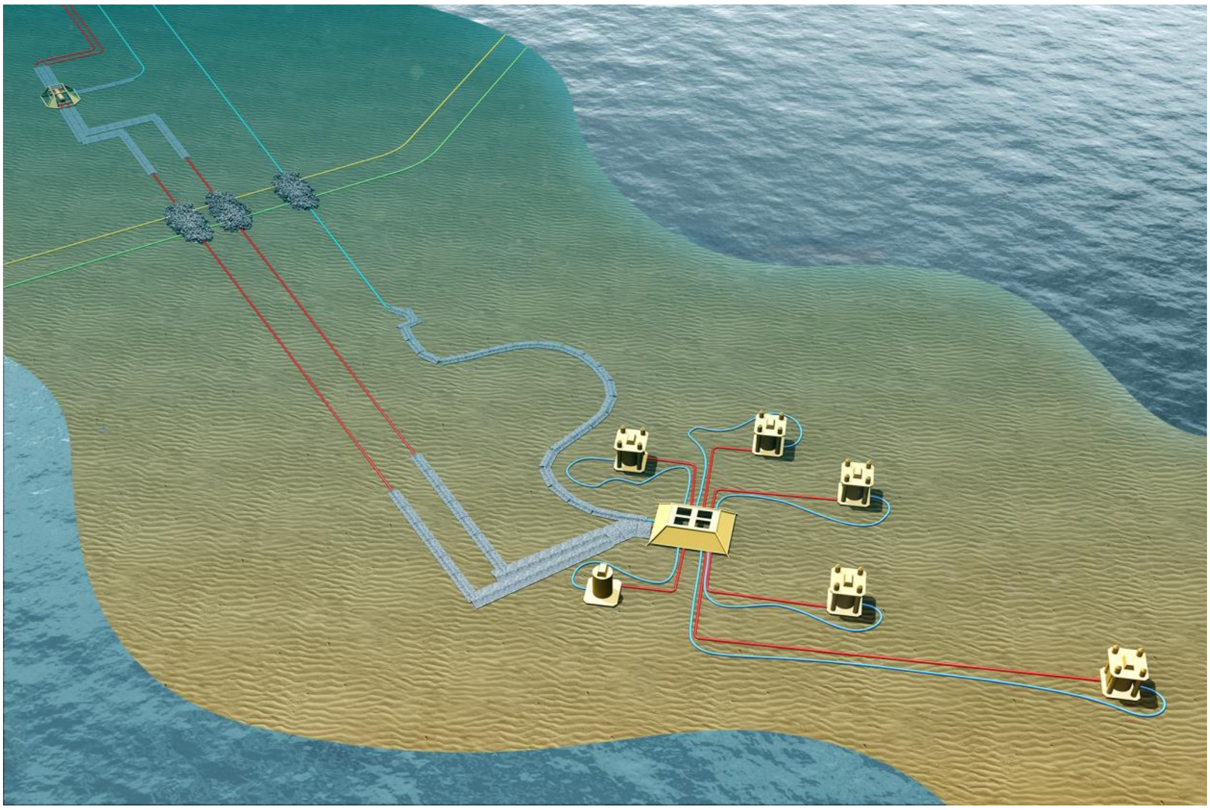
Kingfisher Field Decommissioning
Final Environmental Appraisal – Part 1



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Revision History

Rev #	Reason for Issue / Change
R01	Team Review
R02	Second Team Review
A01	Pre-Draft report for Issue
A02	Updated to reflect Marathon's change of name to RockRose UKCS8 LLC Updated to clarify scope relates to Part 1 of the DP only
A03	Updated to clarify that 2018 Fugro report refers to 2017 survey Updated per RockRose UKCS8 LLC (now TAQA Bratani Ltd) comments
A04	Updated with comments received during public consultation
A05	Final revision, issued for OPRED approval
A06	Updated per Rev A09 DP. Issued for OPRED approval.

Table of Contents

List of Tables

List of Figures

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Glossary and Abbreviations

ACOPS	Advisory Committee on Protection of the Sea
ALARP	As Low as Reasonably Practicable
AP/APE	Alkylphenol ethoxylates
BEIS	Department for Business, Energy and Industrial Strategy
CA	Comparative Assessment
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CF IA	Shell's Control Framework Impact Assessment Manual
CNS	Central North Sea
CoP	Cessation of Production
DECC	Department of Energy and Climate Change
DP	Decommissioning Programmes
DSV	Dive Support Vessel
EA	Environmental Appraisal
EC	European Commission
EET	Ecological Effects Threshold
EIA	Environmental Impact Assessment
ENVID	ENVironmental Impact iDentification
EPS	European Protected Species
ERL	Effects Range Low
ERM	Effects Range Medium
ERT	Emergency Response Team
ESAS	European Seabirds at Sea
ESHMP	Environment, Social and Health Management Plan
EUNIS	European Nature Information System
GIS	Geographical Information Systems
GMAS	(Shell's) Global Marine Assurance System
HCV	Heavy Crane Vessel
HSSE&SP CF	Health, Safety, Security and Environment & Social Performance, Control Framework
HYCOM	Hybrid Coordinate Ocean Model
ICES	International Council for the Exploration of the Sea

IMO	International Maritime Organization
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
km	Kilometres
KP	Kilometre Point
LAT	Lowest Astronomical Tide
m/s	Metres per second
MARPOL	International Convention for the Prevention of Pollution from Ships
MAT	Master Application Template
MPA	Marine Protected Area
MS	Marine Scotland
NCMPA	Nature Conservation MPA
nm	Nautical Miles
NMPi	National Marine Plan interactive
NOAA	National Oceanic and Atmospheric Administration
NORM	Naturally Occurring Radioactive Material
OBM	Oil Based Mud
OCIFM	Oil Companies International Marine Forum
OGA	Oil and Gas Authority
OGUK	Oil and Gas UK
OiW	Oil in Water
OPEP	Oil Pollution Emergency Plan
OA	Osbourn Adams toxicity calculations
OSPAR	Oslo/Paris Convention
P&A	Plug and Abandonment
P&L	Plug and Lubricate
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated biphenyls
PL	Prefix for OGA pipeline numbering system
PMF	Priority Marine Features
PMS	Power Management System

PNEC	Predicted No-Effect concentration
PPC	Pollution Prevention and Control
Ppm	Parts Per Million
Ppt	Parts Per Trillion
PWA	Pipeline Works Authorisation
ROV	Remotely Operated Vessel
ROVSV	ROV Support Vessel
SAC	Special Area of Conservation
SAT	Subsidiary Application Template
SCANS	Small Cetacean Abundance in the North Sea
SFF	Scottish Fisheries Federation
SNH	Scottish Natural Heritage
SOPEP	Shipboard Oil Pollution Emergency Plan
SOSI	Seabird Oil Sensitivity Index
Spp	Non-determined species
SPA	Special Protection Area
SSIV	Sub Sea Isolation Valve
Te	tonnes
THC	Total Hydrocarbon
TTA	Through tubing abandonment
UK	United Kingdom
UKCS	UK Continental Shelf
UKOOA	UK Offshore Operators Association
VMS	Vessel Monitoring System
WMP	Waste Management Plan

Note on Scope of Environmental Appraisal

The Kingfisher Decommissioning Programmes will be issued as two separate documents. This Environmental Appraisal is submitted in support of Decommissioning Programmes Part 1, which includes decommissioning proposals for all Kingfisher subsea infrastructure outside the 500m safety zone of the TAQA Bratani Ltd Brae Bravo Platform. This includes the following:

- Kingfisher Manifold
- Six wellheads for wells BP1.1, BP1.2, BP1.3, BP2, HP1 and HP2
- Drill cuttings pile at the Kingfisher well site
- PL1488 Production Pipeline from the 500m safety zone at TAQA Bratani Ltd Brae Bravo to the Kingfisher Manifold
- PL1489 Production Pipeline from the 500m safety zone at TAQA Bratani Ltd Brae Bravo to the Kingfisher Manifold
- PLU1490 Manifold Control Umbilical from the 500m safety zone at TAQA Bratani Ltd Brae Bravo to the Kingfisher Manifold
- PL1497, PL1498, PL1499, PL1500, PL1501 and PL1502 – production jumpers from the Kingfisher Manifold to each of the six wells
- PLU1491, PLU1492, PLU1493, PLU1494, PLU1495, PLU1496 – chemical and control umbilical jumpers from the Kingfisher Manifold to each of the six wells
- All associated stabilisation features such as concrete mattresses and grout bags

Part 2 of the Decommissioning Programmes will be issued at a future date and include the following infrastructure, all within the 500m safety zone at the TAQA Bratani Ltd Brae Bravo Platform:

- Kingfisher SSIV Manifold
- PL1488 Production Pipeline from the TAQA Bratani Ltd Brae Bravo Platform to the edge of the 500m safety zone
- PL1489 Production Pipeline from the TAQA Bratani Ltd Brae Bravo Platform to the edge of the 500m safety zone
- PLU1490 Manifold Control Umbilical from the TAQA Bratani Ltd Brae Bravo Platform to the edge of the 500m safety zone
- Kingfisher SSIV Control Umbilical from the TAQA Bratani Ltd Brae Bravo Platform to the Kingfisher SSIV Manifold – note that this umbilical is currently un-numbered, but a PWA variation will be submitted to apply for a PLU number
- All associated stabilisation features such as concrete plinths, mattresses and grout bags

This Environmental Appraisal has been developed to support the scope of Decommissioning Programmes Part 1 as detailed above, however the environmental baseline and broad environmental description etc will be equally applicable to Decommissioning Programmes Part 2. The decommissioning proposals included herein reflect the outcomes of the Comparative Assessment for Part 1 that is being submitted to OPRED, stakeholders and the public for consideration. Should it become necessary during the development of Decommissioning Programmes Part 2, this Environmental Appraisal will be updated.

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Non-Technical Summary

Introduction

This Environmental Appraisal (EA) documents the environment and societal impact assessment carried out in support of the Kingfisher Decommissioning Programmes (DPs). The DP documentation contains full details of the plans to decommission the Kingfisher offshore infrastructure, although some information has been repeated in this report to aid the understanding of the context for assessing the significance of potential environmental and societal impact.

The DPs and this supporting EA cover the decommissioning works for the offshore infrastructure. They do not include the plugging and making safe of the Kingfisher wells. These activities and associated environmental assessment are conducted under separate regulation.

The Kingfisher field is a gas condensate and oil field in Blocks 16/8a and 16/8d of the central North Sea (CNS) in an average 110 m water depth. The field is located approximately 280 km northeast of Aberdeen, Scotland.

The Field comprises three reservoirs: Brae I (Gas/condensate); Brae II (Oil); and Heather (Gas/Condensate), tied back to TAQA Bratani Ltd's Brae Bravo platform. Following confirmation from Marathon (now TAQA Bratani Ltd) that the host platform had reached the end of economic life and received Cessation of Production (CoP) approval from the Oil and Gas Authority, the Kingfisher field was shut in on 5th July 2018.

The Subsea infrastructure to be decommissioned comprises six subsea wells located 9 km away from the host (TAQA Bratani Ltd Brae Bravo) platform. The wells are connected to a subsea manifold via rigid pipeline jumpers. The production fluids from the wells were commingled in the manifold and routed to the host platform via the two 10" production pipelines (PL1488 and PL1489) which are approximately 9 km in length.

The pipelines are fabricated from super duplex stainless steel with a plastic coating and have a nominal outside diameter of 10". They are trenched and buried along much of their length with remedial rock cover installed in places along the pipeline to resist upheaval buckling. Both 10" production pipelines were flushed and cleaned in July 2018 achieving a post flushing Oil in Water concentration of 3.8 mg/l. On approach to the TAQA Bratani Ltd Brae Bravo Platform the pipelines are, in part surface laid, and in part supported above the seabed on concrete plinths to enable them to cross other pipelines.

A total footprint area of 5, 900 m^2 of rock berm is currently installed.

Power, hydraulics and chemicals are provided to the manifold and wells via a single composite control and chemical injection umbilical from the TAQA Bratani Ltd Brae Bravo platform to the Kingfisher manifold. The umbilical is laid in a trench with a minimum depth of 0.5 m and buried through natural backfill. At the approach to the manifold, it is protected by concrete mattresses. A subsea safety isolation valve (SSIV) is installed approximately 350 m from the TAQA Bratani Ltd Brae Bravo platform. A control umbilical from TAQA Bratani Ltd Brae Bravo platform to the Kingfisher SSIV structure controls the Kingfisher SSIV. This umbilical is surface laid with mattresses and spot rock cover on top.

There are approximately 240 exposed concrete mattresses placed along the Kingfisher subsea infrastructure.

The Kingfisher infrastructure first became operational in 1997.

Summary of Planned Decommissioning Works

It is acknowledged that the decommissioning works are subject to approved DPs, but the recommendations in the DPs include the following activities, on which the EA has been based:

- Trenched and buried pipelines between the TAQA Bratani Ltd Brae Bravo 500m zone boundary and the Kingfisher manifold will be decommissioned *'in situ'*. This includes the surface laid crossing of Equinor's Heimdal pipeline midway between the Kingfisher SSIV and the Kingfisher Manifold;
- The Kingfisher manifold and production jumpers will be removed and recovered to shore for recycling/disposal;
- Wellheads to be cut -3 m below seabed and will be removed and recovered to shore for recycling/disposal;
- Drill cuttings will be decommissioned *'in situ'* with the minimal necessary disturbance during wider decommissioning activities.

The decommissioning activities will utilise a variety of vessels, with an anticipated aggregate of 126 vessel-days' service.

Following completion of the decommissioning, surveys, overtrawl trials will be conducted to demonstrate that the seabed has been left safe for other users of the sea.

It is possible that all works will be carried out in a single campaign. Options from decommissioning contractors or collaboration with other operators for phasing the removal activities over an extended period of time will however be considered if this flexibility provides more optimum delivery and cost savings.

Environmental Baseline Summary

The seabed sediment in the area around Kingfisher largely comprises fine or very fine sand which is assigned predominantly to the EUNIS biotope 'Circalittoral muddy sand' with some small patches of 'Circalittoral mixed sediments'. A pre-decommissioning environmental survey around the Kingfisher manifold was carried out in 2017. The survey recorded the presence of sea pen species *Virgularia. mirabilis* and *Pennatula phosphorea*. In addition, some burrows were observed, although they did not appear to form a prominent feature of the sediment. Neither of these seapen species were observed around TAQA Bratani Ltd Brae Bravo, during a separate environmental survey carried out in 2013. Notwithstanding this, there remains the potential for the localised presence of elements of 'Seapen and burrowing megafauna communities' habitat that has been classed as a threatened and/or declining habitat by OSPAR. This habitat type covers large areas of the CNS and has been degraded through historical activities such as fish trawling. Juvenile stages of the long-lived bivalve Ocean Quahog were also observed in proximity to the Kingfisher manifold but no adult examples of this species were identified by environmental survey.

Drill cuttings records indicate that approximately 3487 m^3 of drill cuttings were originally generated at Kingfisher during initial drilling in 1997. These included cuttings drilled with Oil Based Muds (OBM) deposited beneath, immediately adjacent to and in some cases overlying the Kingfisher wellhead and manifold infrastructure. Estimates taken from available bathymetric data indicate a residual drill cuttings pile of approximately 1851 m^3 exists at the Kingfisher manifold and wellheads. Hydrocarbon distribution in sediments sampled in the area during the 2017 survey was typical of low level, weathered petroleum residues commonly found in North Sea sediments. The 2017 environmental survey included push core sampling within the drill cuttings deposits and samples collected showed localised elevated THC levels, along with certain metals.

A further drill cuttings pile exists at the TAQA Bratani Ltd Brae Bravo platform. The Brae Bravo pile is located on the northern side of the jacket footings, whilst the Kingfisher pipelines approach the platform from the east and south. A review of the Brae Bravo environmental survey data has confirmed that the sample location closest to the Kingfisher infrastructure recorded THC concentrations below the mean THC concentration for the CNS indicating no contamination of seabed sediments in the area of the Kingfisher subsea infrastructure from the platform cuttings pile.

There are no designated areas of conservation interest in the area of the Kingfisher infrastructure. The nearest designated site under the Habitats Directive (92/43/EEC) is the Braemar Pockmarks Special Area for Conservation (SAC) including the Annex I Habitat '*Submarine Structures made by leaking gases*' which is located approximately 22 km to the north of the Kingfisher manifold and approximately 20 km from the TAQA Bratani Ltd Brae Bravo platform.

Only a small number of marine mammals are regularly recorded in the area around the Kingfisher infrastructure, including Harbour Porpoise, White-beaked dolphin and Minke whale. The area around the Kingfisher infrastructure is recorded as an area of low 'at sea' usage for both grey and harbour seals. Occasional presence in the area around Kingfisher of Priority Marine Features (PMF) including basking shark and porbeagle shark as well as tope and the spiny dogfish has also been recorded.

Seabirds of various species, are present in the area around the Kingfisher infrastructure throughout the year although in low numbers for the majority of species as the area is at some distance from their breeding colonies. There are limited records of significant aggregations of seabirds in the area around Kingfisher. Vulnerability of seabirds to oil spills within the area around Kingfisher varies seasonally and is generally low from July to October and from January to March, rising to 'Extremely High' from April to June. There are no data available for November and December

The Kingfisher lies within ICES rectangle 46F1 which makes a low (1.8%) contribution to overall fishing effort in UK waters, based on 2017 ICES data for vessels of 15 m in length. ICES rectangle 46F1 also lies within spawning grounds for a number of fish species of commercial and/or conservation importance, including haddock, Norway pout and Norway lobster.

Stakeholder Engagement

Shell has actively engaged with key external stakeholders to inform them of the intention to decommission the Kingfisher infrastructure, discuss options and listen to stakeholder opinion and issues raised to consider in the development of our decommissioning plans. Many of the issues raised relate to the need to demonstrate understanding of the baseline environment and ensure protection of sensitive features. In addition, the EA provides consideration of specific issues raised by stakeholders including: the potential for interaction between Kingfisher DP activities and other sea user activities, specifically the overtrawlability of any infrastructure decommissioned '*in situ*'; the potential for drill cuttings to contaminate fishing nets and commercial fish catches; and whilst it was agreed that seabed disturbance associated with the Kingfisher DP activities when considered on their own were unlikely to result in any significant effect, the EA has nonetheless also looked at the potential for seabed disturbance in-combination with other known DP activities in the area, including any cumulative effect of additional protective rock placement.

ENVID

Potential environmental and societal risks arising from the DPs were determined through Environmental Impact Identification (ENVID) workshop. The ENVID uses standard definitions for rating the magnitude of impact based on the sensitivity of the receptor and the scale and duration of the activities. Whilst the ENVID process did not identify any decommissioning activities with related environmental interactions of high significance, a small number of activities were identified resulting in interactions with the environment of potentially minor to moderate significance. These were further investigated and evaluated within the EA report

The ENVID, along with additional evaluation of options and subsequent analysis and study, concluded that the decommissioning of Kingfisher infrastructure can be executed with readily implementable controls that will result in minimal impact to the receiving environment.

The EA report provides a robust justification for this conclusion by presenting the science, reasoning and professional judgement that was used in drawing these conclusions. The following summarises the key findings and mitigations planned for the DPs. Further details are included in the main body of the report.

Summary of Key Findings of the EA

The assessment considered potential impacts of planned activities and the risk of impacts from unplanned events.

Planned Activities

Air Quality

Potential effects as a result of emissions to air from vessels active at sea during decommissioning activities were considered likely to be insignificant, as the emissions will constitute only a minor addition to the overall emissions from routine shipping in the area. All vessels used will be compliant with all relevant international air pollution standards.

Noise

No high energy noise source activities such as blasting, piling or deep sediment penetration seismic survey will be utilised during the DPs. Noise sources will be limited to underwater cutting activities, some rock placement activities as well as vessel movements which will all be of relatively short duration.

Seabed Disturbance

Disturbance to sediments and increases in turbidity within the water column during cut and lift of Kingfisher infrastructure to be removed will be short term and localised with re-settlement occurring quickly. A small quantity (estimated at less than 800 m^2) of additional protective rock placement is also to be used. Additional rock placement will be minimised.

Whilst benthic communities have been identified around the Kingfisher manifold with the potential to support certain PMFs including seapens and burrowing mega fauna as well as juvenile individuals of Ocean Quahog, these species are considered tolerant to a degree of smothering from suspended sediment as a result of their ability to burrow within the sediment. Direct physical disturbance or loss of a small number of individuals may occur, but this will be limited and is not expected to affect the population viability of any PMF species.

The EA acknowledges that a number of other decommissioning activities associated with other nearby oil and gas infrastructure may also occur in a similar timescale. Consideration has therefore been given specifically to activities associated with TAQA Bratani Ltd's adjacent Brae Area DPs. It is understood that additional rock placement associated with Brae Area decommissioning will be optimised and whilst the timing of localised seabed disturbance associated with Brae and Kingfisher DP activities may be spatially and/or temporally aligned, disturbance will be temporary in nature with short term seabed recovery expected.

Discharges to Sea

The two production pipelines to be decommissioned at Kingfisher have been flushed and cleaned to a very low oil in water concentration. Any residual discharge quantities during decommissioning, should they occur, will be very small.

Discharge calculations have been carried out for the possible loss of chemicals contained within Kingfisher's umbilical sections for which flushing and cleaning is not possible. These calculations concluded that any volume of residual chemicals lost to sea during umbilical cutting would be limited and not significant.

All routine vessel discharges will be compliant with relevant legislative requirements including the International Convention for the Prevention of Pollution from Ships (MARPOL) and International Maritime Organisation (IMO) standards for sewage discharge, garbage management, ballast water management and emissions control.

The Kingfisher DPs include some decommissioning '*in situ*' of plastic coated pipeline and umbilicals. All pipelines and umbilicals left '*in situ*' will be trenched and buried within the seabed or covered by rock protection. Whilst plastics in the marine environment are of increasing concern, the low temperatures, reduced UV light levels and decreasing oxygen levels which exist in the seabed around Kingfisher will ensure degradation of any plastic products decommissioned '*in situ*' will occur extremely slowly, with any degraded plastic products contained within the seabed and not available to the water column or benthic community.

A Stage 1 Assessment of the drill cuttings pile as required by OSPAR Recommendation 2006/5 has been carried out. The calculated rate of oil loss from the Kingfisher drill cuttings pile is well below the thresholds listed within the recommendation, therefore the majority of the drill cuttings will be decommissioned '*in situ*'. Notwithstanding this, a degree of disturbance of drill cuttings will occur to a small proportion of the drill cuttings pile in immediate proximity to the Kingfisher infrastructure to be removed. This disturbance will result in some, localised re-suspension of contaminated sediments into the water column, Contaminated sediments will settle back to the seabed rapidly with distance from point of disturbance.

Benthic survey data indicates that seabed biology is currently dominate by hydrocarbon tolerant species in the seabed assemblage. With the increased distribution of contaminants an increased rate of natural process of bioremediation of contaminants is also expected.

Waste

A total of approximately 876 tonnes of materials will be recovered to the shore for recycling/disposal. Approximately 34% of the total is steel, 65% concrete and grout and 1% non-ferrous metals. An inventory of materials has been compiled and the fate of all materials will be tracked through an active waste management plan using waste consignment notes, up to the point of materials re-entering the supply system following recycling or, where necessary, to the point of disposal.

Disturbance to Other Users of the Sea

Disturbance to other Sea Users, including Commercial fisheries has been considered throughout the EA. In most cases any potential for interaction with other sea users would be as a result of potential impacts from seabed disturbance, discharges to sea, unplanned events etc. as discussed above.

In addition, post-decommissioning overtrawl trials or alternative means of verification of seabed clearance to be discussed and agreed with OPRED will be completed to demonstrate that the as-left condition of the seabed does not present a hazard to fishing, and to confirm a clean seabed. Where rock placement is required, the safety of other users of the sea will be considered along with the goal of minimising disturbance to seabed habitats.

A study undertaken by the Fisheries Research Service in 2002 concluded that although contamination may be disturbed as a result of trawl disturbance, the limited quantity would be unlikely to pose serious contamination of toxicological threats to the marine environment as the act of spreading will encourage increased oxygenation of deposited material, which will enhance the rate of breakdown of contaminants, by natural processes. Ecotoxicological effects on commercial fish stocks or fishing gear as a result of the disturbance of drill cuttings at Kingfisher are not anticipated to affect commercial catch viability.

Unplanned events

Fuel spills

The assessment considered the impacts that may result following an accidental loss of fuel from a vessel whilst operating during the decommissioning programme. The hypothetical spill scenario, considered the release of the anticipated largest potential diesel fuel inventory of a vessel operating in these areas. Past records of all spill events in the UKCS available from the Advisory Committee on Protection of the Sea indicate that a loss of vessel fuel inventory is highly unlikely, although such a spill is considered to be a worst case scenario for the Kingfisher DPs. The likelihood of a diesel release is low due to the stringent operating procedures that are in place.

Oil spill modelling carried out for the loss of a ship's diesel fuel inventory to sea at Kingfisher location concluded that, a spill would not reach the UK or any mainland European coastlines, but that there is up to a 70% probability of crossing the UK/Norwegian median line within 6 hours, during spring, summer and autumn conditions. Diesel is a non-persistent hydrocarbon, its residence in the marine environment is low, as such, the risk to the marine environment from accidental spills is considered to be slight or minor, if effectively managed.

The potential for a diesel spill during operations will also be covered under the vessels' approved Shipboard Oil Pollution Emergency Plans (SOPEPs).

Dropped objects

Objects to be recovered by lifting to vessel deck during Kingfisher decommissioning comprise small objects such as grout bags and concrete mattresses, pipeline sections etc, with the largest single piece of infrastructure to be lifted being the Kingfisher manifold structure. Any dropped object would fall back to the seabed causing localised sediment disturbance.

Mitigation Measures

During the development of the decommissioning programme, the control and mitigation measures identified in this EA to avoid or minimise impacts to the prevailing environment, minimise the risk of unplanned events and response to stakeholder concerns have been documented. These are summarised in the table on the following pages. These commitments will be carried through the contracting process for contract award and will be tracked to ensure the contractors who are awarded the contracts have sufficient mechanisms, processes, procedures and competent resources in place to implement the measures required.

Conclusion

The baseline environment in the affected area is well understood and this EA has identified environmental and societal risks associated with the planned decommissioning activities at Kingfisher and the potential for impacts. Implementation of well-established contract management measures including careful planning will eliminate many of the potential risks and avoid adverse impacts to the environment or to other users of the sea. Where potential for impact during the programme is unavoidable, mitigation measures can be readily adopted to reduce impacts to the minimum.

The conclusion of the assessment indicates that with careful management, including effective management of contractors, the DPs can be executed with minimal impact on the environment and minimal disturbance to other users of the sea.

MITIGATION AND CONTROL MEASURE	ASPECTS CONTROLLED
The scheduling of vessels' operations and the types of vessels used will be optimised to execute the decommissioning as efficiently as possible.	Emissions to Air Underwater Noise
No high energy noise sources such as blasting, piling activities or deep sediment penetration seismic survey are proposed	Underwater Noise
Rock placement will be completed by a specialist fall pipe vessel or similar, to allow accurate placement of rock on the seabed.	Underwater noise
Notification of decommissioning activities will be advertised to other users of the sea such as via publication of Notices to Mariners and Kingfisher Bulletin. Notification will include details of vessel positions, activities and timing.	Socio-economic Accidental Events (Oil Spill) Accidental Events (Dropped Object)
Drill cutting disturbance will be minimised to only those drill cuttings which must be moved in order to gain access to the infrastructure to be removed.	Discharge to sea
Disturbance of the seabed will be minimised through: • Minimising the amount and type of rock cover required while also minimising risk of snagging by careful selection of rock sizes that can be overtrawled while seeking to minimise change of seabed habitat. • Liaison with environmental stakeholders including the fishing industry body has confirmed a preference to use a standard trawl net during overtrawl trials, thereby minimising potential for seabed disturbance.	Seabed Disturbance
All vessels commissioned will be subject to the Operator's Group Maritime Assurance System. This includes assurance in line with the Oil Companies International Marine Forum (OCIMF) inspection (OVIQ2) and review of the Maritime Contractor Offshore Vessel Managers Self-Assessment (OVMSA). The review includes (inter alia) consideration of reliability and maintenance standards, navigational safety, emergency preparedness and contingency planning, spill prevention and spill response, control of emissions to air and adherence to requirements of MARPOL for the discharge of sewage, control of garbage and management of ballast water. All vessels will have current Shipboard Oil	Emissions to Air Discharges to Sea Accidental Events (Oil Spill) Waste Management

Pollution Emergency Plans which are regularly reviewed by the vessels' crews.	
An Active Waste Management Plan (WMP) will describe and quantify wastes arising from the decommissioning activities, segregation and storage requirements, and identify available disposal options for each waste stream. Waste management options will be based on the waste hierarchy of reduce, reuse, recycle, recover, dispose. Achievable recycling goals will be identified and performance monitored using key performance indicators. Assurance will be carried out at the disposal yard and key subcontractors' disposal sites.	Waste Management
Co-ordinated industry oil spill response capability will be available round the clock.	Accidental Events (Oil Spill)
Following removal of all infrastructure, the decommissioned area will be subjected to overtrawl trials, or alternative means of verification of seabed clearance to be discussed and agreed with OPRED, and further remediation provided if required.	Socio-economic
All contractors commissioned will be subject to the Operator's Contractor management and assurance procedures.	All

1. Introduction

In accordance with the Petroleum Act (1998), the Section 29 notice holders of the Kingfisher installations/fields are applying to the Department of Business, Energy and Industrial Strategy (BEIS) to obtain approval for decommissioning the Kingfisher offshore installations, pipelines and associated subsea infrastructure. The Decommissioning Programmes (DP) are required to be supported by an assessment of the anticipated effects of the DP activities on the marine environment. BEIS guidelines (BEIS, 2018).

This Environmental Appraisal (EA) report has been prepared by Shell U.K. Limited (Shell) on behalf of the Section 29 Notice Holders, to satisfy the regulatory requirement for environmental assessment and to inform the planning and execution of the DPs' activities. The EA should be read in conjunction with the DPs to which it refers. Where appropriate information set out within the DPs has been further developed and explained, to give sufficient and appropriate consideration to the appraisal of potential effects on the marine environment, which may occur as a result.

1.1. Field Overview and Production History

The Kingfisher field lies 280 km northeast of Aberdeen in Block 16/8a and 16/8d of the UK Sector of the North Sea (UKCS) as shown in Figure 1-1. The Field comprises three reservoirs: Brae I (Gas/condensate); Brae II (Volatile Oil); and Heather (Gas/Condensate), tied back to TAQA Bratani Ltd's Brae Bravo platform. The Kingfisher infrastructure first became operational in 1997.

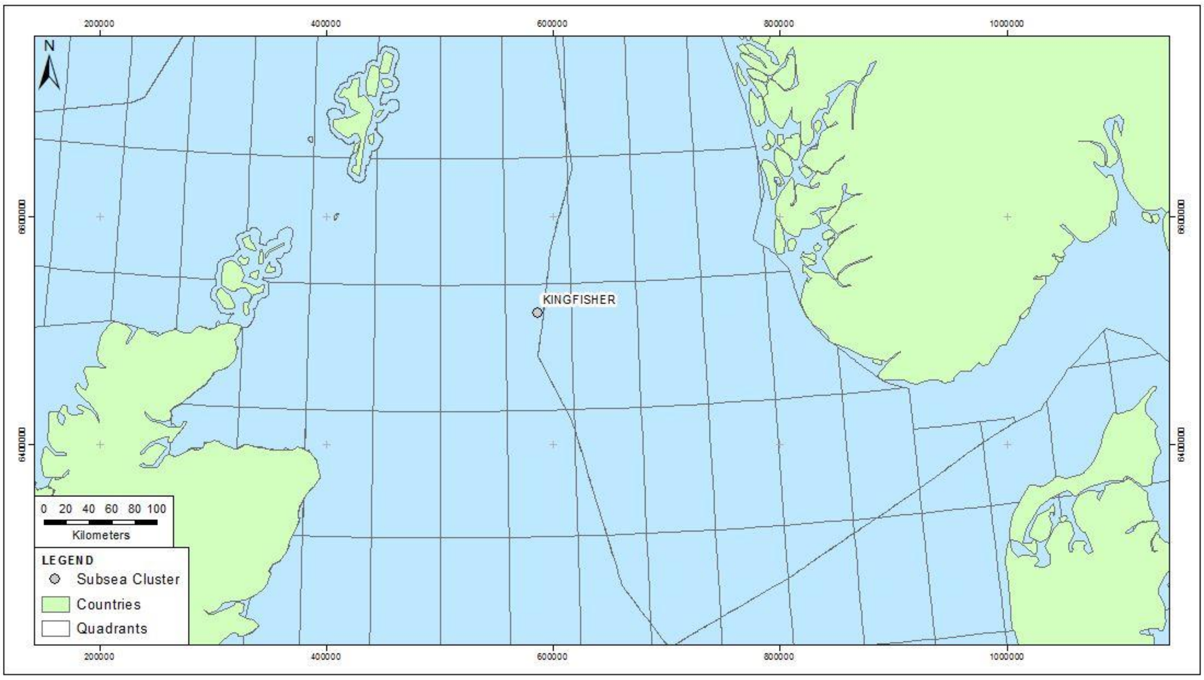

Figure 1-1: Location of Kingfisher Field

Shell have completed a Cessation of Production (CoP) assessment for the Kingfisher field, following confirmation from Marathon (now TAQA Bratani Ltd) that the host platform, Brae

Bravo, had reached the end of economic life and received CoP approval from the Oil and Gas authority. The field was shut in on the 5th July 2018.

1.2. Kingfisher Subsea Infrastructure

The Subsea infrastructure to be decommissioned comprises six subsea wells located 9 km away from the host (TAQA Bratani Ltd Brae Bravo) platform. The wells are connected to a subsea manifold via rigid pipeline jumpers. The production fluids from the wells were commingled in the manifold and routed to the host platform via the two 10" production pipelines (PL1488 and PL1489) which are approximately 9 km in length. The pipelines are linked at the Kingfisher manifold to provide a pigging loop to allow round-trip pigging.

The pipelines are fabricated from super duplex stainless steel and have a nominal outside diameter of 10 inches. They are trenched and buried along much of their length with remedial rock cover installed in places along the pipeline to resist upheaval buckling, resulting in some sections of the pipeline being covered by a rock berm. A total footprint area of 5900 m^2 of rock berm is currently installed. On approach to TAQA Bratani Ltd Brae Bravo Platform the pipelines are, in part, surface laid, and in part supported above the seabed on concrete plinths.

Power, hydraulics and chemicals were provided to the manifold and wells via a single composite control and chemical injection umbilical from the TAQA Bratani Ltd Brae Bravo platform to the Kingfisher manifold. The umbilical is laid in a trench with a minimum depth of 0.5 m and buried through natural backfill. At the approach to the manifold, it is protected by concrete mattresses. A subsea safety isolation valve (SSIV) is installed approximately 350 m from the TAQA Bratani Ltd Brae Bravo platform. A control umbilical from TAQA Bratani Ltd Brae Bravo platform to the Kingfisher SSIV structure controls the Kingfisher SSIV. This umbilical is surface laid with mattresses and spot rock cover on top.

There are approximately 240 exposed concrete mattresses placed along the Kingfisher subsea infrastructure. Pipelines and umbilical are protected by concrete mattresses and spot rock cover. Figure 1-2 below provides a schematic of the Kingfisher field infrastructure layout.

A 500 m operational safety zone currently exists around the TAQA Bratani Ltd operated Brae Bravo platform. Within this zone, the Kingfisher lines cross the following third-party infrastructure:

- TAQA Bratani Ltd's 18" Gas Transfer Pipeline (PL360);
- TAQA Bratani Ltd's 18" Condensate pipeline (PL361);
- TAQA Bratani Ltd's Power Management System (PMS) Cable to TAQA Bratani Ltd Brae Bravo;
- Brae Control Umbilical (PLU4189); and
- 18" Condensate pipeline (PL894).

Outboard of the Kingfisher SSIV structure, the Kingfisher lines are crossed by the 16" Miller Gas Pipeline (PL1971) (BP) and cross the PMS Cable to East Brae (TAQA Bratani Ltd) and 8" Condensate Heimdal Pipeline (PL301) (Equinor (formerly Statoil)).

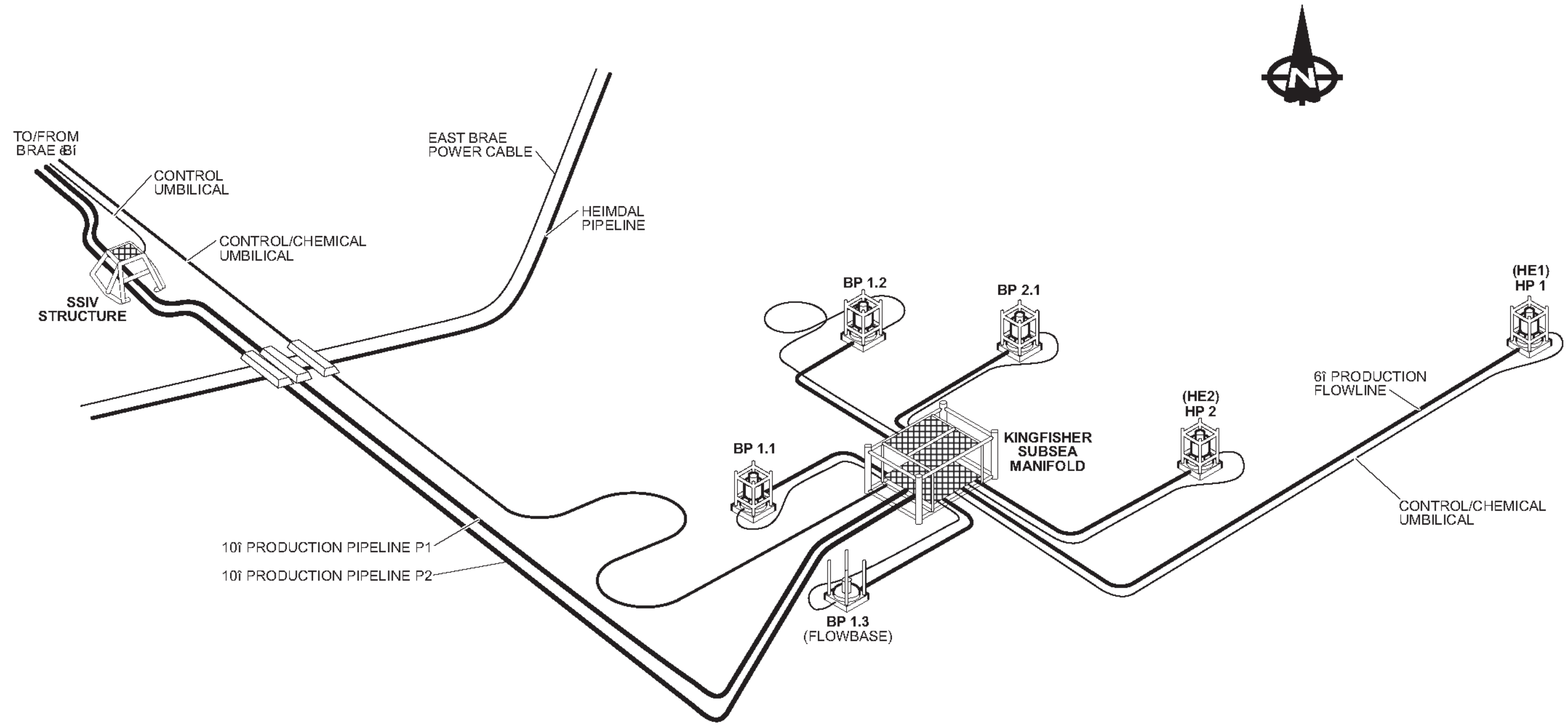

Figure 1-2: Kingfisher Infrastructure to be decommissioned including pipelines and umbilicals

1.3. Outline of Decommissioning Activities

The decommission activities are proposed in five phases:

- Phase 1: Flushing of available chemical cores in the Kingfisher manifold umbilical, flushing of hydrocarbons from 10" production pipelines (completed July 2018) and physical isolation of the pipelines from the Kingfisher manifold (completed Sept 2018);
- Phase 2: Subsea wells Plug and Lubricate (P&L), flushing of hydrocarbons from production jumpers and flushing of Kingfisher manifold umbilical hydraulic cores (flushing completed Jan – Apr 2019);
- Phase 3: removal and/or remediation of subsea infrastructure outside the TAQA Bratani Ltd Brae Bravo 500 m zone in accordance with the approved DP including the wellheads for the six Kingfisher wells. Well Plug and Abandonment (P&A) completion is regulated separately by the OGA and will be scheduled in a separate campaign ;
- Phase 4 – removal and/or remediation of Kingfisher subsea infrastructure inside the TAQA Bratani Ltd Brae Bravo 500m safety zone in accordance with DP Part 2;

For clarity, these Programmes, i.e. Decommissioning Programmes Part 1, cover the decommissioning of all Kingfisher Field pipelines and installations outside the Brae Bravo 500 m safety zone. This includes the Kingfisher wellheads, although the approval of the plug and abandonment activities are regulated separately.

1.3.1. Phase 1

This phase was commenced immediately on CoP (July 2018) with the flushing of pipelines and flushable umbilical chemical cores and then subsequently securing the physical isolation of the Kingfisher wells from the Marathon (now TAQA Bratani Ltd) Brae Bravo platform. This phase was completed under the terms of the existing operating permits held by Marathon for the Brae Bravo platform. All pipelines have been confirmed cleaned to residual hydrocarbon and chemical concentrations As Low as Reasonably Practical (ALARP). Reported results from flushing operations have confirmed a post flushing Oil in Water (OIW) concentration of 3.8 mg/l was achieved (19 July 2018). This is well below the target hydrocarbon concentration on completion of flushing of at or below 40 ppm. Production pipelines have also (September 2018) been disconnect from the manifold structure[1] during this phase (positive isolation is in place).

1.3.2. Phase 2

This phase was completed following Phase 1 and was subject to well intervention permitting Master Application Template (MAT) and associated Subsidiary Application Template (SAT) applications. Well plug and abandonment (P&A) activities included flushing of hydrocarbons from production jumpers; flushing of Kingfisher manifold; and flushing of the umbilical hydraulic cores. This phase was completed by Q1 2019.

1.3.3. Phase 3

This phase comprises decommissioning of Kingfisher infrastructure outside the TAQA Bratani Ltd Brae Bravo 500m zone and will be undertaken in accordance with the terms of the approved

[1] Completed under Pipeline Works Authorisation (PWA) 22/W/97

Decommissioning Programme (DP) Part 1. This Environmental Appraisal (EA) considers the potential for environmental effects as a result of the activities proposed as part of Phase 3 only.

All offshore installations will be fully removed during decommissioning, in line with the requirements of OSPAR Decision 98/3. Pipelines associated stabilisation features will be decommissioned in accordance with the agreed outcomes of the Comparative Assessment process (March 2018).

Table 1-1 and Table 1-2 below describe the project elements considered within the EA and the decommissioning activities proposed for each element.

Table 1-1: Project elements between Kingfisher SSIV and Kingfisher manifold

PROJECT ELEMENT	DESCRIPTION	ACTION
Trenched and Buried pipelines and manifold umbilical	Both production pipelines and manifold umbilical run buried in parallel trenches for approximately 9 km between the Kingfisher SSIV and the Manifold structure. Within this section, the production pipelines and umbilical remain trenched and buried at the point where they are crossed by the Miller pipeline (between 150 m and 235 m east of Kingfisher SSIV). Approximately 4.5 km east of the Kingfisher SSIV, production pipelines and umbilical temporarily exit their respective trenches to cross Equinor's Heimdal pipeline. This crossing is protected with rock cover.	Trenched and buried pipelines and umbilicals will be decommissioned '*in situ*' Pipeline crossing of the Heimdal pipeline will also be decommissioned '*in situ*'

Table 1-2: Project elements in proximity to Kingfisher manifold

PROJECT ELEMENT	DESCRIPTION	ACTION
Pipeline transition out of trenches on approach to manifold structure	Both production pipelines transition out of seabed trenches and are surface laid on approach to the Kingfisher manifold.	Exposed mattresses will be removed, pipelines will be disconnected at seabed surface at first accessible point at the end of the existing rock berm, rock berm will be extended to cover the exposed end of pipeline.
Umbilical end at Kingfisher manifold	The manifold umbilical transition out of its trench, immediately prior to its connection point with the Kingfisher manifold.	Mattresses will be removed. The umbilical will then either be excavated and cut at depth of 0.6m or will be cut at seabed surface, with underlying seabed fluidised to allow umbilical to settle into the seabed and be buried. The surface laid section of umbilical between

PROJECT ELEMENT	DESCRIPTION	ACTION
	This transition is currently protected by concrete mattresses.	the cut and the manifold will be removed (along with the manifold, see below) and recovered for onshore recycling/disposal.
Kingfisher manifold	Manifold structure: A piled structure with an in-air weight of 123.3 Te.	Manifold to be removed and recovered to shore for recycling/disposal. Manifold piles will be cut to a minimum of -3 m below seabed and decommissioned 'in situ'.
Production jumpers	Production jumpers PL1497, PL 1498, PL 1499, PL1500, PL 1501, and PL1502 link the six Kingfisher wells to the manifold structure.	All lines, structures and exposed mattresses in this project element will be removed and recovered to shore for recycling/ disposal
Wellheads	All wells have already undergone full and permanent isolation from the reservoir.	Wellheads to -3m below seabed will be removed and recovered to shore for recycling/disposal.
Drill Cuttings	Drill cuttings have been identified associated with each of the six production wells.	Assessment against OSPAR 2006/5 Screening thresholds confirms both rate of oil loss and persistence parameters are well below the defined thresholds. Drill cuttings will be decommissioning *'in situ'* with minimal necessary disturbance during wider decommissioning activities.

1.3.4. Phase 4

This phase comprises decommissioning of Kingfisher infrastructure inside the TAQA Bratani Ltd Brae Bravo 500m zone and will be undertaken in accordance with the terms of the approved Decommissioning Programmes Part 2, to be issued at a later date.

1.4. Materials to be left '*in situ*'

Material types and estimated quantities of these materials that will remain on or below the seabed following decommissioning removal activities are summarised in Table 1-3 below:

Table 1-3: Materials to be left 'in situ'

Material Type	Quantity (Te)	Percentage of total materials	Quantity to be brought to shore	Notes	Quantity to be left in situ (Te)
Pipelines and Umbilicals					
Carbon Steel	121	5	2	Pipelines, Umbilical armour wire	119
Stainless Steel	1493	64	35	Pipelines, , umbilical strain wire	1458
Non-Ferrous	9	<1	0	Copper (signal/power cable) Aluminium (anodes)	9
Concrete	622	27	571	Mats, Grout bags	51
Plastics	98	4	5	Umbilicals and insulation	93
Hazardous Materials / NORM	0	0	0	N/A	0
Other	0	0	0	N/A	0
Installations					
Carbon Steel	136	44	121	Manifold piles left *in-situ* below -3 m MSL.structure steel, piles	15
Stainless Steel	140	56	140	Manifold pipework, wellheads	0
Non-Ferrous	1	0	1	Aluminium anodes	0
Concrete	0	0	0		0
Plastics	0	0	0		0
Hazardous Materials / NORM	0	0	0		0
Other	0	0	0		0

1.5. Post-Decommissioning Survey Requirements

A post-decommissioning environmental seabed survey centred on the sites of subsea installations and pipeline/umbilical corridors will be carried out. The survey will focus on any chemical and physical disturbances of the decommissioning activities compared with the pre-decommissioning data. Results of this survey will be available once the work is complete, with a copy forwarded to DBEIS. All pipeline routes and structure sites will be the subject of geo-physical surveys when decommissioning activity has concluded. After the summary of the survey has been sent to DBEIS and reviewed, a post-monitoring survey regime will be agreed. Over trawl trials or alternative means of verification of seabed clearance to be discussed and agreed with OPRED will be completed to demonstrate that the seabed has been left clear and safe. It is not proposed to complete physical over trawl trials in the area of the Kingfisher drill cuttings.

The default OPRED policy requirement is for clear seabed verification to be undertaken using non-intrusive means, such as side scan sonar. Overtrawl surveys as a means to locate debris and/or verify clear seabed, are likely only to be approved in cases where it is deemed necessary i.e. where there are specific safety concerns such as pipeline bundle ends, extensive debris and/or extensive seabed disturbance resulting from decommissioning operations. However, for the purposes of estimating environmental impact, a worst-case position has been taken in this DP and supporting EA with the assumption that over-trawling may be required. It should be understood that assumption has been used only for estimating worst-case environmental impact; actual methods of verification will be discussed and agreed with OPRED on a case-by-case basis with an assumption that less intrusive methods of clear seabed verification are the base case.

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1.6. Onshore Disposal

Infrastructure to be removed will be recovered to vessel deck and shipped to shore for recycling or disposal. There may be requirement for clean-up parts of the recovered equipment (e.g. marine growth).

The port and waste processing facilities to be used will be determined through competitive tender, but, at the time of writing have not yet been selected. Aspects such as onshore transport of materials, either from port to dismantling/recycling yard, or final destination of materials are not currently known.

1.7. Vessel Usage

At the time of writing, the decommissioning campaign is currently in the planning phase. For the purposes of this assessment a total of 42.5 vessel days has been estimated, comprising 9.5 Survey Vessel days; 15 days of Dive Support (DSV) vessels; 11.5 days of ROV support vessels; and 6.5 days of heavy crane (HCV) vessels.

1.8. Other concurrent, third party decommissioning activities

As discussed in section 1.2, Kingfisher pipelines tie back to the UKCS8 LLC Brae Bravo platform, operated by TAQA Bratani Ltd. In addition, between the Kingfisher manifold and the UKCS8 LLC Brae Bravo platform, the Kingfisher pipelines cross the following third-party infrastructure operated by TAQA Bratani Ltd as part of the Brae Area:

- PL 360 - 18” Gas Transfer Pipeline;
- PL 361 -18” Condensate pipeline;
- Brae Alpha / Brae Bravo Power Management System (PMS) Cable;
- PLU 4189 - Brae Control Umbilical; and
- PL 894 - 8” Condensate pipeline.

The above listed installations and subsea infrastructure are subject to a series of separate Decommissioning Programmes (DPs) currently submitted by TAQA Bratani Ltd, to BEIS for consideration. For the purposes of this EA, it has been assumed that the decommissioning of the above listed infrastructure may be spatially and temporally concurrent with the decommissioning activities proposed for Kingfisher.

2. Environmental Appraisal (EA) Methodology

2.1. Policy, Legal and Administrative Framework

The DPs will comply with all relevant legislative, regulatory and policy standards and requirements for decommissioning the Kingfisher infrastructure. Where specific standards and requirements apply, these have been discussed in the relevant appraisal chapters of the EA Report.

2.1.1. UK Legal Framework

The decommissioning of offshore O&G infrastructure on the UK Continental Shelf (UKCS) is principally governed by the Petroleum Act 1998, as amended by the Energy Act 2008. The Petroleum Act sets out the requirements for a formal Decommissioning Programme (DP), which must be approved by BEIS before the owners of an offshore Installation or pipeline may proceed with decommissioning. The DP is supported by an Environmental Appraisal (EA) and a Comparative Assessment (CA).

The 1992 OSPAR Convention decision 98/3 sets out the UK's international obligations on the decommissioning of offshore Installations. Decision 98/3 prohibits the dumping and leaving wholly or partly in place of offshore Installations.

In addition, relevant permits, e.g. Marine License, etc., will be required in order to undertake proposed activities. These permits require submission of an Environmental Impact Assessment (EIA) justification.

2.1.2. Shell HSSE&SP Control Framework

In addition to being subject to the requirements of UK and European Union (EU) legislation, international treaties and agreements, Shell has company requirements, guidelines and standards that also need to be complied with. These are detailed in the Shell Health, Safety, Security, Environment & Social Performance (HSSE&SP) Control Framework (CF).

The EA for the Kingfisher DPs follows the requirements of the Shell Control Framework, Impact Assessment (CF IA) manual to ensure compliance with national laws and applicable international standards.

2.2. Process and Methodology of Environmental Appraisal

The EA process begins with identification of potential environmental, social and community health 'aspects', defined as interactions between the project decommissioning activities and sensitive receptors. This was achieved through an ENVironmental (Social and Community Health) impact IDentification (ENVID) workshop, involving the Shell project team and the EA team. The Shell Kingfisher ENVID identified all aspects and activities over the lifecycle of the decommissioning project that may impact upon valued environmental, social and community health attributes. A summary of the findings of the ENVID workshop is discussed in **Section 4.1** of this report and the detailed findings are presented in the ENVID outcomes report (Shell, 2018) and Kingfisher Scoping Report (Shell, 2018)

Section 2.2.4 below provides a description of the process and methodology used during this EA to identify and assess potential impacts and risks. Chapter 4 to Chapter 8 then assess the environmental, social and community health impacts and risks for offshore and onshore project aspects.

The following text provides a description of the process and methodology used during this EA to identify and assess potential impacts and risks. **Chapter 5** to **Chapter 8** then assess the environmental, social and community health impacts and risks for offshore and onshore project aspects.

2.2.1. Impact Identification and Appraisal

Potential impacts/risks are evaluated using a methodology developed by Shell and the IA contractor team.

A screening exercise was undertaken internally, early on in the project cycle. The next step was to further identify environmental, social and community health impacts/risks, in an ENVID workshop. The ENVID assessed initial impact 'significance' for both planned and unplanned activities. Then unplanned events were also assessed against their 'likelihood'. The same method was used in the next phase of the EA which is described in this EA report.

The significance of an impact is determined based on the magnitude of the impact and sensitivity of receptors identified to be affected by an aspect.

2.2.1.1. Magnitude

The magnitude of an impact or predicted changes considers the following key elements:

- Area of influence, potential for transboundary and cumulative impacts;
- Duration and frequency of an impact;
- Extent of contamination/degradation; and
- Degree of socio-economic change, level of community concern.

Table 2-1 shows how the magnitude of an impact is quantified for different receptors (i.e. Land, Air, Water, Biodiversity / Conservation).

It is not common practice to include magnitude indicators for social performance and community health impacts. These are generally managed for neutral or positive impact, and so there is generally no need to categorise or delineate these impacts. Additionally, the assessment of impacts and determination of magnitude more easily lends itself to the application of professional judgement than trying to derive numerical criteria that may be incorrectly applied. For this reason, social performance and community health are not included in the tables.

Table 2-1: Impact Magnitude Criteria

Definition	Environmental Impact
No effect	Not measurable above background levels
Slight effect (1)	Measurable above background levels No contribution to transboundary or cumulative effects. Highly localised to immediate vicinity of the asset (e.g. within 500m zone) Confined within 10,000 m^2 area and/or fence line of site
Minor (2)	Unlikely to contribute to transboundary or cumulative effects Impacts from activities may be felt at field level Extending over 100,000 m^2 area
Moderate (3)	Minor transboundary and cumulative effects Impacts limited in their effect at the regional level, over 1km ^{2} area
Major (4)	Transboundary effects or major contributor to cumulative effects

Definition	Environmental Impact
	Widespread effects reaching outside area of interest, but can be contained to neighbouring environment Extending over 10 km^2 area
Massive (5)	Major transboundary and cumulative effect Widespread, regional impact, multiple stakeholders affected Extending over 100km^2 area

2.2.1.2. Receptor Sensitivity

Sensitivity criteria of receptors are provided in Table 2-2, based on the following key factors:

- Importance of the receptor at local, national or international level – for instance, a receptor will be of high importance at international level if it is categorised as a designated protected area (such as Ramsar site or SAC). Areas that may potentially contain e.g. Annex I Habitats are of medium importance if their presence/extent has not yet been confirmed;
- Sensitivity/vulnerability of a receptor and its ability to recover – for instance, certain species could adapt to changes easily or recover from an impact within a short period of time. The EA consider immediate or long-term recovery of a receptor from identified impacts. It also considers if the receptor is under stress already; and
- Sensitivity of the receptor to certain impacts – for instance, emissions can cause significant air quality impacts, but will not affect other receptors such as seabed

Table 2-2: Sensitivity Criteria of Receptors (Planned Events)

Sensitivity	Definition
Not sensitive (A)	Not sensitive to activities
Low (B)	Receptor with low value or importance attached to them. E.g. habitat or species which is abundance and not of conservation importance And/or Immediate recovery and easily adaptable to change
Medium (C)	Receptor of importance e.g. recognised as an area/ species of potential conservation significant for example Annex I habitats and Annex II species And/or Recovery likely within 1-2 years following cessation of activities, or localised medium-term degradation with recovery in 2-5 years.
High (D)	Receptor or key importance e.g. recognised as an area/ species of potential conservation significance with development restrictions for example SACs, NCMPAs And/or Recover not expected for an extended period (5-10 years) following cessation of activity, or that cannot be readily rectified.
Very high (E)	Receptor or key importance e.g. recognised as an area/ species of potential conservation significance with development restrictions for example SACs, NCMPAs And/or Recover not expected for an extended period (>10 years) following cessation of activity, or that has permanent deleterious effects

2.2.1.3. *Impact Significance*

The magnitude of the impact and sensitivity of receptor is then combined to determine the impact significance of such an event occurring (Table 2-3). Mitigation measures will then be identified to reduce the significance of an impact, in order to determine residual significance.

Table 2-3: Impact Significance Matrix

		SENSITIVITY				
		A	B	C	D	E
IMPACT MAGNITUDE	No effect (0)	No effect				
	Slight (1)	Negligible	Negligible	Minor	Minor	Minor
	Minor (2)	Negligible	Minor	Minor	Moderate	Moderate
	Moderate (3)	Minor	Minor	Moderate	Moderate	Major
	Major (4)	Moderate	Moderate	Moderate	Major	Major
	Massive (5)	Major	Major	Massive	Massive	Massive

2.2.1.4. *Likelihood Criteria (Unplanned Events)*

For unplanned events the likelihood of such an event occurring also requires consideration. For example, based on magnitude and sensitivity alone a hydrocarbon spill would be classed as having major impact significance, however the likelihood of such an event occurring is very low. In addition, the mitigation measures for such impacts focus on reducing the likelihood of the impact occurring, as opposed to reducing the effects of the impact itself. Thus, unplanned events also require assessment in terms of environmental 'risk'.

As with planned activities, the potential impacts of unplanned events are identified, and their magnitude and sensitivity defined and combined to determine the impact significance.

The significance of the impact are combined with the likelihood of the event occurring (Table 2-4) in order to determine its overall environmental 'risk' as summarised in Table 2-5. Mitigation measures are then identified to reduce the risk of such an event occurring in order to determine residual risk.

Table 2-4: Likelihood Criteria (Unplanned events)

Likelihood	Definition
Improbable (A)	Never hear of happening in the Oil and Gas industry $<10^{-5}$ per year
Remote (B)	Incident/impact has never occurred during company's activities, including non-operator projects Or Incidents/impact has occurred in the Oil and Gas industry $10^{-5} – 10^{-3}$ per year
Occasional (C)	Incidents/impact has occurred during company's activities, including non-operator projects $10^{-3} – 10^{-2}$ per year
Probable (D)	Incidents/impact happen multiple times a year during company's activities, including non-operator projects $10^{-2} – 10^{-1}$ per year
Frequent (E)	Incidents/impact happen multiple times a year at one operational site in company's group. 10^{-1} – >1 per year

2.2.1.5. Evaluation of Risk (Unplanned Events)

Table 2-5: Evaluation of environmental risk (unplanned events)

		LIKELIHOOD				
		A	B	C	D	E
IMPACT SIGNIFICANCE	No effect (0)	No effect				
	Slight (1)	Negligible	Negligible	Minor	Minor	Minor
	Minor (2)	Negligible	Minor	Minor	Moderate	Moderate
	Moderate (3)	Minor	Minor	Moderate	Moderate	Major
	Major (4)	Moderate	Moderate	Moderate	Major	Major
	Massive (5)	Major	Major	Massive	Massive	Massive

2.2.2. Mitigation/Risk Management Measures

Measures (sometimes referred to as project controls or included mitigation) to reduce or eliminate the impact/risk of an activity have already been included in the design. This is the design assessed in the ENVID and the IA process leading to the IA report.

If during this phase of the assessment, impacts are considered unacceptable or the impact has not been reduced to ALARP, additional mitigation measures are then identified, evaluated for the effect and whether they can be implemented in the project design. If a significant change in design occurs, then the impacts are reassessed. This cycle of redesign can be repeated until either (a) impacts are acceptable or (b) no further design changes are possible or practical.

Where an impact cannot be reduced to acceptable levels, compensation (for impacts to humans) or offsets are considered. Once all necessary, practical and possible mitigations are included in the design, the resulting impact of that design is termed the residual impact. This is what is documented in the EA Report.

Mitigation measures can include but are not limited to, the following:

- Modification of the project design;
- Alteration of the timing/scheduling of the project implementation;
- Operational management (e.g. waste management); and
- Behavioural (e.g. training and competency)

2.2.3. Residual Impacts/Risks

A residual impact/risk is that remaining after the implementation of proposed project controls, safeguards and mitigation measures.

The EA process provides the basis for determining if further mitigation, monitoring and/or management measures are required. Residual impacts/risks will be incorporated into the Environmental, Social and Health Management Plan (ESHMP) and monitored to see if additional mitigation is required.

3. Offshore Baseline Conditions

3.1. Environmental Surveys

Subsea surveys have been carried out at Kingfisher since initial installation in 1997 with a range of objectives including regular integrity inspections and surveys to facilitate maintenance activities throughout the operational life of the infrastructure. In addition, subsea survey data from surveys carried out associated with adjacent infrastructure, including TAQA Bratani Ltd's Brae Area infrastructure, has been used, to inform baseline characterisation for elements of Kingfisher infrastructure in proximity to the TAQA Bratani Ltd Brae Bravo platform.

Key surveys and primary data studies which have been used to inform the characterisation of the existing environment around the Kingfisher infrastructure are listed below:

- Fugro Ltd (2018) for Shell UK Ltd: Environmental Monitoring Report for Kingfisher Pre-decommissioning Survey. UKCS blocks 16/8a and 16/8d. Document ref 170020-14rev2 (Fugro Ltd, 2018). Note that this report was issued in 2018 but is relevant to the survey conducted in June 2017.
- AECOM Ltd (2018): Phase 1 Screening Assessment of Kingfisher Drill Cuttings Pile for Shell UK Ltd. PN 60568298 (AECOM Ltd, 2018).
- Shell UK Ltd (2016): Kingfisher Decommissioning. Drill Cuttings Volumetrics. Sophie Salway. Based on data collated during Brit Survey (1997) Drill Cuttings Survey (BritSurvey, 1997).
- Survey data around Brae Bravo platform, as provided by Marathon Oil, now TAQA Bratani Ltd (Marathon Oil, 2013)

Figure 3-1 below shows the sample locations from each of the above listed reports, results from which have been used to inform the characterisation of baseline conditions, as set out within this report.

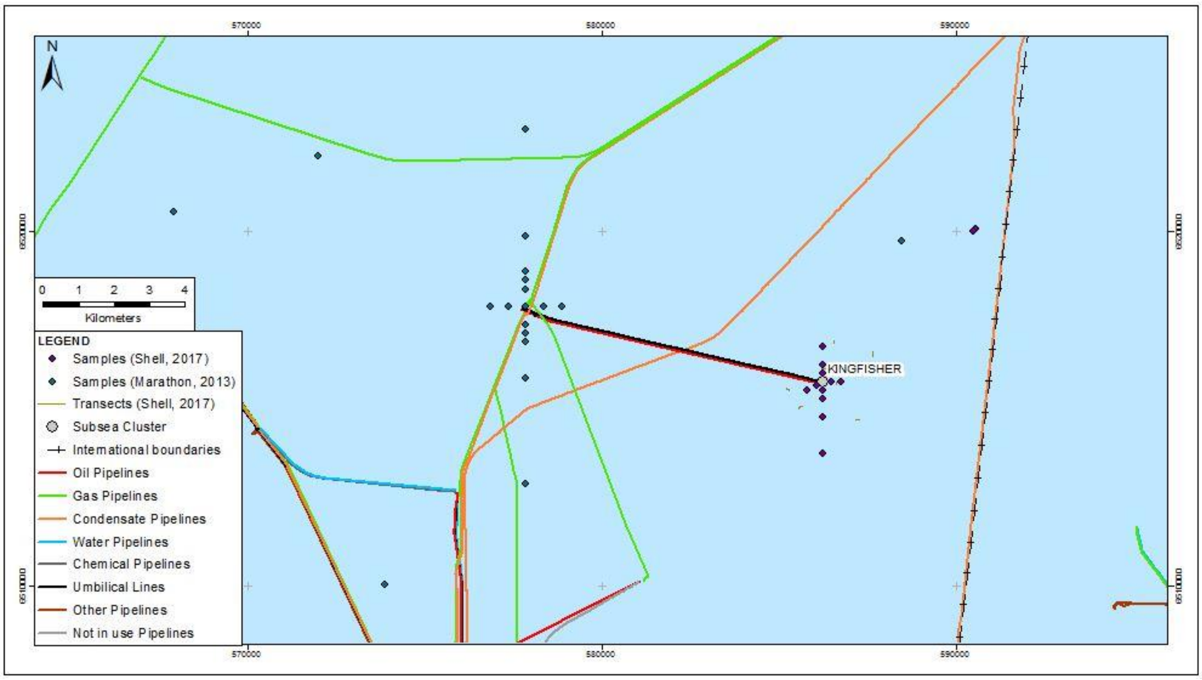


Figure 3-1: Environmental Survey Sample Locations

3.1.1. Kingfisher Environmental Monitoring Report (2018)

A pre-decommissioning environmental site survey was completed in the vicinity of the Kingfisher subsea infrastructure (manifold and wells) including push cores within the drill cuttings pile, between 1st and 21st June 2017 (Fugro Ltd, 2018). Samples collected were subject to a series of physicochemical and biological analyses. Figure 3-2 shows the sample locations that were used.

Digital still and video photography was also taken at 13 locations and eight camera transects, also shown on Figure 3-2 below

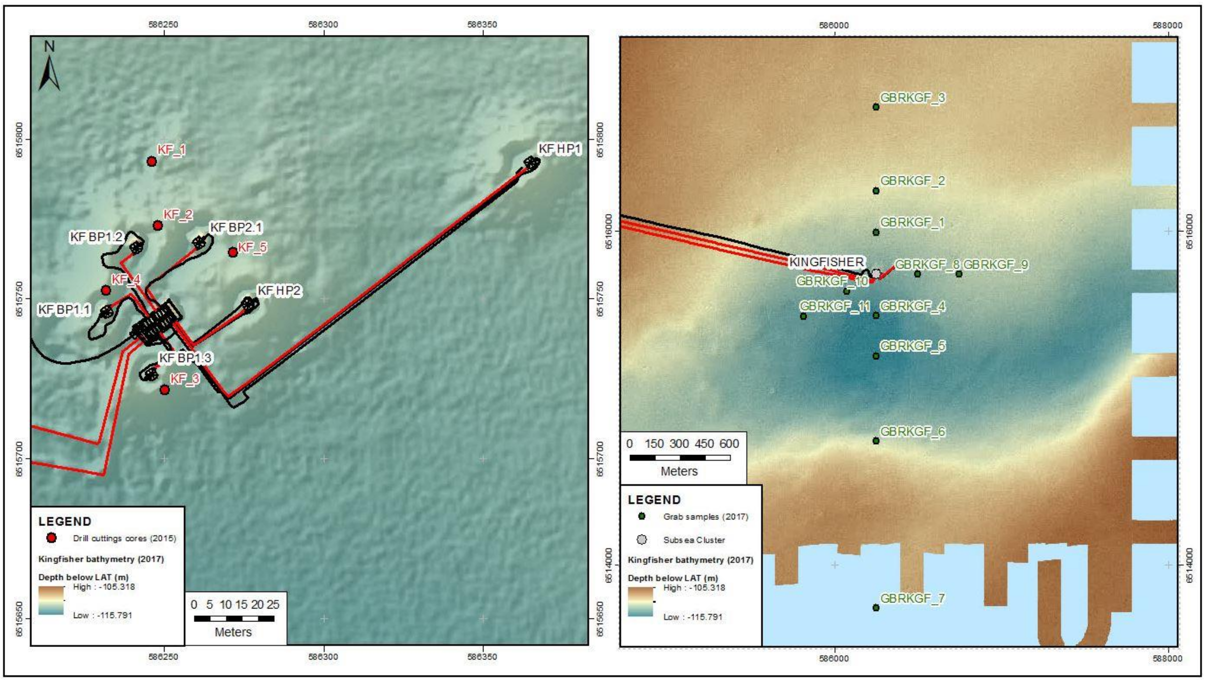
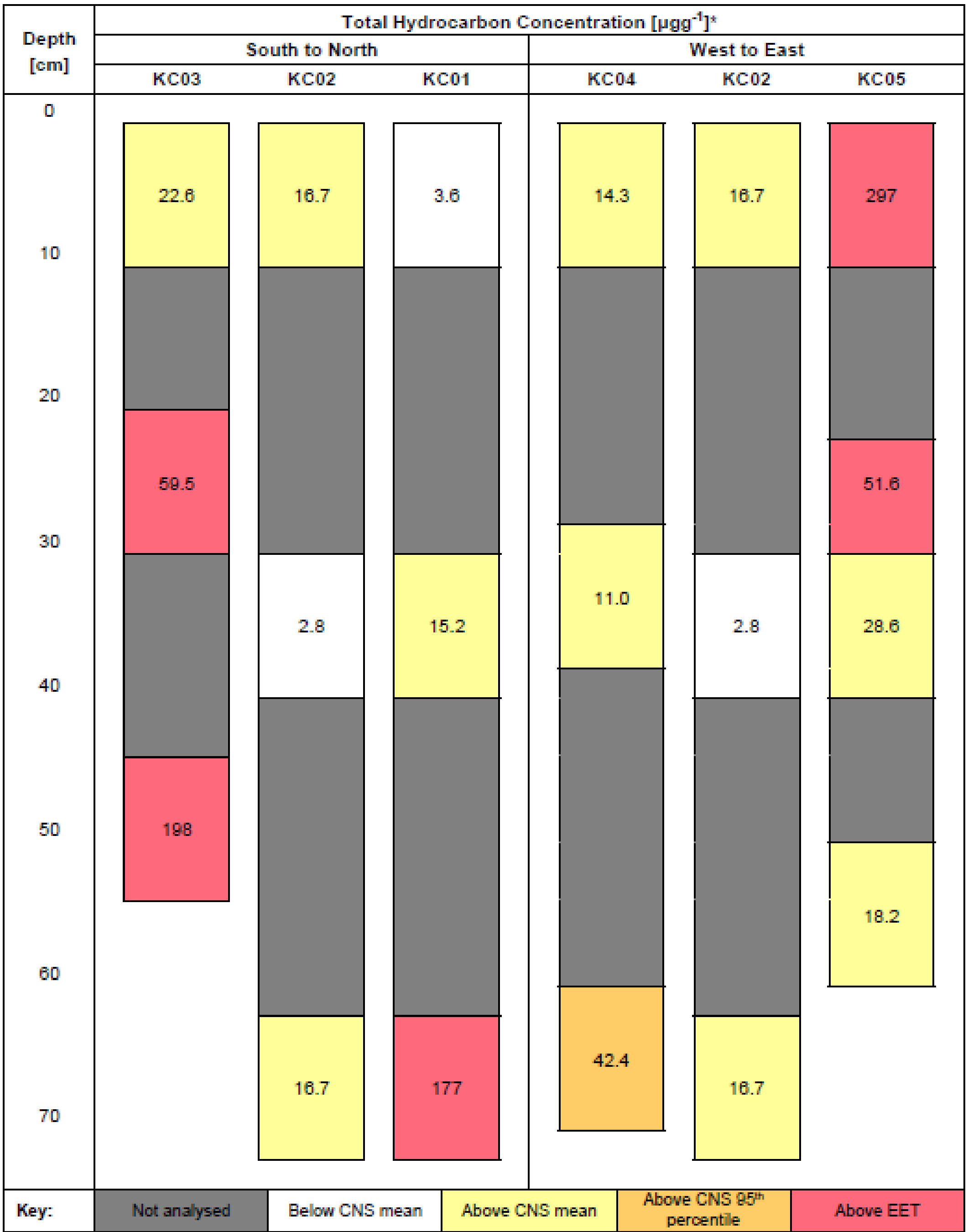


Figure 3-2: Kingfisher Environmental Survey Sample Locations (Fugro Ltd, 2018)

Sediments were classified as 'fine sand' or 'very fine sand' with mean particle size generally lower within the drill cuttings pile than the surrounding sediments.

Out with the samples taken from the drill cuttings themselves, observed hydrocarbon distribution was typical of low level, weathered petroleum residues commonly found in North Sea sediments. Outside 200 m from the Kingfisher infrastructure Total Hydrocarbon (THC) levels and metals were recorded below the Central North Sea (CNS) background mean levels. Although several samples around the Kingfisher showed evidence of weathered Ultidrill drilling fluid, of the type used to drill the Kingfisher wells in 1997.

Samples taken from within the drill cuttings pile showed elevated THC levels which exceeded the CNS 95th percentile and the ecological effects thresholds (EET) as set by OSPAR. Figure 3-3 (Fugro Ltd, 2018) provides a summary of the distribution of THC concentration with depth within the drill cuttings pile samples.



Notes:
EET = Estimated 'ecological effects' threshold for drill cuttings (OSPAR, 2006)
CNS mean/95th percentile = Mean and 95th percentile estimated from data reported at stations ≥ 5 km from nearest active platform in the central North Sea from 1975 to 1995 (UKOOA,2001)
* = concentrations expressed as µgg-1 of dry sediment

Figure 3-3: THC Concentration (ugg-1) with reference to available reference data: Kingfisher cuttings pile cross section (Fugro Ltd, 2018)

Physical sediment characteristics, hydrocarbon and metals concentrations are discussed further in **Section 3.4**.

Seabed habitats identified comprise 'circalittoral muddy sand' (A 5.26) according to the EUNIS[2] Classification (EEA, 2017). Areas of 'circalittoral mixed sediments' including shell debris (A 5.44) were also identified. Most frequently observed benthic taxa included sea urchins from the suborder Brissidina, also *Gracilechinus actus*, *Spatangus purpreus*, also starfish, brittle stars, sea lilies, hermit crabs, spider crabs and tusk shells and burrowing megafauna including seapens and bivalve siphons.

Specifically, individuals of the bivalve siphon *Arctica islandica*, which is listed as a Scottish Priority Marine Features (PMF) were identified in some samples. The benthic ecology in the study area is discussed in more detail in **Section 3.4.2**.

3.1.2. Brae Bravo Environmental Baseline Report (2013)

Pre-decommissioning surveys were carried out at the Brae Bravo platform by the platform operator Marathon Oil (now TAQA Bratani Ltd). Shell was provided with access to the survey data conducted in 2013.

The survey campaign, completed in the summer 2013, which comprised a total of 14 sample stations in a cruciform pattern around the TAQA Bratani Ltd Brae Bravo platform. An additional six samples were taken in the wider Brae Area, as reference points. **Figure 3-1** above shows the sample locations that were used.

Sediments surrounding TAQA Bratani Ltd Brae Bravo platform are predominantly poorly sorted fine sands with low organic and carbonate content. Sample locations in closest proximity to the Kingfisher infrastructure to be decommissioning, were located 500 m east and 500 m south of the platform centre, respectively. A further sample location approximately 2 to 3 km to the north-north east of the Kingfisher drill centre provides additional survey data to support baseline characterisation.

[2] European Nature Information System

Figure 3-4 below summarizes the THC survey results from the survey (Marathon Oil, 2013) MB12, located 500 m south of the TAQA Bratani Ltd Brae Bravo platform and out board of the alignment of the Kingfisher infrastructure on approach to the platform, recorded the highest concentration of THCs in any of the Brae Bravo samples at 7.3 µgg^{-1} (dry sediment) compared to an average of 3.1 µgg^{-1}. However, this measurement still remains below the CNS Mean concentration reported at 9.51 µgg^{-1} (UKOOA, 2001) (UKOOA, 2005) and well below the OSPAR EET of 50 µgg^{-1} (OSPAR, 2006).

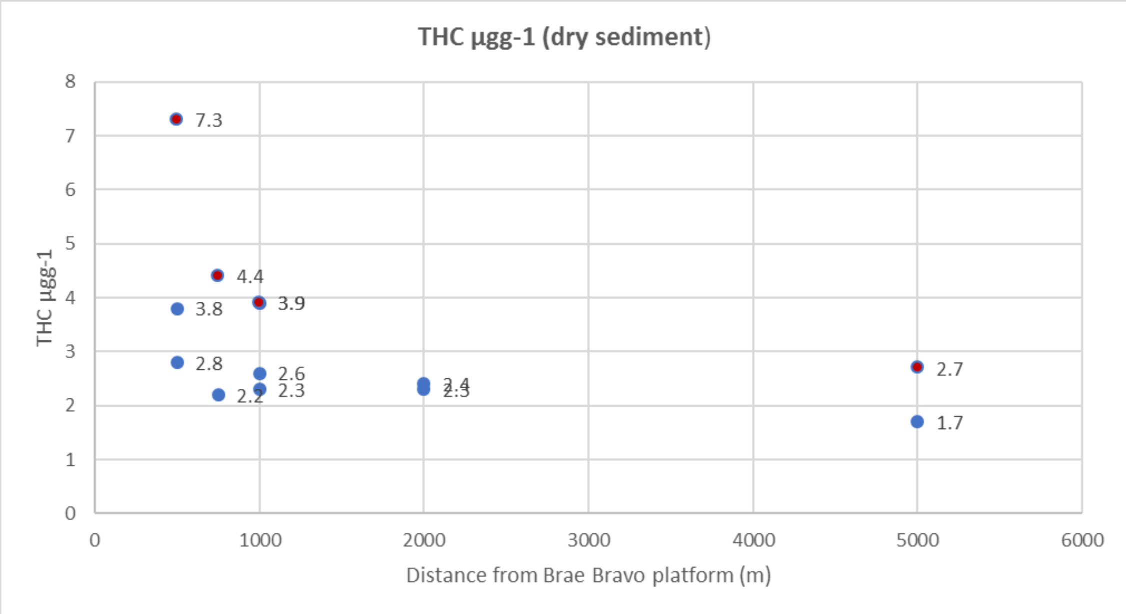


Figure 3-4: TAQA Bratani Ltd Brae Bravo THC concentrations with distance from platform

3.1.3. Drill cuttings at Kingfisher wells and manifold

Drill cuttings records indicate that approximately 3487 m^3 of drill cuttings were originally generated at Kingfisher during initial drilling in 1997. Volumetric calculations have since been completed in order to establish the expected physical characteristics of the drill cuttings deposits associated with the Kingfisher manifold and wells. These calculations have drawn on bathymetric data reported within (BritSurvey, 1997)

Assuming a mean seabed level of -113.3 m below Lowest Astronomical Tide (LAT), it is estimated that the drill cuttings total volume of drill cuttings deposits at Kingfisher is 1851 m³., approximately 1500 m³ of which are present within an identifiable drill cuttings pile Figure 3-5 provides an indication of the expected physical profile of the

drill cuttings deposits.

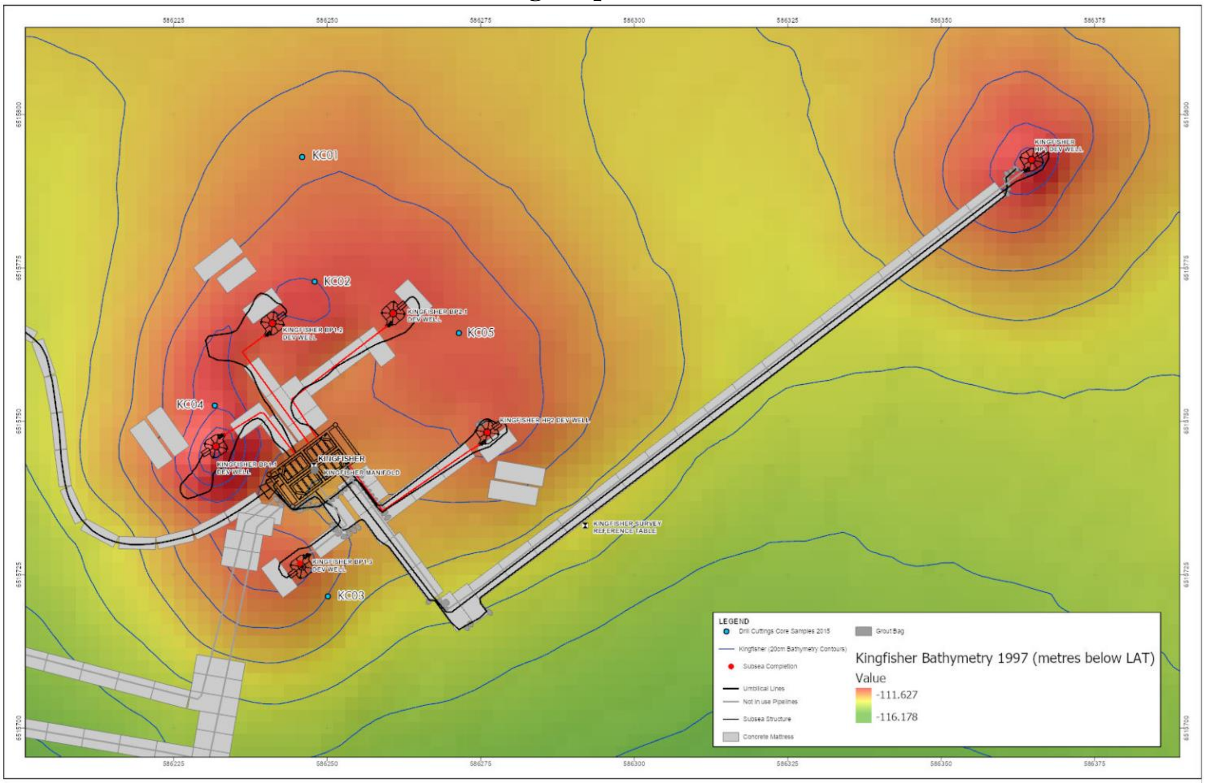


Figure 3-6 illustrates the drill cuttings configuration within the context of the Kingfisher infrastructure.

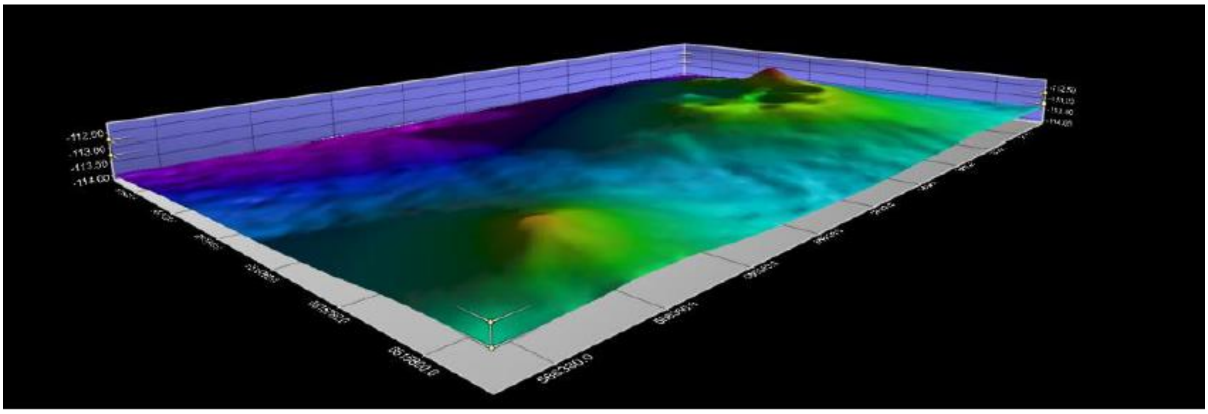


Figure 3-5: Kingfisher drill cuttings based on 1997 raster data from BritSurvey report (BritSurvey, 1997)

It is anticipated that the difference between the estimate of volume of cuttings generated, and the estimated drill cuttings deposits volume based on the volumetric calculations is likely to be as a result of a range of factors including:

- an uneven initial sediment distribution profile in which heavier sediments may have consolidated and settled in close proximity to the drilled wells, with finer sediments carried further through the water column, settling out in a finer more widely distributed film layer over the seabed, which is not evident as a part of the definable cuttings pile;

- natural losses to the water column over time as a result of water currents and natural movements; and
- disturbance to drill cuttings as a result of installation and maintenance of infrastructure over the lifetime of the infrastructure.

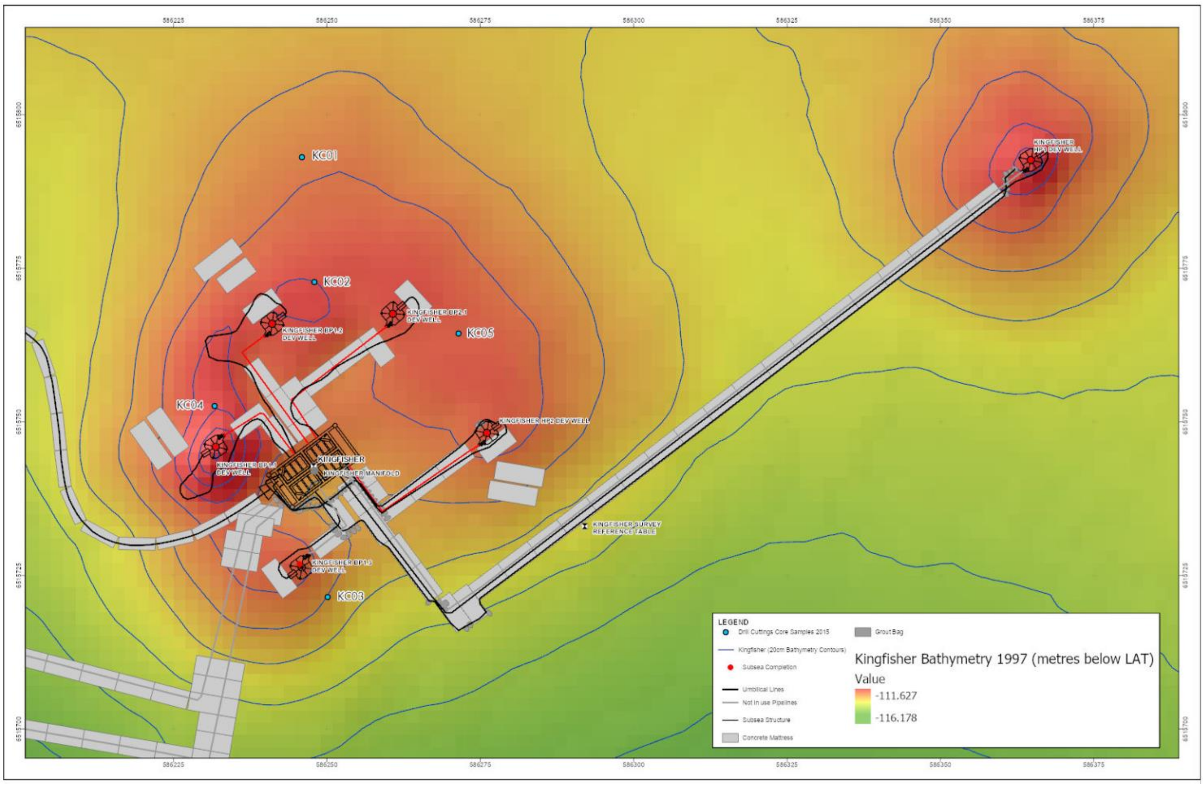


Figure 3-6: Drill cutting deposits elevations at Kingfisher manifold and wells, based on recorded bathymetry

Key hydrocarbon and metals measurements for the following sample locations, extracted from the above-mentioned survey reports, are included in Appendix B.

- Sample stations MB06, MB07 and MB12 at TAQA Bratani Ltd Brae Bravo which lie in closest proximity to the Kingfisher infrastructure;
- Sample stations K01 to K11 and KC01 to KC05 at Kingfisher manifold, including drill cuttings cores;
- Sample stations KREF01, KREF02 (Fugro Ltd, 2018) and WA02 (Marathon Oil, 2013) provide background measures at distance from the Kingfisher and Brae infrastructure.

Results for all of the above listed samples outside the Kingfisher drill cuttings were recorded below relevant environmental thresholds[3] . Table 3-2 summarises the results and exceedances which have been identified specifically within the drill cuttings samples.

[3] Estimated Ecological Threshold (EET) (OSPAR, 2006); Effects Range Low (ERL) and Effects Range Medium (ERM) (OSPAR, 2014); ; CNS Mean Background and Background 95th percentile (UKOOA, 2001)

Table 3-1: Sediment Analysis Data (Summary) all metals are in µgg^{-1}

	Depth (cm)	Source	Block	THC (µgg-1 dry sediment)	Total n-alkanes (nC_{12} to nC_{36}) (µgg-1 dry	PAH (µgg-1 dry sediment)	Al	As	Ba	TB a	Cd	Cr	Cu	Fe	Hg	Ni	Pb	V	Zn
KC01	Top (0-10)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	3.6	0.39	0.161	2110	2.05	-	-	0.03	8.75	5.48	3680	0.07	4.65	5.11	-	11.2
	Middle (31.5 to 41.5)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	15.2	4.11	0.312	14900	13.5	-	-	0.126	73.5	21.2	27800	0.024	26.50	8.11	-	63.8
	Bottom (63 to 73)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	177	6.03	1.05	9480	10.2	-	-	0.614	26.6	27.5	17400	0.794	17.70	131	-	248
KC02	Top (0-10)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	16.7	2.37	0.426	7350	6.05	-	-	0.067	16.9	13.2	1200	0.072	12.50	9.41	-	53.9
	Middle (31.5 to 41.5)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	2.8	0.34	0.041	2700	2.72	-	-	0.075	12.6	5.68	5440	0.005	4.29	1.79	-	10.6
	Bottom (63 to 73)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	16.7	0.93	0.151	5220	5.07	-	-	0.134	18.4	7.31	10900	0.059	11.20	10.2	-	42.9
KC03	Top (0-10)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	22.6	4.27	0.634	14600	16.3	-	-	0.8	31.7	27.2	27400	1.24	24.50	197	-	566
	Middle (23 to 33)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	59.5	4.97	0.203	5710	5.89	-	-	0.239	19.3	12.9	11500	0.232	10.10	47.4	-	146
	Bottom (46 to 56)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	198	7.16	1	4420	4.99	-	-	0.304	16.1	26.5	9470	0.384	8.50	50.1	-	121

	Depth (cm)	Source	Block	THC (µgg-1 dry sediment)	Total n-alkanes (nC_{12} to nC_{36}) (µgg-1 dry	PAH (µgg-1 dry sediment)	Al	As	Ba	TB a	Cd	Cr	Cu	Fe	Hg	Ni	Pb	V	Zn
KC04	Top (0-10)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	14.3	1.61	0.191	7200	5.8	-	-	0.155	20	9.13	14500	0.036	12.40	9.1	-	47.3
	Middle (30 to 40)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	11	1.15	0.132	2770	2.97	-	-	0.067	11.3	4.11	7390	0.013	6.38	2.97	-	19.2
	Bottom (60 to 70)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	42.4	1.95	0.35	5910	5.74	-	-	0.177	19.2	16.3	13400	0.248	11.10	38.8	-	98
KC05	Top (0-10)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	297	3.03	2.12	5530	9.64	-	-	1.11	20.3	24.9	14400	0.689	16.50	108	-	280
	X (24 to 33)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	51.6	0.55	0.779	8010	11.8	-	-	1.28	12.7	41.1	19900	2.1	7.54	439	-	919
	Middle (31 to 41)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	28.6	0.85	0.335	6400	7.67	-	-	0.237	22	24.3	16800	0.94	18.70	45.7	-	111
	Bottom (51 to 61)	Kingfisher (Fugro, 2018)	16/8a / 16/8d	18.2	1.29	0.535	10100	7.85	-	-	0.168	23	19.4	19000	0.113	17.60	29	-	90
EET (Estimated 'ecological effects threshold) for drill cuttings	**EET (Estimated 'ecological effects threshold) for drill cuttings**	**OSPAR 2006**	-	**50**	-	-	-	-	-	-	-	-	-	-		-	-	-	-

	Depth (cm)	Source	Block	THC (µgg-1 dry sediment)	Total n-alkanes (nC_{12} to nC_{36}) (µgg-1 dry	PAH (µgg-1 dry sediment)	Al	As	Ba	TB a	Cd	Cr	Cu	Fe	Hg	Ni	Pb	V	Zn
Effects Range Low (ERL)	**Effects Range Low (ERL)**	**OSPAR 2014**	**-**	**-**	**-**	**Various**	**-**	**-**	**-**	**-**	**1.2**	**81**	**34**	**-**	**0.15**	**20.9**	**47**	**-**	**150**
Effects Range Medium (ERM)	Effects Range Medium (ERM)	OSPAR 2014									9.6	370	270		0.71	51.6	218		410
CNS Mean Background	CNS Mean Background	UKOOA, 2001	-	9.51	0.4	0.233	-	-	178	348	0.03	9.13	2.41	4725	0.03	7.31	6.75	14.9	13.5
CNS Background 95th percentile	CNS Background 95th percentile	UKOOA, 2001	-	40.1	1.18	0.736	-	-	523	720	0.12	31	6	11160	0.12	19	16.7	31.3	32.5

	Above CNS Background Mean
	Above CNS Background 95th Percentile
	Above EET
	Above ERL

3.2. Physical Environment

Characteristics of the bathymetry, currents, meteorology, sea temperature, salinity and seabed sediments in the Kingfisher area are described in the following subsections.

3.2.1. Metocean Conditions

3.2.1.1. Bathymetry

Water depth within the CNS typically varies between 50 m and 200 m. Mean depth to seabed at the Kingfisher manifold has been measured at 113.3 m LAT (Shell UK Ltd, 2016).

3.2.1.2. Wave and Currents

Regional near surface water movement in the CNS is dominated by the Fair Isle Current, with Atlantic water moving in from the north at depth. Local to the Kingfisher area, water movement is predominantly in the north easterly direction.

Current profiles at 2 m, 50 m and 100 m depth for the nearest HYCOM[4] measurement location are shown in Figure 3-7, Figure 3-8 and Figure 3-9 below (HYCOM, 2012). This measurement location is approximately 6 km south of the location of the Kingfisher manifold.

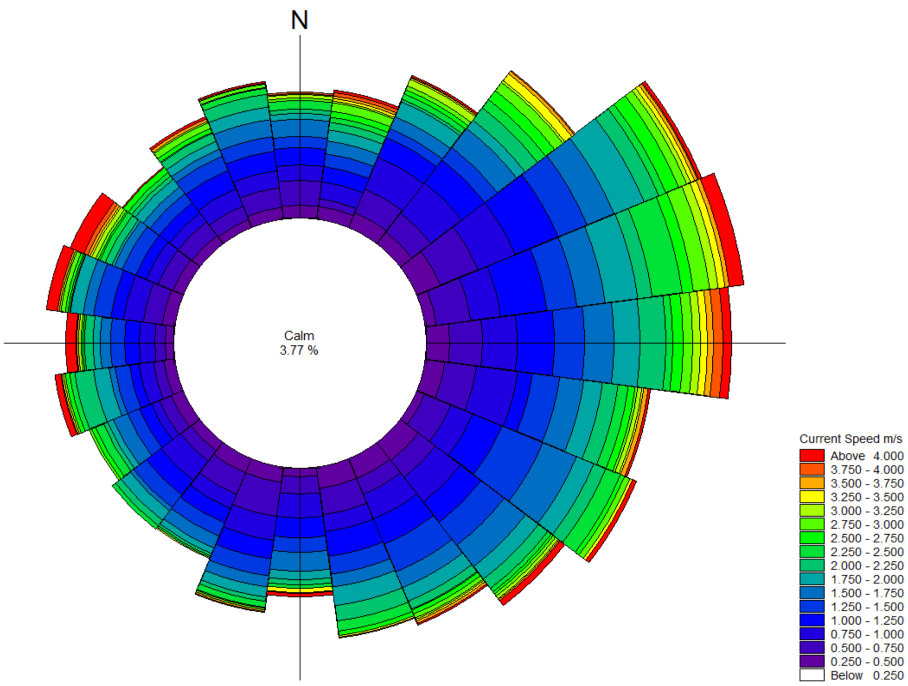


Figure 3-7: Surface Current Rose (2m Depth)

[4] Hybrid Coordinate Ocean Model (HYCOM), https://hycom.org/data/glbu0pt08/expt-19pt1: Full year data for 2012 has been used as this is currently the most recent period available for the quality assured 're-analysis' data for this sample location.

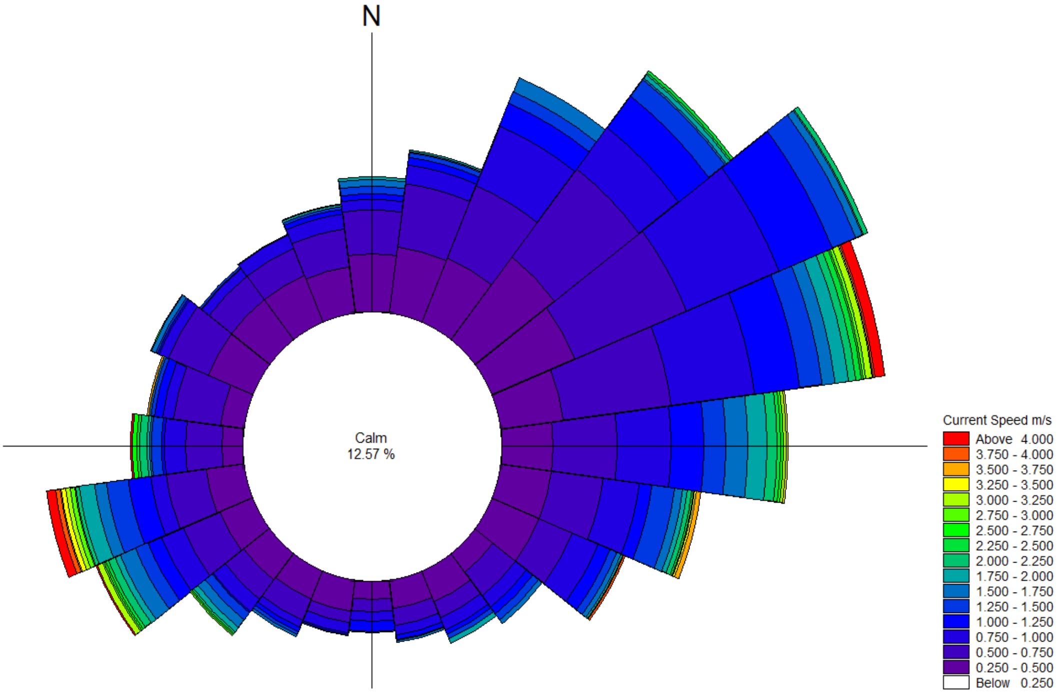


Figure 3-8: Mid-water Current rose (50m depth)

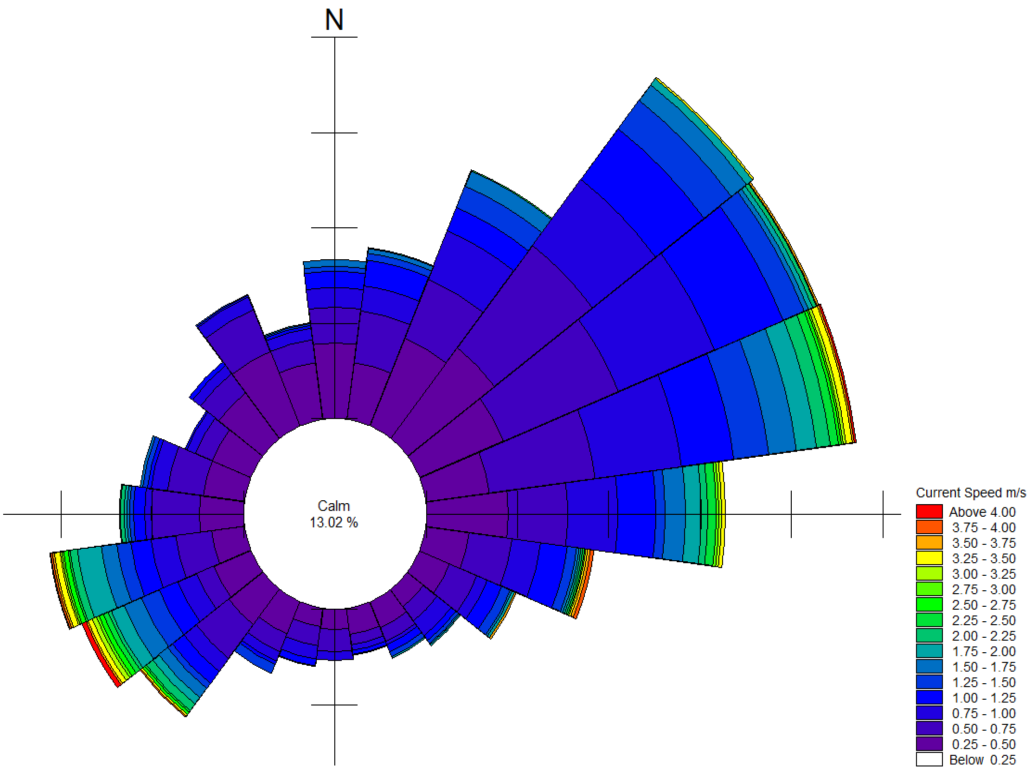


Figure 3-9: Bottom current rose (100m depth)

In addition, Table 3-2 below contains 10 year return period data for current speed at Kingfisher (m/s) taken from (Shell UK Ltd, 2010).

Table 3-2: Year Return Data for Current Speed at Kingfisher (m/s)

Current Speed (m/s)	Direction (From)							
	N	NE	E	SE	S	SW	W	NW
1.00d	1.02	0.93	0.52	0.57	0.85	0.73	0.39	0.71
0.75d	1.02	0.93	0.52	0.57	0.85	0.73	0.39	0.71
0.50d	1.02	0.93	0.52	0.57	0.85	0.73	0.39	0.71
0.30d	0.94	0.86	0.48	0.53	0.79	0.67	0.36	0.66
0.10d	0.81	0.74	0.41	0.45	0.67	0.58	0.31	0.56
0.05d	0.73	0.67	0.37	0.41	0.61	0.52	0.28	0.51
1m asb	0.57	0.52	0.29	0.32	0.48	0.41	0.22	0.40

Mean significant wave height is recorded at 2.7 m to 3 m (Marine Scotland, 2018). This is supported by available data relating to wind speed and significant wave height in proximity to the Kingfisher field which is included in Figure 3-10 and Figure 3-11 below.

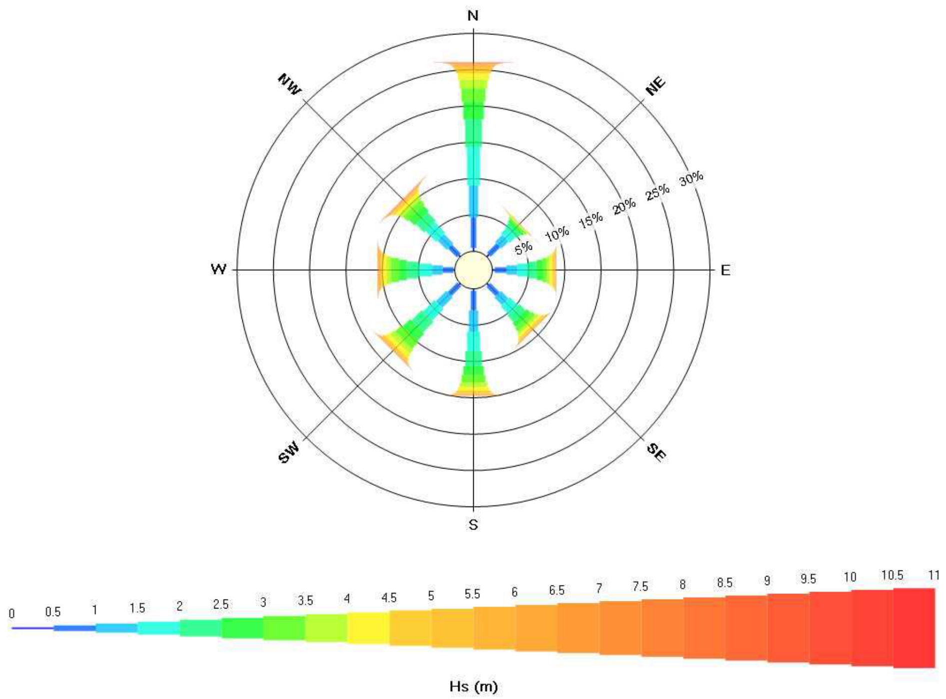


Figure 3-10: Significant wave height rose and directional distribution (all year) (Shell UK Ltd, 2010)

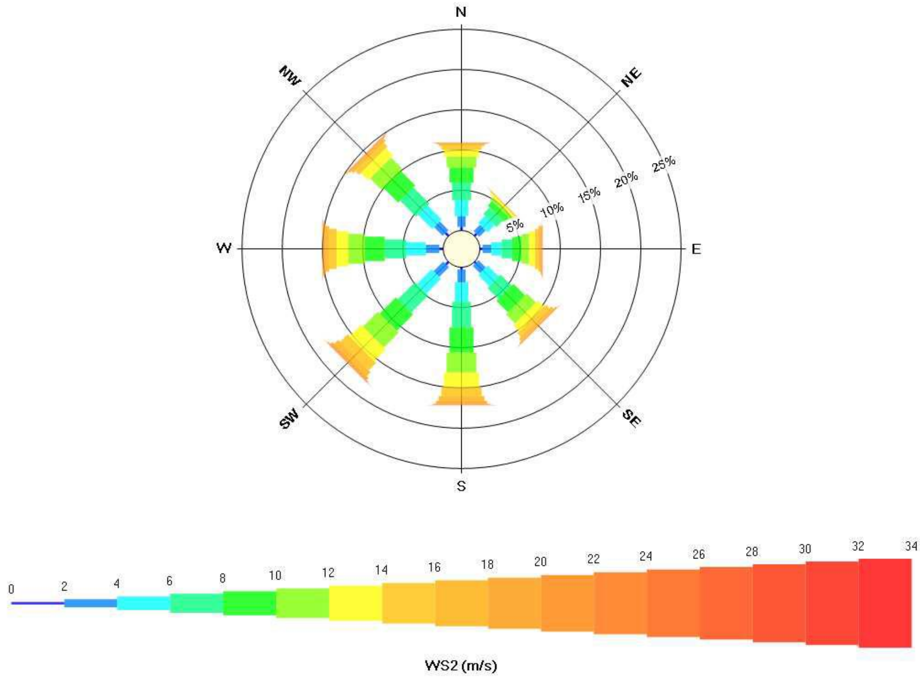


Figure 3-11: Hourly Mean Wind Speed rose and Directional Distribution (all year)

3.2.1.3. Sea Temperature and Salinity

Annual mean sea surface water temperature in the vicinity of Kingfisher field is estimated at 9ºC, with near seabed temperature dropping to 7ºC (Marine Scotland, 2018). Annual mean surface salinity is estimated at 25 ppt with near seabed salinity at 35 ppt. (Marine Scotland, 2018). Water density changes seasonally with a pycnocline[5] forming particularly in the summer months (Johns & Reid, 2001); (Richardson, et al., 1998).

Metocean conditions are considered to be of Low sensitivity representing a receptor which is easily adaptable and likely to recover immediately.

3.2.2. Water Quality

Water Quality in the area around the Kingfisher infrastructure is a function of various influencing factors including (but not limited to):

- CNS background levels.
- Existing produced water discharges to sea from nearby oil and gas infrastructure operations. Discharge levels including hydrocarbons, heavy metals, polyaromatic hydrocarbons (PAHs), and production chemicals are regulated and monitored through appropriate operating licences. It can be expected that water quality in the area around Kingfisher is currently compliant with relevant standards and, as the adjacent platforms move towards cessation of production (CoP) in the short to medium term, if anything, is likely to improve over time.
- Contaminants release to water column from historic seabed deposits, particularly drill cuttings piles. Drill cuttings piles have been identified at the Kingfisher manifold and

[5] A stratified zone within the water column in which water density increases rapidly with depth, as a result of changes in temperature and salinity.

associated with TAQA Bratani Ltd's drilling operations at its three nearby platforms as well as at associated subsea installations. All drill cuttings piles in the area have been subject to a Stage 1 Screening Assessment under OSPAR Regulations 2006/5. Under their current status, none of these drill cuttings piles are believed to demonstrate oil loss to water or persistence rates above the Ecological Effect Threshold (EET) as set out by OSPAR.

Water Quality in the area around the Kingfisher infrastructure provides a valuable function as an environmental parameter supporting certain habitats and species of commercial and/or conservation importance, particularly pelagic feeding commercial fish species, the PMF habitat 'Seapen and burrowing megafauna communities' and the PMF species Ocean Quahog *Arctica islandica*.

Water currents close to the seabed in the Kingfisher area are likely in the region of 1 to 1.5 m/s, predominantly in a north easterly direction, allowing for some movement and dispersion of any water contaminant release into the water column as a result of seabed disturbance activities.

Local water quality is considered to be a receptor of Low to Medium sensitivity representing a receptor easily adaptable to change and likely to recover immediately yet providing a support function to identified habitats and species of conservation importance.

3.2.3. Air Quality

Air Quality is not routinely monitored at offshore sites, although regional air quality monitoring is carried out in coastal areas. Inshore waters in certain parts of the CNS have shown increased levels of pollutants close to coastal industry but these levels decrease with distance offshore. Oil and Gas platforms are also known to represent point sources of offshore atmospheric pollution (DECC, 2016).

The area around the Kingfisher infrastructure lies in close proximity to a number of oil and gas platforms, including TAQA Bratani Ltd's Brae Bravo, Brae Alpha and East Brae platforms, as well as BP's Miller platform. No monitoring data is available. Whilst it may be the case that current local air quality may be affected by point source pollution from the nearby platforms it is understood that all four of these platforms are at or moving towards COP in the short to medium term. It can be expected that air quality in the area around Kingfisher is compliant with relevant standards and if anything is likely to improve over time.

Local Air Quality is considered to be of Low sensitivity, easily adaptable to change and likely to recover immediately.

3.2.4. Geology and Seabed Sediments

Sea floor sediments of the North Sea are dominated by sands in the southern extent, grading to fine muds in the deeper and more central parts. Figure 3-12 provides an overview of sea floor sediments in the North Sea.

Extensive oil and gas activity in the CNS over the past 40 years has resulted in the introduction of a range of industry related discharges to the marine environment including drilling discharge, produced water discharges, accidental spills etc. (OSPAR, 2010). Consequently, various persistent contaminants have been found at low concentrations across the area, away from the immediate proximity of O&G installations.

A review of available survey data for the adjacent Brae Area, extending to include the area surrounding the Kingfisher wells and manifold and the flowlines back to Brae Bravo platform, was completed by Marathon Oil (now TAQA Bratani Ltd) and reported in the Environmental

Statement in support of the Brae Alpha, Brae Bravo etc. Decommissioning Programme (Marathon Oil, 2017). The review considered data relating to the presence and concentrations of both organic and inorganic contaminants with the seabed sediments of the region. TAQA Bratani Ltd (2017) reports THC away from known installations to be in the region of 1.7 μgg to 3.6 μgg, which is considered to provide an indication of sediment chemistry in areas unaffected by oil and gas activity. In addition, (Marathon Oil, 2017) reported sediments in the study area have a low organic and carbonate content, with metals recorded within the range of background concentrations (CEFAS, 2001); (UKOOA, 2001).

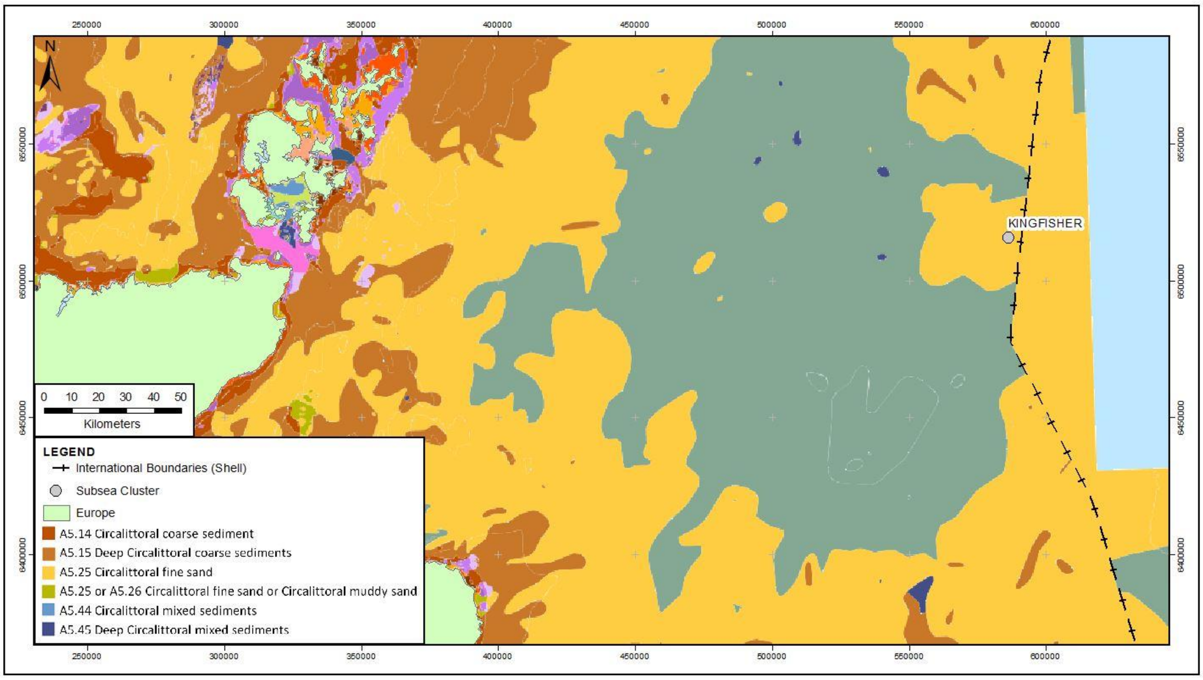


Figure 3-12: Sea floor sediments of the North Sea

Pre-drill survey at the Kingfisher field (Geoteam-Wimpol Ltd, 1995) identified the shallow geology as comprising shallow deposits of silty fine sand to soft clay of the Witch Ground formation (<1 m, thickening up to 2 m to the south of the Kingfisher manifold) infilling channel like depressions in the older, Quaternary sediments.

Pre-decommissioning survey (Fugro Ltd, 2018) records sediments classified as 'fine sand' and 'very fine sand' using the Wentworth sediment descriptions (Wentworth, A Scale of Grade and Class Terms from Clastic Sediments, 1922). When compared to the wider survey area, mean particle size was generally lower in the drill cuttings pile. Sediments were generally homogenous through the majority of the Kingfisher survey area although variation was observed in the proportions of shell fragments and coastal material present (Fugro Ltd, 2018).

Chemical analysis of (Fugro Ltd, 2018) samples in the Kingfisher survey area were observed to share a common underlying hydrocarbon distribution typical of low level, weathered petroleum residues commonly found in North Sea sediments.

Sediments in the area around the Kingfisher infrastructure have been sampled and analysed for the presence of hydrocarbon and metal contaminants. A drill cuttings pile showing elevated levels of a number of contaminant parameters exists in and around the manifold and well head structures.

OSPAR Stage 1 Assessment of the cuttings pile indicates these contaminated sediments are currently stable with calculated leaching and persistent rates well below the OSPAR thresholds.

Seabed sediments in the area around the Kingfisher infrastructure provide a valuable function as an environmental parameter supporting certain habitats and species of commercial and/or conservation importance, particularly pelagic feeding commercial fish species, the PMF habitat 'Seapen and burrowing megafauna communities' and the PMF species Ocean Quahog *Arctica islandica*.

Seabed sediments are therefore considered to be a receptor of Low to Medium sensitivity representing a receptor easily adaptable to change and likely to recover immediately yet providing a support function to identified habitats and species of conservation importance.

3.3. Biological Environment

This section summarises the characteristics of plankton, benthos, fish and shellfish including spawning and nursery grounds, marine mammals, seabirds and offshore conservation areas relevant to the area around the Kingfisher infrastructure.

3.3.1. Plankton

The plankton community comprises both phyto- and zoo- plankton. Phytoplankton composition in the North Sea is dominated by the dinoflagellate genus *Ceratium*, with the most frequent species wide spread and tolerant of fluctuations in the metocean conditions, including temperature and salinity (Johns & Reid, 2001). Composition may change seasonally with plankton blooms dominated by diatoms recorded in spring, sometimes with a smaller second bloom in autumn. Dinoflagellates are more dominant in the phytoplankton community during summer months. The density gradient which is seasonally evident in the North Sea (see section 3.1.3) restricts much of the plankton community to the upper parts of the water column (approximately upper 20 m depth). Low light levels through the winter months limit the growth and extent of the phytoplankton community in the North Sea. Copepods such as *Para-Psuedocalanus* spp., *Acartia* and juvenile *Calanus* spp dominate the zooplankton and provide a main food source for higher trophic levels.

In the North Sea there have been extensive changes in the planktonic ecosystem in terms of plankton production, biodiversity and species distribution with the population of the previously dominant and important cold water species, *Calanus finmarchicus* has declined in biomass by 70% since the 1960s. Warmer-water species such as *Calanus helgolandicus* are moving northward to replace *C. finmarchicus* but are not numerically abundant or as nutritionally (i.e. less lipid rich) important (Edwards M, 2013)

The plankton community is considered to be a receptor of Low sensitivity representing a receptor easily adaptable to change and likely to recover quickly yet providing an important support function of higher ecosystem species, including those of conservation importance.

3.3.2. Benthic ecology

The benthic communities in the CNS are dependent on the seabed sediment characteristics which support them (see **Section 3.3.4** for physical sediment characteristics). Benthic communities comprise species which live on or in the surface of the sediment. Two biotopes have been identified within the seabed around the Kingfisher infrastructure:

- Circalittoral muddy sand (EUNIS classification A5.26; JNCC classification SS.SSA.CMuSa). Is the predominant biotope, described as circalittoral non-cohesive muddy sands with silt content typically ranging from 5 to 20% supporting animal-dominated communities including polychaetes, such as *Abra alba* and *Nucela nitidosa* and echinoderms, particularly *Amphiura* spp. And *Ophiura* spp. These habitats tend to be more stable than their infralittoral counterparts and as such support a richer infaunal community (EEA, 2017)

  Most frequently observed burrowing mega fauna within this biotope included *Virgularia mirabilis* (Slender sea pen) and *Pennatula phosphorea* (phosphorescent seapen). *Holothuroidea* (sea cucumbers) and *Cerinathidae* (tube anemones) were also observed. Polychaete worms including *Paramphinome jefferysii* were ranked as most abundant and dominant across the study area, with one station, 1000 m north of Kingfisher manifold, dominated by the opportunistic polychaete *Chaetozone setosa*. Bivalve siphons, potentially of *Arctica islandica,* were also observed.

  The most frequently observed mobile species were sea urchins (Brissidina, *Gracilechinus acutus*, *Spatangus purpureus*). Other mobile species included starfish (Asteroidea, *Asterias rubens*, *Hippasteria phrygiana*, cf. *Luidia sarsi*), brittlestars (Ophiuroidea), sea lilies (Crinoidea), hermit crabs (Paguroidea), spider crabs (Hyas sp.) and gastropods (Neogastropoda, Buccinidae, *Aporrhais* sp.) (Fugro Ltd, 2018).

- Circalittoral mixed sediment (EUNIS classification A5.44); JNCC classification SS.SMx.CMx). Described as circalittoral well mixed muddy gravelly sands or very poorly sorted mosaics of shell, cobbles and pebbles embedded or lying on mud, sand or gravel. The variable nature of the seabed supports a wide range of infaunal polychaetes, bivalves, echinoderms and burrowing anemones such as *Cerianthus lloydii*. The presence of hard substrata also may allow epifaunal species to establish including hydroids (e.g. *Nemertesia* spp., and *Hydrallmania falcata*). Often species rich communities (EEA, 2017)

  The circalittoral mixed sediment biotope was observed in small patches along transects KTR 01, and also KTR03, KTR04 and KTR 07 (as shown in Figure 3-2). The most frequently observed burrowing species within this biotope complex was the slender sea pen (*V. mirabilis*). Epifaunal abundance and diversity was generally low, with sea urchins (Brissidina, *Gracilechinus acutus*, *Spatangus purpureus*) the most frequently recorded taxon, and gastropods (Buccinidae) recorded infrequently. Where anthropogenic and shell debris were present for epilithic attachment, sessile epifauna such as anemones (Actinaria, *Bolocera tuediae*, *Urticina eques*), hydroid/bryozoan turf (Hydrozoan/Bryozoan), soft coral (*Alcyonium digitatum*) and sponges (Porifera) were also present. Sea cucumbers (Holothuroidea) were also observed (Fugro Ltd, 2018).

Figure 3-13 and Figure 3-14 provide examples of still photographs of the circalittoral muddy sand (A5.26) biotope seabed immediately to the north and to the south of the Kingfisher manifold. The locations are shown on Figure 3-2.

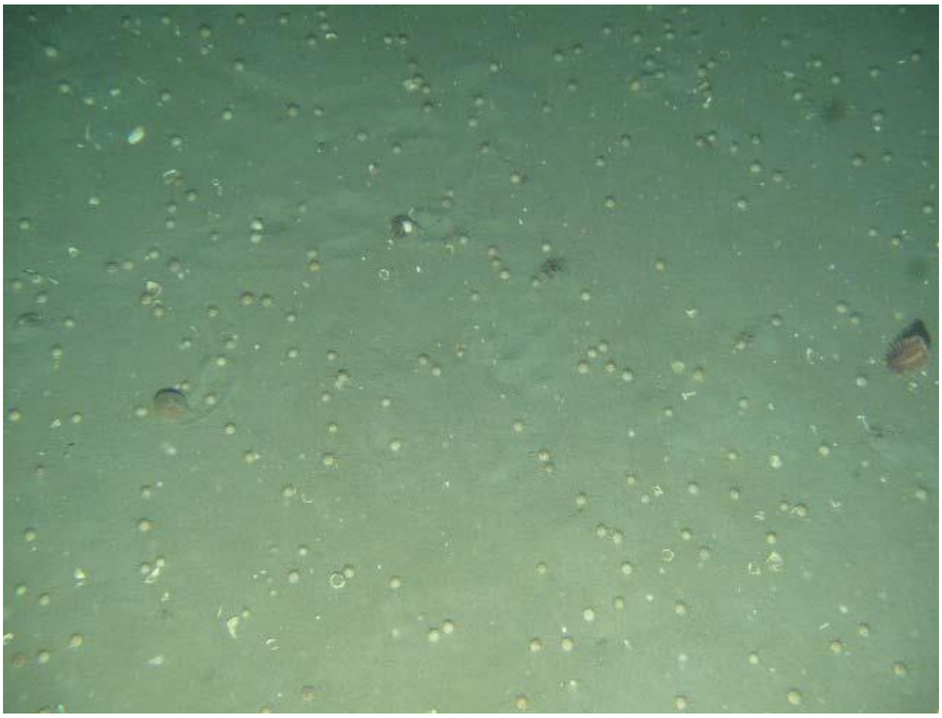


Figure 3-13: Transect KTR01_4. North of Kingfisher Manifold. Muddy sand with shell fragments: sea urchin *Gracilechinus acutus*. Brissindina. seapen *Pennatula phosphorea.* Faunal tracks

Figure 3-14: Transect KTR02_16. South of Kingfisher Manifold. Muddy sand with shell fragments. sea urchin *Gracilechinus actus,* Brassidina, faunal burrows. *Nephrops norvegicus.* tubes and tracks

Figure 3-15 provides an example still photograph of the circalittoral mixed sediment (A5.44) biotope.

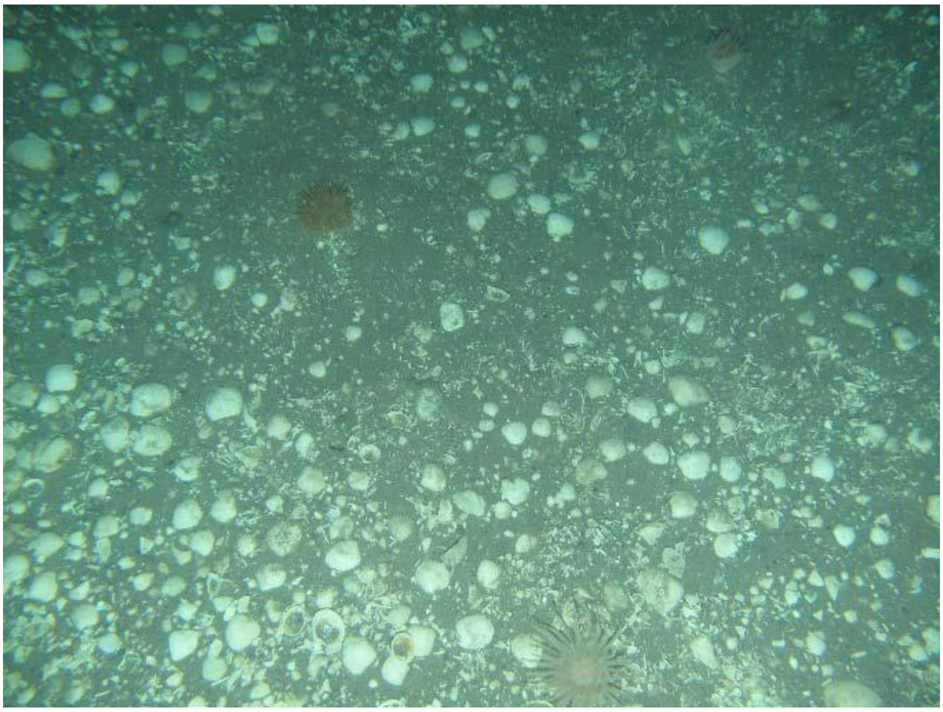


Figure 3-15: Transect KTR01_18. East of Kingfisher Manifold. Mixed sediments including bivalve shells. Sea anemones *Bolocera tudediae. Urticina eques*

Survey results from pre-decommissioning survey at TAQA Bratani Ltd Brae Bravo (Marathon Oil, 2013) also indicate the presence of the same circalittoral muddy sand biotope where Kingfisher infrastructure approaches the Brae Bravo platform.

Whilst the dominant biotopes identified are typical and widespread through the CNS, potential for the presence of species of conservation importance in the area has been identified.

3.3.2.1. Sea pens and burrowing mega fauna

Fugro (2018) records the presence of seapens *V. mirabilis* and *P. phosphorea* in survey photography with the observed abundance for *V. mirabilis* recorded as 'Frequent'[6] in all but one survey transects (no evidence of the species was observed in transect KTR02). *P. phosphorea* was recorded as 'occasional' in 3 of the 8 transects. Burrows were recorded as 'Frequent' over all transects. Whilst burrows consistent with Norway lobster were identified, (Fugro Ltd, 2018) acknowledge that mounds with conspicuous burrows did not appear to form a prominent feature of the sediments. No evidence of Annex I habitats were recorded around TAQA Bratani Ltd Brae Bravo platform. (Marathon Oil, 2013).

As a result of these observations there is the potential for the presence of the OSPAR listed threatened and or declining habitat 'Seapens and burrowing megafauna communities' to occur around the Kingfisher manifold and wellheads. (see **Section 3.3.6** for further details)

[6] Based on the SACFOR abundance scale (JNCC: www.jncc.defra.gov.uk/page-2684 accessed 04 June 2018.

3.3.2.2. Ocean Quahog: *Arctica islandica*

The ocean quahog is a slow growing, long lived cockle-shaped bivalve found in the North East Atlantic, including UK offshore waters. International Council for Exploration of the Sea (ICES) surveys throughout the last century have recorded a notable decline in the presence of this species, particularly in shallower locations (between 30 m and 50 m water depth) (OSPAR, 2009) *A. islandica* is an OSPAR listed threatened and/or declining species, and is also a PMF as part of the Scottish Government's Strategy for the Marine Conservation in Scotland's Seas.

(Fugro Ltd, 2018) reports a specific sample analysis process to identify presence/absence and density estimates for this species within the Kingfisher study area. Grab sample analysis records presence of *A. Islandica* as 'common' at some stations, 'abundant' at others and absent at others. No clear relationship was reported between the abundance of this species and distance from the drill cuttings. It was also noted that with the exception of individuals recorded at single sample station, all individuals noted were small, potentially juvenile, specimens of <1cm wide.

Benthic ecology in the area surrounding the Kingfisher infrastructure including on approach to TAQA Bratani Ltd Brae Bravo platform which is not currently disturbed by the existing presence of the infrastructure is considered to be of Medium to High sensitivity to disturbance. Areas of seabed and supported benthos which are already influenced by the existing infrastructure are considered to be of lower sensitivity.

3.3.3. Fish and Shellfish

Several fish species are known to be present in the CNS including in the area around the Kingfisher infrastructure, although species richness in the CNS is lower than in more coastal areas of the North Sea (ICES, 2008).

The Kingfisher infrastructure lies within or in close proximity to known spawning areas for: Blue Whiting *Micromesistius poutassou;* Cod *Gadus morhua*, Haddock *Melanogrammus aeglefinus*; Norway Pout *Trispoterus esmarkii;* Saithe *Pollachinus spp.;* Sandeels *Ammodytidae spp.;* Norway lobster *Nephrops norvegicus*; Herring and mackerel *Scomber scombrus*. The area is also used as nursery grounds for those listed above as well as Whiting *Merlangius merlangus*, Ling *Molva molva*, Hake and Angler fish *Lophius piscatorius*. (Marine Scotland, 2018) (Coull, Johnstone, & Rogers, 1998) (Ellis, Milligan, Readdy, Taylor, & Brown, 2012). Of these, Norway Pout, Blue Whiting, Herring and Mackerel are listed as Priority Marine Features (PMF) (Tyler-Walters, et al., 2016). In addition, the potential presence of juvenile Norway pout and haddock in the area is also recorded (Aires, Gonzalex-Irusta, & Watret, 2014).

Figure 3-16 shows the extent of known spawning and nursery grounds which coincide with the area around the Kingfisher Infrastructure. In all cases, spawning grounds which include the area around the Kingfisher infrastructure are extensive, covering large areas of the North Sea. Fish eggs are released to either the seabed or the water column, making them vulnerable to effects on larval development as a result of pollution and disturbance from increased turbidity etc. The area represents a small proportion of the grounds available for spawning for these species and is therefore considered likely to recover easily from disturbance and is likely to be easily adaptable to changes.

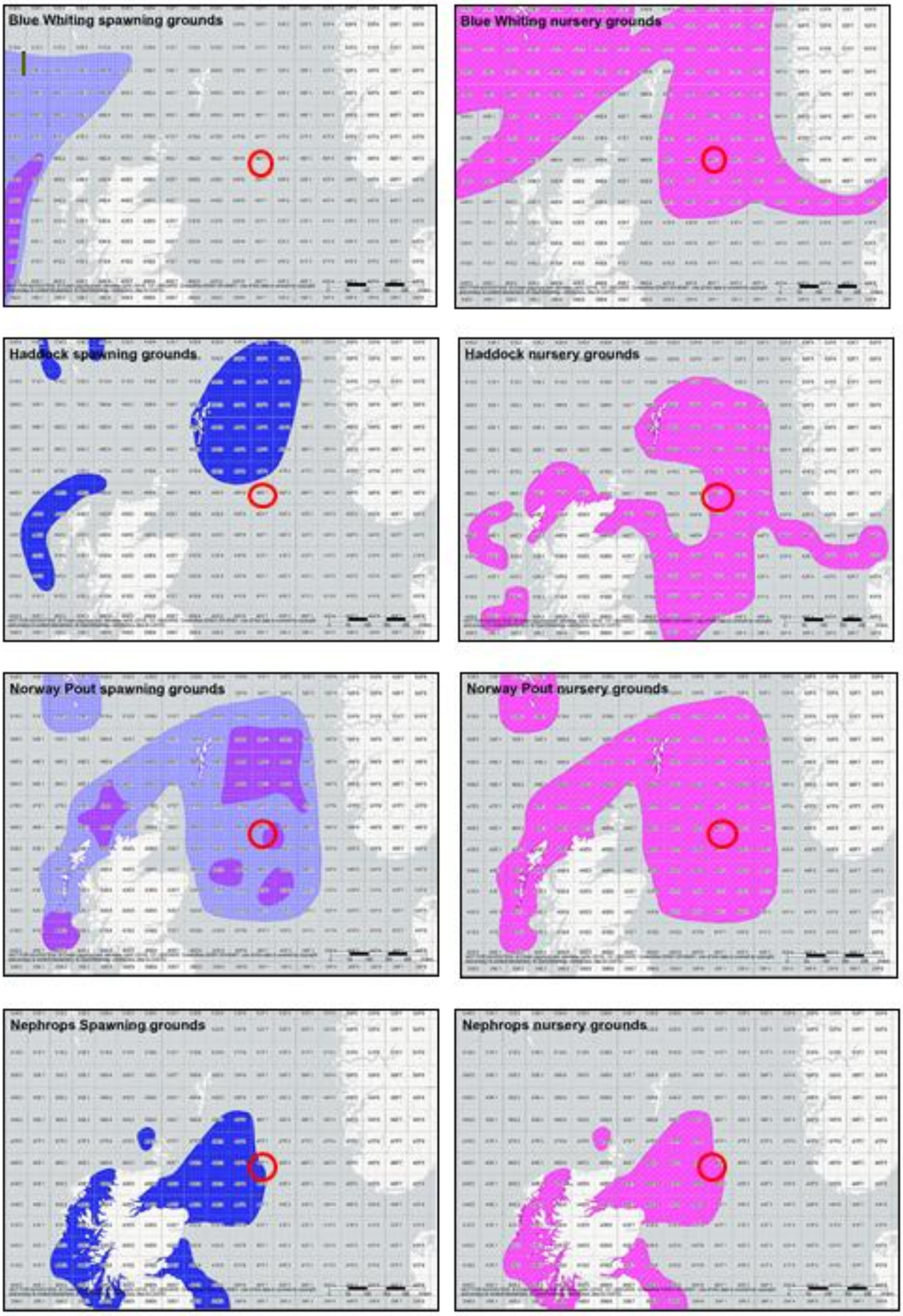


Figure 3-16: Spawning and Nursery Grounds for key fish species in the area of the Kingfisher infrastructure

In addition, occasional records are also available indicating the potential presence a number of elasmobranch species including species identified as Priority Marine Features (PMF) under the Marine (Scotland) Act, 2010. These include basking shark *Cetorhinus maximus* and porbeagle *Lamna nasus* ((Tyler-Walters, et al., 2016)) as well as tope *Galehorhinus galeus*; and the Spiny dogfish *Squalus acanthias*. (Marine Scotland, 2018); . There are also historic records of sandy ray *Leucoraja circularis* common skate *Raja batis* in the area around the Kingfisher infrastructure in low densities (Marine Scotland, 2018).

Table 3-3 indicates particular seasonal sensitivities associated with likely spawning grounds.

Table 3-3: Fish Spawning Periods (Coull, Johnstone, & Rogers, 1998) (Ellis, Milligan, Readdy, Taylor, & Brown, 2012) (Aries, Gonzalez-Irusa, & Watret, 2014)

Species	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Nursery
Cod		*	*										o
Haddock		*	*	*									
Saithe	*	*											
Norway Pout		*	*										
Blue Whiting													
Sand eel													
Nephrops				*	*	*							
Whiting													
Ling													
Hake													
Anglerfish													
Mackerel													
Herring													

* = Peak spawning period

O = O Group aggregations (<1 year juveniles) (Aires, Gonzalex-Irusta, & Watret, 2014)

Months of highest observed abundance

Fish and shellfish are considered to be of Low sensitivity to disturbance rising to Medium sensitivity for certain species of elasmobranch. Note: elasmobranchs are not considered to be of high sensitivity in this area, despite their legal protection levels. This reflects the infrequency of records of their known presence and the expectation that the area is not a core part of their territory.

3.3.4. Marine Mammals

3.3.4.1. Cetaceans

Whilst a wide range of marine mammal species have been recorded in the waters around the British Isles only a small number are regularly recorded in the area around the Kingfisher infrastructure, including Harbour Porpoise *Phocoena phocoena*, White-beaked dolphin *Lagenorhynchus albirotris* and Minke whale *Balenoptera acutorostrata*. Harbour porpoise are listed under Annex II of the EU Habitats Directive and all three species are listed as Scottish PMFs (Tyler-Walters, et al., 2016).

The most abundant marine mammal species in the North Sea are important predators influencing the food chain by feeding on a wide range of prey including a number of commercially important fish species (CEFAS, 2001). Recorded distribution patterns for these three most commonly sighted species are show in Figure 3-17 (Hammond, et al., 2016) (Reid, Evans, & Northridge, 2003) (ICES, 2008) and discussed further below.

3.3.4.1.1. Harbour Porpoise

Commonly encountered and widely distributed, the harbour porpoise *Phocoena phocoena* is the smallest species of cetacean found in European waters. Usually observed in small groups of 1 to 3 individuals, density of individuals of harbour porpoise has been recorded as highest in the southern CNS (ICES 2008) with a recorded density of 0.88 individuals per km^2 (survey block O as reported within (Hammond, et al., 2016)). A southward shift in the distribution pattern of this species has also been observed with increasing numbers recorded in the southern North Sea and a significant reduction in the number of sightings in the northern North Sea (JNCC, 2017). The Kingfisher infrastructure lies within survey Block T and adjacent to survey Block U as reported within (Hammond, et al., 2016) where densities of 0.4 and 0.3 individuals per km^2 respectively was recorded.

3.3.4.1.2. White-beaked dolphin

Another common species of cetacean in the North Sea, the White-beaked dolphin *Lagenorhynchus albirostris* is a continental shelf species usually found in waters of 50 to 100m depth. It is the most commonly sighted dolphin in the North Sea and has been recorded all year round, but with a noted increase in sightings in the summer months. (Reid, Evans, & Northridge, 2003). Most usually observed in groupings of less than 10 animals a density of 0.03 individual per km^2 of white-beaked dolphin has been recorded in survey Block T in proximity to the Kingfisher infrastructure. (Hammond, et al., 2016).

3.3.4.1.3. Minke whale

Minke whale *Balenoptera acutorostrata* are widely distributed in norther hemisphere including the North Atlantic but in small numbers including in the northern North Sea Usually found singly or in pairs they are often seen in the vicinity of other cetaceans, particularly harbour porpoise and sometimes White-beaked dolphins. They are known to approach vessels and will occasional bow or stern ride. Their abundance is often and seasonally linked to prey abundance including certain seabirds. Minke whales are particularly observed in feeding aggregations from May to September (Reid, Evans, & Northridge, 2003). (Hammond, et al., 2016) recorded a density of 0.03 individuals per km^2 in survey Block T in proximity to the Kingfisher infrastructure.

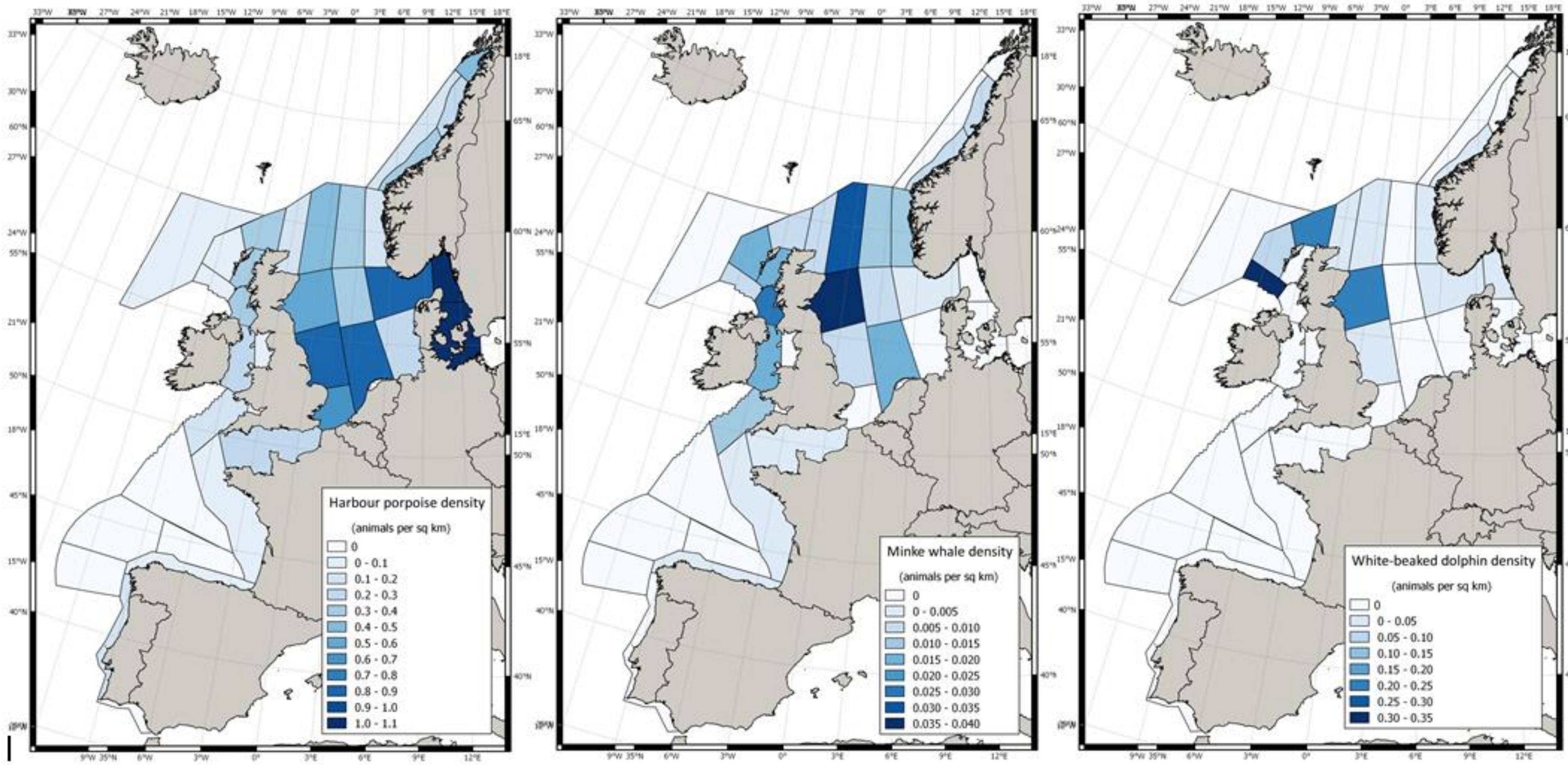


Figure 3-17: Distribution of most commonly sighted marine mammal species in the area of Kingfisher infrastructure (Hammond, et al., 2016)

In addition, possible records of the following two species have also been identified.

- Atlantic white-sided dolphin *Lagenorhynchus acutus:* Most usually encountered offshore in deeper water they are also found in the northern North Sea. There frequency in the central and southern North Sea is rare. They are recorded in all months of the year, with larger numbers noted in coastal waters particularly July to September (Reid, Evans, & Northridge, 2003). (Hammond, et al., 2016) recorded a density of 0.02 individuals per km^2 in survey Block T in proximity to the Kingfisher infrastructure
- Killer whale *Orchinus orca:* Whilst the closest NMPi (Marine Scotland, 2018) record of killer whale in the CNS is located to the south of Kingfisher (in ICES rectangle 45F0), anecdotal reports from platform and vessel operators at TAQA Bratani Ltd's Brae Bravo platform have reported occasional sightings of this species (Pers. Comm. Marathon Oil. 2014).

The potential presence of cetaceans in the area of the Kingfisher infrastructure is considered to be of Medium sensitivity to disturbance particularly from underwater noise generation and propagation. Sensitivity will also be seasonal depending on the individual species (Table 3-4). Under most circumstances it is anticipated that individual cetacean species have a certain capacity to adapt to disturbance including through avoidance behaviour moving further from the disturbance source, whilst still remaining within alternative suitable habitat.

Table 3-4: Cetacean North Sea Seasonal Abundance (Reid, Evans, & Northridge, 2003) (Hammond, et al., 2002)

Species	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Harbour Porpoise												
White-beaked dolphin												
Minke Whale												

Months of highest observed abundance

3.3.4.2. Pinnipeds

Two species of seal are resident in UK waters; the grey seal *Halichoerus grypus* and the harbour (common) seal *Phoca vitulina*. Both occur regularly over large areas of the North Sea (SMRU, 2001). The grey and harbour seal are both Annex II and Scottish PMF species.

Grey seals spend most of the year at sea, travelling long distances between haul-out sites and ranging widely in search of prey (DECC, 2015). The majority of the grey seal population will be on land for several weeks from October to December during the pupping and breeding seasons, and again in February and March during the annual moult. Densities of grey seals offshore are likely to be lower during these periods (DECC, 2015).

Harbour seals travel less extensively, with feeding trips recorded lasting up to 2 to 3 days and within approximately 40km of their haul out sites. Individuals are also thought to return to the same haul-out points after foraging. (Johnston, Turnbull, & Tasker, 2002).

The area around the Kingfisher infrastructure is recorded as an area of low 'at sea' usage (0-<1 per $25km^2$ mean annual) for both grey seal and for harbour seal (Marine Scotland, 2018).

3.3.5. Seabirds

The North Sea and its coastal areas support international important numbers of seabirds. Seabirds are present in the area around the Kingfisher infrastructure throughout the year, although in low numbers for the majority of species as the area is at some distance from their breeding colonies (Thaxter, et al., 2012). Aggregated density of all seabirds is expected to be lowest in the area in late spring/summer when many birds are nesting and therefore are in close proximity to coastal colonies (DTi, 2001). Diversity and density may increase in the offshore area once chicks have fledged as foraging behaviours allow for birds to travel further distances from their coastal colonies.

Seabirds anticipated to be present in the Kingfisher area (Kober, et al., 2010) (DTi, 2001) include:

- Northern Fulmar *Fulmarus glacialis* (All year);
- Northern Gannet *Morus bassanus* (All year);
- European Storm Petrel *Hydrobates pelagicus* (June to October);
- Pomerine skua *Stercorarius pomarinus* (March to June);
- Arctic skua *Stercorarius parasiticus* (May to August);
- Great skua *Stercorarius skua* (May to August);
- Black-legged kittiwake *Rissa tridactyla* (All year);
- Greater black-backed gull *Larus marinus* (Sept to March);
- Common gull *Larus canus* (July to February);
- Herring gull *Larus argentatus* (July to April);
- Guilliemot *Uria aalge* (All year);
- Little auk *Alle alle* (November to February); and
- Atlantic Puffin *Fratercula arctica* (April to September)

Of these species, the European storm petrel, and guillemot are both afforded protection under the EC Birds Directive (2009/147/EC).

Seabirds are particularly vulnerable to surface pollutants when they are gathering for the breeding season and when they undergo a moult of primary feathers. Sensitivity to oil pollution varies between different seabird species affected by *inter alia:* time spent sitting on water; habitat flexibility; seasonal presence; breeding productivity etc. (Webb, Elgie, Irwin, Pollock, & Barton, 2016). Diving seabird species are typically more sensitive to the effects of oil pollution than more aerial species such as gulls. In general, seabird vulnerability is highest in inshore waters. The Kingfisher infrastructure lies in an area of the CNS where available data is limited to inform the SOSI and where confidence in the sensitivity analysis is low (Webb, Elgie, Irwin, Pollock, & Barton, 2016).

Figure 3-18 summarises the monthly Seabird Oil Sensitivity Index (SOSI) in the area around the Kingfisher infrastructure, as documented within (Webb, Elgie, Irwin, Pollock, & Barton, 2016).

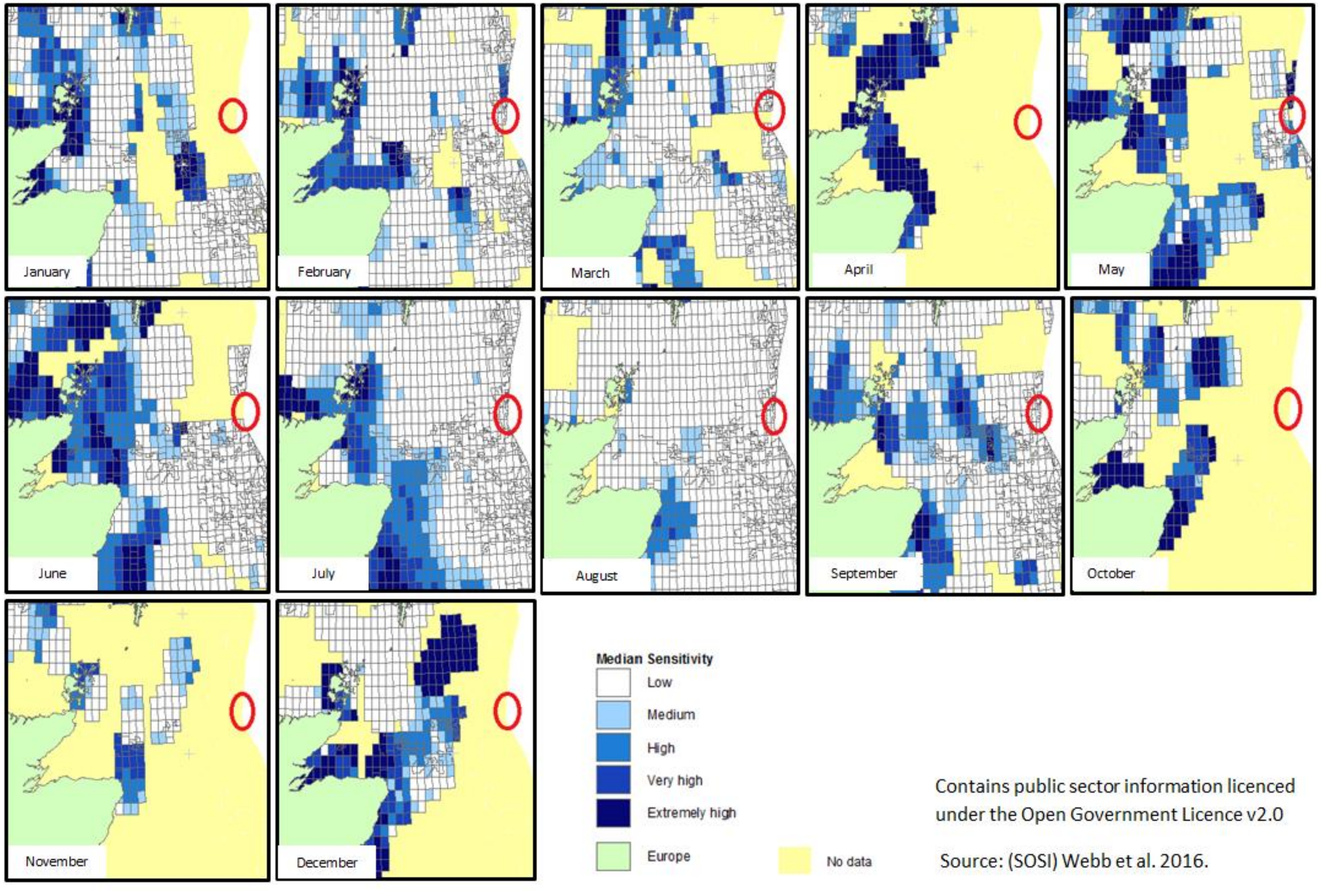


Figure 3-18: Monthly seabird oil sensitivity index for block 16/8 around the Kingfisher infrastructure

The limited presence of records of significant aggregations of seabirds in the area of the Kingfisher infrastructure through the year is considered to be of Low sensitivity to disturbance or impacts of pollution. It is worth noting however that whilst sensitivity is considered low in block 16/8 during both February and May, aggregated seabird density in adjacent blocks to the north indicated very high, or extremely high sensitivity to oil pollution.

The mean sensitivity SOSI data discussed above has been used to provide an indicative assessment of likely seabird vulnerability throughout the year. For blocks with 'no data', an indirect assessment has been made based upon guidance from JNCC (Webb, Elgie, Irwin, Pollock, & Barton, 2016). As can be seen from the data available in Figure 3-18 and the indirect assessment in Table 3-5, the sensitivity of seabirds to surface oil pollution in Block 16/8 and the immediately adjacent blocks is generally low from July to October and from January to March, and extremely high from April to June. There are no data available for November and December.

Table 3-5: SOSI and Indirect assessment in Block 16/8 and surrounding vicinity.

Block	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
16/2	5*	5	5	5*	5	5	5	5	5	5*	N	N
16/3	2*	2	5	1*	1	5	5	5	5	5*	N	N
16/7	5*	5	5	5*	1**	5*	5	5	5	5*	N	N
16/8	5*	**5**	**5**	**1***	**1**	**1***	**5**	**5**	**5**	5*	**N**	**N**
16/12	5*	5	5*	5*	5	5*	5	5	5	5*	N	N
16/13	5*	5	5*	N	1**	5*	5	5	5	5*	N	N

** Data taken from same block in adjoining month*

*** Data taken from adjacent block in same month.*

Key	1 = Extremely high	2 =Very High	3 = High	4 = Medium	5 = Low	N= No data

3.3.6. Offshore Conservation Areas and Protected Species

A network of Marine Protected Areas (MPAs) are in place to aid the protection of vulnerable and endangered species and habitats through structured legislation and policies. These sites include Special Areas of Conservation (SAC) and Special Protection Areas (SPA), designated under the EC Habitats Directive (92/43/EEC) and EC Birds Directive (2009/147/EC) respectively, along with Nature Conservation Marine Protected Areas (NCMPAs) designated under the Marine (Scotland) Act 2010 or the Marine and Coastal Access Act 2009. In addition, Scottish National Heritage (SNH) and JNCC list 81 species and habitats considered PMFs of conservation importance in Scotland's seas.

3.3.6.1. Designated Sites including Annex I Habitats

There are no designated Marine Protected Areas (MPA), including Natura 2000 sites, in the area of the Kingfisher infrastructure. The nearest designated site under the Habitats Directive (92/43/EEC) is the Braemar Pockmarks Special Area for Conservation (SAC) including the Annex I Habitat '*Submarine Structures made by leaking gases*' which is located approximately 22 km to the north of the Kingfisher manifold and approximately 20 km from the TAQA Bratani Ltd Brae Bravo platform.

The Braemar pockmarks are a series of crater-like depressions in the sea floor. Methane derived authigenic carbonate (MDACS) have been observed deposited within two of the recorded craters as a result of precipitation during the oxidation of methane gas. These structures provide a very specific rocky reef habitat supporting specific chemosynthetic organisms rarely seen elsewhere within the OSPAR North East Atlantic region. Within the UK this habitat is usually associated with large pockmarks formed through the expulsion of shallow gas. The Brae Area environmental survey (Marathon Oil, 2013) observed pockmarks out with the boundary of the Braemar pockmarks SAC around the flowlines from Braemar to East Brae platform.

No evidence of pockmarks in the seabed around the infrastructure, nor along the pipeline route to TAQA Bratani Ltd Brae Bravo has been documented within the available survey reports.

Figure 3-19 below shows the location of the nearest designated sites.

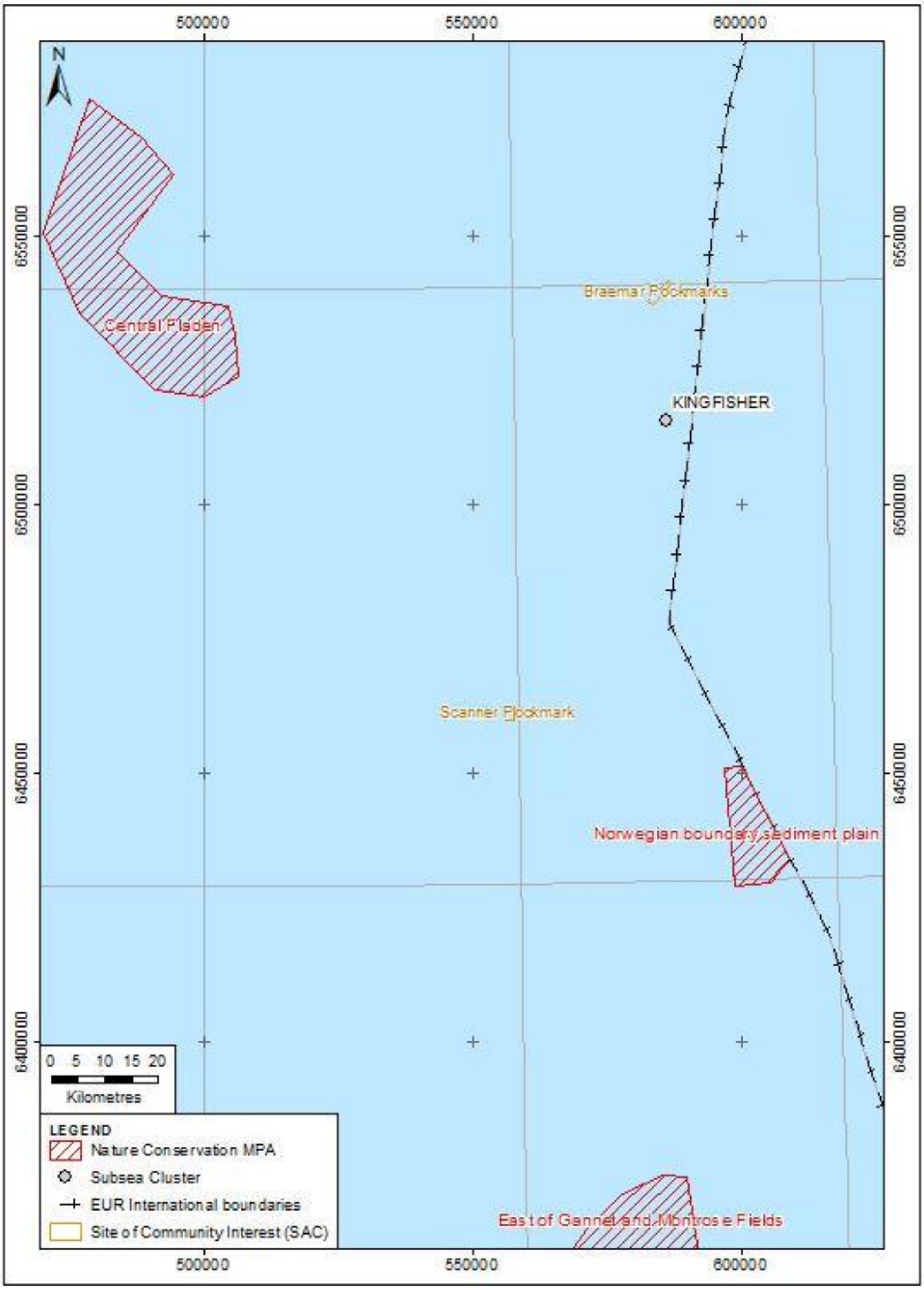


Figure 3-19: Designated Sites

3.3.6.2. Annex II Species

Harbour porpoise as well as the grey seal and the common seal are specifically identified as protected species under Annex II of the Habitats Directive (92/43/EEC). All cetaceans are protected under Annex IV of the Habitats Directive, as well as Appendix II of the Bern Convention and under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended). Under the Offshore Marine Conservation (Natural Habitats, &c.) Regulations, it is an offence to deliberately disturb any European Protected Species (EPS), or to capture, injure or kill an EPS at any time.

Cetaceans and pinnipeds (at low densities) are the only EPS likely to occur in the area.

3.3.6.3. OSPAR Threatened and/or Declining Habitats and Species / Priority Marine Features (PMFs)

'Seapen and burrowing megafauna in circalittoral fine muds' is a habitat included within (OSPAR, 2008) as a threatened and/or declining habitat.

This habitat is described as 'Plains of fine muds, at water depths ranging from 15 to 200 m, which are heavily bioturbated by burrowing megafauna: burrow and mounds may form a prominent feature of the sediment surface with conspicuous populations of sea-pens, typically *Virgularia mirabilis* and *Pennatula phosphorea*. The burrowing crustaceans present may include *Nephrops norvegicus, Calocaris macandreae* or *Calinassa subterranean*. The burrowing activity of megafauna creates a complex habitat, providing deep oxygen penetration. This habitat occurs extensively in sheltered basins of fjords, sea lochs, voes and in deeper offshore waters such as the North Sea and Irish sea basins, and the Bay of Biscay. (OSPAR, 2010). Point source locations identified as representing the OSPAR burrowing megafauna communities habitat in the CNS are shown on Figure 3-20 above (EMODNet, 2017). Clarification to the definition of this habitat (JNCC, 2014) indicates that where burrows and/or mounds which may be attributable to these species are observed, the habitat should be considered representative of sea pen and burrowing megafauna communities.

As a result of observations during seabed survey (Fugro Ltd, 2018) (Marathon Oil, 2013) (section 4.2.1) there is the potential for the presence of the OSPAR listed threatened and or declining habitat 'Seapens and burrowing megafauna communities' to occur within the Kingfisher survey area.

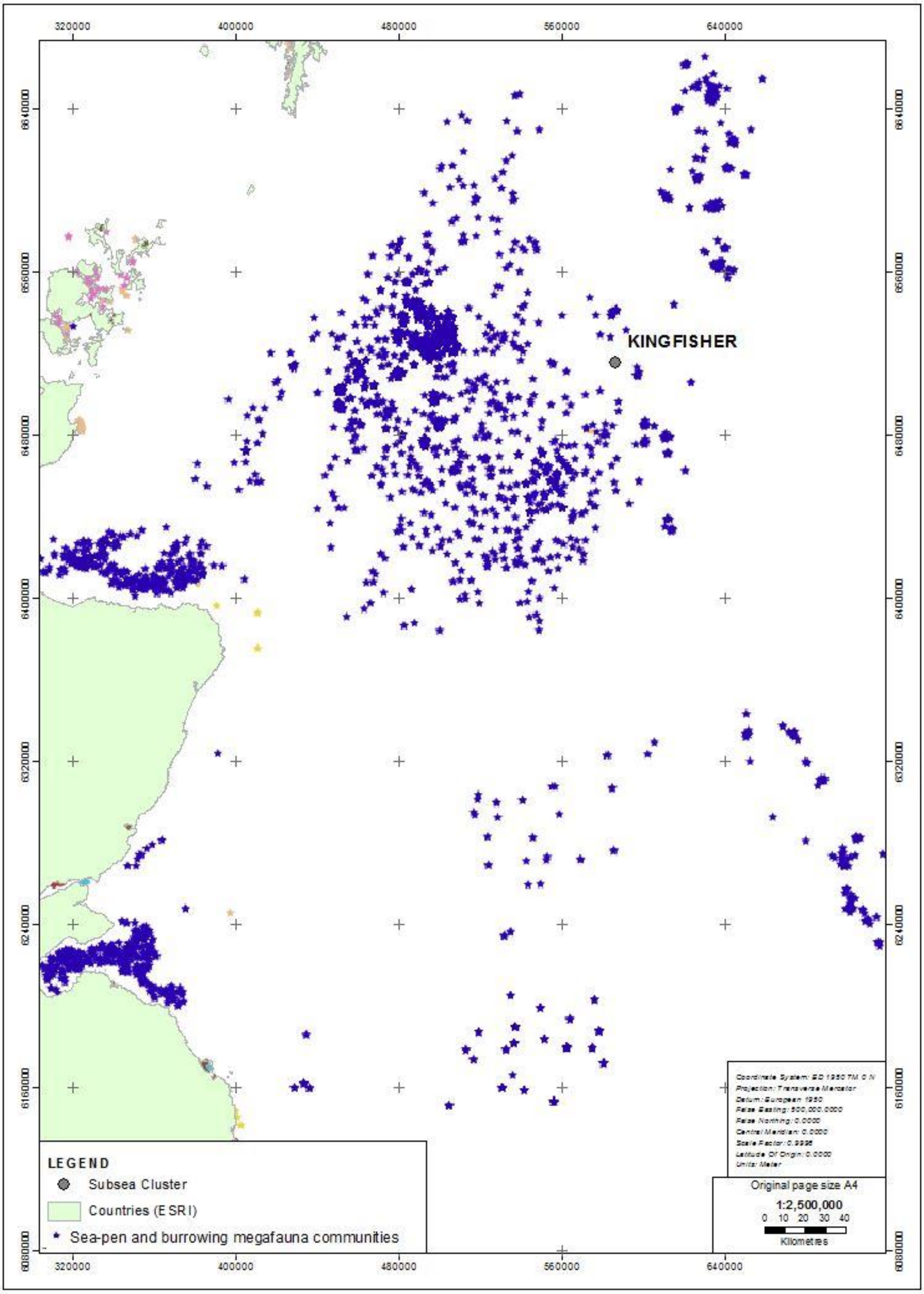


Figure 3-20: OSPAR Seapen and burrowing megafauna community habitats in CNS

3.3.6.4. Mobile PMFs

It is noted that a number of marine mammals and fish species (including elasmobranchs) as discussed in **Sections 3.4.3** and 3**.4.4** are also listed as PMF. These species are shown in Table 3-6**.**

Table 3-6: Mobile Scottish PMF Species in the vicinity of Kingfisher Infrastructure

Taxonomic Group	Species	
Cetaceans	Harbour porpoise	*Phocoena phocoena*
	Atlantic white sided dolphin	*Lagenorhynchus acutus*
	White beaked dolphin	*Lagenorhynchus albirostris*
	Killer Whale	*Orcinus orca*
	Minke whale	*Balaenoptera acutorostrata*
Seals	Harbour seal	*Phoca vitulina*
	Grey seal	*Halichoerus grypus*
Fish	Basking shark	*Cetorhinus maximus*
	Atlantic Herring	*Clupea harengus*
	Porbeagle shark	*Lamna nasus*
	Blue whiting	*Micromesistius poutassou*
	Atlantic mackerel	*Scomber scombrus*
	Norway pout	*Trisopterus esmarkii*

3.4. Human Environment

This section focuses on the broader socio-economic elements of the existing baseline in the area around the Kingfisher Infrastructure.

3.4.1. Commercial Fisheries

The Kingfisher infrastructure is located within ICES rectangle 46F1. The importance of an area to the fishing industry is assessed by measuring the fishing effort which may be defined as the number of days (time multiplied by fleet capacity (tonnage and engine power), landing values and tonnage of catch. It should be noted that fishing activity may not be uniformly distributed over the area of the ICES rectangle. Effort and landings data for UK vessels greater than 10 m for each ICES rectangle are available from the Scottish Government (Scottish Government, 2017).

UK reported landings for ICES rectangle 46F1 as well as for the adjacent ICES rectangles are summarised in Figure 3-21 below

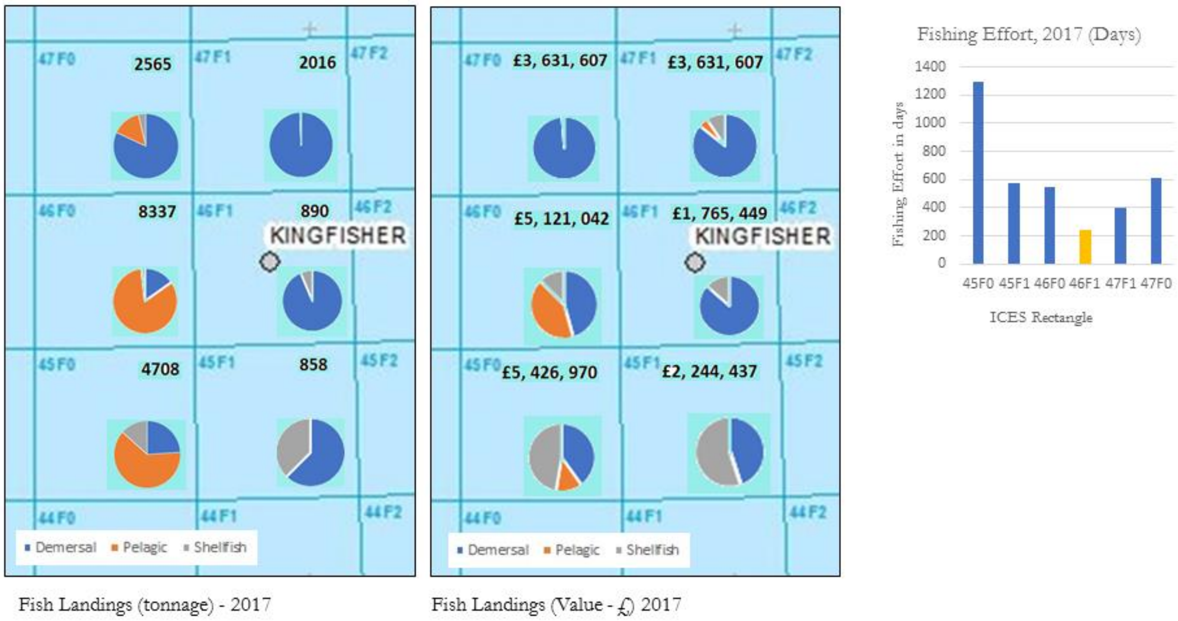


Figure 3-21: Commercial Fisheries Landing data for vessels over 15m in length (2017)

The total effort for all ICES rectangles in UK waters is 131,871 days, with some ICES rectangles recording over 1,000 days. As such rectangle 46F1 represents 0.18% of the total UK fishing effort and can be considered low.

Gear types associated with this effort is dominated by bottom trawls as well as mid-water trawls particularly in 46F0 adjacent and to the west of the Kingfisher infrastructure. Some use of seine nets is also recorded in 47F1, to the north of the Kingfisher infrastructure.

In addition, using data provided by the Scottish Government (Marine Scotland, 2018) and also in (Kafas, Jones, Watret, Davies, & Scott, 2012) an estimated fishing effort (vessel days) in ICES 46F1 is also shown, in Table 3-7 for UK vessel less than 10 m in length.

Table 3-7: Monthly Fishing Effort

ICES	Monthly fishing effort (1)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
46F1	15	18	51	5	16	8	13	31	14	47	8	13	239(2)
UK total													131,871(2)
46F1 as % of UK													0.18

Notes: [1]Monthly effort data are shown where five or more UK vessels over 10 m undertook fishing activity in a given year. Where less than five such vessels undertook fishing activity in a given month, the data are "disclosive" (D) and not shown. Where data is not available a – has been provided. [2]Total includes disclosed data, thus total presented here is less than actual landings reported.

Fishing intensity data relating to frequency of interactions with seabed pipelines is also provided by the Scottish Government (Marine Scotland, 2018). Figure 3-22 below summarises data relevant to Kingfisher pipelines and indicates that an average of less than 5 VMS tracks per week were recorded between 2007 and 2015, indicating a low intensity of fishing activity over the Kingfisher pipelines.

Figure 3-22: Fishing Intensity over Kingfisher pipelines (Marine Scotland, 2018)

3.4.2. Commercial Shipping and Navigation

The North Sea contains some of the world's busiest shipping routes, with significant traffic generated by vessel trading between ports at either side of the North Sea and the Baltic. Shipping activities in the North Sea are categorised to have either: very low; low; moderate; high; or very high shipping densities. (Oil and Gas Authority, 2017).

Shipping activity in the area around the Kingfisher infrastructure is classified by the (Oil and Gas Authority, 2017) as low. An average weekly density of non-port service vessels is recorded in the adjacent block 16/7 which coincides with the location of TAQA Bratani Ltd's Brae Alpha and Bravo platforms. This is consistent with rig supply vessel activity which would be expected. A preferred North Sea cargo vessel transit route is evident passing on an east-west orientation approximately 40 km to the south of the area of the Kingfisher infrastructure. These are shown on Figure 3-23 below.

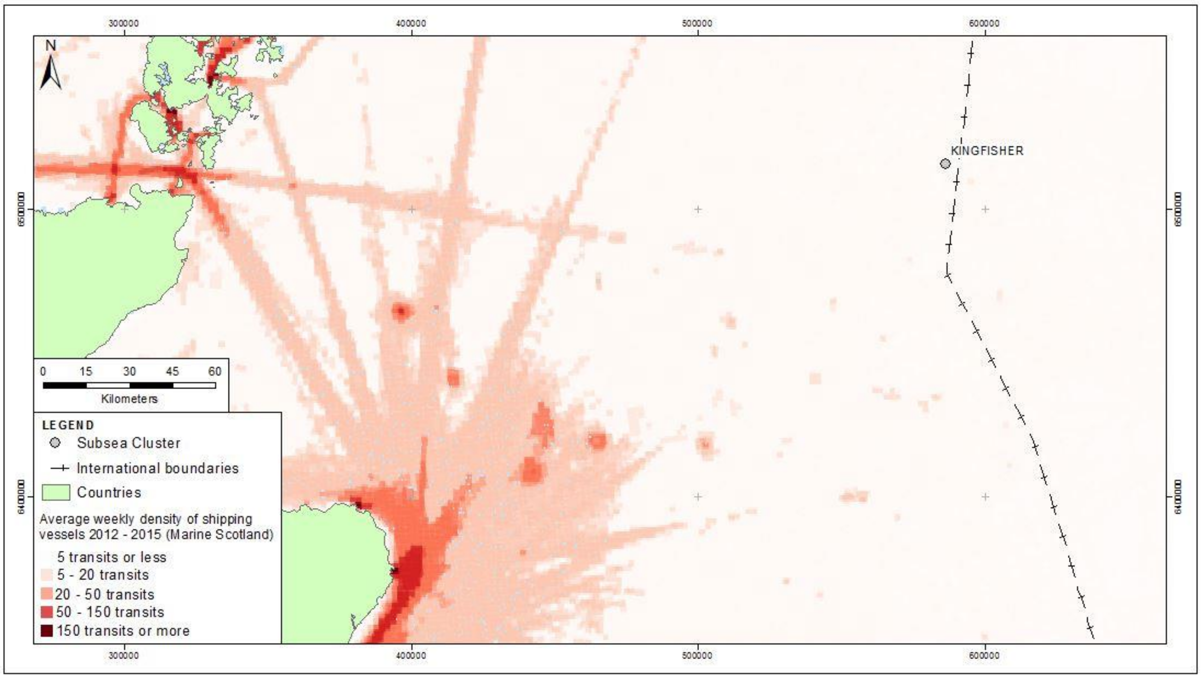


Figure 3-23: Shipping Density in the area around Kingfisher infrastructure

3.4.3. Oil and Gas Activity

The Kingfisher infrastructure forms part of an integrated and extensively developed oil and gas infrastructure network in this part of the CNS. The Kingfisher infrastructure itself ties back to TAQA Bratani Ltd's Brae Bravo platform approximately 9 km to the west of the Kingfisher manifold. TAQA Bratani Ltd's Brae Alpha platform is located approximate 15 km south west, with BPs Miller platform (currently being decommissioned) approximately 7.5 km south west of the Kingfisher manifold. TAQA Bratani Ltd's East Brae platform is located approximately 12 km to the north.

Other nearby Oil and Gas infrastructure is shown in Figure 3-24.

3.4.4. Other Sea Users

There are no records of telecommunication cables, defence activities, offshore windfarm locations, Scheduled Monuments or Historic Marine Protected Areas within the area of the Kingfisher infrastructure. A previously used alignment for a historic telecommunications cable is recorded running parallel to the Heimdal pipeline and crossing the kingfisher pipeline approximately 4.5 km from the Kingfisher manifold.

A single record of a 'wreck' is recorded (Marine Scotland, 2018) however further investigation of this record indicates the presence of an abandoned piece of pipeline/dropped object as a result of previous oil and gas activity.

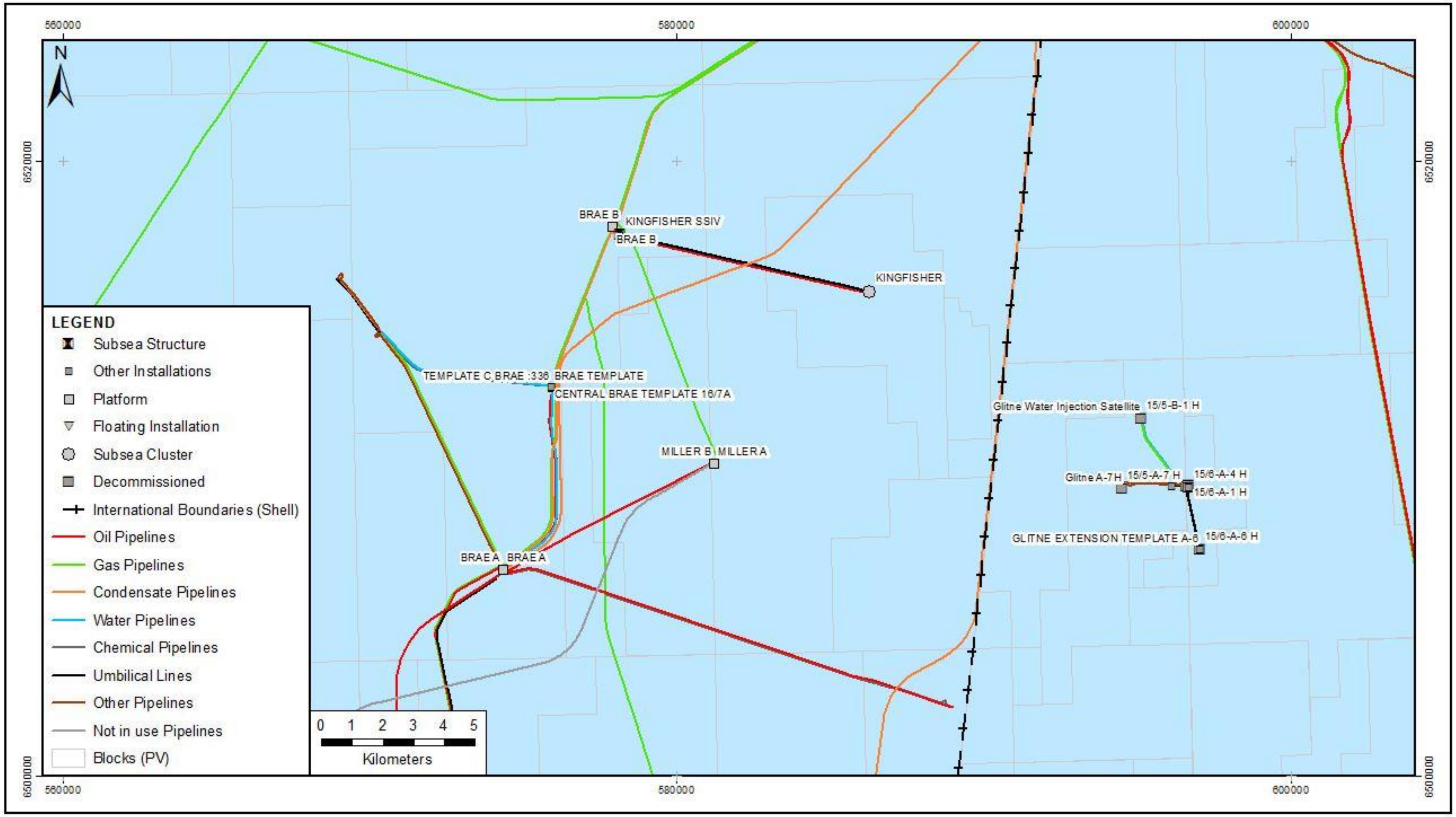


Figure 3-24: Other nearby Oil and Gas infrastructure

4. Environmental Scoping and Stakeholder Engagement

4.1. Environmental Impact Identification (ENVID)

An Environmental Impact Identification (ENVID) was undertaken during the early stages of decommissioning planning, to identify potential environmental hazards, or' aspects' associated with the various operations related to decommissioning of the Kingfisher infrastructure.

An ENVID workshop was held on 29th May 2018 the objectives of which were to: identify potential environmental aspects of the Project; identify controls in place to prevent adverse environmental effects; and identify further actions to identify, prevent or mitigate effects.

The scope of the project considered during the ENVID reflected the emerging Decommissioning Programmes at the time the ENVID was completed. The scope of the ENVID workshop also reflected the outcomes of the pipeline Comparative Assessment workshops held on 5th March 2018 and also on 24 May 2018.

The ENVID reviewed potential for project interactions with a range of environmental aspects including: Discharges to Air (gaseous emissions); Discharges into water; Discharges to soil/seabed; Waste materials; Disturbance to soil/seabed; Use of raw materials, additives and materials; water consumption; energy consumption; usage of space; radiation (heat and ionizing); noise and vibrations; smell/odour; light; aesthetics; biodiversity; commercial fisheries; commercial shipping and navigation; and marine archaeology.

Outcomes from the ENVID process were recorded within an ENVID matrix and used to guide and focus further environmental considerations. **Appendix A** provides a summary of the ENVID outcomes.

Of those aspects considered during the ENVID, potential activity interactions were identified with the following:

- Discharges to Air (gaseous emissions);
- Discharges to Water (Sea);
- Disturbance to Soil/Seabed;
- Waste Materials;
- Noise and Vibration;
- Smell/odour;
- Biodiversity; and
- Commercial fisheries.

These potential interactions are explored further throughout the remainder of this report.

4.2. Impact Assessment Scoping

Following ENVID, an additional scoping exercise was completed to further evaluate the potential for significant environmental effect on the environmental aspects identified above.

Environmental aspects considered, but scoped out from detailed assessment included:

- Discharges to Air (gaseous emissions); and
- Noise and Vibration.

Justification for this scoping decision in relation to these two environmental aspects is set out in **Section 4.4** below.

In some cases, consideration of environmental aspects identified certain activity interactions which were not considered likely to result in significant effect. These activity interactions were therefore scoped out from detailed assessment.

Other activity interactions were however taken forward for further consideration. This was the case with the following Environmental aspects:

- Discharges to Water (Sea) (see **chapter 5**);
- Disturbance to soil/Seabed (see **chapter 6**);
- Waste Materials (see **chapter 8**); and
- Smell/odour (see **chapter 8**).

In addition, the risk of unplanned events is further considered within **Chapter 7.**

Where appropriate, the potential for cumulative effects with other third-party DP activities, specifically with TAQA Bratani Ltd's DP activities for the Brae Area infrastructure, has been considered throughout the above appraisals.

Biodiversity and impacts on other sea users, including Commercial fisheries are considered throughout the above appraisals, as environmental receptors to the environmental aspects identified above.

4.3. Stakeholder Engagement

Consultation was completed with key environmental stakeholders during the scoping process. A consultation meeting was held on 27th July 2018, at which the proposed scope of the EA was presented and discussed. Attendees included representatives from Marine Scotland (MS); Joint Nature Conservation Committee (JNCC); Scottish Fishermen's Federation (SFF). Written consultation was also completed with representative from BEIS.

4.4. Environmental aspects Scoped out from detailed assessment

4.4.1. Discharges to Air

4.4.1.1. Vessel Emissions

At the time of writing, the decommissioning campaign is currently in the planning phase. For the purposes of this assessment a reasonable worst-case total of 42.5 vessel days has been estimated, comprising 9.5 Survey Vessel days; 15 days of Dive Support (DSV) vessels; 11.5 days of ROV support vessels; and 6.5 days of heavy crane (HCV) vessels.

Vessel activities will give rise to emissions of a range of gaseous combustion products including carbon dioxide (CO_2), sulphur dioxide (SO_2), and oxides of nitrogen (NOx) as well as trace quantities of unburned hydrocarbons. Emissions of SO_2, NOx, and trace unburned hydrocarbons reduce air quality locally, including through contributing to low level ozone concentrations. Emissions of SO_2 and NOx lead to formation of respective acids, contributing to acid rain on a regional scale. Emissions of CO_2 and CH_4 both contribute to global greenhouse gas (GHG) emissions, and ultimately to climate change.

Emissions of SO_2, NOx and VOC will contribute to reduced air quality in the vicinity of the vessels' location. The activities will be of localised extent, of relatively short duration and will take place a significant distance (c. 100 km) from the nearest coastline. In general, prevailing metocean conditions would be expected to lead to the rapid dispersion and dilution of the emissions resulting in localised and short-term impacts on air quality, typical of general shipping.

All vessels will comply with MARPOL 73/78 Annex VI on air pollution; and will comply with relevant air pollution regulations (The Offshore Combustion Installations (Prevention and Control of Pollution) (Amendment) Regulations 2007.

On this basis whilst vessel emissions will occur they will be kept As Low as Reasonably Practicable (ALARP) and are considered likely to be of minor magnitude. No significant effect as a result of atmospheric emissions is anticipated.

This activity interaction has been scoped out from further consideration within the EA.

4.4.2. Underwater Noise

Ambient noise in the marine environment is background sound generated by natural parameters including wind, waves, rain, marine organisms etc, as well as human activities including background shipping traffic (Hildebrand, 2009). The characteristics of the sound produced, in terms of amplitude, range of frequencies and temporal features varies with the type of activity and equipment. Ambient noise levels in the area around the Kingfisher Infrastructure are expected to be dominated by natural sound sources and by existing vessel noise.

Sensitive noise receptors in the area around the Kingfisher infrastructure are anticipated to be marine mammals and fish.

Noise generating activities associated with Kingfisher decommissioning are anticipated to be limited to cutting and lift activities; additional rock placement; and decommissioning vessel movements. No high energy noise sources such as blasting, piling activities or deep sediment penetration seismic survey are anticipated to be required.

4.4.2.1. Underwater noise from pipeline and infrastructure cutting in preparation for lift

Cutting activities will be required to facilitate removal of subsea infrastructure. This may potentially include cutting of pipelines to be removed into sections suitable for direct lift recovery.

The Kingfisher manifold is fixed to the seabed through four 610 mm diameter piles. These will require to be cut. Wellhead removal will also be completed using non-explosive cutting techniques.

Several different underwater cuttings methods may be employed during decommissioning operations, including:

- Abrasive water jetting – using a high-pressure jet of water and a sand and grit mix directed onto the item to be cut;
- Diamond wire cutting – using a continuous loop of diamond wire mounted onto a pully system, which enables a continuous, clean cut to the achieved;
- Hydraulic shears – used for cutting smaller items of up to 1.4m diameter.

Cutting activities will be short term, intermittent and will generate slight underwater noise. In addition, underwater sound levels as a result of cutting activities are expected to be influenced by vessel noise from the associated support vessel(s) as well as by the noise associated with the cutting itself.

There are currently little published data on the sound generated by underwater cutting or other tools. Peak source levels of 148 to 180 dB re 1 μPa have been reported for a range of diver operated tools including drills, saws, waterjets etc. in a frequency range 200 to 1000Hz (Anthony, Wright, & Evans, 2009).

Whilst there is no published information on the response of marine mammals or fish to sound generated by underwater cutting, JNCC acknowledge that "non-explosive cutting technology produces relative little noise production" (JNCC, 2008).

No significant effect from cutting activity is anticipated. This activity interaction has been scoped out from further consideration within the EA. Noise from vessel activity is considered in section 4.4.2.3 below.

4.4.2.2. Underwater noise from rock placement

Rock placement will be completed by a specialist fall pipe vessel, or similar which will allow accurate placement of rock on the seabed. It has been assumed that this vessel will hold station during rock placement activities using dynamic positioning. Underwater sound levels as a result of this activity are expected to be dominated by vessel noise rather than the noise associated with the rock placement itself (Nedwell & Edwards, 2004).

No significant effect from underwater noise generated during rock placement, over and above any impact anticipated from the rock placement vessel noise is anticipated (see section 5.1.4.3 below). (JNCC, 2008). This activity interaction has been scoped out from further assessment within the EA.

4.4.2.3. Underwater noise from vessel activity

Vessel noise is the largest contributor to ambient low frequency noise in the marine environment. In general vessel noise is continuous as a result of propeller operation, propulsion and other machinery with an estimated 85% of vessel noise resulting from propeller cavitation (Barlow & Gentry, 2004). Shipping activity in the immediate area around the Kingfisher infrastructure is classified as low (OGUK, 2017)) and dominated by rig supply and fishing vessels. A preferred cargo vessel transit route is evident passing on an east-west orientation approximately 40 km south of Kingfisher.

Underwater noise receptors considered include both marine mammal and fish and any impact from underwater noise is dependent on both the nature of the sound and the acoustic sensitivity of the receptor. The ambient underwater sound levels are already influenced by background levels of vessel activity both in the local area, and also across the wider CNS, and it is anticipated that marine mammals and fish receptors are already subject to a degree of habituation and tolerance of vessel noise.

An estimated total of 126 vessel days is required to complete the decommissioning activities and would be short term and intermittent. Single short-term operations resulting in temporary sporadic disturbance including from short term vessel noise are not considered likely to impair the ability of an animal to survey, reproduce etc. nor result in significant effects on the local abundance or distribution. (JNCC, 2010).

Of the vessel types anticipated to be required, the greatest noise signature and propagation is anticipated from the Heavy Crane Vessel (HCV), estimated required for 42 days in total. Previous noise propagation studies (Xodus (2014) reported in (Marathon Oil, 2017) indicate that underwater noise disturbance from a heavy crane vessel resulting in behavioural alterations within sensitive receptors may extend up to 3 km from source.

Impacts associated with vessel activity are likely to be temporary. Should displacement or disturbance occur to an individual it is considered likely that these individuals would recover and return to the location following cessation of the decommissioning activity.

No significant effect is anticipated. This activity/receptor interaction has been scoped out from further consideration within the EA.

5. Discharges to Sea

5.1. Activity/Environment interactions scoped out from detailed assessment

5.1.1. Release of residual hydrocarbons, chemicals etc. from cleaned pipelines

The two 10” production pipelines have been flushed and cleaned from the Marathon Oil (now TAQA Bratani Ltd) Brae Bravo platform (July 2018). The two pipelines are connected by a pigging loop at the Kingfisher manifold, which has allowed the pipelines to be flushed from, and back to, the existing processing unit on TAQA Bratani Ltd Brae Bravo Platform. Flushing and cleaning was completed immediately on Cessation of Production (CoP) at Kingfisher (July 2018). This activity was delivered under Marathon Oil’s existing operational permitting regime at Brae Bravo. Water quality sampled from fluid exiting the pipeline and achieved an oil in water (OIW) concentration of 3.8 mg / l. Note: the production pipelines have since been disconnect from the manifold structure[7]. This activity was monitored by divers and ROV. No discharge was observed.

In addition, residual discharge quantities, should they occur, will be very small. Studies of releases of much larger quantities of oil contaminated waters (production stage produced waters) have consistently demonstrated that effects on pelagic organisms will be limited to the immediate area around the release point as a result of the effects of rapid dilution and short exposure times (Bakke, Klungsoyr, & Sanni, 2013) (OSPAR, 2014).

No significant effect as a result of any residual release is expected. This activity interaction has therefore been scoped out from further consideration within the EA.

5.1.2. Release of hydrocarbons, chemicals etc. from unflushable umbilicals

All umbilical cores originally designated for Methanol use for Kingfisher have been successful flushed to seawater. Remaining hydraulic lines will be flushed to appropriate standards, prior to decommissioning. A small number or cores containing water-based fluid (Oceanic HW 540) have been identified as unflushable as they do not have any injection or round trip configuration. In addition, 2 hydraulic fluid return cores in the main umbilical were determined to have been blocked during operations. The reason for this blockage is unknown. These cores contain up to 2.7 m^3 of mineral oil (Micronic SV3). During disconnection it is anticipated that these cores will be cut, and some or all of their contents may be released to the water column over time. This activity will be carried out under licence under the Offshore Chemicals Regulations 2002 (as amended) for which a Chemical Risk Assessment will consider the potential impact via Osborne Adams modelling.

The potential for significant effect associated with these releases has been assessed using Osbourne Adam (OA) toxicity calculations [8] which showed that T1>T2 for all proposed releases, therefore these calculations concluded that volumes discharged are expected to be an acceptable risk. Additionally, none of the substances anticipated to be released fall within defined applicable environmentally toxic hazard categories.[9] These results will be included in the permitting activity under the Offshore Chemicals Regulations 2002 (as amended)

[7] Completed under Pipeline Works Authorisation (PWA) 22/W/97

[8] Calculations were based on a ‘worst-case’ assumption of a single release of all umbilical core content.

[9] Hazard categories H401; H40; H41; H411 as defined under the Globally Harmonised System (GHS) for the classification and labelling of chemicals. United Nations. 2017.

No significant effect is expected. This activity interaction has therefore been scoped out from further consideration within the EA.

5.1.3. Dropped Objects

Objects to be recovered by lifting to vessel deck during Kingfisher decommissioning range from small objects such as grout bags, to concrete mattresses, pipeline sections, with the largest single piece of infrastructure to be lifted being the Kingfisher manifold structure.

The primary environmental impact under these circumstances would be seabed disturbance (see chapter 6 below), with the most significant potential impact arising should the Kingfisher manifold be dropped as a result of integrity failure during its removal. However, with no live oil and gas infrastructure in the vicinity, the impact is considered to be low with minimal, localised seabed disturbance.

No significant effect is anticipated. This activity interaction has therefore been scoped out from further assessment within the EA.

5.1.4. Routine vessel discharges

At the time of writing it is not yet known which vessels will be used to deliver the Kingfisher infrastructure decommissioning.

All vessels used will be subject to vessel inspection under the terms of the Oil Companies International Marine Forum (OCIFM) vessel inspection (OVIQ2) and Maritime Contractors Health, Safety, Security and Environment (HSSE) Capability Review. These include (*inter alia)* consideration of reliability and maintenance standards, navigational safety, emergency preparedness and contingency planning and compliance with the International Convention for the Prevention of Pollution from Ships (MARPOL) and International Maritime Organisation (IMO) standards for sewage discharge, garbage management, ballast water management and emissions control.

Routine discharges of vessel's sanitary waters and ballast water are subject to specific requirements under MARPOL (Annex IV) and the International Convention on the Control and Management of Ships Ballast Waters and Sediments. These minimise the potential impact on the water column from these shipping activities.

No significant effect is anticipated. Potential impacts from routine vessel discharges have been scoped out from further assessment within the EA.

5.2. Decommissioning of Plastics 'in situ'

The Kingfisher infrastructure includes an estimated 98 tonnes of plastics in the form of pipeline coatings and umbilicals with an estimated 93 tonnes of plastics anticipated to be decommissioning '*in situ*'.

Plastics are synthetic, organic polymers composed of long, chain molecules with a high average molecular weight (Law, 2017). An estimated 80% of marine plastic pollution is from land- based sources. (Summerhayes, 2011) and is released into the surface layers of the marine environment, where it remains buoyant until or unless it subsequently becomes waterlogged or fouled with marine life, causing it to sink. (Barnes, Galgani, Thompson, & Barlaz, 2009). By contrast the plastics to be decommissioned *in situ* from Kingfisher, are in the form of pipeline coatings and umbilicals. Plastics in the pipeline coatings, comprise both polyurethane and polypropylene types. They may also contain additional compounds specifically added to the plastic compound in order to enhance certain properties such as flexibility, durability etc. Where pipelines and umbilicals are to be decommissioning *in situ* they will be trenched and buried within the seabed or covered with rock protection.

Degradation of plastic polymers can occur through both abiotic or biotic pathways. Abiotic degradation usually precedes biotic degradation and can be triggered thermally, hydrolytically or by UV-light in the environment. (Gewert, Plassmann, & MacLeod, 2017). Exposure to sunlight and oxidising conditions typically causes initial weathering of the polymers, leading to degradation. The degree of exposure to these conditions is also an important rate-determining factor for degradation (Gewert, Plassmann, & MacLeod, 2017). Lower temperatures and reduced UV exposure with increasing water depth and decreasing oxygen levels in the marine environment, as could be expected in the seabed around the Kingfisher infrastructure, results in a significantly slower degradation rate, than would be expected on land (Summerhayes, 2011). In the case of plastics from Kingfisher, including polyurethane and polypropylene with a carbon-carbon backbone, extensive abiotic degradation would be required to break the plastics into much smaller pieces, before any risk of plastic particles becoming bioavailable to surrounding benthic organisms would be realised (Gewert, Plassmann, & MacLeod, 2017).

External corrosion of pipeline coating and umbilicals would most usually be expected in localised areas where there are defects or damage in the coating, or where the coating has become disbonded from the pipe. Corrosion is therefore expected to present as localised pits, which will eventually result in irregular perforations throughout the pipeline length. Structural degradation will be long-term as a result of this corrosive process, until the eventual collapse of the pipelines under their own weight and buried beneath the overlying sediment.

Degradation of plastics decommissioned *in situ* is consequently expected to occur extremely slowly, with degraded plastic products localised and contained within the seabed sediments. Any long term release of plastics or breakdown products to the water column or benthic environment could be expected to be minimised by sediment containment, and highly diffused.

Given the characteristics and nature of expected degradation, effects will be of slight or minor magnitude, primarily affected a benthic community of low sensitivity. Effects from the decommissioning of Kingfisher plastics *in situ* on the receiving marine environment are considered to be of minor significance.

5.3. Disturbance to Drill Cuttings

The Stage 1 assessment requirements set out within OSPAR Recommendation 2006/5 requires all drill cuttings piles in the North Sea to be evaluated against the following threshold criteria:

- Rate of oil loss to water column: 10 tonnes per year
- Persistence as a reflection of the area of seabed where oil concentrations remain above 50 ppm and the length of time that the contamination level is expected to remain. 500 km^2yr

The rate of oil loss from the Kingfisher drill cuttings pile has been calculated as 1.16 tonnes per year, which is significantly below the above listed OSPAR threshold of 10 tonnes per year.

Exceedances of the 50 ppm threshold have been observed in three of the six core samples taken from within the drill cuttings pile (Fugro Ltd, 2018). Observed exceedances were not uniformly distributed across the drill cuttings pile and were seen at varying depths. Notwithstanding this, the anticipated area of seabed surrounding the Kingfisher cuttings pile where concentrations of oil may currently exceed 50 ppm has been conservatively interpreted based on these sampling results and assuming a linear regression in THC concentration with distance from wells. For the purposes of this assessment at worst case, it is estimated that THC concentrations may exceed the 50ppm threshold up to a maximum of 215 m from the wells. Using the (UKOOA, 2005) conversion factor, a persistence of drill cuttings contamination has been calculated at a maximum of 10.3 km^2yr. This is significantly below the above listed OSPAR threshold of 500 km^2yr.

Samples from within the drill cuttings pile returned concentrations of certain metals, including Mercury (Hg), Lead (Pb) and Zinc (Zn) above the OSPAR Effects Range Low (ERL) thresholds (OSPAR, 2014). Measured levels of Iron (Fe) and Nickel (Ni) within the drill cuttings pile cores were consistently above the CNS background mean. Levels of Fe in four of the five sample cores exceeded the CNS background 95th percentile.

Samples the from drill cuttings pile were also analysed for the presence of endocrine disruptors comprising polychlorinated biphenyls (PCB), organotins and Alkylphenol ethoxylates (AP/APE) (Fugro Ltd, 2018). These are discussed further below.

5.3.1. Anticipated Mechanisms of Disturbance to Drill Cuttings

Evidence from drilling records at the time of field opening, as well as from available bathymetry survey data indicates that the drill cuttings are deposited beneath, immediately adjacent to, and in some cases overlying the wellhead and manifold infrastructure and associated jumpers and stabilisation structures. An estimated 10% of the drill cuttings by weight were deposited after the Kingfisher infrastructure was installed. This 10% is estimated to comprise approximately 26% of the Oil Based Muds (OBM) deposits[10]. As a result, a degree of disturbance of drill cuttings deposits during decommissioning is considered likely to be unavoidable, particularly when wellhead cutting, and removal operations take place as well as a consequence of activities required to cut the manifold fixing piles and to facilitate the lift of the manifold infrastructure.

[10] Muds using base-oil, plus water or brine as an emulsion (Hudgins, 1994)

For the purposes of this assessment an anticipated 'work area' has been assumed incorporating the seabed within an approximate 2.5 m radius from each wellhead representing approximately 264 m^3 of drill cuttings. In addition, drill cuttings will also be disturbed as a result of cutting of the manifold piles and the subsequent lift of the manifold structure and associated jumpers, surface laid section of export pipelines on approach to the manifold as well as pipeline protection structures (mattresses, grout bags etc.) It has been assumed that all drill cuttings within this combined 'work area' will be disturbed as a result of removal activities. This represents an estimated <20% of the visibly defined drill cuttings pile (as referenced within the DPs). Within this work area, it has also been assumed for assessment purposes that drill cuttings at all depths within the pile will be disturbed. Remaining drill cuttings will be left un- or minimally disturbed as it is not intended to complete any overtrawl fishing survey(s) within the immediate vicinity of the drill cuttings pile.

5.3.2. Potential contaminant dispersion characteristics

Disturbance of contaminated sediments as a result of the removal of Kingfisher infrastructure will result in some mobilisation and resuspension of contaminated sediments into the local water column. As it is not proposed to dredge sediments prior to removal, it has been assumed that sediments will be resuspended at the point of disturbance. Re-suspension is likely to be short term with the largely sandy sediment resettling rapidly with distance from point of disturbance.

Drill cutting dispersion modelling has not been completed specifically for disturbance of Kingfisher drill cuttings, however evidence from other drill cuttings piles, from academic study, and from other offshore industry experience indicate that resettlement can reasonably be anticipated within approximately 400 m of point of suspension and that the majority of hydrocarbons will remain bound to those sediments thereby limiting the potential for any significant increase in hydrocarbon in water levels (BMT Cordah, 2013) (OSPAR , 2009).

5.3.3. Potential for eco-toxicology effects on benthic communities

Analysis of benthic survey data (Fugro Ltd, 2018) indicates a relatively high abundance of the hydrocarbon tolerant thasirid mollusc *Adontorhina similis* within a cluster of samples (cluster B including four sample stations located up to 250 m from the Kingfisher manifold and drill cuttings. However, this cluster also included the two reference stations both located over 8 km away from Kingfisher. By contrast the heavy metal tolerant polychaete *Hetermnastus filiformis* was observed in low abundance in the same four sample stations. Several hydrocarbon tolerant taxa were observed within the top ten most abundant taxa across the survey area including the hydrocarbon tolerant, but metals intolerant polychaete *Paramphinome jefferysii* (Hiscock, Langmead, Warwick, & Smith, 2005). Despite this, no correlations were demonstrated between existing hydrocarbon contaminants and the macrofaunal community.

5.3.3.1. Total Hydrocarbons (THCs)

As discussed above, disturbance to drill cuttings would be expected to result in the localised mobilisation of particle-bound contaminants potentially also with limited increased leaching of hydrocarbon contamination to the water column. THC concentrations above EET (OSPAR, 2006) have been recorded within five samples, ranging between the surface sediment layer (<10cm below the surface) to >70cm below the surface, in three locations within the existing cuttings piles (KC01, KC03 and KC05, Figure 3-2 and Figure 3-3). Two of these locations lie within the estimated 1851 m^3 of residual drill cuttings at Kingfisher anticipated to be disturbed during decommissioning activities. As a result of the disturbance a temporary increase in bioavailability of identified hydrocarbons, particularly to localised benthic fauna may therefore be expected.

Previous North Sea environmental monitoring indicates that the bioavailability of hydrocarbons are mainly found within 100 m to 200 m distance from the cuttings disposal area, while small particles (e.g. barite) may drift to greater distances (up to 1 to 2 km in some instances (DNV GL, 2017) (OSPAR , 2009). Monitoring undertaken near cuttings piles which are known to have historically been contaminated with OBM indicates a clear pattern of reduction in spatial extent of contamination over time, as well as a long-term reduction in leaching rates since initial discharge (OSPAR , 2009). In addition, the rate of chemical degradation of identified contaminants is determined by the geochemical environment within the sediments. With the increased availability of oxygen as a result of cuttings pile disturbance and spreading of contaminants an increased rate of bio-degradation of Kingfisher cutting contaminants may be expected. (Breuer, Stevenson, Howe, Carroll, & Shimmield, 2004).

Whilst drill cutting disturbance is therefore expected to result in a short-term increase in the distribution and bioavailability of hydrocarbon compounds within the immediate vicinity of Kingfisher, survey evidence confirms that the existing benthos is already dominated by hydrocarbon tolerant species. In addition, it is anticipated that the natural bio-remediation process which will occur as a result of the increased availability of oxygen to contaminants currently present within the drill cuttings, will result in a reduction of hydrocarbon concentration over time.

Effects of disturbance of THC concentrations within the drill cuttings pile will be of minor magnitude and short to medium term, affecting an existing benthic community of low sensitivity. Effects from drill cutting disturbance on surrounding benthos are considered to be of minor significance.

5.3.3.2. Endocrine Disruptors

5.3.3.2.1. Polychlorinated biphenyls (PCBs)

Normalised PCB concentrations did not exceed the European assessment criteria (EAC) value (OSPAR, 2014) at any station sampled within the Kingfisher survey area. Consequently, no chronic effects are expected on the macrofaunal community due to the concentrations of polychlorinated biphenyl (PCBs). (Fugro Ltd, 2018).

5.3.3.2.2. Organotins

Organotin concentrations were generally below the minimum reporting value (MRV) out with 200 m of Kingfisher and within the Kingfisher cuttings pile. (Fugro Ltd, 2018). Consequently, toxicological effects on the macrofaunal community are expected to be restricted to the Kingfisher cuttings pile.

5.3.3.2.3. Alkylphenol ethoxylates (AP/APE)

When stations out with 200 m of Kingfisher were considered, the alkylphenol (AP) and alkylphenol ethoxylate (APE) concentrations reported 200 m to 2000 m from Kingfisher were broadly comparable to those reported at reference stations. When normalised to 1 % TOC, octylphenol and nonylphenol concentrations at the majority of stations, including the reference stations exceeded their respective Norwegian Pollution Control Authority (NPCA) predicted no effect concentration (PNEC) values (NPCA, 2007). All however, were below their respective NPCA Class V values (NPCA, 2007). The highest concentrations, that were above both the background level and the PNEC value were observed only at two stations (stations KC01 and KC04) both within 250 m of the cuttings pile. This indicates ecological effects, but not extensive toxic effects, may occur to the macrofaunal community but only in a very small localised area. However, elevated normalised AP concentrations may be partially due to the low values of total organic carbon (TOC) reported across the survey area.

When normalised to 1 % TOC, the nonylphenol concentrations of Alkylphenol Ethyoxylate (APE) exceeded the PNEC value in 15 of the 16 sections analysed and exceeding the Class V value in five of these. Elevated levels of were noted specifically within the bottom section of station KC04, as well as the top and mid sections of KC05. The concentration at the bottom of KC04 was the only value found to be significantly higher (over ~30% higher) than the Class V standard. Drill cuttings in the vicinity of both of these sample stations lie within the estimated 1851 m^3 of residual drill cuttings at Kingfisher anticipated to be disturbed during decommissioning activities. As a result of the disturbance a temporary increase in bioavailability of these identified compounds, particularly to localised benthic fauna, may therefore be expected. However, disturbance will distribute and dilute the contaminants so that a larger area may be affected but the concentrations will be lower, most likely below the Class V: Extensive Toxic Effect Threshold. As previously mentioned, the high values versus the standards may be partially due to the low values of TOC reported across the survey area.

Effects of disturbance of potential endocrine disrupting chemicals, which can disrupt hormone levels leading to potential development and birth defects, within the drill cuttings deposits are expected to be of minor magnitude and short to medium term, affecting an existing benthic community of low sensitivity. Effects from disturbance of potential endocrine disrupting chemicals within the drill cutting disturbance on surrounding benthos are considered to be of minor significance.

5.3.4. Potential for contamination of fishing gear/commercial catch

The DPs commit to the complete removal of all Kingfisher installations in this location[11] A post decommissioning survey will be completed to confirm complete removal has been achieved. It is therefore not intended to complete any overtrawl fishing survey(s) within the immediate vicinity of the drill cuttings pile. The UK hydrographic office will be notified of the ongoing residual presence of drill cuttings on the seabed. Notwithstanding this, once decommissioning is complete, the area will be open for fishing and there remains a possibility that residual drill cuttings may be disturbed in the future by bottom trawl fishing nets.

A study undertaken by the Fisheries Research Service (Fisheries Research Services, 2002) using a heavy monkfish trawler to disturb a cuttings pile in the outer Moray Firth, concluded that although contamination was spread across the seabed as a result of trawl disturbance, it was not in amounts or at rates likely to pose serious wider contamination or toxicological threats to the marine environment. The act of spreading will encourage, albeit at a slow rate, increased oxygenation of deposited material which will enable its further degradation by natural processes (see discussion above). Ecotoxicological effects on commercial fish stocks as a result of the disturbance of drill cuttings at Kingfisher, are not anticipated nor are any effects on commercial catch availability.

Effects will be of minor magnitude and short to medium term, affecting fish and shellfish stocks and commercial fisheries activities of low to medium sensitivity. Effects from drill cutting disturbance on fish and shellfish, and commercial fisheries activities are considered to be of minor significance.

5.4. Cumulative Effects

Contaminant levels as recorded during the pre-decommissioning survey (Fugro Ltd, 2018), and as evaluated through the Stage 1 OSPAR screening assessment (AECOM Ltd, 2018) return to background levels typical of the CNS outside approximately 200 m from the drill cuttings. Whilst drill cuttings associated with other oil and gas infrastructure do exist in the area, the closest of which is located beneath TAQA Bratani Ltd's Brae Bravo platform approximately 9 km to the west of the Kingfisher drill cuttings, none have been identified within sufficient proximity to result in any cumulative levels of contamination.

6. Seabed Disturbance

6.1. Activities/Environment interactions scoped out from detailed assessment

6.1.1. Seabed disturbance during pipeline and infrastructure removal activities

The surface-laid tie-in spools of the two 10" production lines, between the rock-berm transition from each pipeline's trench and the Kingfisher Manifold, will be removed. Similarly, the surface-laid section of the manifold umbilical, between the transition from its trench and the Kingfisher Manifold, will be removed, this will result in approximately 75 m of PL1488, 80 m of PL1489 and 175m of PLU1490 being removed.

The Kingfisher Manifold will be removed. This is a piled structure with dimensions of approximately 13.5 m x 6.5 m x 5 m, weighing approximately 123 tonnes. Piles will be cut 3 m below the seabed with the remaining pile being left *in-situ*.

The production tie-in spools and umbilical jumpers between the Kingfisher Manifold and the six wells will also be removed.

Mattresses and grout bags associated with the surface-laid pipelines and umbilicals will be removed.

As a result of the low bottom currents and water movement in the area, the natural sediment movement regime is considered likely to be low. No significant sediment build-up against and around the wells or Kingfisher Manifold structure is therefore expected. As a result, no pre-lift sediment excavation is anticipated to be required. Only surface sediments in immediate proximity to the infrastructure to be lifted are anticipated to be disturbed by removal operations. This represents a low and localised volume of mobilised sediment.

The volume of sediment disturbed, local sediment characteristics and local hydrodynamic conditions all affect the potential magnitude of any sediment mobilisation and dispersion characteristics of disturbed sediment (Wenger, 2017). Fine sediment particles can be expected to disperse greater distances than coarser fractions of sediment. Sediments in the area around the Kingfisher infrastructure have been classified as fine or very fine sand (Wentworth, A Scale of Grade and Class Terms from Clastic Sediments, 1922).

Disturbance of the sediment is expected to be short term, with resettlement occurring rapidly with distance from point of disturbance.

Benthic community biotopes in the area around the Kingfisher infrastructure comprise predominantly 'circalittoral muddy sand' (EUNIS A5.26) supporting often rich infaunal communities of polychaete worms, echinoderms and including burrowing megafauna such as seapens (*Virgularia mirabilis* and *Pennatula phosphorea)*. Seapens are considered to be tolerant of smothering from suspended sediment, with the ability to burrow and move in and out of their own burrows ((Hughes, 1998); (Hiscock, Water Movement, 1983).

Individuals of the PMF bivalve ocean quahog, *Arctica islandica,* were also observed within samples during the environmental survey ((Fugro Ltd, 2018)). The highest total of *A. islandica* at any sample station during the Fugro 2018 study was 16.7 individuals per 1 m^2 of sediment. The majority of these specimens were juveniles (<1cm wide) indicating a recent settlement event. *A. islandica* is considered to be not sensitive to smothering (of up to 30 cm of material added to the seabed in a single event) (Tyler-Walters & Sabatini, Arctica Islandic. Icelandic cyprine, cited 28-06-2018).

The species lives buried vertically in the top few centimetres of sediment with inhalant and exhalent siphons at surface and are known to withdraw deeper into the sediment and respire anaerobically for a period of time ((Morton, 2011)). When *A. islandica* was buried in both field and laboratory trials individuals were able to burrow to the surface from up to 41 cm of sediment (Powilleit M. G., 2009); (Powilleit M. K., 2006). This species is therefore considered able to tolerate some short-term smothering by disturbed sediments as a result of Kingfisher decommissioning activities.

A. islandica is however, more sensitive to physical disturbance and displacement as the species is not mobile and is known to be vulnerable to physical abrasion. (Ragnarsson, 2015). It remains possible that individuals of this species may be directly impacted by seabed disturbance as a result of Kingfisher decommissioning activities, potentially resulting in individual mortality. It is not considered that the potential loss of a small number of juvenile individuals of this species will result in a significant effect on population viability of this species.

Any impacts on seabed disturbance are likely to be of low magnitude affecting receptors with the ability to adapt and recover from any changes which may occur. Consequently, seabed disturbance as a result of the removal of the surface-laid spools, umbilical jumpers and Kingfisher Manifold are not considered likely to give rise to significant environmental effects. They have therefore been scoped out of further consideration within the EA.

6.1.2. Seabed disturbance as a result of additional rock placement

An approximate additional 150 m^2 (approximately 30 Te) of rock placement is anticipated at the ends of the 9 km section of trenched and buried pipelines and manifold umbilical, where they transition out of their trenches at the Kingfisher manifold.

The placement of additional rock on the seabed has the potential to affect approximately 150 m^2 of soft sediment circalittoral muddy sandy habitat that similarly to the wider vicinity has the potential to support the OSPAR threatened and declining habitat and Marine Scotland PMF habitat '*Seapen and burrowing megafauna communities*', although this habitat has not been specifically identified in the pre-decommissioning survey (Fugro Ltd, 2018). It is noted that whilst individuals of the defining species for this habitat were identified in the area around the Kingfisher infrastructure during the environmental survey (Fugro Ltd, 2018), the habitat is more usually associated with fine mud sediments, rather than the coarser particles of fine sand that have been observed (OSPAR, 2010). The seabed around Kingfisher is not a designated area for the presence of this habitat. Nor are the sediments present considered optimal to support any good quality example of this habitat.

Notwithstanding this clarifications to the definition of this habitat (JNCC, 2014) indicate that where burrows and/or mounds which may be attributable to these species are observed, the habitat should be considered representative of the seapen and burrowing megafauna communities. Burrows which could be attributable to key species of this habitat have been observed, particularly around the Kingfisher manifold and wells (Fugro Ltd, 2018) No evidence of this habitat was recorded around TAQA Bratani Ltd Brae Bravo platform. (Marathon Oil, 2013)

The seapen and burrowing megafauna habitat is also identified as a PMF as a reflection of its OSPAR 'threatened/declining' status and (OSPAR, 2010) goes on to note that a 'declining habitat' status is related to consideration of habitat quality rather than extent (e.g. effect on a small area of a good quality example of this habitat could be considered of potentially greater significance, than a similar impact on a poor quality example or an area in which the habitat has not been clearly identified, but where potential may exist).The circalittoral muddy sand habitat classification is wide spread across the central North Sea and the area of seabed affected by additional rock placement represents a tiny fraction of the available habitat. It remains possible that additional rock placement could result in impact on individual seapens, but the number of individuals is likely to be low.

It also remains possible that individuals of the bivalve *A. islandica* may be directly impacted by seabed disturbance as a result of additional rock placement, potentially resulting in individual mortality. It is not considered that the potential loss of a small number of juvenile individuals of this species as a result of the small area of additional rock placement would result in a significant effect on population viability of this species.

Effects on benthic communities, including protected habitats and species, as a result of additional rock placement have therefore been scoped out from further assessment within the EA.

6.1.3. Seabed disturbance as a result of post decommissioning overtrawl trials

The default OPRED policy requirement is for clear seabed verification to be undertaken using non-intrusive means, such as side scan sonar. Overtrawl surveys as a means to locate debris and/or verify clear seabed, are likely only to be approved in cases where it is deemed necessary i.e. where there are specific safety concerns such as pipeline bundle ends, extensive debris and/or extensive seabed disturbance resulting from decommissioning operations. However, for the purposes of estimating environmental impact, a worst-case position has been taken in this DP and supporting EA with the assumption that over-trawling may be required. It should be understood that assumption has been used only for estimating worst-case environmental impact; actual methods of verification will be discussed and agreed with OPRED on a case-by-case basis with an assumption that less intrusive methods of clear seabed verification are the base case.Worst-case post-decommissioning overtrawl trials are typically undertaken by the Scottish Fisheries Federation (SFF). During overtrawl trials the fishing industry has indicated a preference to use a standard trawl net, rather than a heavier chain mat configuration (SFF, 2018), particularly when overtrawling rock berm. A standard trawl net is not expected to disturb significant quantities of rock from any rock berm and is therefore not expected to degrade any rock berm height or configuration.

Overtrawl trials may be conducted running along, and up to 50 m either side of, the pipeline. Snagging trials may be conducted utilising various angles of approach resulting in an overall swept path of the trawl gear that extends up to 400 m either side of the pipeline along its length. Overtrawling may be completed along the length of the pipeline outside the TAQA Bratani Ltd Brae Bravo designated zone, until the approach to the Kingfisher cuttings pile. This represents an estimated 8.5 km of overtrawl area giving an impacted area of approximately 6.8 km^2. Disturbance of the seabed is also inherent in ongoing seabed fishing activities and temporary disturbance to the seabed sediments will occur during these operations. (Collie, Hall, Kaiser, & Poiner, 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.

6.1.4. Increased turbidity resulting from seabed disturbance

Natural turbidity in the water column will be a product of both local sediment characteristics and local hydrodynamic conditions. Natural turbidity in the water column in the area around the Kingfisher infrastructure is expected to be low. Disturbance of the sediment as a result of decommissioning activities is expected to be short term, with resettlement of largely sandy sediments occurring rapidly with distance from point of disturbance.

Localised, temporary increases in turbidity are not considered likely to give rise to significant environmental effects. They have therefore been scoped out of further consideration within the EA.

6.1.5. Dropped objects

Objects to be recovered by lifting to vessel deck during Kingfisher decommissioning range from small objects such as grout bags, to concrete mattresses and pipeline sections, with the largest single piece of infrastructure to be lifted being the Kingfisher manifold structure.

A total of 107 exposed concrete mattresses are anticipated to be recovered. Heavily degraded mattresses may be more difficult to recover and are anticipated to present an increased risk of dropped objects.

Grout bags, mattresses etc. if dropped during recovery would cause localised disturbance to seabed sediments at and in immediate proximity to the impact point. Direct impacts to a small number of individuals of sensitive species (i.e. seapens and the ocean quahog) may occur, however it is considered unlikely that seabed disturbance as a result of dropped objects impacting natural surrounding seabed would result in significant effect. This activity interaction has been scoped out from further assessment within the EA.

Potential effects associated with larger dropped object such as the Kingfisher manifold, affecting contaminant sediments associated with the Kingfisher cuttings pile have however been taken forward for further consideration within the EA.

6.1.6. Long term changes to seabed characteristics

Trenched and buried pipelines will be decommissioned 'in situ'. They will be flushed and cleaned and filled with seawater before being left. Activities to prepare pipelines for decommissioning 'in situ' are not expected to result in any change to the overlying seabed. External corrosion of pipeline coating would most usually be expected in localised area where there are defects or damage in the coating, or where the coating has become disbonded from the pipe. Corrosion is therefore expected to present as localised pits, which will eventually result in irregular perforations throughout the pipeline length. Structure degradation will be a long-process as a result of this corrosive process, until the eventual collapse of the pipelines under their own weight and that of the overlying sediment. This may cause minor disruption and pitting in the seabed surface but is expected to recover through natural processes over a short-term period of time. No significant effects are anticipated.

As discussed above a very small additional area of hard substrate habitat will be introduced to the seabed as a result of additional rock placement to secure and stabilise equipment decommissioned in situ'. Conversely a very small surface area of existing hard substrate habitat currently provided by the infrastructure (manifold, concrete mattresses etc.) will be removed as a result of decommissioning.

No significant long-term alteration to seabed characteristics or supporting habitat types is anticipated. This activity interaction has been scoped out from further consideration within the EA.

6.1.7. Vessel anchoring

No vessel anchoring activity is anticipated to be required to facilitate the delivery of the activities covered by the DPs. Decommissioning vessels, when required to hold station to complete specific activities will use dynamic positioning. No significant effect on seabed disturbance from vessel anchoring activities is expected. This activity interaction has been scoped out from further consideration within the EA.

6.2. Cumulative effects on seabed as a result of additional rock placement

As discussed above, seabed disturbance associated with the Kingfisher DPs when considered in isolation is not expected to be significant and is expected to be limited to localised sediment disturbance resulting in temporary increases in turbidity and smothering of benthic organisms, as disturbed sediment re-settles in the immediate vicinity of the infrastructure to be lifted (pipeline , mattresses and the Kingfisher Manifold structure).

At the time of writing, TAQA Bratani Ltd has draft Decommissioning Programmes for the Brae Alpha, Brae Bravo, Central Brae, West Brae and Sedgwick. Therefore, no assumptions can be made regarding the decommissioning outcomes for these facilities.

To provide a baseline for cumulative effects, an analysis has been conducted using the proposals within the DPs submitted by TAQA Bratani Ltd for public consultation. Considering the proposals within the TAQA Bratani Ltd Decommissioning Programmes or any alternatives considered within the CA, the incremental cumulative impact of Kingfisher's decommissioning activities are negligible.

Whilst the timing of localised seabed disturbance associated with Brae and Kingfisher DP activities may be spatially and/or temporally aligned, disturbance will be temporary in nature with short term seabed recovery expected.

No significant cumulative effects from seabed disturbance is expected.

7. Unplanned Events

7.1. Unplanned leaks and spills from vessel activity

The Advisory Committee on Protection of the Sea (ACOPS) collates spill data for all of the North Sea by region and 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.

Not-with-standing the above, the prevention of oil spills is of the highest environmental priority during the Operators operations with operating procedures, systems and training in place to reduce the risk of a spill occurring and to ensure rapid response to any such event.

7.1.1. Modelling of fuel oil loss from vessel in vicinity of Kingfisher

The impact from a major loss of fuel in the vicinity of the Kingfisher infrastructure has been assessed, most recently as part of the Oil Pollution Emergency Plan (OPEP) in support of rig activity to plug and abandon the wells proposed for Autumn 2018. (OPEP 180179/0) (Shell UK Ltd, 2018).

At the time of writing the decommissioning campaign is currently in the planning phase. For the purposes of this assessment, it has been assumed that the largest single vessel required on site, at any time during the decommissioning activities will be a Heavy Crane Vessel (HCV) required in order to achieve the lift and recovering of the Kingfisher manifold structure.

Stochastic (probability) modelling has been undertaken for a 'worst case' instantaneous spill of a vessel's diesel inventory up to volume 2,695m^3 [12]. The modelling parameters are provided in Table 7-1 whilst the spill modelling results are summarised in Table 7-2**.**

Table 7-1: Diesel spill modelling parameters (Shell UK Ltd, 2018)

Scenario	Failure of diesel storage tank from infield vessel operating at the Kingfisher wells	Release duration	N/A
Worst case volume	2,695 m^3	Persistence duration	10 days
Release rate	Instantaneous	Total simulation time	10 days
Justification for predicted worst case scenario	The volume of diesel spill modelled was based on the largest diesel inventory onboard any vessels currently or previously working in the Kingfisher field. This was therefore considered to represent a worst-case diesel spill scenario. In the event that any vessel contracted to support the decommissioning activities holds a larger diesel inventory, appropriate spill modelling will be completed and appropriate OPEP will be implemented		

[12] The volume of diesel spill modelled was based on the largest diesel inventory onboard any HCV vessels currently or previously working in the Kingfisher field and therefore is considered to represent a worst case diesel spill scenario. In the event that any vessel contracted to support the decommissioning activities holds a larger diesel inventory, appropriate spill modelling will be completed and appropriate OPEP will be implemented.

Table 7-2: Probability of a diesel spill crossing the median line or resulting in shoreline contamination in the UK or coast states (Shell UK Ltd, 2018)

Oil Spill Modelling Summary				
Spill Scenario/Descriptor	Rupture of diesel tanks on decommissioning vessel at Kingfisher, resulting in instantaneous loss of 2, 695m3 of diesel			
Maritime Boundaries	**Probability and shortest time to reach median line**			
Identified median line	**Dec-Feb**	**March-May**	**June-Aug**	**Sept-Nov**
Norway	50-60%	60-70%	60-70%	60-70%
	<6 hours	<6 hours	<6 hours	<6 hours
Landfall	**Probability and shortest time to beach**			
Predicted locations	**Dec-Feb**	**March-May**	**June-Aug**	**Sept-Nov**
None	N/A	N/A	N/A	N/A
	N/A	N/A	N/A	N/A
Volume beached (m^3)	N/A	N/A	N/A	N/A

In the event of a loss of fuel inventory from a decommissioning vessel up to 2, 695m^3, modelling results show that the spill will not reach the UK coastline or any mainland European coastline, but there is up to a 70% probability of crossing the UK/Norwegian median line within <6 hours during the spring, summer and autumn, with a slightly decreased probability of up to 60% during winter (Shell UK Ltd, 2018). The likelihood of a diesel release is low due to operating procedures in place (e.g. vessel will be subject to audits and inspections, regular maintenance and inspection of hoses and tanks, adequate bunding in place etc.). All appropriate notifications to mariners will be made prior to the operations. It should also be noted that shipping is very low in Block 6/8 (Shell UK Ltd, 2018) Additionally, the possibility of a diesel spill during operations will be covered under the vessels' approved Shipboard Oil Pollution Emergency Plans (SOPEPs). As diesel is a non-persistent hydrocarbon, its residence in the marine environment is low, as such, the risk to the marine environment from accidental spills is considered to be slight or minor, if effectively managed.

7.1.2. Potential effects on sensitive receptors

Sensitive receptors may include biological receptors such as plankton, benthos, fish, seabirds and marine mammals.

Impacts on plankton community are expected to be localised only and unlikely to be significant as a result of natural variability, high turnover and seasonal fluctuations within the community.

Likewise, surface release of hydrocarbons as a result of loss of marine diesel from decommissioning vessel, is unlikely to impact the benthic community.

Marine Mammals and Seabirds are particularly sensitive to the effects of oil pollution. Seabird sensitivity varies between species dependant on a range of factors, including: time spent sitting on water, habitat flexibility, seasonal presence etc. with mortality occurring from *inter alia* ingestion of oil leading to organ failure etc; and contamination of plumage affecting insulation properties leading to Hypothermia (Webb, Elgie, Irwin, Pollock, & Barton, 2016). Whilst the Kingfisher infrastructure lies within an area of the CNS considered to be of low sensitivity to seabird disturbance, it should be noted that data for the area is limited and confidence in the sensitivity analysis is low. (Webb, Elgie, Irwin, Pollock, & Barton, 2016). Likewise, whilst a wide range of marine mammal species have been recorded in the waters around the British Isles, only a small number are regularly recorded in the area around the Kingfisher infrastructure.

With the likelihood of a diesel release considered to be low, and the impact significance of any oil pollution affecting seabirds in the area around Kingfisher assessed as minor, on the environmental risk to seabird populations as a result of unplanned vessel fuel release is also assessed as minor.

8. Waste Management and Onshore Effects

8.1. Waste Management

The activities undertaken in the decommissioning of Kingfisher will generate quantities of controlled waste, defined in Section 75 (4) of the Environmental Protection Act 1990 as 'household, industrial and commercial waste or any such waste'. The sequence and quantities of controlled waste generated at any one time depend on the processes of dismantling and the subsequent treatment and disposal methods of the waste itself.

The key challenge associated with waste management for Kingfisher is to manage the logistics associated with transporting waste to shore, its temporary storage and the onward treatment/disposal of materials.

In accordance with the Petroleum Act, Decommissioning of Offshore Oil and Gas Installations and Pipelines Guidance Note (Department for Business, Energy and Industrial Strategy (BEIS), 2018), the disposal of O&G infrastructure should be governed by the precautionary principle. Companies must adhere to early engagement, and to the implementation of: active waste management plans; the requirements of the Waste Framework Directive; Duty of Care; and a complete Inventory of Offshore Waste. The designation of whether a material or substance is 'waste' is determined by EU law. The EU Waste Framework Directive (2008/98/EC) defined 'directive waste' as "any substance or object which the holder discards or intends or is required to discard". Revisions to the Waste Framework Directive are implemented in Scotland through the Waste (Scotland) Regulations 2012, and in England and Wales through the Waste (England and Wales) Regulations 2011 and ancillary legislation in Wales, which were both introduced in April 2011.

Responsibility for waste management lies with the producer or Duty holder, including the decision on which materials are to be treated as waste. The action of removal and transfer of redundant installations and infrastructures to shore falls within the legal definition of waste. Having determined the substance or object is waste, subsequent labelling, storage, handling, transfer and treatment of the waste generated is then governed by specific regulations.

The Operator will ensure compliance and adherence to requirements of all applicable regulations. In the event that wastes are transferred outside of the UK, the waste will be dealt with in line with the receiving country's waste legislation and will be subject to the approval of a Transfrontier Shipment of Waste application, as per UK regulations.

The Operator will engage with the relevant waste regulator as appropriate.

As a 'waste producer' under UK legislation, The Operator has a Duty of Care to ensure that waste is properly transported and disposed of. The following activities will be completed in order to meet this obligation:

- Ensure waste is appropriately segregated, labelled, stored and transported;
- Ensure applicable permits are in place, including Transfrontier Shipment, and their conditions are met; and
- Use only licensed carriers and disposal sites.

The BEIS Guidance Notes (BEIS, 2018) require decommissioning decisions to be consistent with the principles of the waste hierarchy, as shown in Figure 8-1. A Waste Management Plan (WMP) will ensure compliance with relevant legislations and the Operator's internal requirements, including the waste hierarchy. Via implementation of the WMP, waste materials will be tracked to the recycling endpoint. Those materials that cannot be reused or recycled will be tracked to landfill disposal.

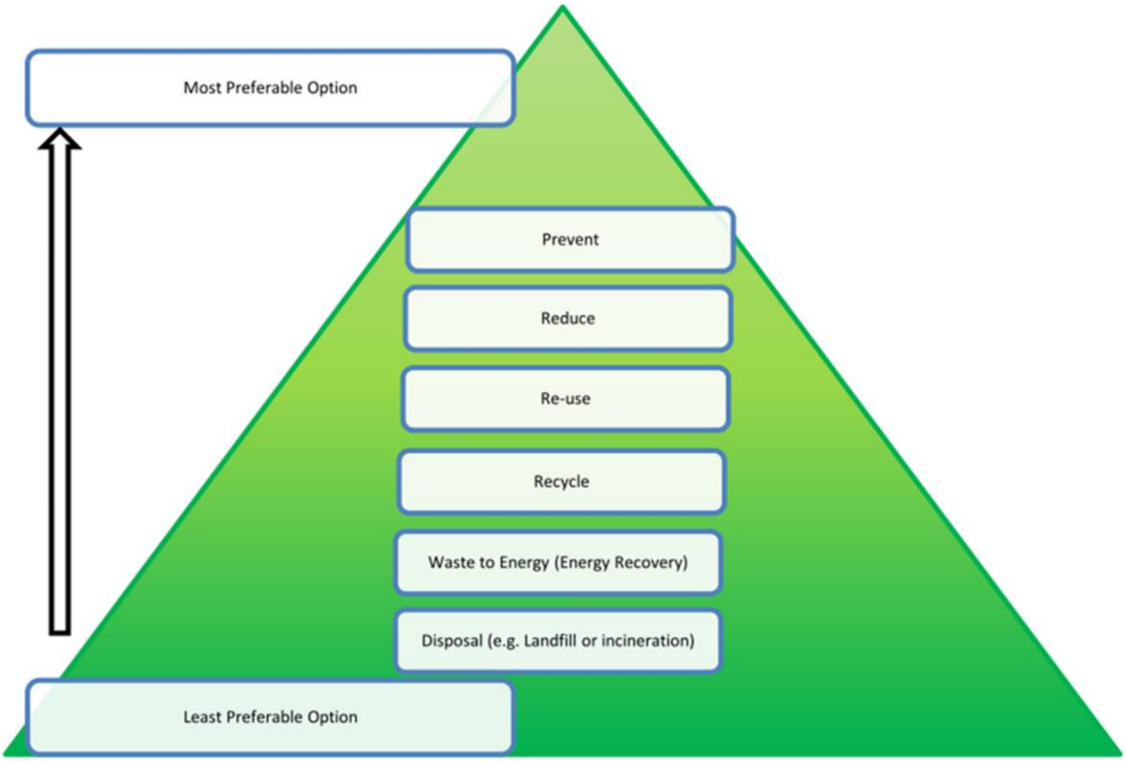


Figure 8-1: The Waste Hierarchy

8.1.1. Waste Generation and Waste Inventory

No hazardous wastes are expected to be generated during the decommissioning of Kingfisher. The non-hazardous waste will predominantly include scrap metals, concrete and plastics that are not cross-contaminated with hazardous waste and can therefore be removed or recovered for re-use, recycling or landfill, or decommissioned and left in-situ. However, if hazardous or 'special' waste is identified during the decommissioning process it will be handled appropriately.

Table 8-1 details the total inventory tonnage planned to be decommissioned in situ and those planned to be recovered to shore. The inventory to be left in-situ comprises predominantly pipelines and umbilicals, which are currently trenched and buried, as well as several structural piles, which will be cut to a certain depth and partially left in the seabed.

Table 8-1: Waste Inventory

Pipelines and Umbilicals					
Material	**Total Amount (tonnes)**		**Description**	**Management**	
				To shore	**Left in-situ**
Carbon steel	121	5%	Umbilical armour wire,	2	119
Stainless Steel	1493	64%	Pipelines, umbilical strain wire	35	1458
Non-Ferrous	9	0%	Copper (signal/power cable) & Aluminium (anodes)	0	9
Concrete	622	27%	Mats, grout bags	571	51

Plastic	98	4%	Umbilicals and insulation	5	93
Hazardous Material/NORM	0	0%		0	0
Other	0	0%		0	0
TOTAL	**2343**	**100%**		**614**	**1730**

Note that numbers are rounded to the nearest whole and therefore the totals do not always align.

Installations					
Material	**Total Amount (tonnes)**		**Description**	**Management**	
				To shore	**Left in-situ**
Carbon steel	136	49%	Manifold structural steel, piles	121	15
Stainless Steel	140	50%	Manifold pipework, wellheads	140	0
Non-Ferrous	1	<1%	Aluminium anodes	1	0
Concrete	0	0%		0	0
Plastic	0	0%		0	0
Hazardous Material/NORM	0	0%		0	0
Other	0	0%		0	0
TOTAL	**277**	**100%**		**262**	**15**

8.1.2. Waste Management Routes

Table 8-2 presents the options and disposal route for project waste. When removed from the seabed, the equipment will be transported to a decommissioning contractor's onshore yard, where different types of material will be segregated with a view to optimising reuse and recycling. The recycling yard has not been selected yet, but recycling and disposal of these materials will be carried out in accordance with current established processes and applicable legal requirements.

Table 8-2: Waste Management Routes

Description	**Quantity (tonnes)**	**Option**	**Management Route**
Carbon steel manifold pipework and wellheads	136	Partial recovery	Return to shore for recycling or leave in situ
Stainless steel manifold structural steel and piles	140	Full recovery	Return to shore for recycling
Carbon steel umbilical armour wire	121	Partial recovery	Return to shore for recycling or leave in situ
Stainless steel pipelines, and umbilical strain wire	1493	Partial recovery	Return to shore for recycling or leave in situ
Copper wiring and	9	Leave in situ	n/a
Aluminium anodes	1	Full recovery	Return to shore for recycling
Concrete mats and grout bags	622	Partial recovery	Return to shore for disposal or leave in situ

Plastic umbilical insulation	98	Partial recovery	Return to shore for recycling or leave in situ

Drill cuttings are to be decommissioned by being left in situ. Further details relating to drill cuttings are contained in Chapter 6.

8.1.3. Radioactive and Hazardous Wastes

It is not anticipated that there will be any hazardous waste or NORM. If any radioactive wastes are identified, they would be managed in line with the Radioactive Substances Act 1993 Amendment (Scotland) Regulations 2011, which regulates the handling, storage, transfer and disposal of such waste.

8.1.4. Contractor Management

Waste management activities include:

- Handling;
- Storage and treatment of waste offshore;
- Transfer of waste to a waste treatment facility for further storage/handling; and
- Treatment as appropriate and then further transfer to the final disposal or treatment point.

Contractors and sub-contractors will conduct many of these activities on the Operator’s behalf. In these instances, the legal liability, i.e. Duty of Care, for all waste generated from decommissioning remains with the Operator. The selection and management of contractors will be carried out in line with the requisite contractor control processes and procedures.

Specific actions to support the management and minimisation of waste generated by contactors during decommissioning will include:

- Ensuring that waste management issues are included during the contract procurement process, for example, consideration of a contractor’s past HSSE performance;
- Ensuring that waste management issues are covered within the contractor interface documents; and
- Engaging with contractors to identify effective technical solutions that support waste minimisation with the reuse and recycling of waste, where possible.

8.1.5. Transboundary Impacts

Transboundary impacts, such as the recycling of Kingfisher infrastructure overseas, will be evaluated and managed and, if required, would be subject to the required regulatory controls on trans-frontier shipment of waste.

8.1.6. Mitigation Measures, Safeguards and Controls

Measuring and monitoring performance is an important element of an Environmental Management System (EMS) With respect to the management and minimisation of waste during the decommissioning of the Kingfisher infrastructure, the key areas for action are:

- Monitoring legislative compliance
- Measuring performance against stated targets

A range of methods will be used to ensure effective monitoring of waste management activities including, for example, auditing of contractors and disposal sites, monthly waste statistic summaries and the routine inspection of waste handling facilities, and provision of waste reports.

The following standard industry practice, legislative requirements and project-specific controls will be implemented:

- WMP in place prior to decommissioning
- the Waste Management Hierarchy are followed during all activities to increase reuse/recycling and minimise landfill disposal
- Onward transportation agreements will be in place
- Use of designated licensed sites only approved waste treatment/disposal facilities
- Compliance with the UK and any third country's waste legislation and duty of care
- Permits and traceable chain of custody for waste management, shipment, treatment and onshore disposal
- Duty of Care Audit(s) to be conducted on the selected management facilities (including disposal facilities)
- Verify competence of personnel with waste management responsibilities
- Ensure subcontractor management process in place for third-party disposal sites
- Contract in place that adequately describes waste management requirements

Although the decommissioning activities will produce some waste streams, these wastes in accordance with the principles of the waste hierarchy and apply controls as appropriate include those set out within the Decommissioning Portfolio Waste Management Strategy (Shell UK Ltd, 2018). The resulting significance of impacts associated with waste is assessed to be minor.

8.2. Odour Management

Approximately 25 Te (wet) of marine growth is expected to be recovered. Most of this weight represents water. Some marine growth will dry out in transit and onshore, so a much smaller dry weight of biological waste will require disposal. It is likely that the marine growth will be disposed of by land-farming or to landfill.

Marine growth is identified as potentially producing an odour, which may impact immediate neighbours and nearby local communities. Environmental conditions such as prevailing wind direction and temperature will also determine the severity and area impacted by any such odour. The main source of odour is thought to be due to the disturbance of low-oxygen layers and removal of putrefying organisms.

Some volume of the expected marine growth will be brought onshore for disposal. Odour from storing marine growth might potentially be detectable in immediately surrounding areas in the short term. Whilst the onshore site has not yet be identified, it will be experienced in decommissioning either of ships and subsea structures or O&G offshore platforms and will have processes in place to deal with the potential odour pollution. Mitigation measures may include rapid removal of marine growth and spraying of odour suppressants. With these measures in place, the impact from marine growth is assessed as minor.

9. Summary and Conclusions

This environmental appraisal (EA) report documents a systematic process of environmental consideration which has been completed to comply with all relevant legislative, regulatory and policy requirements for environmental assessment. The EA also delivers best practice requirements as set out within Shell's Health Safety, Securing Environment and Social Performance (HSSE&SP) Control Framework (CF), and the Shell Control Framework Impact Assessment (CF IA) manual.

Environmental characteristics of the Kingfisher area are well understood and have been established through a combination of desk study and site specific environmental survey. The development of the Decommissioning Programmes for Kingfisher has been informed by ongoing consideration of potential environmental interactions and risk at various stages include:

- during Comparative Assessment (CA) consideration of options;
- comprehensive identification of potential impacts associated with the preferred option(s);
- further consideration of specific potential interactions through environmental scoping and environmental appraisal, where necessary and appropriate.

The EA confirms that the Kingfisher DPs can be executed with readily implementable controls that will result in minimal impact to the receiving environment. Whilst the ENVID process did not identify any potential activity/environment interactions of high significance, a small number of activity/environment interactions were identified as of potentially minor to moderate significance. These were further investigated and evaluated within the EA report. Potential effects as a result of discharges to air and underwater noise were considered but were appraised as unlikely to be significant, as all vessels used will be compliant with relevant international air pollution standards and emissions will be kept as Low as Reasonably Practicable (ALARP). No high energy noise source activities such as blasting, piling or deep sediment penetration seismic survey are required, with noise sources limited to underwater cutting activities, limited rock placement activities and associated vessel movements. Whilst there is no published information on the response of marine mammals or fish to sound generated by underwater cutting, JNCC acknowledge that "non-explosive cutting technology produces relative little noise production" (JNCC, 2008).

The two production pipelines have been flushed and cleaned achieving a very low oil in water (OIW) concentration of 3.8mg/l. In addition, Osborne-Adams toxicity calculations have been carried out for the small number of umbilical sections for which flushing and cleaning is not possible. These calculations concluded that any volume of residual chemicals which may be discharged from these umbilicals during decommission would be very small and of acceptable risk.

Benthic community biotopes in the area around the Kingfisher infrastructure comprise predominantly 'circalittoral muddy sand' (EUNIS A5.26) supporting often rich in-faunal communities of polychaete worms, echinoderms and including Priority Marine Feature (PMF) burrowing megafauna including seapens and ocean quahog. Seabed disturbance as a result of removal of Kingfisher infrastructure (pipeline sections, mattresses, manifold etc.) and potential smothering of benthic communities as a result of decommissioning activities was considered. Both seapens and ocean quahog are considered to be tolerant of a degree of smothering from suspended sediment. Decommissioning 'in situ' of much of the trenched and buried Kingfisher pipelines also allows disturbance to seabed and the benthic communities they support to be minimised. Any resultant impacts are therefore considered likely to be of low magnitude, affecting receptors with the ability to adapt and recover from any changes which may occur. Seabed disturbance as a result of Kingfisher DPs is not considered likely to give rise to significant environmental effects. In addition, a small quantity of additional rock placement is expected as a result of Kingfisher DPs. It is possible that a small number of individual benthic species may be lost as a result of rock placement. It is not considered that this would result in any significant effect on the population viability of any individual benthic species, or on the benthic assemblage as a whole.

Potential for significant environmental effects as a result of: disturbance to drill cuttings; the long-term degradation of plastic pipeline and umbilical coatings decommissioned 'in situ'; and effects associated with unplanned leaks and spills from decommissioning vessels were given further consideration.

The Stage 1 assessment requirements set out within OSPAR Recommendation 2006/5 requires all drill cuttings piles in the North Sea to be evaluated against threshold criteria for both rate of oil loss to water column and persistence. The rate of oil loss from the Kingfisher cuttings pile has been calculated as 1.16 tonnes per year, which is significantly below the above listed OSPAR threshold of 10 tonnes per year.

Exceedances of the 50 ppm THC threshold have been observed in three of the six core samples taken from within the drill cuttings pile (Fugro Ltd, 2018). Using the (UKOOA, 2005) conversion factor, a persistence of drill cuttings contamination has been calculated at a maximum of 10.3 km^2yr. This is significantly below the above listed OSPAR threshold of 500 km^2yr. Elevated levels of certain metals, as well as APE endocrine disruptors were observed in individual samples from within the Kingfisher cuttings pile. An estimated 17% of the identified drill cuttings at Kingfisher are expected to be disturbed as a result of wellhead and manifold removal activities. This will result in some localised mobilisation and resuspension of contaminated sediments into the local water column. Effects of disturbance of elevated THC concentrations as well as potential endocrine disrupting chemicals within the drill cuttings pile will be of minor magnitude and short to medium term, affecting an existing benthic community of low sensitivity. Effects from disturbance of elevated THC concentrations as well potential endocrine disrupting chemicals within the drill cutting disturbance on surrounding benthos are considered to be of minor significance.

An estimated 93 tonnes of plastic products largely comprising pipeline and umbilical coatings are proposed to be decommissioning 'in situ'. Plastic decommissioned '*in situ'* will be trenched and buried within the seabed and will be left in low light and oxygen conditions. As a result, degradation of these plastics is expected to occur extremely slowly, and any release of plastics or breakdown products to the water column or benthic environment will consequently be highly diffused. Given the characteristics and nature of expected degradation effects will be of slight or minor magnitude, primarily affected a benthic community of low sensitivity. Effects from the decommissioning of Kingfisher plastics *in situ* on the receiving marine environment Are considered to be of minor significance.

Impact from a major loss of fuel in the vicinity of the Kingfisher infrastructure has been assessed, based on the assumption that the largest single vessel required on site, at any time during the decommissioning activities will be a Heavy Crane Vessel (HCV) required in order to achieve the lift and recovering of the Kingfisher manifold structure. Stochastic (probability) modelling has been undertaken for a 'worst case' instantaneous spill of a vessel's diesel inventory up to a volume of 2, 695m^3 has been completed. Results show that such a spill will not reach the UK coastline or any mainland European coastline. The likelihood of a diesel release is low due to operating procedures in place (e.g. vessel will be subject to audits and inspections, regular maintenance and inspection of hoses and tanks, adequate bunding in place etc.) As diesel is a non-persistent hydrocarbon, its residence in the marine environment is low, as such, the risk to the marine environment from accidental spills is considered to be slight or minor, if effectively managed.

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Appendix A: ENVID Summary Matrix

Project Activities			Environmental Aspects																		Social Aspects		
			Emissions/Spills					Extraction and Consumption of Resources					Others										
			to Air	to Water	to land (inc. Groundwater)																		
Project Element	Project Activity	Potential Impacts/Issues and assumed mitigation	Gaseous Emissions	Fluids etc. into water	Fluids into soil	Waste Materials	Disruption to soil and subsoil	Raw materials, additives and materials	Water consumption	energy consumption	Usage of Space	Product extraction	Radiation (heat and ionising)	Noise and vibrations	Smell / odour	Light	Dust	Materials to subsoil	Aesthetics	Biodiversity	Commercial Fisheries (Communities)	Shipping and Navigation	Marine Archaeology
Umbilical and Pipeline preparation	Pigging and flushing of umbilical and production lines, spools etc. to achieve a level of less than 40 mg/l, best efforts including disconnection from TAQA Bratani Ltd Brae Bravo platform infrastructure. This will be completed immediately on CoP (July 2018) under the terms of the operating permits currently held by TAQA Bratani Ltd for the Brae Bravo platform. For the purposes of the DP and this ENVID it has been assumed that all pipelines will have been flushed and cleaned to appropriate standards.																						
Pipeline Group 2: Surface laid lines	Pipeline spools and umbilical jumpers to be cut, recovered and returned to shore for recycling/disposal	Noise generation during cut and lift												X						X			
		Disturbance to drill cuttings during cut and recovery					X													X			
		Accidental release of residual chemicals etc. even after cleaning. Pipelines have been flushed back to TAQA Bratani Ltd Brae Bravo to an oil in water content of 3.8mg/l (July 24th, 2018).		X																X			
	Kingfisher SSIV structures, exposed mattresses and grout bags etc. to be recovered and returned to shore for recycling/disposal	Localised seabed disturbance during recovery activities					X													X			
		Dropped objects during lift and recovery activities					X													X			
		Requirement for onshore disposal as waste materials	Considered in 'onshore activities' line item below																				
Pipeline Group 5: Pipeline ends	Exposed mattresses to be removed	Localised seabed disturbance during recovery activities					X													X			
	Pipelines to be cut where they leave existing rock berm with ends recovered and returned to shore for recycling / disposal	Noise from cutting activities												X						X			
	Rock cover to be added to cut end to reduce snagging risk	Seabed disturbance and habitat alteration as a result of additional rock cover noise from rock placement activities					X							X						X	X		
	Decommission in situ	Long term changes to seabed characteristics.					X																

Project Activities			Environmental Aspects																		Social Aspects		
			Emissions/Spills					Extraction and Consumption of Resources					Others										
			to Air	to Water	to land (inc. Groundwater)																		
Project Element	Project Activity	Potential Impacts/Issues and assumed mitigation	Gaseous Emissions	Fluids etc. into water	Fluids into soil	Waste Materials	Disruption to soil and subsoil	Raw materials, additives and materials	Water consumption	energy consumption	Usage of Space	Product extraction	Radiation (heat and ionising)	Noise and vibrations	Smell / odour	Light	Dust	Materials to subsoil	Aesthetics	Biodiversity	Commercial Fisheries (Communities)	Shipping and Navigation	Marine Archaeology
Pipeline Group 6: Trenched and buried pipeline sections. Group includes crossing of Statoil's Heimdal pipeline.		Long term degradation of 'in situ' plastics		X			X													X			
		long term change to seabed characteristics					X													X			
Pipeline Group 7: Umbilical end at manifold	Exposed mattresses to be removed	Localised seabed disturbance during recovery activities					X													X			
	Umbilical ends will be cut, recovered and returned to shore for recycling / disposal	Noise from cutting activities												X						X			
		Release of chemicals from un-flushable umbilical cores. Assumes all discharge at the same time.		X																X			
	Umbilical end at to be lowered by fluidising the soil OR umbilical end to be lowered by excavating the surrounding soil with a cut made at the point where the umbilical reaches 0.6 m depth of cover	Seabed disturbance and increased turbidity in water column.		X			X													X			
		Local mobilisation of drill cuttings contamination to water column. Increase in bioavailability of contaminants compared to mechanical excavation of sediments. Umbilical ends will be cut at sufficient distance from the manifold to minimise, as far as reasonably practicable disturbance to drill cuttings		X	X		X													X			
		Seabed disturbance and increased turbidity in water column.		X			X													X			
Well Plug and Abandonment (P&A)	Flushing of spools from individual wells through the manifold structure and into adjacent wells. P&A to be completed by semi-submersible drill rig, anchored to seabed.	This will be completed as an activity integrated with the Well P&A programme. P&A is not expected to disturb drill cuttings. Only if the option to put the trees down on the seabed is used would disturb drill cuttings																					
Wellhead removals	Cutting and removal of well heads. Well will be cut -3m below mean seabed. X trees may be laid on seabed temporarily after cutting and prior to lift for removal.	Mobilisation of drill cuttings, redistribution and increase in bioavailability of contamination		X																X			

Project Activities			Environmental Aspects																			Social Aspects		
			Emissions/Spills					Extraction and Consumption of Resources					Others											
			to Air	to Water	to land (inc. Groundwater)																			
Project Element	Project Activity	Potential Impacts/Issues and assumed mitigation	Gaseous Emissions	Fluids etc. into water	Fluids into soil	Waste Materials	Disruption to soil and subsoil	Raw materials, additives and materials	Water consumption	energy consumption	Usage of Space	Product extraction	Radiation (heat and ionising)	Noise and vibrations	Smell / odour	Light	Dust	Materials to subsoil	Aesthetics	Biodiversity	Commercial Fisheries (Communities)	Shipping and Navigation	Marine Archaeology
Kingfisher Manifold is a piled structure. In-air weight 123.3Te SSIV frame. Gravity based structure. 63 tonnes. 10.2 m x 10.3 m x 4.4 m.	Manifold to be recovered to shore by reverse installation for onshore disposal. Piles will be cut to a suitable depth and left in-situ. Kingfisher SSIV will be recovered to surface for onshore disposal	Noise generation												X						X			
		Seabed / Cuttings pile disturbance		X	X		X													X			
Drill Cuttings pile volume estimated 1,800m³ pile footprint estimated 6000m²	Leave in situ	Drill cuttings believed to be distributed around and over manifold. Manifold lift will cause disturbance and contaminant mobilisation to water column. OSPAR Stage 1 Assessment drill cuttings below the defined thresholds.		X	X		X													X	X		
Vessel Use	All Activities	Emissions from offshore vessel, helicopter etc. activity. (CO_2, CO, SO_x, NO_x etc.). Assumes a single campaign not integrated with other DPs. All vessels will compliance with MARPOL Annex IV requirements. Emissions will be maintained ALARP	X	X						X													
		Decom activity causing temporary restrictions to other sea users (other decom activity, other navigation and fishing)									X										X	X	
		Vessel anchoring during decommissioning activities																					
		Use of DP to hold station during decom activities												X						X			
		Routine discharges from vessel activities. All standard vessel operating practices will be completed in full compliance with MARPOL requirements		X																X			
		Accidental leaks and spills from vessels, including loss of fuel oils.		X																X			

Project Activities			Environmental Aspects																		Social Aspects		
			Emissions/Spills					Extraction and Consumption of Resources					Others										
			to Air	to Water	to land (inc. Groundwater)																		
Project Element	Project Activity	Potential Impacts/Issues and assumed mitigation	Gaseous Emissions	Fluids etc. into water	Fluids into soil	Waste Materials	Disruption to soil and subsoil	Raw materials, additives and materials	Water consumption	energy consumption	Usage of Space	Product extraction	Radiation (heat and ionising)	Noise and vibrations	Smell / odour	Light	Dust	Materials to subsoil	Aesthetics	Biodiversity	Commercial Fisheries (Communities)	Shipping and Navigation	Marine Archaeology
Onshore activities onshore dismantling and Waste disposal	Waste Management	A Waste Management Plan (WMP) will quantify wastes arising, segregation and storage, and identify disposal options, In accordance with the waste hierarchy. Onshore yard will have appropriate capability, t licences and consents for recycling of wastes identified in the WMP.				X																	
		Disturbance to local communities e.g. from Marine Growth causing odour issues.	X							X	X			X	X	X	X	X	X				

Appendix B:

	Depth (cm)	Source	Block	THC (µgg-1 dry sediment)	Total n-alkanes (nC_{12} to nC_{36}) (µgg-1 dry	PAH (µgg-1 dry sediment)	Al	As	Ba	TB a	Cd	Cr	Cu	Fe	Hg	Ni	Pb	V	Zn
MB06	Surface	Brae Bravo ((Marathon Oil, 2013)	16/7a	2.3	-	0.033	888	3.1	36.1	182	0.01	7.44	0.89	-	<0.03	2.10	5.66	8.35	7.24
MB07	Surface	Brae Bravo (Marathon Oil, 2013)	16/7a	3.8	-	0.035	964	3.14	115	89	0.01	7.5	1.46	-	<0.03	2.08	6.99	8.86	9.75
MB12	Surface	Brae Bravo (Marathon Oil, 2013)	16/7a	7.3	-	0.149	1180	2.34	245	406	0.02	7.66	2.55	-	<0.03	2.98	6.27	7.73	12.2
K01	Surface	Kingfisher (Fugro, 2018)	16/8a	9.5	0.22	0.116	2360	2.58	-	-	0.017	8.76	3.47	3960	0.018	3.69	6.84	-	12.8
K02	Surface	Kingfisher (Fugro, 2018)	16/8a	7.4	0.204	0.103	2010	2.48	-	-	0.012	7.77	3.85	3650	0.009	3.39	5.41	-	10.4
K03	Surface	Kingfisher (Fugro, 2018)	16/8a	5	0.141	0.074	1760	2.19	-	-	0.01	7.68	4.83	3140	0.006	2.89	4.97	-	8.77
K04	Surface	Kingfisher (Fugro, 2018)	16/8a	10.9	0.265	0.136	3047	2.19	-	-	0.035	10.2	7.64	4450	0.044	4.82	9.74	-	23.2
K05	Surface	Kingfisher (Fugro, 2018)	16/8a	5.1	0.151	0.082	3140	1.86	-	-	0.022	10.4	5.26	4550	0.013	4.81	5.95	-	24.1

	Depth (cm)	Source	Block	THC (µgg-1 dry sediment)	Total n-alkanes (nC_{12} to nC_{36}) (µgg-1 dry	PAH (µgg-1 dry sediment)	Al	As	Ba	TB a	Cd	Cr	Cu	Fe	Hg	Ni	Pb	V	Zn
K06	Surface	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	5.5	0.154	0.153	3047	2.02	-	-	0.012	6.86	1.39	3250	0.009	2.91	4.13	-	9.56
K07	Surface	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	4.3	0.126	0.06	3140	2.07	-	-	<0.010	6.08	3.1	2820	0.005	2.43	3.58	-	7.65
K08	Surface	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	7.4	0.249	0.144	1860	2.65	-	-	0.02	8.95	3.48	4260	0.057	3.92	6.02	-	16.8
K09	Surface	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	3.3	0.097	0.048	2180	1.9	-	-	0.014	7.9	1.77	3540	0.008	3.43	4.35	-	10.1
K10	Surface	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	10.4	0.247	0.089	2760	1.99	-	-	0.118	9.32	4.51	4280	0.013	4.39	4.4	-	20.5
K11	Surface	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	5.1	0.153	0.084	2350	1.72	-	-	0.015	7.87	3.2	3620	0.008	3.83	4.48	-	10.8
WA02	Surface	Brae Bravo (Marathon Oil, 2013)	16/8 a	2.5	-	0.052	1640	1.79	99.4	196	0.02	7.57	1.58	-	<0.03	3.80	4.64	6.77	9.59
KREF01	Surface	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	4.8	0.176	0.083	2100	1.65	-	-	0.013	6.95	1.76	3220	0.008	3.20	3.81	-	9.37
KREF02	Surface	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	4.3	0.153	0.075	2230	1.73	-	-	0.014	8.07	3.4	3250	0.007	3.61	4.27	-	10.7
KC01	Top (0-10)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	3.6	0.39	0.161	2110	2.05	-	-	0.03	8.75	5.48	3680	0.07	4.65	5.11	-	11.2

	Depth (cm)	Source	Block	THC (µgg-1 dry sediment)	Total n-alkanes (nC_{12} to nC_{36}) (µgg-1 dry	PAH (µgg-1 dry sediment)	Al	As	Ba	TB a	Cd	Cr	Cu	Fe	Hg	Ni	Pb	V	Zn
	Middle (31.5 to 41.5)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	15.2	4.11	0.312	14900	13.5	-	-	0.126	73.5	21.2	**27800**	0.024	26.50	8.11	-	63.8
	Bottom (63 to 73)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	177	6.03	1.05	9480	10.2	-	-	0.614	26.6	27.5	**17400**	0.794	17.70	131	-	248
KC02	Top (0-10)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	16.7	2.37	0.426	7350	6.05	-	-	0.067	16.9	13.2	1200	0.072	12.50	9.41	-	53.9
	Middle (31.5 to 41.5)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	2.8	0.34	0.041	2700	2.72	-	-	0.075	12.6	5.68	5440	0.005	4.29	1.79	-	10.6
	Bottom (63 to 73)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	16.7	0.93	0.151	5220	5.07	-	-	0.134	18.4	7.31	10900	0.059	11.20	10.2	-	42.9
KC03	Top (0-10)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	22.6	4.27	0.634	14600	16.3	-	-	0.8	31.7	27.2	27400	1.24	24.50	197	-	566
	Middle (23 to 33)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	59.5	4.97	0.203	5710	5.89	-	-	0.239	19.3	12.9	11500	0.232	10.10	47.4	-	146
	Bottom (46 to 56)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	198	7.16	1	4420	4.99	-	-	0.304	16.1	26.5	9470	0.384	8.50	50.1	-	121
KC04	Top (0-10)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	14.3	1.61	0.191	7200	5.8	-	-	0.155	20	9.13	14500	0.036	12.40	9.1	-	47.3
	Middle (30 to 40)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	11	1.15	0.132	2770	2.97	-	-	0.067	11.3	4.11	7390	0.013	6.38	2.97	-	19.2

	Depth (cm)	Source	Block	THC (µgg-1 dry sediment)	Total n-alkanes (nC_{12} to nC_{36}) (µgg-1 dry	PAH (µgg-1 dry sediment)	Al	As	Ba	TB a	Cd	Cr	Cu	Fe	Hg	Ni	Pb	V	Zn
	Bottom (60 to 70)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	42.4	1.95	0.35	5910	5.74	-	-	0.177	19.2	16.3	13400	0.248	11.10	38.8	-	98
KC05	Top (0-10)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	297	3.03	2.12	5530	9.64	-	-	1.11	20.3	24.9	14400	0.689	16.50	108	-	280
	X (24 to 33)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	51.6	0.55	0.779	8010	11.8	-	-	1.28	12.7	41.1	19900	2.1	7.54	439	-	919
	Middle (31 to 41)	Kingfisher (Fugro, 2018)	16/8a/ 16/8d	28.6	0.85	0.335	6400	7.67	-	-	0.237	22	24.3	16800	0.94	18.70	45.7	-	111
	Bottom (51 to 61)	Kingfisher (Fugro, 2018)	16/8a / 16/8d	18.2	1.29	0.535	10100	7.85	-	-	0.168	23	19.4	19000	0.113	17.60	29	-	90
EET (Estimated 'ecological effects threshold) for drill cuttings	**EET (Estimated 'ecological effects threshold) for drill cuttings**	**OSPAR 2006**	-	**50**	-	-	-	-	-	-	-	-	-	-		-	-	-	-
Effects Range Low (ERL)	**Effects Range Low (ERL)**	**OSPAR 2014**	-	-	-	**Various**	-	-	-	-	**1.2**	**81**	**34**	-	**0.15**	**20.9**	**47**	-	**150**

	Depth (cm)	Source	Block	THC (µgg-1 dry sediment)	Total n-alkanes (nC_{12} to nC_{36}) (µgg-1 dry	PAH (µgg-1 dry sediment)	Al	As	Ba	TB a	Cd	Cr	Cu	Fe	Hg	Ni	Pb	V	Zn
Effects Range Medium (ERM)	Effects Range Medium (ERM)	OSPAR 2014									9.6	370	270		0.71	51.6	218		410
CNS Mean Background	CNS Mean Background	UKOOA, 2001	-	9.51	0.4	0.233	-	-	178	348	0.03	9.13	2.41	4725	0.03	7.31	6.75	14.9	13.5
CNS Background 95th percentile	CNS Background 95th percentile	UKOOA, 2001	-	40.1	1.18	0.736	-	-	523	720	0.12	31	6	11160	0.12	19	16.7	31.3	32.5

	Above CNS Background Mean
	Above CNS Background 95th Percentile
	Above EET
	Above ERL