



**Projects & Engineering**  
**UK & Ireland Operated Projects**  
*Decommissioning Strategy*



# Goldeneye Decommissioning Environmental Appraisal Report

<b>Project</b>	Goldeneye Decommissioning
<b>Client</b>	Shell UK
<b>Shell Document Number</b>	GDP-PT-S-HE-0702-00003
<b>Originating Company Document Number</b>	N/A
<b>Security Classification</b>	Unrestricted
<b>ECCN</b>	EAR 99
<i>Revision History is shown next page</i>	



Rev #	Date of Issue	Status Description	Originator	Checker	Approver
R01	22-Apr-2018	Issued for Review	Nicholas Green	Paul Wood	Trevor Crowe
R02	18-Jun-2018	Issued for Review	Nicholas Green	Paul Wood	Trevor Crowe
A01	13-Aug-2018	Issued for Approval	Nicholas Green	Paul Wood	Trevor Crowe
A02	16-Oct-2018	Consultation Draft	<div>X Originator </div>	<div>X Checker </div>	<div>X Approver </div>

### Revision History

Rev #	Reason for Issue / Change
R01	First Draft for Review.
R02	Draft for Partner, Legal and ES Review
A01	Issued for Approval
A02	Consultation Draft

This document includes rolled up DCAF Deliverables as follows:

DCAF No	Title



## Non-Technical Summary

### Introduction

This Environmental Appraisal (EA) documents the environment and societal impacts assessment carried out in support of the Goldeneye Decommissioning Programmes (DP). The DP documentation contains full details of Shell's plans to decommission the Goldeneye offshore facilities, 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 Goldeneye field is a gas condensate field in Block 14/29 of the central North Sea in 120 m water depth. The field is located approximately 100 km east-northeast of the St Fergus Gas Plant near Peterhead, Scotland.

Facilities in the Goldeneye field consist of a platform comprising a topsides and a steel framed jacket installed in 2004. The platform was designed and operated as a normally unattended installation with control from the St Fergus Gas Plant. Production was between 2004 and 2011 from five wells, with wellheads located on the platform topsides. In addition to the wellheads, the topsides provided fiscal metering, basic supporting utilities and facilities for short stay accommodation of up to 12 persons.

Produced fluids from the platform were transported to the St Fergus Gas Plant for processing through a dedicated 102 km, 20" diameter export pipeline made of concrete-coated steel. The pipeline is buried to a depth of at least 1 m for the 610 m from the intertidal zone to the fenceline of the gas plant. The pipeline is also buried to a distance of 20 km offshore, and thereafter surface laid for 82 km to the platform location. A 102 km, 4" diameter supply line, made of bonded epoxy coated steel, fed hydrate inhibitor to the wellheads from the St Fergus plant onshore. The 4" line is piggy backed to the export pipeline up to a transition point at a distance of 20 km offshore, where it diverges on its own route to the platform. The 4" pipeline is buried along its entire length. Both pipelines were flushed of hydrocarbons and chemicals in 2013 and flooded with freshwater and corrosion inhibitor in readiness for final decommissioning.

A subsea isolation valve is situated on the pipeline within 100 m of the platform.

Following the cessation of production, the topsides piping and equipment were vented, flushed and left isolated in 2012. The five wells were plugged and made safe in 2018 and all remaining fluids, such as diesel, hydraulic oils and lubes, were removed from the platform topsides at this time. The platform will remain as a permanently unattended installation from October 2018 until the final platform removal works begin.

The DP, and this supporting EA, covers the decommissioning works for the offshore facilities. It does not include decommissioning of onshore infrastructure which is permitted by Aberdeenshire Council under the Town & Country Planning Regulations.

### Summary of Planned Decommissioning Works

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

- The platform topsides and jacket will be removed from their location and recovered to a shore yard for dismantling and recycling;
- The subsea infrastructure, including isolation valve and connection spools, will be removed and recovered to a shore yard for dismantling;



- The 20" export pipeline will be decommissioned *in situ*. The pipeline end offshore will be capped and the surface laid section buried below the seabed except at locations where the line is crossed by other pipelines used by third parties, and at the transition point where the 20" export pipeline and 4" supply pipeline diverge;
- The 4" supply pipeline will be decommissioned *in situ*;
- Exposed pipeline stabilisation features (concrete mattresses and grout bags) will be removed. Those required for ongoing stabilisation of the pipelines, e.g. for the protection of pipeline crossings, are currently covered with rock and will remain *in situ*;
- Steel piles that attach the platform jacket and the subsea isolation valve unit to the seabed will be cut below seabed level to enable their removal;
- Following pipeline burial, a depth survey will determine any area of the pipelines that are buried to a depth of less than 0.6 m. These areas will be assessed for potential risk of snagging of fishing gear. Some sections may require additional rock cover to mitigate this risk;
- Depressions caused by activities from the drilling of the wells, production at the field and its decommissioning that could potentially cause a risk to other users of the sea will be made safe by use of rock cover. This may include e.g. spud cans and anchor scars; and
- Any oil and gas operations related debris on the seabed within the 500 m safety zone around the platform, and along the pipeline corridor will be removed where feasible.

The decommissioning activities will utilise a variety of vessels, with an anticipated aggregate of 300 vessel-days' service. A guard vessel will be stationed at the platform location from the time when Navigational Aids have been removed until the seabed is safe for other users of the sea.

Following completion of the decommissioning, surveys and overtrawl trials will be conducted to demonstrate that the seabed has been left clear and safe.

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

## Environmental Baseline Summary

The seabed sediment in the area around the Goldeneye platform is largely homogeneous comprising poorly sorted silty fines, with the underlying layers of sediment comprising very soft sandy clay and soft to firm clay. The platform area habitat is assigned to the EUNIS biotope 'Circalittoral fine sand' and is considered to support elements of the habitat for 'Seapen and burrowing megafauna communities' that has been classed as a threatened and/or declining habitat by OSPAR. This habitat type covers large areas of the central North Sea and has been degraded through historical activities such as fish trawling. Juvenile stages of the long-lived bivalve Ocean Quahog are present at the platform location but no adult examples of this species were identified by environmental survey.

No oil based mud (OBM) was discharged during the drilling of the five wells and consequently there are no OBM-contaminated cuttings piles at Goldeneye. Discharges of cuttings drilled with water based mud (WBM) were likely to have taken place and bathymetry data shows evidence of sediment disturbance under the platform which could be interpreted as being WBM cuttings. Environmental survey has shown that the sediments around the platform show no sign of hydrocarbon contamination.



The seabed along the pipeline corridor includes sediment types typical of the wider central North Sea. These comprise mainly 'circalittoral mixed sediment' out to approximately 45 km from shore. The sandy areas exhibited low biodiversity, while areas which featured fragmented shells, gravel, pebbles and cobbles exhibited relatively high biodiversity. Several depressions were observed, most of which contained possible boulders of up to 1.2 m height. The reef-forming tube worm species *Sabellaria spinulosa* has been observed at near shore sample locations (i.e. within 12 nautical miles of the coast) along the Goldeneye pipeline route but at no point has a contiguous reef formed along the surveyed route.

There are no designated areas of conservation interest in close proximity to the Goldeneye field. The export and supply pipelines pass through the south-eastern section of the Southern Trench proposed Marine Protected Area (pMPA) which has been proposed for the following features: minke whale, ocean fronts, shelf deeps and burrowed mud habitat; and Submarine mass movement – slide scars; Quaternary of Scotland sub-glacial tunnel valleys and moraine.

The pipeline landfall location is not a designated area of conservation interest. The nearest conservation areas to the Goldeneye landfall include the Loch of Strathbeg Special Protection Area (SPA) and Ramsar site 4.5 km to the north and the Buchan Ness to Collieston Coast SPA 10 km to the south.

The Goldeneye platform is located on the edge of an area of Annex 1 habitat of submarine structures that are formed by leaking gases, although active bubble streams were not evident in the numerous pockmarks in the area. No Methane-Derived Authigenic Carbonate reefs have been identified through survey near to the platform.

Moderate densities of harbour porpoise, white-beaked dolphin, Atlantic white-sided dolphin and minke whale may be expected in the part of the central North Sea where the Goldeneye platform and pipelines are located. Grey seals are also likely to occur here, in increasing numbers closer to shore.

A large number of seabirds, of various species, inhabit the area of the decommissioning activities at different seasons throughout the year, with high densities of combined species in July and August. Vulnerability of seabirds to oil spills varies across the area and at different seasons, reaching a level of Extremely High sensitivity nearshore in April and in October.

The Goldeneye installation and pipelines lie within spawning grounds for a number of fish species of commercial and/or conservation importance. Of these, herring and sandeels spawn at the seabed and would be vulnerable to seabed disturbance.

The nearshore area of the pipeline corridor is an important fishing ground for smaller vessels while, for areas further offshore, fishing intensity from larger vessels is considered to be moderate relative to activity throughout the rest of the UKCS.

## Stakeholder Engagement

Shell has actively engaged with key external stakeholders to inform them of our intention to decommission Goldeneye, 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 an in depth understanding of the baseline environment and ensure protection of sensitive features. These points have been addressed throughout the EA report.

In addition, Shell received requests to:

- Consider the retention of infrastructure that could be beneficial for future developments;
- Give due consideration to the size of rock selected for rock placement, where required, as large rock sizes may present increased risks to the snagging of fishing equipment; and



- Ensure that adequate care and attention is given to the lifting and transportation of the major structures being removed and avoid loss at sea, to minimise the risk of structures being lost at sea and the consequent impact to navigation or the environment.

Each of these requests was considered during planning and have been provided for:

- The pipelines will be capped and decommissioned *in situ*, protected from corrosion by corrosion inhibitor added at the time of pipeline flushing and cleaning (covered in Section 1.5.4).
- Shell will undertake to leave a clear and safe seabed following decommissioning in accordance with the approved DP. This will be demonstrated through seabed surveys and overtrawl trials. Where rock placement is required, the safety of other users of the sea will be considered along with the goal of minimising disturbance of seabed habitats. Both concerns are heightened where scallop fishing occurs within the waters of the Southern Trench pMPA. Shell will develop a plan for rock cover on the basis of data collected from post-decommissioning pipeline burial surveys and will liaise with the relevant stakeholders to agree details of location, type and extent of rock cover required (covered in Section 4.2.3 and 4.8.2.3).
- Shell will award the contract for the removal of the Goldeneye platform topsides and jacket to a competent lifting contractor. A requirement of the contract award is that the contractor provides and implements a comprehensive Lift Plan and Transit Plan which will address the points more particularly set out in Section 4.7.2.

## ENVID

Potential environmental and societal risks arising from the DP 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.

The ENVID, along with additional evaluation of options and subsequent analysis and study, concluded that the decommissioning of Goldeneye would give rise to no impacts categorised as “major” or “moderate”. Identified risks can be mitigated using standard control measures and procedures due to the relatively small scale of the facilities to be decommissioned, the nature of the activities to be carried out and the relatively short duration of these activities.

This 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 DP. 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

#### *Disturbance to Other Users of the Sea*

There will be a number of vessels active at sea during the planned decommissioning activities. Vessels will be required for relatively short durations and will cause minimal interference to other



users of the sea as most sea surface activity will be within the 500 m safety zone around the platform from which other shipping is excluded.

Fishing activity along the pipeline route will not be permitted while pipeline decommissioning activities from vessels are underway. These activities will be for limited short durations and will be communicated through notices to Mariners and the Kingfisher Bulletin which will allow fishing vessels to plan avoidance of these areas during periods of sea surface activity.

Adoption of the OSPAR goal of achieving a clear and safe seabed will minimise any potential risk of snagging of fishing gear. Post decommissioning surveys and overtrawl trials will ensure potential snagging points are identified and remedied.

#### *Air Quality*

Emissions to air from the vessels and equipment required for execution of the DP constitute a very minor addition to the overall emissions from routine shipping in the area and will have a negligible impact on air quality and on greenhouse gas emissions.

#### *Discharges to Sea*

The decommissioning works will require minimal discharges to sea. Discharges associated with wastewaters generated on vessels are controlled by standard requirements of vessels operating in the North Sea for compliance with the International Convention for the Prevention of Pollution from Ships (MARPOL).

Discharges during disconnection of the pipelines, removal of the subsea isolation valve, connecting spools and risers will be limited to the inhibited water that remains in these systems following cleaning to below 5 ppm oil content in 2013. If the pipelines are not re-used by third parties inhibited water within the pipelines will ultimately be released in the future as the pipeline deteriorates over time.

If the jacket is removed in more than one section there will be a release of approximately 20 litres of hydraulic fluid from control lines on the subsea isolation valve. This release will be agreed under permit from BEIS.

#### *Seabed Disturbance*

Disturbance of the seabed will occur during:

- the activities to bury the 82 km section of the 20" export pipeline that is currently laid on the seabed;
- removal of subsea infrastructure within the 500 m safety zone around the platform;
- overtrawl trials to demonstrate a clear and safe seabed; and
- in areas where rock additional cover is required.

The nature of the seabed, the habitats that it provides, and the ecological communities that it supports are found throughout the central North Sea. Even though these have been considered as being of moderate sensitivity, the area of the seabed affected is very small in the context of the overall coverage of these widespread habitats in the central North Sea. Recovery of the seabed communities following disturbance is anticipated to be around 1 – 3 years, except in the areas where rock cover is required as rock cover results in a change to the seabed from its natural type. This harder substrate will support a different community, with fewer sediment-resident animals but increased species of brittle star, star fish and crabs. Although this is a change from the natural baseline habitat, the activity will result in an increase in biodiversity in these areas.



The activity with potential for most widespread disturbance of the seabed is the overtrawl trials and fishermen contracted to undertake these trials will be advised of the spawning periods for herring and sandeels.

### *Underwater Noise*

There is no requirement for major noise sources during the planned decommissioning activities, however the activities will contribute to the general levels of anthropogenic underwater noise due to vessel engine noise and the use of cutting tools and other equipment. The activities will take place within an area of moderate to high shipping intensity and the cumulative impact of the Goldeneye decommissioning programme on the baseline noise levels will be minimal.

Measurement of pipeline burial depth relies on sound-wave penetration of the top few meters of the seabed. Sub-bottom profiling equipment used for depth of burial surveys utilise electromagnetic techniques for sound generation and are of a much lower amplitude than that generated by equipment such as air gun arrays used during seismic acquisition surveys. Sub-bottom profile surveys are commonly undertaken throughout the North Sea and, although the sound generated is within the audible range of most cetacean species, a previous survey of this type in nearshore waters off St. Fergus demonstrated that there would be negligible potential for injury, and minor potential for disturbance.

### *Waste*

A total of approximately 6,800 tonnes of materials will be recovered to the shore yard. Approximately 74% of the total is steel, 16% is marine growth, 7% concrete and grout and 2% non-ferrous metals. With the exception of marine growth, in excess of 97% of the recovered material is anticipated to be recycled.

In preparation for decommissioning the platform has been stripped of residual hazardous materials offshore where feasible, although some (such as paint work containing lead or chromium) remains and will be safely treated for disposal at the onshore yard. A full 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.

## **Unplanned events**

### *Fuel spills*

The assessment considered the impacts that may result following an accidental loss of fuel from a vessel whilst operating either at the platform or close to shore during the decommissioning programme. The hypothetical spill scenario, at both locations, considered the release of the 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 Goldeneye decommissioning programme.

Oil spill modelling carried out for the loss of a ship's diesel fuel inventory to sea at the Goldeneye platform location concluded that, more than half of the diesel would evaporate within 24 hours with negligible amounts of diesel remaining on the sea surface after 16 days. Modelling predicted that approximately one quarter of the diesel spilled would end up in seabed sediments over a wide area at low concentrations not expected to cause any measurable impact to the environment. The remainder of the diesel would disperse within the water column where it would biodegrade, leaving around 1 % of the volume within 30 days. As such the environmental impact of such an event at the platform location would be localised and short-term.



Modelling a loss of diesel inventory from a vessel operating in the nearshore area predicted a higher potential for negative impact due to the proximity to sensitive coastal areas and the reduced currents that would limit spill dispersion. The modelling study concluded that, were such an event to occur, there would be a moderate impact to seabirds, marine mammals, protected sites, commercial fisheries, shipping and tourism. To ensure the risks of fuel spills from all vessels commissioned for the decommissioning works are as low as is practically possible, vessels will be subject to review using Shell's Group Maritime Assurance System. Assurance will include detailed evaluation of the vessels fuel integrity system, spill prevention measures and spill response arrangements before the vessel can mobilise for the offshore decommissioning campaign.

#### *Dropped large object*

An additional worst case scenario for the decommissioning programme would be the loss of control and dropping of the platform topsides or jacket during lifting operations or in transit to the shore yard. The lifting of such structures at sea and in port, and the transportation of these facilities to shore, are recognised as high risk activities and are consequently subject to extensive and detailed planning, including the preparation of a robust Lift Plan and Marine Transport Plan prior to commencing the activities.

### **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 respond 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 commissioned contractors have sufficient mechanisms, processes, procedures and competent resources in place to implement the measures required. Shell's assurance procedures will monitor implementation.

### **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 the Goldeneye field and the potential for impacts. With implementation of Shell's robust, well established control measures and procedures including careful planning to 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 DP can be executed with minimal impact on the environment and minimal disturbance to other users of the sea.



MITIGATION AND CONTROL MEASURE	ASPECTS CONTROLLED
A policy of a clear seabed has been adopted in line with OSPAR Decision 98/3. Exceptions to this are limited to pipeline crossings and at the transition point 20 km from the shore, where burial is not feasible.	Natural Capital and Ecosystem Services Socio-economic
The scheduling of vessels' operations and the types of vessels used will be optimised to execute the decommissioning as efficiently as possible.	Natural Capital and Ecosystem Services Emissions to Air 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)
Disturbance of the seabed will be minimised through: <ul style="list-style-type: none"><li>Minimising the need for excavation to remove facilities attached to the seabed (platform jacket and subsea isolation valve assembly) by preferentially adopting internal cutting of piles</li><li>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.</li><li>Liaison with environmental stakeholders and the fishing industry body on the development of a strategy for pipeline burial protection following analysis of post-trenching depth of burial survey data.</li></ul>	Natural Capital and Ecosystem Services Seabed Disturbance
All vessels commissioned will be subject to Shell'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 Pollution Emergency Plans which are regularly reviewed by the vessels' crews.	Emissions to Air Discharges to Sea Accidental Events (Oil Spill) Waste Management
Discharges of chemicals during the decommissioning campaign will be permitted under the Offshore Chemicals Regulations and any controls identified in the permit following risk assessment will be adopted.	Discharges to Sea
Adoption of JNCC guidelines for minimising the risk of injury to marine mammals will be followed as necessary (and as agreed during permit approvals).	Underwater Noise
An Active Waste Management Plan (WMP) will describe and quantify wastes arising from the decommissioning activities, segregation and	Waste Management



<p>storage requirements, and identify available disposal options for each waste stream.</p> <p>Waste management options will be based on the waste hierarchy of reduce, reuse, recycle, recover, dispose.</p> <p>Achievable recycling goals will be identified and performance monitored using key performance indicators.</p> <p>The dismantling contract will be awarded to a yard with appropriate capability, with relevant licences and consents in place and with established arrangements in place with facilities for recycling of wastes identified in the WMP.</p> <p>Assurance will be carried out at the disposal yard and key subcontractors' disposal sites.</p>	
<p>Co-ordinated industry oil spill response capability will be available round the clock.</p>	Accidental Events (Oil Spill)
<p>Each lifting operation will be managed in accordance with a Lift Plan that will include:</p> <ul style="list-style-type: none"><li>• Confirmation of the structural integrity of the lifting points</li><li>• Centre of gravity calculation</li><li>• Specification of the sizing of crane and vessel</li><li>• Specification of weather and sea state</li><li>• Duration of weather window required.</li></ul>	Accidental Events (Dropped Object)
<p>Marine transport of major structures will be managed in accordance with a Transit Plan that will:</p> <ul style="list-style-type: none"><li>• Stipulate the towing and support vessel required</li><li>• Stipulate the route to be followed</li><li>• Identify sheltered locations along the route which can be used to shelter from storms</li><li>• Detail emergency response procedures.</li></ul>	Accidental Events (Dropped Object)
<p>Following removal of all infrastructure, the 500 m safety zone and pipeline route will be subjected to overtrawl trials and further remediation provided if required.</p>	Socio-economic
<p>All contractors commissioned will be subject to Shell's Contractor management and assurance procedures.</p>	



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## 1. Introduction

In accordance with the Petroleum Act 1998, the Section 29 notice holders of the Goldeneye installations/fields are applying to the Department for Business, Energy and Industrial Strategy (BEIS) to obtain approval for decommissioning the Goldeneye installation and associated subsea elements.

Under the Petroleum Act 1998 there is a requirement to provide an assessment of the impact of the decommissioning activities on the marine environment. In accordance with BEIS guidelines, the environmental assessment shall be documented in an Environmental Appraisal report. The Environmental Appraisal report is submitted along with the Decommissioning Programme and Comparative Assessment<sup>1</sup> in draft form for consideration at the Public Consultation stage, and in final form when the Decommissioning Programme is submitted for approval.

The Goldeneye Environmental Appraisal (EA) report has been prepared by Shell U.K. Limited (hereinafter 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 activities required to fulfil the Goldeneye Decommissioning Programmes (DP).

This EA report is intended to be read in conjunction with the DP, to which it refers for certain details although some information from the DP is repeated here, or further elaborated on, to enhance understanding of the assessment of impacts on the environment.

### 1.1. Location of the Goldeneye Field

The Goldeneye Field is located in blocks 14/28b, 14/29a, 20/3b and 20/4b of the United Kingdom Continental Shelf (UKCS) in the central North Sea (CNS). The platform is located in Block 14/29, approximately 100 km North-East of St. Fergus and approximately 110 km from the UK/Norway median line in water depths ranging between 118 m and 122 m below Lowest Astronomical Tide (LAT) (Figure 1-1).

Two pipelines connect the platform with St. Fergus Gas Plant, PL1978 and PL1979. The pipelines traverse blocks 19/9, 19/10, 19/12, 19/13, 19/14, 20/1, 20/2 and 20/3.

### 1.2. Production History

Goldeneye is a normal pressure, normal temperature gas condensate field which was produced from 2004 via five production wells that were all drilled in that year. The wells were shut-in in 2011 and Cessation of Production (CoP) was approved by the Department of Energy and Climate Change (DECC, now BEIS) in 2011.

### 1.3. Goldeneye Installation Facilities and Infrastructure

The Goldeneye facilities comprise a normally unattended installation (NUI) which housed the five wellheads and fiscal metering. Produced fluids were exported to the St. Fergus Gas Plant from where production was controlled, and from where hydrate inhibitor and corrosion inhibitor were supplied. Inhibitor supply and hydrocarbon export was via dedicated pipelines between St. Fergus and Goldeneye.

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<sup>1</sup> The process and conclusions of the Comparative Assessment are documented in an Emerging Recommendations report

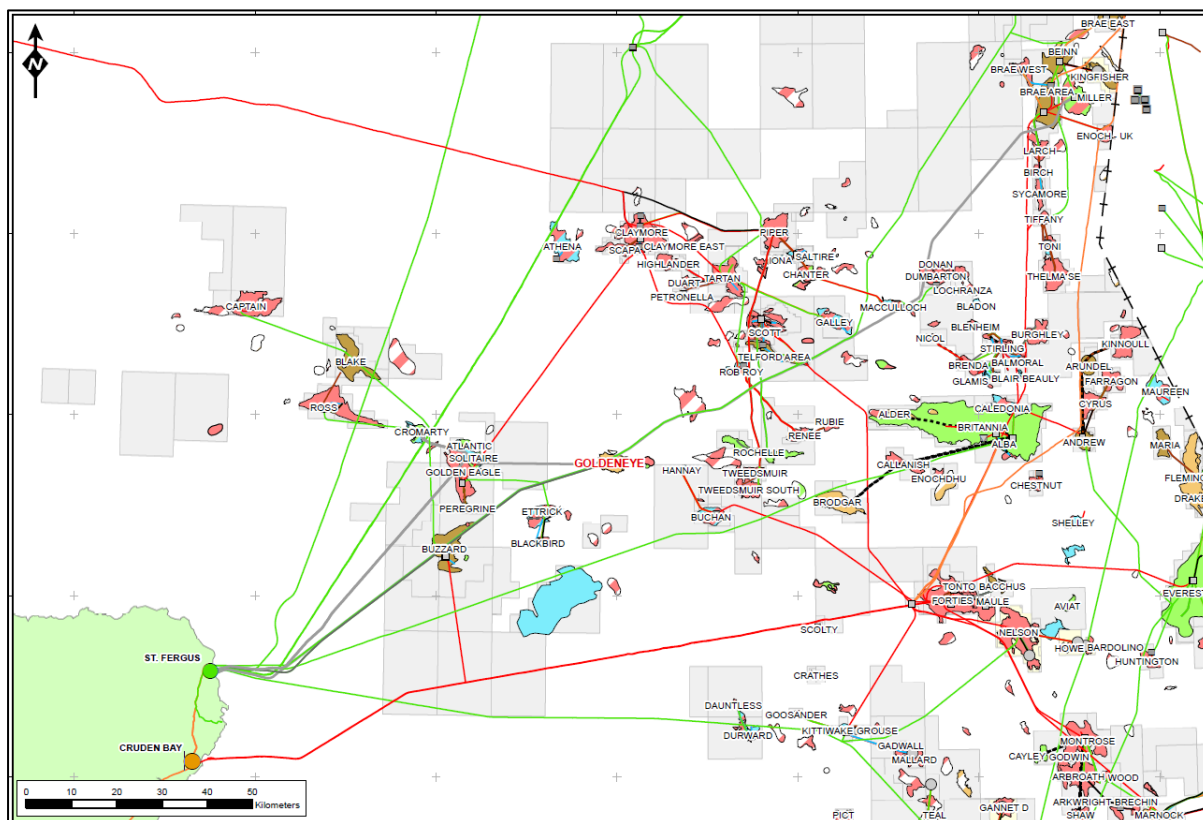


Figure 1-1 Location of Goldeneye within the UKCS

### 1.3.1. Goldeneye Platform

The NUI is a 4-leg steel jacket substructure supporting an integrated topsides deck structure. A photograph of the platform is shown in Figure 1-2.

#### 1.3.1.1. Jacket

The four-legged substructure is 35 m by 35 m at the seabed and stands 141 m tall. The permanent foundation system consists of eight support piles, two in each corner. Each leg also has a docking pile from its installation. The total installed weight of the jacket is 2,500 te although extensive marine growth on the jacket is estimated to add a further c. 1,000 te weight.

#### 1.3.1.2. Process Facilities

The topsides consist of continuous chemical injection of monoethylene glycol (MEG) and corrosion inhibitor, fiscal metering and provision of basic supporting utilities (e.g. power, venting etc). Metering necessitated separation of gas, condensate and water, which were subsequently recombined for export.

#### 1.3.1.3. Accommodation

The platform included facilities for short stay accommodation of up to 12 persons including sleeping quarters, canteen and workshop. Power was provided by three diesel powered generators and lifting was undertaken by a diesel powered pedestal crane.

Drainage from the weather deck and helideck are direct to sea, with valved connection to the hazardous open drains tank for use in the event of a spill. Secondary containment, such as bunds



and drip trays, for the diesel system are also routed to the hazardous open drains tank, which is emptied by pumping to tote tanks for return to shore.

The installed total topsides weight is 1,300 te.



Figure 1-2 Goldeneye Platform

### 1.3.2. Pipelines

Goldeneye is serviced by two bespoke pipelines between the platform and St. Fergus Gas Plant. The export pipeline (PL1978) is 20" carbon steel with asphalt enamel and concrete coating and the MEG pipeline (PL1979) is 4" carbon steel with fusion bonded epoxy coating.

The pipelines terminate at a valve pit within Shell's St. Fergus Gas Plant. The onshore sections of both pipelines are buried. The near-shore and inshore sections are trenched and buried, with rock-cover in places to increase the depth of burial. The two lines separate 20 km from mean low water springs (MLWS) (KP20), beyond which the export line is surface laid while the MEG line is trenched and buried. The Goldeneye pipelines cross above five third-party pipelines within the nearshore section, at which points the pipelines come above the seabed and are covered with a combination of mattresses and rock. From KP20 to the platform, the Goldeneye pipelines are crossed by three third-party pipelines. This is shown in schematic form in Figures 1.2 and 1.3 of the DP.

### 1.3.3. Subsea Infrastructure

Subsea infrastructure at Goldeneye consists of one subsea isolation valve (SSIV), pipeline connection spools and risers. The umbilical between the platform and the SSIV consists of two hydraulic umbilical hoses each of 1/2" diameter.

The SSIV, located approximately 100 m from the platform, has a seabed footprint of 10.3 m by 6.5 m and is secured to the seabed by four tubular driven piles to a depth of 22 m. Connecting spools link the end of the export pipeline to the SSIV and the SSIV to the riser. All spools and risers are of the same diameter and material as the respective pipelines.



Pipeline stabilisation features consist of approximately 100 concrete mattresses (of 5 te each) and 700 grout bags (of 25 kg each).

### **1.3.4. Inter-connections with Other Fields**

Atlantic and Cromarty (A&C), a third-party field, was controlled via the Goldeneye platform by means of an umbilical and associated equipment, also located on Goldeneye. The A&C field ceased production in 2011 and all equipment (including umbilicals and pipelines) connecting Goldeneye with A&C are outside the scope of the Goldeneye decommissioning programmes.

## **1.4. Current Status**

The five wells were plugged and made safe in 2018 and the conductor casings removed. The topsides piping and process equipment were flushed and vented in 2012.

The pipelines, SSIV, spools and risers were flushed and cleaned to <5 ppm oil in water (OIW) and filled with inhibited river water in 2013. The pipelines remain shut-in by valves at the St. Fergus Gas Plant and at the platform.

The power generators have been disconnected, drained down and electrically isolated. The accommodation facilities' potable water and sewage systems have been drained. Fire protection systems have been drained and/or discharged.

It is intended that the platform will next be boarded when the decommissioning contractor arrives to remove the topsides to shore for dismantling. To avoid any potential for contamination of the topsides or fluid releases to sea to occur, either prior to removal or during the subsequent lifting of the topsides, all residual liquids, such as unused fuel, machinery lubricants, hydraulic fluids and rig wash chemicals, were drained and removed from the platform topsides in 2018.

The hazardous open drains tank was drained and isolated.

All items of equipment on the installation Fluorinated Greenhouse Gas (F-gas) register have been drained in accordance with the F-gas regulations.

Batteries providing emergency power back-up, and with the potential to corrode and leak acid, were also removed from the platform.

Since CoP the subsea infrastructure has been preserved for potential future use.

The umbilical lines could not be flushed in 2018 and remain filled with hydraulic fluid.

## **1.5. Outline of Decommissioning Activities**

The topsides and jacket will be recovered to shore. The risers and connection spools of both pipelines will also be recovered, along with SSIV, umbilical control lines and any debris identified within the 500 m safety zone or along a 100 m wide corridor along the pipelines.

The offshore ends of both pipelines will be capped with blind flanges and decommissioned in situ. The MEG supply pipeline (PL1979) is already buried along its entire length. The export pipeline (PL1978) is buried from the onshore valve pit up to the pipeline transition point at KP20 (the point 20 km along the pipeline from MLWS). The surface laid section of PL1978 (i.e. from KP20 to KP102) will be buried as part of the decommissioning works.

All material recovered during the decommissioning activities will be returned to shore for re-use, processing and recycling or disposal.

Offshore activities will be finalised with trawler sweeps and as-left surveys as required.

Much of the detail of how the works will be undertaken has not been determined at this stage and will be subject to offers received from the market. However, certain aspects including those



required by regulation or regulatory guidance, will be built in to the scope of works for the decommissioning contractor. Further detail about the decommissioning activities in as much as they have been established to date, and in as much as it significantly influences the potential for environmental impact is presented in the following subsections.

### 1.5.1. Topsides Removal

It is anticipated that the topsides will be cut and lifted as a single lift and transported to shore either on the vessel used for the lift or on an independent barge. Cutting of jacket members and both pipeline risers will be required. In order to maintain the integrity of the pipelines, a blind flange will be fitted to each prior to cutting of the risers. The umbilical lines will be disconnected and removed in anticipation of the topsides lift.

The scale of the platform is such that a heavy lift vessel (HLV) is not essential for removal of the topsides, although an HLV may prove to be the preferred option. The type of vessel to be used for the lift will be determined by market availability and commercial suitability to the wider decommissioning activities.

### 1.5.2. Jacket Removal

To enable removal of the jacket, its piles will be cut below the seabed and both pipeline risers will be cut at the seabed. Cutting of the piles is anticipated to be by way of internal cutting equipment. However, if this proves unfeasible it would be necessary to excavate the seabed around the piles to enable external cutting.

The jacket may be removed as a single lift or cut in sections. Removed jacket structures will be transported to shore either on the lift vessel or on an independent barge.

There may be a period of time between removal of the topsides and removal of the jacket.

### 1.5.3. Subsea Infrastructure Removal

To enable removal of the SSIV, its piles will be cut below the seabed. As with the jacket piles, it is anticipated that these will be cut internally, although excavation for external cutting may be required if internal cutting proves unfeasible.

Connecting spools will be cut into manageable sections and removed.

Approximately 50 of the mattresses and 600 of the grout bags are exposed and will be removed during decommissioning. The remainder, for instance at pipeline crossings, and will remain *in situ*.

NAVAids are currently installed on the topsides. When the topsides are removed, NAVAids may be installed on the jacket or a guard vessel will be stationed on site. If no NAVAids are in use, a guard vessel will be stationed on site until the seabed is safe for other users of the sea.

### 1.5.4. Pipelines

Both pipelines will be decommissioned *in situ* and made available for potential future re-use.

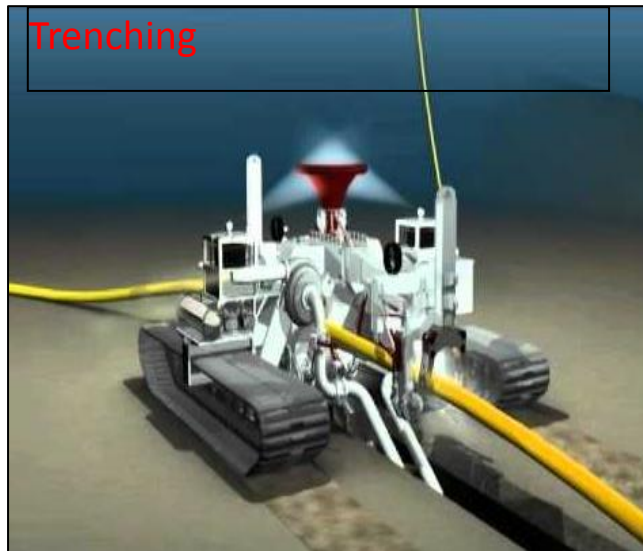
The MEG pipeline is buried along its length except at nearshore pipeline crossings, the pipeline transition point (KP20) and at its end. The transition point and nearshore crossings are protected and made safe with rock cover and this will remain following decommissioning. The blank-flanged offshore end will be covered with rock to protect it and other users of the sea.

The Export pipeline is buried from the onshore valve pit to KP20 and surface laid thereafter. The section between KP20 and KP102 will be trenched and buried, including the blank-flanged end. Third party pipelines crossing over the Goldeneye export pipeline are currently protected with a



combination of concrete mattresses and rock cover. Trenching of the export line will not be feasible at these locations and the protective covering will remain in place and will need to be enhanced with additional rock cover.

Pipeline burial is anticipated to be by jet trenching, whereby a remotely operated vehicle uses high pressure water jets below the seabed to collapse the sediment structure and causing the pipeline to sink into the collapsed trench under its own weight.



Vehicles typically used for pipelines of around 20" diameter would create a trench of <5 m width, with the vehicle spanning the trench on tracked wheels of approximately 1 m width. An indicative illustration of the technique is presented in Figure 1-3.

The technique will aim to achieve a burial depth of at least 0.6 m above the apex of the pipeline.

Other feasible techniques would be considered if commercially competitive.

**Figure 1-3 Illustration of jet trenching of a pipeline**

#### **1.5.5. Pipeline Burial Survey**

Following infrastructure removal and export pipeline burial, a survey will determine the depth of burial (DoB) of both pipelines along their full length.

The survey is likely to be multipurpose, establishing post-burial bathymetry, information on the status of protective cover at pipeline crossings and evidence of debris in addition to DoB. Several instruments are likely to be used, including side scan sonar (SSS), multibeam echo sounder (MBES) and sub-bottom profiler (SBP).

The results of the survey will be used to identify any points or sections of the pipelines that could benefit from additional protective cover. There may consequently be requirement for targeted placement of rock cover.

#### **1.5.6. Over trawl Trials**

Post-decommissioning overtrawl trials are required to demonstrate that the as-left condition of the seabed does not present a hazard to fishing, and to confirm a clear seabed. These trials are typically undertaken by the Scottish Fishermen's Federation (SFF) using chain mats to represent a worst case snagging potential. The full extent of the 500 m safety zone around the platform will be overtrawled, as will a 100 m wide corridor along the pipeline route (50 m either side of the centre line). The trials include trawling the pipeline from multiple angles of approach, ranging from parallel along the axis of the pipeline to a perpendicular approach. Trawl mats are approximately 20 m wide and the trawling rig used typically has a turning circle of approximately 400 m to achieve a 180° turn.



### 1.5.7. Post-Decommissioning Survey

An as-left survey of the seabed and environment will be undertaken. The scope of the environmental survey will be proportionate to the scale of impact caused by the production of the field, as determined from surveys undertaken in 2009, three years before CoP.

### 1.5.8. Onshore Dismantling

The onshore decommissioning yard will strip the topsides of materials and either process each waste type on site (if suitably authorised) or transfer them to appropriate processing facilities. Steel structures will be cut and packaged for transport to be recycled. There may be a requirement to clean parts of the recovered equipment (e.g. of marine growth, paints or residual contamination) prior to dismantling.

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

### 1.5.9. Vessel Usage

Estimates of use for various vessel types expected for the decommissioning programme are summarised in Table 1-1. The estimate assumes that the topsides and jacket are both lifted by HLV as single items at different times and are each transported to shore by barge.

**Table 1-1: Estimated vessel use for Goldeneye Decommissioning Programme (days)**

VESSEL TYPE	MOBILIS <sup>N</sup> & TRANSIT	OPERAT <sup>N</sup>	INTERIM MOBILIS <sup>N</sup>	WEATHER DISRUP <sup>N</sup>	TRANSIT & DEMOB <sup>N</sup>	TOTAL
DSV	3	24		5	2	34
HLV	4	15	2	6	2	29
Rock placement vessel	3	3		1	2	9
Trenching vessel	3	33		10	2	48
Survey vessel		54				54
Guard vessel		218				218
Barge	3	103	2	3	2	123

Goldeneye, being a relatively small installation, provides opportunities for contractors to take a flexible approach to the timing of the activities so that they can be integrated with their other commitments in the North Sea and thereby optimise their vessel usage. Shell is seeking proposals from appropriately qualified contractors to undertake the decommissioning activities, and opportunities for optimisation may lead to a reduction from the estimates in Table 1-1.

The duration of operation of the barge is dependent on the onshore destination of the material. The decommissioning yard has not yet been appointed but the vessel estimates have assumed that a UK port will be used. As described in Section 1.5.1, a HLV may not be required for the single lifting of the topsides and, as inferred in Section 1.5.5, the extent of rock cover required will only be known following the DoB survey. Furthermore, there is high flexibility over the duration that a guard vessel will be on station.

Helicopter access will not be required.



## 1.6. Environmental Appraisal Process

The Petroleum Act 1998 (as amended by the Energy Act 2008) requires approval of a decommissioning programme by the Secretary of State (BEIS), subject to statutory and public consultations, before the Section 29 notice holders proceed with decommissioning. BEIS has published (BEIS, 2017) a draft update to the Guidance Notes on the Decommissioning of Offshore Oil and Gas Installations and Pipelines (DECC, 2011) which describes the processes introduced into UK regulations to implement OSPAR Decision 98/3 and the Petroleum Act 1998.

Both the extant guidance notes and the revised draft require a decommissioning programme to be supported by a report that documents the assessment of the potential for environmental impact to result from the decommissioning programme activities. The environmental assessment is required to be evidence based and be proportionate to the scale of activities proposed, providing a more robust level of assessment where environmental sensitivities are higher.

Environmental appraisal of the Goldeneye DP is an ongoing process that has informed the development of the Goldeneye Comparative Assessment (CA) and DP, and will continue to inform the delivery of the programme, including risk assessments required for the application of activity-specific permits and consents, monitoring the management of wastes and establishing the as-left environmental status of the seabed.

This EA report records the status of appraisal at the time of the submission of the draft DP for public consultation.

### 1.6.1. Scope of the EA Report

The scope of the Goldeneye DP is limited to offshore installations, offshore pipelines and umbilicals. Installation of the onshore pipelines was permitted by Aberdeenshire Council under the Town and Country Planning Regulations and are not covered by the Section 29 notice. The onshore section of the pipelines will be decommissioned *in situ* in their current, buried state and are outside the scope of this EA. Facilities used for processing Goldeneye fluids within St. Fergus Gas Plant may be re-used and will ultimately be decommissioned as part of the Gas Plant decommissioning. These onshore facilities are therefore outside the scope of this EA.

The DP has been informed by the conclusions of the CA, as recorded in the Emerging Recommendations report, and the EA does not evaluate environmental impacts of options that were rejected through the CA process.

To inform the scope of this EA Report and identify aspects requiring a higher level of assessment, an Environmental Impacts Identification (ENVID) workshop was held.

The ENVID followed a standard approach, with a multidisciplinary group applying their particular expertise to provide a high level assessment of the impacts of activities in the context of established definitions for receptor sensitivity and impact magnitude. These definitions are provided in Appendix A and the workshop output is provided in Appendix B. The output is necessarily a very succinct and compressed record of the full discussion and rationale. This EA Report expands on the ENVID output, citing published data to provide justification for the conclusions reached.

The ENVID identified that none of the planned activities for the execution of the Goldeneye decommissioning programme would give rise to High environmental impact while four activities were conservatively assigned impact ratings of Moderate. In addition, one Moderate risk was identified for the unplanned accidental loss of vessel fuel.

All other impact scenarios were consequently scoped out from requiring further impact assessment.



This is not to say that execution of the DP will have no environmental impact, rather that the sensitivities of the receiving environment are well understood, the scale of the impacts of the activities are minor and that the controls for ensuring all potential impacts are minimised are identified and will be implemented.

This EA report consequently documents the rationale for the scoping conclusions reached and provides further consideration to the aspects identified as having the potential for Moderate impact. The report also provides a list of impact minimisation and mitigation measures that will be implemented.

## 1.7. Stakeholder Consultation

To ensure all environmental issues associated with the Goldeneye decommissioning could be identified, Shell has held a number of sessions to inform stakeholders of decommissioning plans and to seek feedback on any issues of concern to interested parties.

In December 2017 Shell held a stakeholder engagement event covering a portfolio of current and upcoming decommissioning programmes, including Goldeneye. Invitations to the event were extended to a wide array of stakeholders including statutory consultees, non-governmental organisations, engineering companies and Carbon Capture and Storage developers.

A Comparative Assessment workshop was attended by statutory consultees in December 2017 to determine the optimal decommissioning options for the Goldeneye pipelines.

Following preliminary environmental assessment, Shell presented and discussed the proposed scope of this EA with statutory consultees in March 2018. Consultees expressed agreement with the proposed approach and scope of the EA with some specific points raised for inclusion.

The following points were noted from these workshops and from other correspondences with individual organisations:

- The EA should demonstrate an adequate understanding of the environmental baseline from survey data and other sources;
- Consideration should be given to the potential for re-use of the Goldeneye pipelines for the sequestration and storage of carbon dioxide (CO<sub>2</sub>);
- Consideration should be given to the potential for underwater noise generated from nearshore activities to impact on minke whales (*Balaenoptera acutorostrata*) in the proposed Southern Trench Marine Protected Area, and bottle-nose dolphins (*Tursiops truncatus*) accessing the Moray Firth Special Area of Conservation. The assessment should consider the potential cumulative impacts with shipping from and around the port of Peterhead and with any other concurrent development activities;
- Where provision of rock cover is proposed, the rock size and extent of coverage should not present a risk of snagging to scallop dredging and should be balanced with the nature conservation interests of the seabed;
- Consideration should be given to the seasonal sensitivities of seabed spawning fish species when considering the impact and timing of activities disruptive to the seabed;
- Consideration should be given to the cumulative impact of the decommissioning of multiple pipelines approaching St. Fergus; and
- Consideration should be given to the impact of dropping a large structure during lifting operations if this were to be undertaken within a designated area of conservation or within a shipping lane.



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## 2. Environmental Baseline

### 2.1. Introduction

An understanding of the environment at the Goldeneye platform and along the Goldeneye pipelines to St. Fergus has been compiled to provide a basis for assessing the potential interactions of the decommissioning activities with the environment. This section describes the current nature and status of the environment at the Goldeneye platform and along the pipeline route to St. Fergus.

### 2.2. Surveys

Environmental survey data has previously been collected from the Goldeneye platform area (Fugro, 2010). This data has been drawn upon to inform the following sections. An environmental survey of the route of the Goldeneye pipelines to St. Fergus has not been commissioned. However, certain points along the Goldeneye pipelines have been sampled and analysed as part of environmental surveys for other projects, while data from a number of environmental surveys carried out in the wider area provides information relevant to the Goldeneye pipeline corridor and has been referenced. These surveys are identified in Table 2-1 and an indicative location of the referenced survey data is presented in Figure 2-1.

The latter two surveys referenced in Table 2-1 were not environmental surveys, though the reports did contain a description of the sediment type in the areas surveyed.

**Table 2-1 Surveys reports used to support baseline description.**

Area	SURVEY REPORT	REFERENCE
Ettrick and Blackbird Field Area	Ettrick. UKCS Block 20/2a and 20/3a. Habitat Assessment Survey Report. Survey period was September – October 2012.	Calesurvey, 2009
Goldeneye Platform Area	Environmental Survey, UKCS Block 14/29 & 20/4, Goldeneye Field. Survey period was November to December 2009.	Fugro, 2010
Peterhead CCS	Peterhead Carbon Capture and Storage benthic environmental survey field report (2013 Survey). (Peterhead).	CMACS, 2014
Buzzard Development Area	Rig Site Survey Buzzard UKCS Blocks 20/1 and 20/6. Regional Environmental Survey. Survey Period was May – June 2014.	Fugro, 2014
Atlantic and Cromarty Development	Atlantic and Cromarty Fields Pre-Decommissioning Survey. Volume 6 of 7: Habitat Assessment. Atlantic and Cromarty Fields Pre-Decommissioning Survey. Volume 7 of 8: Environmental Baseline Survey. Survey period was August to September 2015.	Fugro, 2016a Fugro, 2016b
Miller pipeline survey	Miller Oil and Gas Export Pipeline Route Geophysical Surveys (Offshore). Volume 1. Survey period was August 1988.	WIMPOL, 1988
Goldeneye pipeline route	Pipeline Route Survey Goldeneye to St. Fergus. Volume 1 Survey period was July 2001.	Fugro, 2001

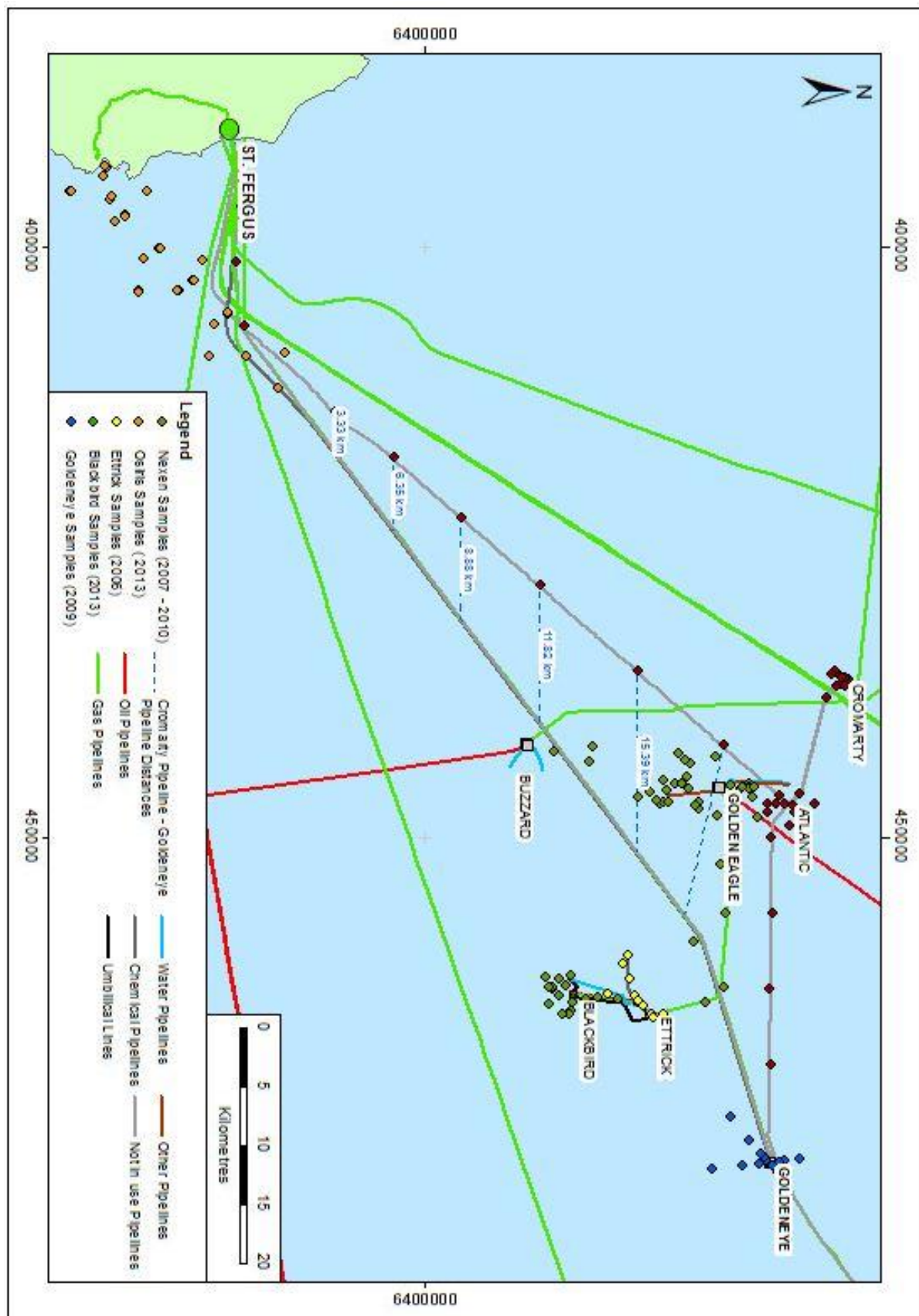


Figure 2-1 Map showing indicative location of surveys identified in Table 2-1.



The oil and gas pipelines approaching St. Fergus are shown in Figure 2-2. From MLWS to *c.* KP10, the Goldeneye pipelines are laid between 70 m and 250 m south of the Atlantic to St. Fergus export line (PL2029), with environmental sample locations which are considered to be representative of the habitat of the Goldeneye pipelines in this area. From KP25 out to the Goldeneye platform, the pipelines are laid between 100 m and 200 m south of the Miller to St. Fergus gas export pipeline (PL720). Between KP10 and KP25 the seabed is represented by data from three environmental sample locations surveyed for the Peterhead Carbon Capture and Storage (CCS) project. These lie between 20 m and 75 m from the Goldeneye export pipeline and are marked 'A', 'B' and 'C' in Figure 2-2. Also marked on Figure 2-2 is the transition point at KP20 where the Goldeneye export pipeline (PL1978) diverges from the MEG supply pipeline (PL1979). Beyond this point PL1978 is surface laid, while PL1979 is buried approximately 25 m to its southeast.

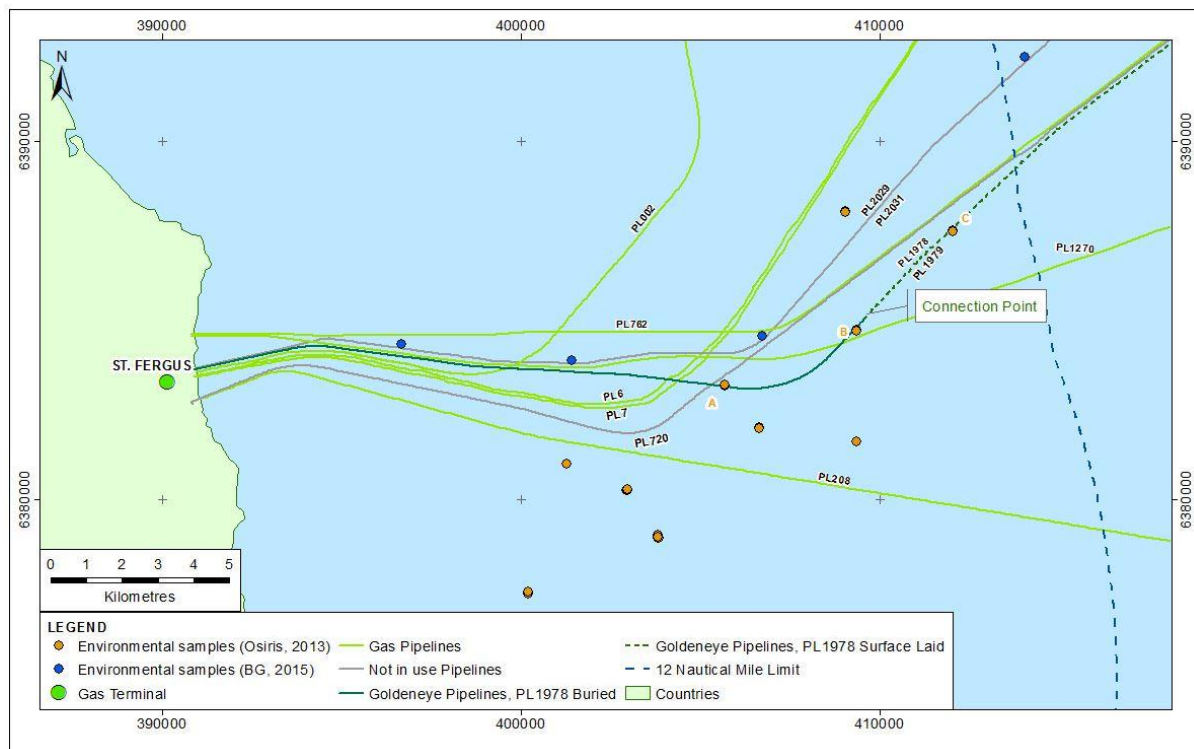


Figure 2-2 Nearshore route of Goldeneye pipelines in relation to other O&G pipelines

## 2.3. Physical Environment

### 2.3.1. Bathymetry

The seabed surrounding the Goldeneye platform is essentially flat and generally deepens from the south-west to the north-west. Water depths within the 1 km by 1 km area centred on the platform ranged from 118.8 m at LAT in the south-south-east to 122 m LAT in a pockmark located *c.* 290 m north-west of the platform. (Fugro, 2010).

### 2.3.2. Water Currents and Waves

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

The predominant regional currents in the North Sea are the vertically well-mixed coastal and Atlantic water inflow of the Fair Isle/Dooley Current. This current flows around the north of Orkney and then south, where it turns east and circulates in the North Sea. The second influencing



current is the East Shetland Atlantic Inflow, which flows just north of the Fair Isle/Dooley Current (DECC, 2016).

Density stratification is well developed in the summer months of most years in the Central and Northern North Sea (CNS & NNS), with the relative strength of the thermocline determined by solar heat input and turbulence generated by wind and tides.

The sea around the Goldeneye field is likely to be subject to severe gales and frequent storms that can result in variable, wind driven surface currents and oscillatory currents at the seabed (Johnson, 1993).

The annual mean significant wave height at the Goldeneye platform is *c.* 2.2 m (Scottish Government NMPi, 2018). The significant wave height of 4 m is exceeded 10% of the time and 75% of the time for heights greater than 1.5 m (British Oceanographic Data Centre, 1998).

### **2.3.3. Sea Temperature and Salinity**

The temperature of the sea affects both the properties of the seawater and the fates of discharges and spills to the environment.

According to data collected between 1971 and 2000 the annual mean temperature at the seabed in the Goldeneye area is 8°C and the annual mean surface temperature is 10°C (Scottish Government NMPi, 2018).

The salinity of seawater has a direct influence on the initial dilution of aqueous effluents such that the solubility of effluents increases as the salinity decreases. Fluctuations in salinity are largely caused by the addition or removal of freshwater to / from seawater through natural processes such as rainfall and evaporation. Salinity in the region of the Goldeneye platform shows little seasonal variation through the water column with annual mean salinity near the seabed equalling 35.1 and 35.02 PSU in surface waters (Scottish Government NMPi, 2018).

### **2.3.4. Sediments**

Understanding the type of sediment in the area assists in understanding its movement, and the plant and animal species found in an area are often closely linked to the sediment type, in particular benthic species.

Sediments classified as sand and slightly gravelly sand cover *c.* 80% of the North Sea (Gatliff, 1994; DECC, 2016). Figure 2-3 shows the general sediment type in the vicinity of Goldeneye and its associated infrastructure. Generally, the sediments in Block 14/29 are shelf sublittoral muds whilst the seabed sediment along the pipeline route is largely shelf sublittoral sand which changes to shelf sublittoral coarse sediment closer to shore.

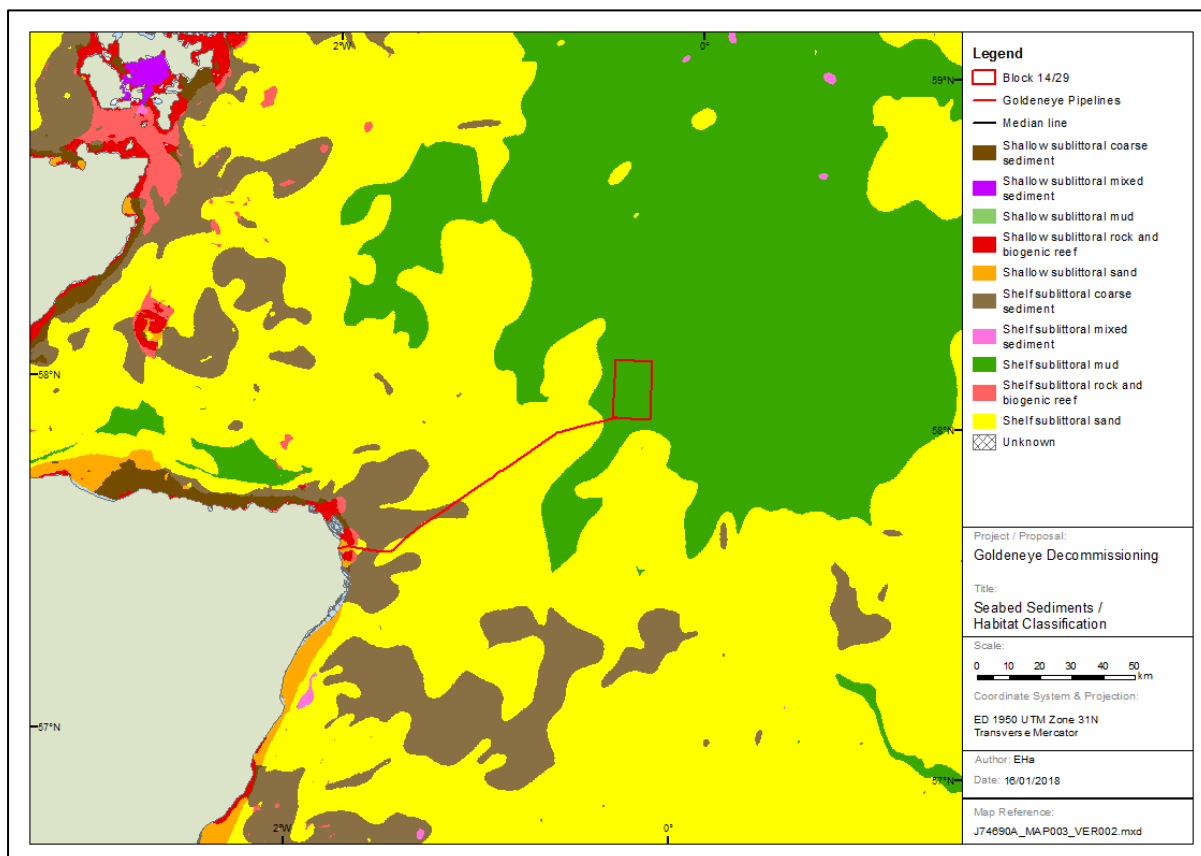


Figure 2-3 North Sea sediment distribution (Marine Strategy Framework Directive predominant habitat type classification) (EMODnet accessed, 2017).

#### 2.3.4.1. Sediments in the Vicinity of the Goldeneye Platform

Particle size analysis of samples taken at the Goldeneye platform showed that the sediments were homogenous within the survey area and generally comprised poorly sorted silty sand with slightly varied amounts of sand and silt (Fugro, 2010) (Figure 2-4).



Figure 2-4 Camera still showing the silty fine sand seabed sediments in the area of the Goldeneye platform (Fugro, 2010).



The sediments were thought to represent the EUNIS biotope complex ‘Circalittoral fine sand’ and was considered to comprise elements of the OSPAR habitat ‘sea pens and burrowing megafauna communities’ (discussed further in Section 2.6.3). The underlying seabed is expected to comprise poorly sorted sediments consisting of very soft silty sandy clay to 5.9 m sub-seabed and firm to hard clay (with occasional gravel and cobbles) extending to 246 m sub-seabed (Fugro, 2010). Sediments were identified as largely homogeneous in their composition and displayed bimodal distributions co-dominated by sand and fines.

Pockmarks were also identified in the vicinity of the Goldeneye platform and are discussed further in Section 2.6.1.

Both the sediment type and presence of pockmarks is consistent with findings for this area of a route survey undertaken for the Miller to St. Fergus pipeline (WIMPOL, 1988). The Miller survey found that the seabed across the Witch Ground formation mainly comprised a thin veneer of clayey fine grained sands underlain by soft clays up to 20 m thick. The survey also noted numerous trawl scars in the area.

#### *2.3.4.2. Sediments along the Pipeline Route*

Approximately 80% of the CNS seabed area comprises sediments classified as sand and slightly gravelly sand (Gatliff, 1994), with coarser sediments covering a further *c.* 10% and finer sediments, of which muddy sand is the most widespread, covering another 10% (Stevenson, *et al.*, 1995). The sediments along the Goldeneye pipeline route conform to this general CNS pattern, with greater coverage of gravelly sediment nearshore, and clayey, silty sand found nearer the platform, as would be expected of waters >100 m depth (Stevenson *et al.*, 1995).

Swathe bathymetry, seabed features and shallow soils geophysical data were acquired along the route of the Goldeneye pipeline, with additional geotechnical testing and sampling undertaken at selected locations (Fugro, 2001). A general description of the seabed sediments and features is provided in Table 2-2 and photographs along the route are shown in Appendix C.

The general sediment types and the variations across the area accords with the more detailed picture established from surveys undertaken for the A&C decommissioning programmes (Fugro, 2016) and for multiple field development and operational requirements in the region to the south of Atlantic (Calesurvey, 2009; Gardline, 2010). These surveys have noted strong correlations between the sediment characteristics, water depth and the macrofaunal communities they support; a finding consistent with current literature interpretation of data for the CNS.

As such, whereas identification of habitat types and biotopes along the Goldeneye pipeline route has not been undertaken, these can be inferred with high confidence by correlation of the sediment types observed (Table 2-2) with environmental data reported for these other studies. This is discussed further below.

The pre-decommissioning survey for the A&C fields (Fugro, 2016b) identified poorly sorted muddy sand across a wide area to the north of the Goldeneye pipeline route (EUNIS code A5.26 – ‘Circalittoral muddy sand’), extending from the Goldeneye platform, incorporating the Atlantic and the Cromarty fields and along the A&C export pipeline to an area roughly of equal latitude to the Buzzard field. An area of gravelly sand to the southwest of this then gives way to an area of moderately well sorted sand (EUNIS code A5.44 – ‘Circalittoral mixed sediments’), with sandwaves, extending into the nearshore waters. Over the final *c.* 20 km to shore, the survey encountered poorly sorted gravelly sands with numerous cobbles and boulders. The high mobility of the nearshore sediments was seen from ripples within the sediment.

**Table 2-2 Seabed sediments along Goldeneye pipeline route (Fugro, 2001)**

KILOMETER POINT	SEABED DESCRIPTION
0.0 – 2.40	Predominantly fine to coarse sand
2.40 – 3.11	Gravelly sand with cobbles / boulders
3.11 – 4.84	Predominantly fine to medium sand
4.84 – 6.24	Predominantly rock outcrop with thin cover of sand, gravel, cobbles and boulders
6.24 – 12.05	Gravelly sand with occasional cobbles / boulders, overlain by a few small areas of mobile, megarippled sand
12.05 – 22.65	Gravelly sand with occasional cobbles / boulders, overlain by areas of mobile, megarippled sand. Occasional sandwaves including a large sandwave (up to 8 m high and 1.8 km long) extends to within 120 m at KP16.31
22.65 – 46.14	Predominantly megarippled sand. Occasional sandwaves up to 3 m high (KP23.20 – KP24.06; KP25.60 – KP32.41; KP34.14 – 40.50)
46.14 – 59.52	Fine to medium sand with north-north-east to south-south-west-trending areas of gravelly sand
59.52 – 70.82	Predominantly megarippled sand
70.82 – 72.81	Fine to medium sand with areas of gravelly sand
72.81 – 89.55	Predominantly clayey silty fine sand with areas of gravelly sand
89.55 – 95.00	Predominantly clayey silty fine sand with outcrops of firm to very stiff clay
95.00 – 101.20	Clayey silty fine sand with occasional pockmarks (up to 120 m across and 4 m deep)

Results of the biological analyses of samples from the A&C survey indicated that the occurrence and distribution of invertebrate communities was strongly associated with depth and sediment type, in line with current literature on the variables affecting macrofaunal distribution in the North Sea (Fugro, 2016b and references therein). The deep muddy sediment hosted communities typical of the offshore muddy sand association, dominated by polychaetes such as *Galathowenia oculata*, *Spiofanus kroyeri*, *S. bombyx*, *Paramphionome jeffreysii*, *Prionospio dubia*, *Owenia* sp. and *Aricidea catherinae*. Predominantly sandy sediments were found to host lower species diversity and abundance, and were characterised by species such as the polychaetes *Spio goniocephala* and *Nephtys cirrosa*. The more mixed sediments, with higher gravel content, hosted high species diversity and abundance, characterised by a dominance of the polychaete *Sabellaria spinulosa*, together with the brittlestar *Ophiactis balli*, the sipunculid worm *Nephasoma minutum*, the bivalve mollusc *Kellia suborbicularis* and the polychaete *Lanice conchilega*. *Sabellaria spinulosa* occurrence was mainly restricted to two stations along the A&C export pipeline route, with abundance of up to 283 individuals in any one sample.

Analysis of samples collected across the Ettrick and Blackbird field area over a number of years (Nexen, 2016) concluded that the majority of the habitats represented the 'Circalittoral muddy sand' biotope with occasional 'fine mud' and 'mixed sediment' habitats recognised. The epifaunal communities were typical of the CNS location, exhibited a stable structure over time but the habitats, though stable, were unexceptional. Areas of pockmarks were identified although, as at Goldeneye, there was an absence of active gas seepage and MDAC, and the area was deemed unlikely to represent an example of Annex 1 habitat. The epifaunal community around Blackbird consisted mainly of seapens and sparsely distributed megafaunal burrows although the density of burrows was not considered sufficient for this area to be selected as representative of the 'seapen and burrowing megafauna communities' PMF (Nexen, 2014).



A review of information from multiple surveys covering the Golden Eagle, Ettrick, Blackbird and Buzzard fields (Gardline, 2010) concluded that the sediments across the majority of this wide were consistently silty fine sand except at the southwestern part of the area around Buzzard. Samples collected between Golden Eagle and Buzzard (crossing the Goldeneye pipeline route) identified a transition from silty fine sand to the north becoming medium sands to the south. Megaripples in the mid-section mark the boundary between the two types. Pockmarks were identified at the north of Golden Eagle and at Blackbird, associated with the Witch Ground Formation which can be seen from Figure 2-3 to extend to both locations. Numerous clay, or dense clay, outcrops occurred throughout the reviewed area in between these two. Analysis of macrofauna communities indicated that the conditions across the area varied naturally with the sediment conditions and depth (Gardline, 2010).

Environmental samples collected in the vicinity of the Goldeneye pipeline for the Peterhead CCS project (CMACS, 2014), centred around the pipeline connection point (KP20) showed a consistent sediment type of gravelly sand or slightly gravelly sand. Faunal analysis showed the area to host a very rich and a diverse fauna which corresponded to the biotope of 'polychaete-rich deep *Venus* community in offshore mixed sediment' (SS.SMx.OMx.PoVen).

From these combined sources of information it can be inferred that the Goldeneye pipeline will traverse habitats of the following type:

- KP2 – KP25: Sandy gravel supporting fauna of the biotope Polychaete-rich deep *Venus* community in offshore mixed sediment, consistent with information from the Peterhead CCS surveys;
- KP25 – KP45: Predominantly megarippled medium sand (Circalittoral mixed sediment) supporting fauna of low diversity and low abundance, consistent with data from the A&C pre-decommissioning surveys;
- KP45 – KP60: Areas of poorly sorted gravelly sand supporting fauna of high diversity and high abundance among areas of medium sand supporting fauna of low diversity and low abundance, consistent with data from the A&C pre-decommissioning surveys and with a band of shelf sublittoral coarse sediment identified in Figure 2-3;
- KP60 – KP70: Predominantly megarippled medium sand (Circalittoral mixed sediment) supporting fauna of low diversity and low abundance, consistent with data from surveys of the Buzzard field; and
- KP70 – KP102: Predominantly clayey silty fine sand with outcrops of firm to very stiff clay (Circalittoral muddy sand), consistent with information from A&C pre-decommissioning surveys and from surveys across the Golden Eagle, Ettrick and Blackbird region.

This interpretation has provided sufficient information on the Goldeneye pipeline route to enable assessment of the environmental impacts of decommissioning.

### 2.3.5. Cuttings Piles

The five Goldeneye wells were drilled in 2004, after the ban on discharges of oil based mud (OBM). Use of OBM was consequently contained and OBM contaminated cuttings were returned to shore for processing and disposal. Discharges of cuttings drilled with water based mud (WBM) were likely to have taken place and bathymetry data from a survey of the Goldeneye area in 2009 (Fugro, 2010) shows evidence of sediment disturbance under the platform which could be interpreted as being WBM cuttings.



### 2.3.6. Sediment Contaminants

Sediments at Goldeneye were collected as part of an environmental survey conducted in 2009 (Fugro, 2010) and analysed to determine the extent of any contamination caused from drilling or subsequent production.

#### 2.3.6.1. Hydrocarbons

Hydrocarbon concentrations in all samples collected at Goldeneye were low and indicative of a relatively uncontaminated site. Levels of Total Hydrocarbons (THC), total n-alkanes and total Polycyclic Aromatic Hydrocarbons (PAH) were lower than mean levels measured at background sites (i.e. sites that are more than 5 km from oil and gas installations) for the central North Sea (UKOOA, 2001) and displayed minimal variation across the Goldeneye area. These data, which are shown in Table 2-3, support the premise that OBM contaminated cuttings were fully contained, with no disposal to sea.

#### 2.3.6.2. Metals

Most metals from the offshore oil and gas industry are introduced to the sediment environment as impurities in the barite used in the drilling fluids, and therefore occur at relatively low concentration. Higher concentrations may, however, occur in drill cuttings due to the mineral composition of the formation drilled. The most relevant elements are cadmium, chromium, copper, lead, mercury and zinc (OSPAR, 2004).

Concentrations of metals in sediments at Goldeneye are shown in Table 2-3. Levels were similar to those measured at background sites within the CNS (UKOOA, 2001). The one metal with concentrations higher than background was Barium.

Barium, in the form of barite, is used as a weighting material to increase the density of drilling muds to prevent blowouts during drilling. The levels of barium measured at Goldeneye indicate some dispersed contamination from water based drilling mud.

**Table 2-3 Concentrations of hydrocarbons and metals in sediments at Goldeneye (Fugro, 2010) and at background sites (>5 km from an oil and gas installation) in the central North Sea (UKOOA, 2001). All concentrations in mg/kg.**

DETERMINAND		THC	n-ALKANES	PAH	BARIUM	CADMIUM	CHROMIUM	COPPER	LEAD	MERCURY	NICKEL	ZINC
GOLDENEYE	Min	1.3	0.13	0.07	351	0.10	7.7	1.7	3.5	0.02	4.6	4.9
	Max	3.3	0.27	0.15	652	0.10	11.9	2.8	5.8	0.03	9.0	6.4
	Mean	2.0	0.17	0.10	416	0.10	9.8	2.0	4.8	0.03	6.2	5.8
CENTRAL NORTH SEA	Mean	9.5	0.40	0.23	178	0.03	9.1	2.4	6.8	0.03	7.3	13.5
	95 %-ile	40.1	1.18	0.74	523	0.12	31.0	6.0	16.7	0.12	19.0	32.6



## 2.4. Designated Sites

A network of designated areas is in place to aid the protection of vulnerable and endangered species and habitats through structured legislation and policies. These sites include internationally recognised Special Areas of Conservation (SAC) and Special Protection Areas (SPA), designated under the European Commission (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 the Joint Nature Conservation Committee (JNCC) list 81 species and habitats considered as Priority Marine Features (PMF) which are of conservation importance in Scotland's seas. Protected areas in the vicinity of the Goldeneye area and pipeline route are shown in Figure 2-5.

No SACs occur within 40 km of Block 14/29. The nearest offshore designated SAC is Scanner Pockmark located *c.* 70 km north east of Block 14/29.

Given its distance from the UK coastline there are no SPAs within 40 km of the Goldeneye platform, however the pipelines come onshore in relatively close proximity to a number of SPAs, the closest of which are described in Table 2-4. It is likely that some of the birds from these SPAs and others further along the coast feed in the vicinity of the pipelines.

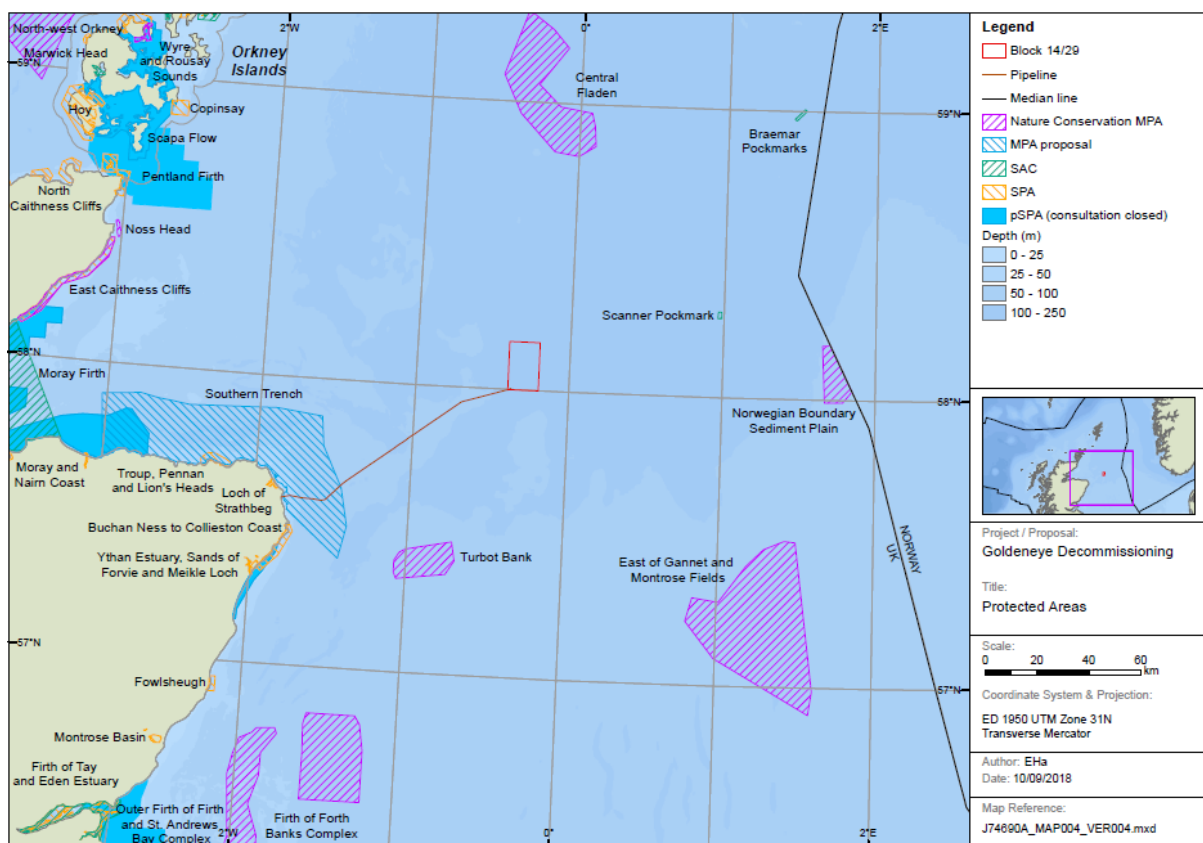


Figure 2-5 Protected areas in the CNS region.

**Table 2-4 SPAs/pSPAs in closest proximity to the proposed project (JNCC, 2018c).**

AREA	QUALIFYING FEATURES	DISTANCE FROM PIPELINES (KM)
Loch of Strathbeg <sup>1</sup>	<b>Breeding species:</b> sandwich tern ( <i>Sterna sandvicensis</i> ), whooper swan ( <i>Cygnus cygnus</i> ), Svalbard barnacle goose ( <i>Branta leucopsis</i> ). <b>Assemblage qualification:</b> wetland of international importance, during the winter season the area supports over 20,000 waterfowl.	4.5
Buchan Ness to Collieston Coast	<b>Assemblage qualification of international importance</b> supporting 95,000 seabirds including: guillemot ( <i>Uria aalge</i> ), kittiwake ( <i>Rissa tridactyla</i> ), herring gull ( <i>Larus argentatus</i> ), shag ( <i>Phalacrocorax aristotelis</i> ), fulmar ( <i>Fulmarus glacialis</i> ).	10
Troup, Pennan and Lion's Head	<b>Breeding species:</b> kittiwake, guillemot, fulmar, herring gull, razorbill ( <i>Alca torda</i> ). <b>A seabird assemblage of international importance</b> supporting at least 20,000 seabirds (150,000 in 1995).	25
Ythan Estuary <sup>2</sup> , Sands of Forvie and Meikle Loch	<b>Breeding species:</b> common tern ( <i>Sterna hirundo</i> ), little tern ( <i>Sterna albigrons</i> ), sandwich tern, winter pink-footed goose ( <i>Anser brachyhychnus</i> ). <b>Assemblage qualification:</b> wetland of international importance, during the winter season the area supports over 20,000 waterfowl.	30

Note 1: The Loch of Strathbeg SPA shares the same boundary as the Loch of Strathbeg Ramsar site. Whereas the SPA is not classed as a Marine SPA it includes intertidal shoreline which may have the potential to be impacted by activities associated with the DP.

Note 2: The Ythan Estuary is also a Ramsar site. The intertidal section of the Ramsar site may potentially be impacted by activities associated with the DP.

### 2.4.1. Southern Trench pMPA

Though there are no designated NCMPAs in close proximity to the Goldeneye platform or associated infrastructure, the pipelines do transect the south east of the Southern Trench proposed MPA (pMPA) (Figure 2-6).

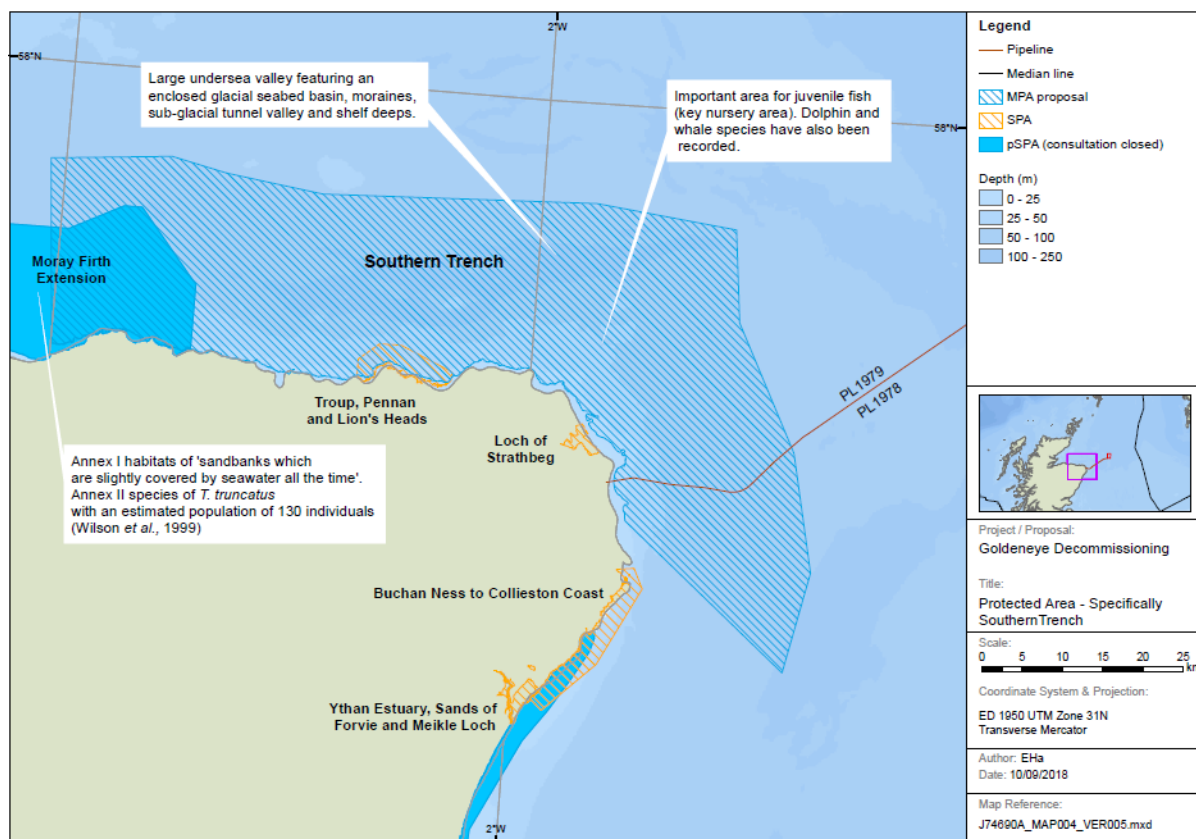


Figure 2-6 Protected features within the Southern Trench pMPA.

The Southern Trench pMPA is shaped around the Southern Trench, a large undersea valley consisting of an area of deep water (*c.* 200 m) extending along the south of the outer Moray Firth, *c.* 10 km from the coast between Banff and Fraserburgh. It is identified as a pMPA for the following:

- Biodiversity features: minke whale (*Balaenoptera acutorostrata*), ocean fronts, shelf deeps and burrowed mud habitat; and
- Geodiversity features: Submarine mass, movement - slide scars; Quaternary of Scotland - sub-glacial tunnel valleys and moraines.

Minke whales are sighted particularly frequently in the outer Moray Firth (the northern section of the pMPA) during summer, while burrowed mud is contained within the Southern Trench deep (also located in the northern section of the pMPA). The pMPA also overlaps the marine part of the Troup, Pennan and Lion's Heads SPA.

The boundary of the pMPA is established to provide protection for the combination of features listed, and not all individual features will extend across the whole site. This is particularly seen for the biodiversity features of burrowed mud habitat and minke whale, which are both found in the northern part of the site, with little occurrence in the southern leg of the site, through which the Goldeneye pipelines are laid. This is illustrated in Figure 2-7 and Figure 2-8.

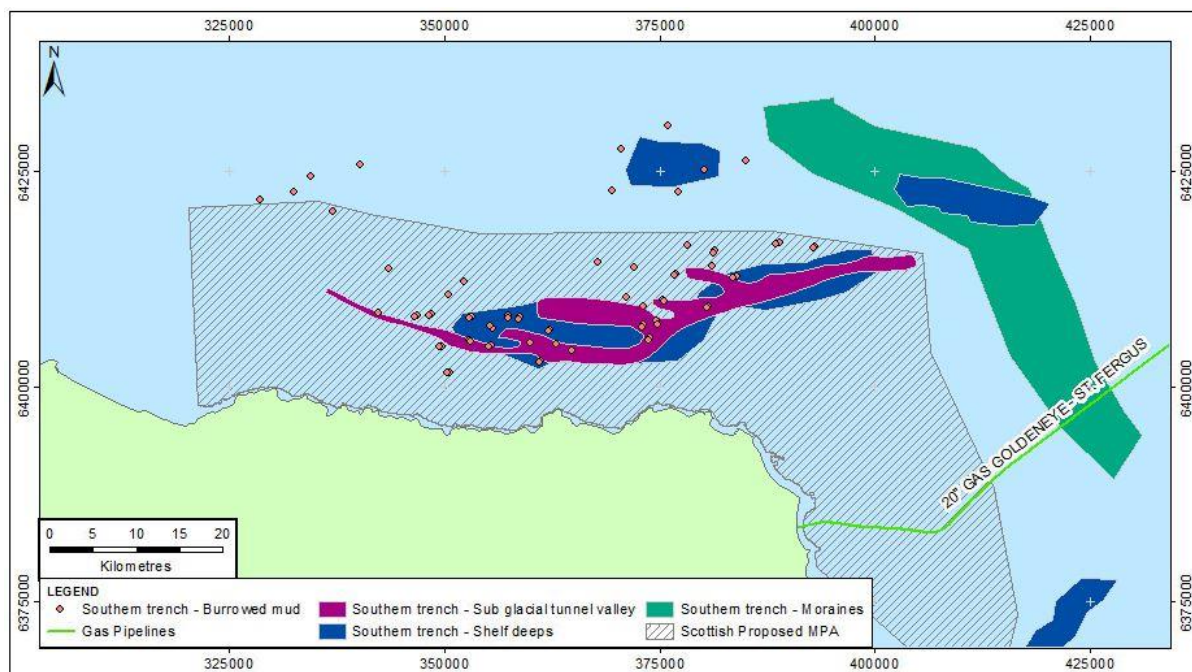


Figure 2-7 Location of burrowed mud habitat within the Southern Trench pMPA in relation to Goldeneye pipelines (Shapefiles from SNH website)

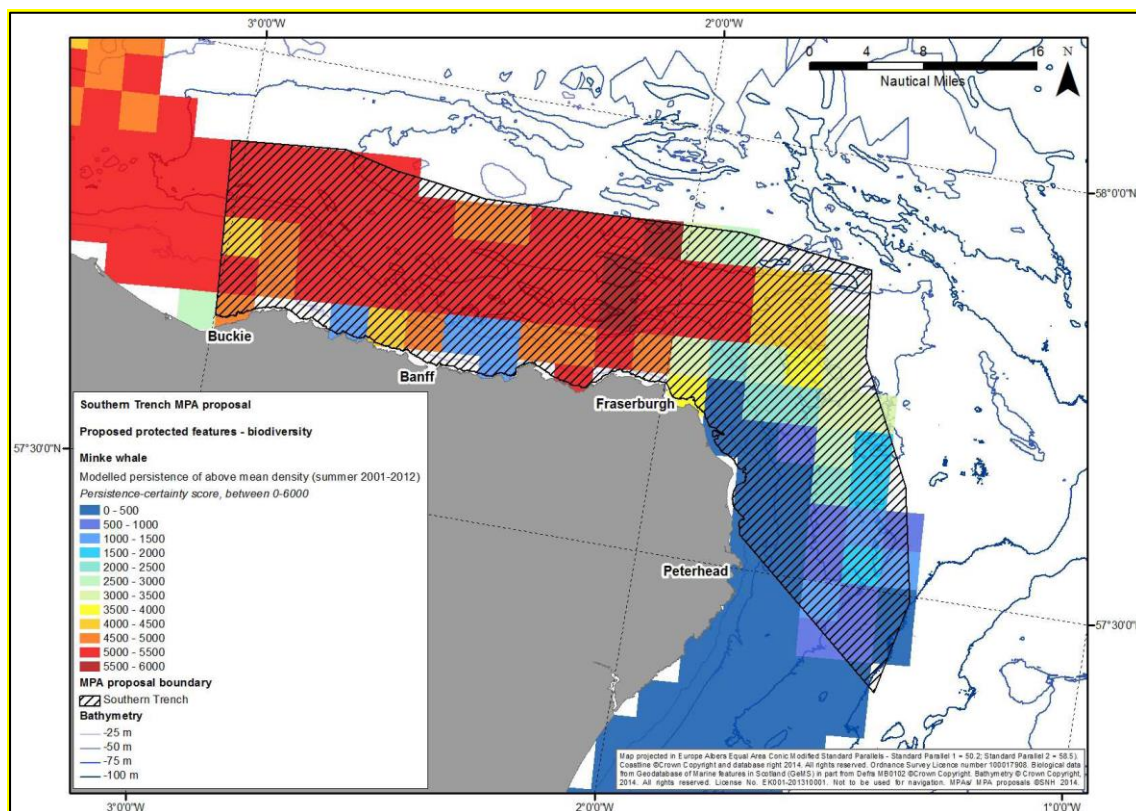


Figure 2-8 Extent of minke whale biodiversity feature within the Southern Trench pMPA (reproduced from SNH, 2014a)



## 2.5. Designated Species

The designation of fish species requiring special protection in UK waters is receiving increasing attention with particular consideration being paid to large slow growing species such as sharks and rays. A number of international laws, conventions and regulations as well as national statutes and other legislation have been implemented which provide for the protection of these species. This includes, but is not limited to:

- The UK Biodiversity Action Plan (UK BAP) priority fish species (JNCC, accessed 2018a);
- The OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR, accessed 2018);
- The IUCN (International Union for Conservation of Nature) Red List of Threatened Species (IUCN, accessed 2018).
- The Wildlife and Countryside Act 1981 (which consolidates and amends existing national legislation to implement the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) and the Birds Directive in Great Britain) (JNCC, accessed 2018b). The Wildlife and Countryside Act makes it an offence to intentionally kill, injure, possess or trade any animal listed in Schedule 5 and to interfere with places used by such animals for shelter or protection.
- The EC Habitats Directive 92/43/EEC (incorporated into the applicable laws of the UK through primary legislation such as the Conservation of Habitats Regulations 2010 and the Conservation (Natural Habitats, &c) Regulations 1994 (as amended) in Scotland).

Those species of fish that could potentially occur in the Goldeneye area and are listed under the protection measures are shown in Table 2-5.

**Table 2-5 Designation of fish species potentially occurring in the vicinity of the Goldeneye field.**

SPECIES	UK BAP	OSPAR	IUCN	BERN CONVENTION	HABITATS REGULATIONS
Allis shad ( <i>Alosa alosa</i> )	✓	✓	Least Concern	✓	✗
Twaite shad ( <i>Alosa fallax</i> )	✓	✗	Least Concern	✓	✗
Angel shark ( <i>Squatina squatina</i> )	✓	✓	Critically Endangered	✓ <sup>1</sup>	✗
Atlantic salmon ( <i>Salmo salar</i> )	✓	✓	Least Concern	✓ <sup>2</sup>	✗
Common skate ( <i>Dipturus batis</i> )	✓	✓	Critically Endangered	✗	✗
Basking shark ( <i>Cetorhinus maximus</i> )	✓	✗	Vulnerable	✓	✗
Porbeagle shark ( <i>Lamna nasus</i> )	✓	✓	Vulnerable	✓	✗
Atlantic cod ( <i>Gadus morhua</i> )	✗	✓	Vulnerable	✗	✗
1 = Applies in the Mediterranean only.					
2 = Does not apply in sea waters.					



In addition, four marine mammal species listed under Annex II of the Habitats Directive occur in relatively large numbers in UK offshore waters:

- Grey seal (*Halichoerus grypus*);
- Harbour seal (*Phoca vitulina*);
- Bottlenose dolphin (*Tursiops truncatus*); and
- Harbour porpoise (*Phocoena phocoena*).

The bottlenose dolphin and harbour porpoise, like all the cetacean species found in UK waters, also have European Protected Species (EPS) status, along with several other marine mammals found in UK waters. Developers must therefore consider the requirement to apply for the necessary licences if there is a risk of causing any potential disturbance or injury to EPS.

#### 2.5.1.1. Priority Marine Features (PMFs)

In addition to the list of features of nature conservation importance for which it is deemed appropriate to use area-based mechanisms (NCMPAs) as a means of affording protection, as part of the Scottish MPA Project, SNH and JNCC have compiled a separate list of 81 habitats and species, termed PMFs which are considered to be of particular importance in Scotland's seas. The purpose of this list is to guide policy decisions regarding conservation in Scottish waters. Table 2-6 lists the PMFs species which are potentially of relevance to the DP. *Arctica islandica* juveniles were noted in all environmental samples of the seabed collected around Goldeneye in 2009 (Fugro, 2010).

**Table 2-6 Table of PMF species potentially occurring in the Goldeneye region (Tyler-Walters, 2016).**

MOBILE SPECIES (FISH)	MOBILE SPECIES (CETACEANS)	LOW OR LIMITED MOBILITY SPECIES (BENTHOS)
Anglerfish ( <i>Lophiiformes spp.</i> )	Atlantic white-sided dolphin ( <i>Lagenorhynchus acutus</i> )	Ocean quahog ( <i>Arctica islandica</i> )
Basking shark ( <i>Cetorhinus maximus</i> )	Harbour porpoise ( <i>Phocoena phocoena</i> )	
Blue whiting ( <i>Micromesistius pontassou</i> )	Killer whale ( <i>Orcinus orca</i> )	
Cod ( <i>Gadus morhua</i> )	Long-finned pilot whale ( <i>Globicephala melas</i> )	
Common skate ( <i>Dipturus batis</i> )	Minke whale ( <i>Balaenoptera acutorostrata</i> )	
Herring ( <i>Clupea harengus</i> )	White-beaked dolphin ( <i>Lagenorhynchus albirostris</i> )	
Ling ( <i>Molva spp.</i> )		
Mackerel ( <i>Scromber scombrus</i> )		
Norway pout ( <i>Trisopterus esmarkii</i> )		
Porbeagle shark ( <i>Lamna nasus</i> )		
Saithe ( <i>Pollachius virens</i> )		
Sandeel ( <i>Ammodytes tobianus</i> )		
Spurdog ( <i>Squalus acanthias</i> )		
Whiting ( <i>Merlangius merlangus</i> )		



## 2.6. Areas / Species of Potential Conservation Significance (out with designated sites)

The following habitat types are found in the vicinity of the Goldeneye infrastructure.

### 2.6.1. Submarine Structures Made by Leaking Gases

The Goldeneye reservoir and platform is located on the edge of an extensive area of natural fluid seeps associated with sediments of the Quaternary Period Witch-Ground Formation, as shown in Figure 2-9. These seeping fluids (gas or water) have given rise to pockmarks on the seabed surface, some of which attract a diverse ecology that is distinct from that in the surrounding habitat (DTI, 2001).

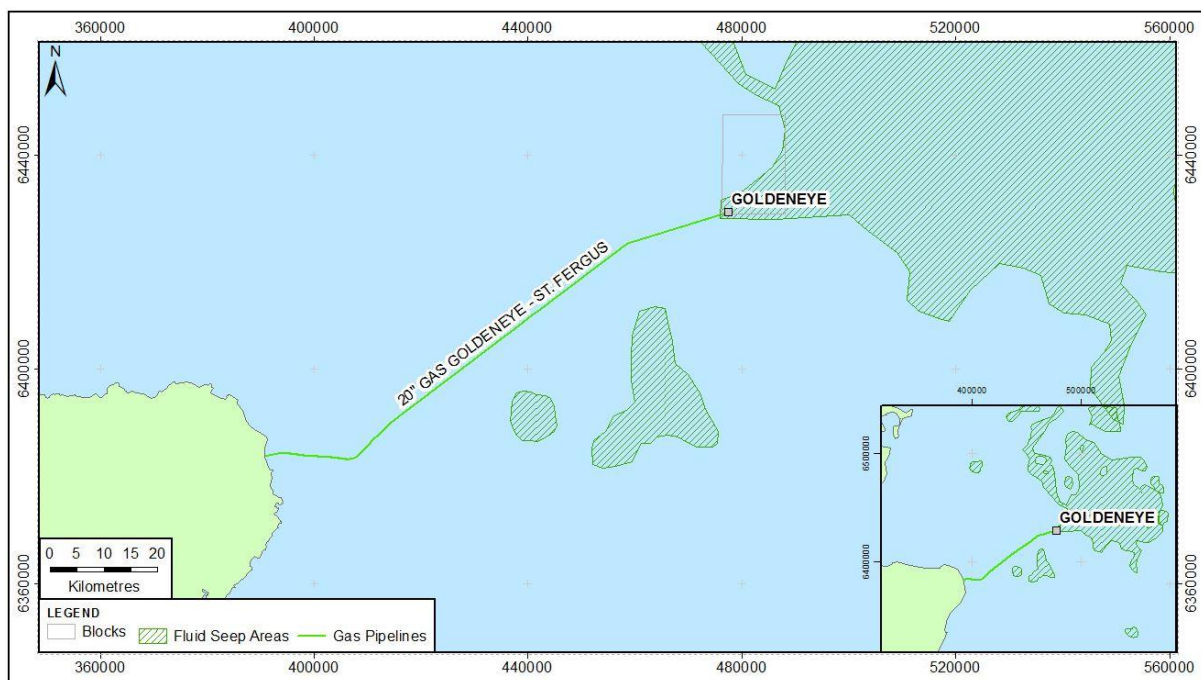


Figure 2-9 Possible locations of 'submarine structures made by leaking gas'.

Pockmarks are shallow seabed depressions, typically several tens of metres across and a few metres deep. Generally, they are formed in soft, fine-grained seabed sediments by the escape of fluids into the water column (Judd, 2001).

Active pockmarks (i.e. those that continue to leak gas), often have significant increases in infaunal abundance and diversity. This has been attributed to a causal relationship between the associated released gas and carbon assimilation from the methane entering the food chain (Bussmann *et al*, 1999 in DTI, 2001). Assimilation of this carbon manifests itself in the form of carbonate encrustations, Methane Derived Authigenic Carbonate (MDAC), and it is these submarine structures that are considered significant habitats under Annex I of the EU Habitats Directive. Pockmarks alone are not considered protected under the Habitats Directive.

The vast majority of pockmarks in this area are thought to be relict (i.e. inactive) gas seepage structures that have formed during the 8,000 years since the sea level stabilised after the last glaciations. The seabed in the Witch Ground Basin has remained relatively unchanged during this time (Long, 1992). Older pockmarks and paleo or 'fossil' pockmarks are known to exist within the Witch Ground Basin region (Long, 1992); the Scanner giant pockmark in UK block 15/25 (~85 km to the northeast of the existing Goldeneye Platform) is one of relatively few pockmarks actually actively seeping gas at the present-day and has been dated back as far as 13,000 years ago (Long,



1992; Holmes & Stoker, 2005). Most present-day pockmarks however, appear to have had a much more limited lifespan and are commonly partially infilled by seabed sediments during subsequent inactivity (Andrews *et al.*, 1990).

Shell commissioned a number of surveys around Goldeneye, from which Figure 2-10 shows the widespread distribution of pockmarks in the area. The figure superimposes pockmarks inferred from seismic datasets and those identified from MBES bathymetry. This widespread distribution is supported by the observation of pockmarks offshore on the Miller pipeline in the area where it passes Goldeneye (passes *c.* 320 m north of the platform).

No MDAC has been identified in any surveys of the Goldeneye area.

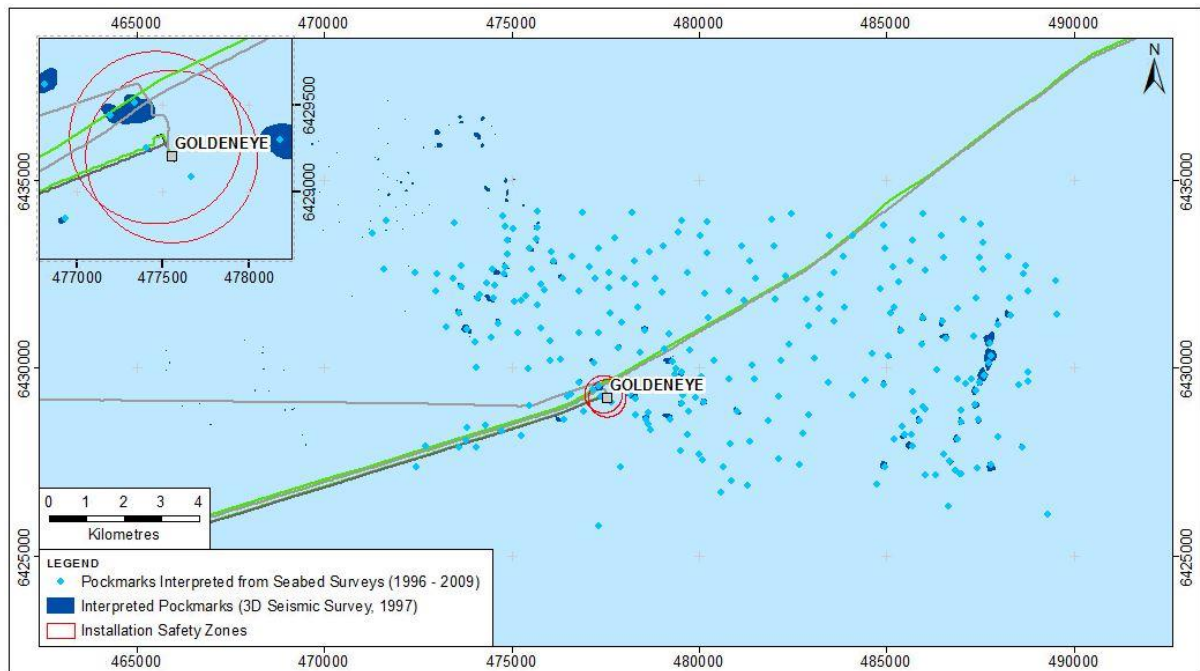


Figure 2-10 Location of pockmarks in the vicinity of Goldeneye

### 2.6.2. Biogenic Reefs

Reefs, including *S. spinulosa* reefs are listed under Annex I of the Habitats Directive. They comprise dense subtidal aggregations of this small tube building polychaete. Reefs formed by aggregations of the Ross worm *S. spinulosa* consolidating the sediment facilitate the settlement of other species not always found in the adjacent habitats. The UK distribution of *S. spinulosa* is concentrated around the coasts of England and Wales with a more scattered distribution around Scotland (OSPAR, 2013). In most parts of its geographical range *S. spinulosa* does not form reefs, but is found as solitary or as small clusters encrusting pebbles, shell and bedrock. Where conditions are favourable, much more extensive thin crusts can be formed, sometimes covering extensive areas of seabed. However, these crusts may only be seasonal features, being broken up during winter storms and quickly reforming through new settlement the following spring. Their ephemeral nature means that these crusts are not considered to constitute true *S. spinulosa* reef habitats, as they do not provide a stable biogenic habitat enabling associated species to become established in areas where they would otherwise be absent (Maddock, 2008).

Surveys carried out in support of the Peterhead CCS project (CMACS, 2014) identified aggregations of *S. spinulosa* *c.* 10 km south of the Goldeneye pipelines, and these aggregations are considered to be representative of the Annex I habitat (*Sabellaria* reef). However, reefs were not



found in the sample locations along the Goldeneye pipeline route marked 'A', 'B' and 'C' in Figure 2-2

Discontinuous non-reef forming *S. spinulosa* aggregations have been observed at the nearshore end (between KP6 and KP15) of the Atlantic to St. Fergus pipeline route (Fugro, 2016b). At these KP points water depths range from 50 m to 88 m. The *S. spinulosa* appeared to be of poor quality and heavily degraded whilst aggregations were not observed continuously. Absences were noticed for stretches of seabed up to 61 m whilst other areas had low densities of *S. spinulosa* that were classified as not a reef. However, across the same extent (i.e. KP6 to KP15) areas showing 'high' percentage reef cover (up to 80%) were also identified. The extent of the patches could not be determined though there was no evidence that the aggregations observed form contiguous reef across the 'area of numerous boulders' and as such the area was not considered a *S. spinulosa* reef. It is possible these discontinuous aggregations extend to encompass the nearshore area traversed by the Goldeneye pipelines. It is expected that any aggregations present will be discontinuous given the presence of boulders across the wider area.

### 2.6.3. Sea Pens and Burrowing Megafauna Communities

As discussed in Section 2.3.4.1, the sediments in the vicinity of the Goldeneye platform were determined to represent the EUNIS biotope complex 'circalittoral fine sand' and are considered to comprise elements of the OSPAR habitat 'sea pens and burrowing megafauna communities' based on the JNCC guidelines for classification (JNCC, 2014b).

The burrowing activity of megafauna creates a complex habitat, providing deep oxygen penetration of the seabed sediment, giving rise to increased biodiversity. The habitat occurs extensively in sea lochs, voes and fjords and also in the deeper waters of the central North Sea and elsewhere. Point sample locations identified as representing the OSPAR burrowing megafauna communities habitat in the CNS are shown in Figure 2-11.

Although found extensively, the habitat type is listed by OSPAR as declining and threatened due to widespread seabed disturbance from fishing activities (OSPAR, 2010). Environmental surveys frequently identify evidence of burrows in areas of the CNS associated with deep mud sediments (e.g. corresponding to shelf-sublittoral mud shown in Figure 2-3) and it is likely that all such sediments have the potential to support sea-pen and burrowing megafauna communities, even where the surveys do not actually observe examples of such megafauna. Absence or low numbers of megafauna may merely be an indication of the degraded state of the habitat (JNCC, 2014b).

The UK Habitat Action Plan (UKHAP) for mud habitats in deep water (JNCC, 1999) establishes the UK approach to protection of deep water muds, including those that support sea-pens and burrowing megafauna communities. A network of MPAs has been established with burrowed mud a designated interest feature in order to implement measures to protect this habitat. One of these is the Southern Trench pMPA discussed in Section 2.4.1. Additional actions and advice proposed in the UKHAP focus on reducing impacts from fishing as the primary threat.

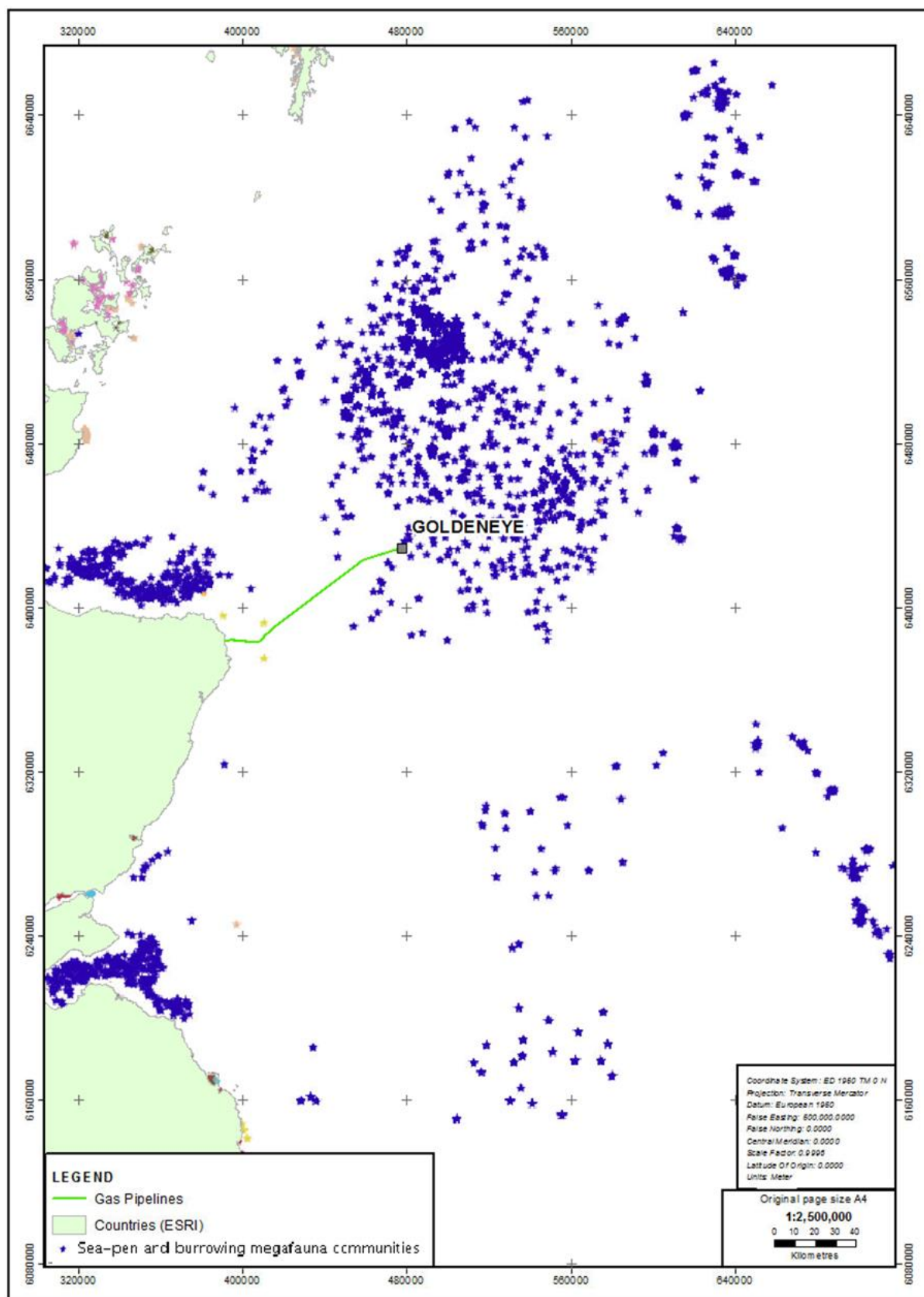


Figure 2-11 Known OSPAR threatened or declining habitat 'sea-pen and burrowing megafauna communities' in the central North Sea (EMODnet, 2017).



## 2.7. Marine Flora and Fauna

### 2.7.1. Plankton

Plankton are drifting organisms that inhabit the pelagic zone of a body of water and include single celled organisms such as bacteria as well as plants (phytoplankton) and animals (zooplankton). Phytoplankton are the primary producers of organic matter in the marine environment and form the basis of marine ecosystem food chains. They are grazed on by zooplankton and larger species such as fish, birds and cetaceans. Therefore, the distribution of plankton directly influences the movement and distribution of other marine species.

The composition and abundance of plankton communities varies throughout the year and is influenced by several factors including depth, tidal mixing, temperature stratification, nutrient availability and the location of oceanographic fronts. Species distribution is directly influenced by temperature, salinity, water inflow and the presence of local benthic communities (Robinson, 1970; Colebrook, 1982; DECC, 2016).

The phytoplankton community in the North Sea is dominated by the dinoflagellate genus *Ceratium* (*C. fusus*, *C. furca*, *C. lineatum*), with diatoms such as *Thalassiosira* spp. and *Chaetoceros* spp. also abundant (DECC, 2016).

The zooplankton community in the North Sea is dominated by calanoid copepods, although other groups such as *Paracalanus* and *Pseudocalanus* are also abundant. There is also a high biomass of *Calanus* larval stages present in the region. *Euphausiids*, *Acartia*, and decapod larvae are all important components of the zooplankton assemblage (DECC, 2016).

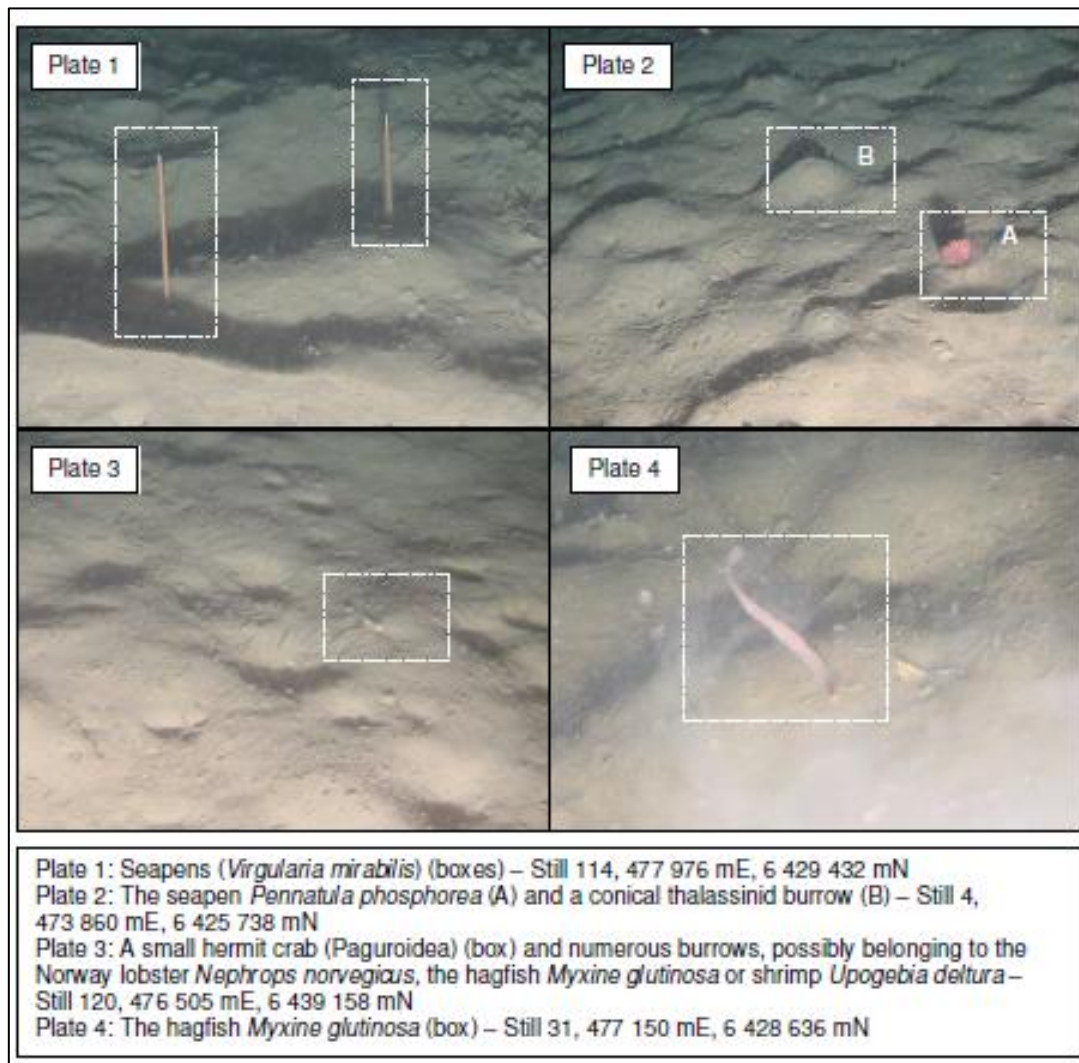
### 2.7.2. Benthos

Bacteria, plants and animals living on or within the seabed sediments are collectively referred to as benthos. Species living on top of the sea floor may be sessile (e.g. sea anemone) or freely moving (e.g. starfish). Animals living within the sediment are termed infaunal (e.g. tubeworms and burrowing clams) while animals living on the surface are termed epifaunal (e.g. crabs, starfish). Semi-infaunal animals, including sea pens, lie partially buried in the sediment. The majority of marine benthic invertebrates exhibit a life cycle that includes a planktonic larval phase from which the bottom dwelling juvenile and adult phases recruit.

Benthic animals display a variety of feeding methods. Suspension and filter feeders capture particles which are suspended in the water column (e.g. sea pens) or transported by the current (e.g. mussels). Deposit feeders (e.g. sea cucumbers) ingest sediment and digest the organic material contained within it. Other benthic species can be herbivorous (e.g. sea urchins), carnivorous (e.g. crabs) or omnivorous (e.g. nematodes).

Photographic data from the Goldeneye environmental survey (Fugro, 2010) suggested the epifaunal community was sparse, although extensive bioturbation was observed suggesting that a substantial burrowing megafaunal community may occur within the survey area. The most prominent epifaunal species seen were the seapens *Virgularia mirabilis* and *Pennatula phosphorea* (Figure 2-12). Occasional hermit crabs were also sighted (Figure 2-12). The numerous burrows evident were thought to belong to the Norway lobster *Nephrops norvegicus* (large crater like depressions) or hagfish *Myxine glutinosa*, the ghost shrimp *Callinassa subterranea* (conical mounds) and the mud shrimp *Upogebia deltura* (multiple smaller depressions per shrimp). The only burrowing megafauna apparent on the surface were single specimens of *N. norvegicus* and *M. glutinosa*, but both *C. subterranea* and *U. deltura* were recorded in the grab samples (Fugro, 2010).

As discussed in Section 2.6.3 the circalittoral fine mud habitat is considered to comprise the OSPAR habitat 'sea pens and burrowing megafauna communities'.

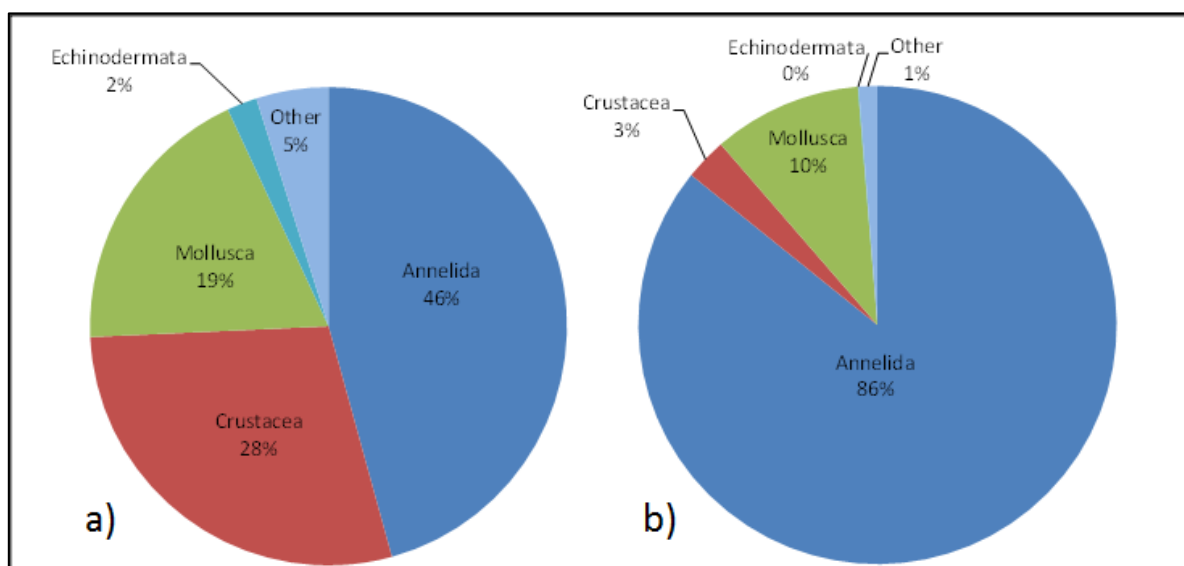


**Figure 2-12 Examples of visible epifauna species from seabed imagery (Fugro, 2010).**

As part of the Goldeneye survey (Fugro, 2010) three macrofaunal grab samples were taken at each of fifteen sampling stations. Across the samples a total of 245 discrete macrofaunal taxa were recorded. Of the taxa recorded: 112 were annelid (of which 100% were Polychaeta); 70 were Crustacea; 46 were Mollusca and 5 were Echinodermata. Representatives of the Cnidaria, Nemertea, Pogonophora, Chelicerata, Phoronida, Hemichordata and Chordata made up the 12 taxa belonging to 'other' phyla (Figure 2-13a). In terms of abundance the polychaetes were dominant, representing 86% of the faunal specimens encountered. Molluscs made the second greatest contribution (10%), crustaceans the third (3%) and members of 'other' phyla the fourth (1.3%). Echinoderms contributed just 0.1% of the total number of individuals recorded (Figure 2-13b).

A high frequency of occurrence of the most abundant taxa across samples was observed suggesting that there was minimal differentiation of community across the survey area.

Overall, the benthic assemblage identified at the Goldeneye platform area (Fugro, 2010) is consistent with silty sand which is the dominant sediment type throughout the Goldeneye area.



**Figure 2-13 a) Numbers of taxa by major group (note others include; Cnidaria, Nemertea, Pogonophora, Chelicerata, Phoronida, Hemichordata and Chordata) and b) Number of individuals by major group (note colonial organisms such as Bryozoa not included) (Fugro, 2010).**

### 2.7.3. Fish

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

Table 2-7 and Figure 2-14 shows approximate spawning and nursery times of some of the commercial fish species known to occur in the area. It should be noted that spawning and nursery areas tend to be transient, and therefore cannot be defined with absolute accuracy (Coull *et al.*, 1998; Ellis *et al.*, 2012).

Of the species identified herring, cod, anglerfish, blue whiting, ling, mackerel, whiting, sandeels and Norway pout have been assessed by SNH and JNCC as PMFs in Scotland such that appropriate protection and conservation measures are required to be in place (Tyler-Walters *et al.*, 2016; JNCC, 2014a).

The species that are most potentially at risk of impact from the activities identified for the DP are those that spawn on the seabed.

Herring deposit sticky eggs on coarse sand and gravel usually at depths of between 15-40 m. A number of different spawning grounds exist around the UK, with spawning occurring at different times, although predominantly late summer in the CNS (DECC, 2016).

Sandeel eggs are also laid in sticky clumps on sandy substrates. Upon hatching, the larvae become planktonic, resulting in a potentially wide distribution. Sandeels adopt a demersal habit by around 2-5 months after hatching (Rogers & Stocks, 2001).



**Table 2-7 Spawning and nursery areas of some commercial fish species in the Goldeneye area  
(Coull *et al.*, 1998<sup>1</sup> and Ellis *et al.*, 2012<sup>2</sup>).**

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	NURSERY*
Herring <sup>1,2</sup>													
Lemon sole <sup>1</sup>													
Sprat <sup>1</sup>													
<i>Nephrops</i> <sup>1</sup>													
Spurdog <sup>2</sup>													
Spotted ray <sup>2</sup>													
Norway pout <sup>1</sup>													
Sandeel <sup>2</sup>													
Plaice <sup>2</sup>													
Mackerel <sup>2</sup>													
Ling <sup>2</sup>													
European hake <sup>2</sup>													
Whiting <sup>1,2</sup>													
Anglerfish <sup>2</sup>													
Cod <sup>2</sup>													
Blue whiting <sup>1,2</sup>													
Key	Spawning					Peak spawning					Nursery ground		

\*Nursery areas have been identified for the whole year and are not displayed by month.

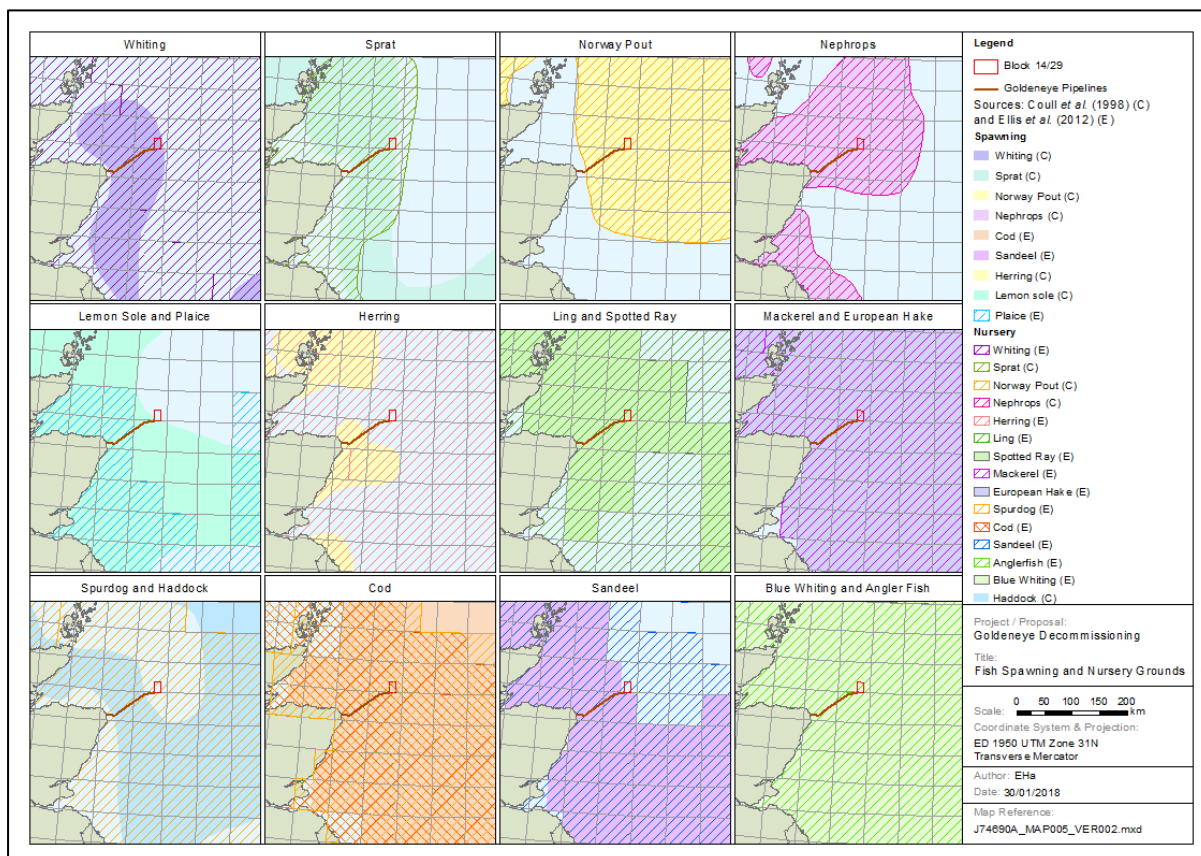


Figure 2-14 Spawning and nursery grounds of some commercial fish species in the Goldeneye area (Coull *et al.*, 1998; Ellis *et al.*, 2012).

#### 2.7.4. Seabirds

The UK and its surrounding seas are very important for seabirds. The extensive network of cliffs, sheltered bays, coastal wetlands, and estuarine areas, provide breeding and wintering grounds for nationally and internationally important numbers of individual bird species and assemblages (DECC, 2016).

The North Sea and much of the coastal waters surrounding the UK are internationally important for breeding and feeding areas for seabirds. Northern and central areas of the North Sea often contain high abundances of species such as fulmars (*Fulmarus glacialis*), kittiwakes (*Rissa tridactyla*), guillemots (*Uria aalge*), gulls (*Larus spp.*) and gannets (*Morus bassanus*) (DECC, 2016).

Predicted maximum monthly abundance of seabirds in the Goldeneye area are presented in Table 2-8. The data presented is based on analysis of European Seabirds at Sea (ESAS) data collected over 30 years (Kober *et al.*, 2010). Continuous seabird density surface maps were generated using the spatial interpolation technique 'Poisson kriging' and fifty-seven seabird density surface maps were created.

The data shows that a number of seabird species are likely to occur in the area over the summer breeding season and winter months. Of the species expected to occur in the area, the following are afforded protection by the EC Birds Directive: European storm petrel (*Hydrobates pelagicus*), arctic tern (*Sterna paradisaea*) and guillemot (*Uria aalge*).



**Table 2-8 Predicted seabird surface density in the area (maximum number of individuals per km<sup>2</sup>) (Kober *et al.*, 2010).**

SPECIES	SEASON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Gannet	Breeding												
	Winter												
Great skua	Breeding												
	Winter												
Black legged kittiwake	Breeding												
	Winter												
Great black-backed gull	Breeding												
	Winter												
European storm petrel	Breeding												
Fulmar	Breeding												
	Winter												
Razorbill	Breeding												
	Additional												
Herring gull	Winter												
Arctic tern	Breeding												
Atlantic Puffin	Breeding												
	Winter												
Lesser black-backed gull	Breeding												
Arctic skua	Breeding												
Guillemot	Breeding												
	Additional												
	Winter												
Little auk	Winter												
ALL species combined	Breeding												
	Summer												
	Winter												
KEY	Species not recorded	≤1.0	1.0 – 5.0	5.0 – 10.0	10.0 - 20.0	20.0 ->30.0							



The sensitivity of seabirds to oil pollution in Block 14/29 and surrounding areas has been assessed according to the JNCC Seabird Oil Sensitivity Index (SOSI). Oil and Gas UK commissioned HiDef (a digital aerial video and image specialist consultancy) to develop the SOSI tool and the results are available on the JNCC website (JNCC, 2018d). The purpose of this index is to identify areas where seabirds are likely to be most sensitive to oil pollution by considering factors that make a species more or less sensitive to oil-related impacts.

The SOSI combines the seabird survey data with individual seabird species sensitivity index values. These values are based on a number of factors which are considered to contribute towards the sensitivity of seabirds to oil pollution, and include:

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

The combined seabird data and species sensitivity index values were then subsequently summed at each location to create a single measure of seabird sensitivity to oil pollution. The mean sensitivity SOSI data for the area is shown in Table 2-9. For blocks with 'no data', an indirect assessment has been made (where possible) using JNCC guidance (JNCC, 2018d). The sensitivity of birds to surface oil pollution ranges between low and medium levels throughout the year within Block 14/29 (Figure 2-15). Adjacent Blocks 14/30 and 20/5 feature extremely high levels of seabird sensitivity in January. Seabird sensitivity along the pipeline (Figure 2-16) ranges between low to extremely high, with higher vulnerability being observed closer to the coast.



**Table 2-9 SOSI and indirect assessment for Block 14/29 and adjacent blocks and along the pipeline route (JNCC, 2018d).**

INFRASTRUCTURE	BLOCK	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PLATFORM	14/23	5*	5	5*	N	4*	4	5	5	4	4*	5	5
	14/24	4	4*	4**	N	2*	2	5	5	4	4*	4*	4
	14/25	4	4*	2**	N	5*	5	5	5	3	3*	3*	3
	14/28	4*	5*	5	5*	4*	4	3	5	5	5*	4*	4
	14/29	5*	4*	4	4*	4*	4	4	5	4	4*	5*	5
	14/30	1	1*	2	2*	5*	5	5	5	3	3*	4*	4
	20/3	5*	5*	5	5*	5*	5	4	5	5	5*	5*	5
	20/4	4*	5*	5	5*	5*	5	4	5	5	5*	4*	4
	20/5	1	1*	3	3*	5*	5	5	5	5	5*	4*	4
PIPELINE ROUTE	19/6	4	2	4	1	4	1	4	5	5	2	2	1
	19/7	2	3	3	1	4	2	3	4	4	2	3	2
	19/12	3	5	4	1	3	3	3	3	3	1	3	4
	19/8	3	2	5	1	1*	5	3	3	5	2	2	2
	19/13	3	5	5	1	3	4	2	3	4	2	3	2
	19/9	5	4	5	1*	5*	5	3	4	5	2	2	4
	19/14	4	5	5	1	1*	5	3	4	5	2	3	3
	19/10	4*	4	5	5*	5*	5	3	5	5	4	4*	5
	19/5	4*	4	5	5*	5*	5	3	5	5	2	2*	4
	20/1	3*	5	5	N	5*	5	3	5	5	2	2*	3
	20/6	5*	5	5	N	5*	5	3	5	5	5*	5*	5
	20/2	4*	5	5	N	5*	5	4	5	5	5*	4*	4
	20/7	4*	5	5	N	5*	5	4	5	4	4*	4*	4
	Key	1-Extremely High	2-Very High		3-High		4-Medium		5-Low		N-No Data		
Indirect Assessment – data gaps have been populated following guidance provided by the JNCC (JNCC, 2018d).													
* Data gap filled gap filled using data from the same block in adjacent months.													
** Data gap filled using data from adjacent blocks from same month													

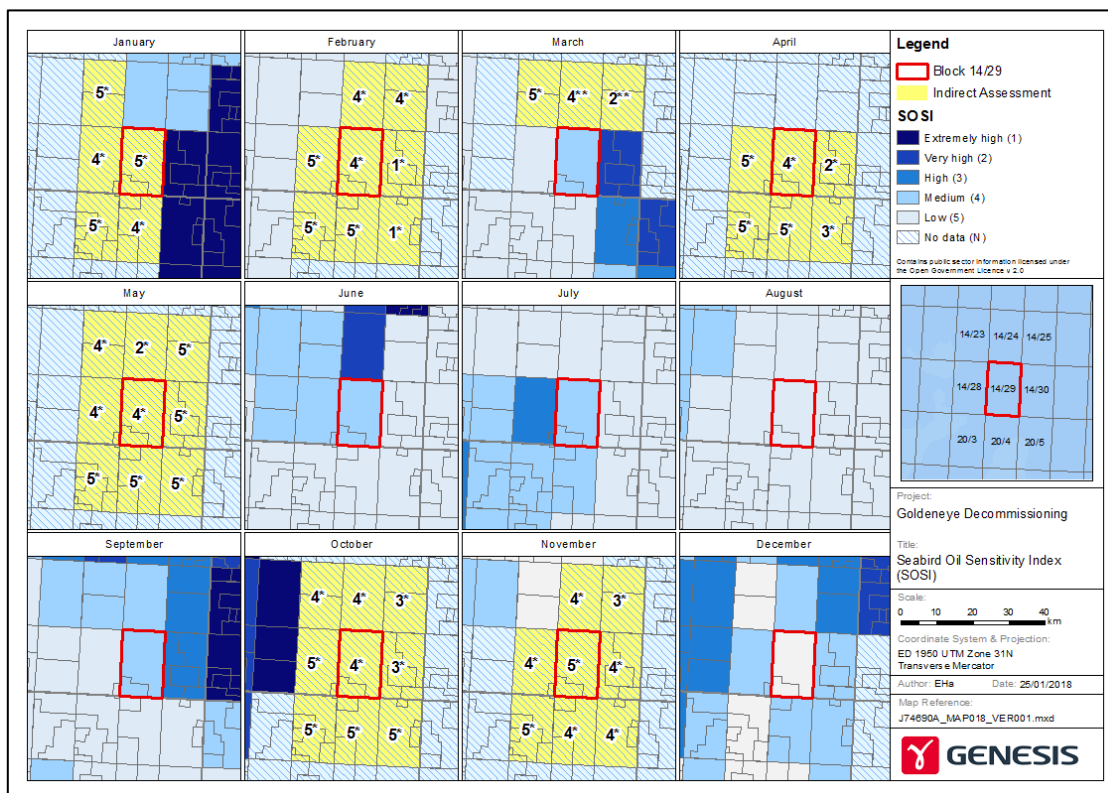


Figure 2-15 SOSI and indirect assessment for Block 14/29 and adjacent blocks (JNCC, 2018d).

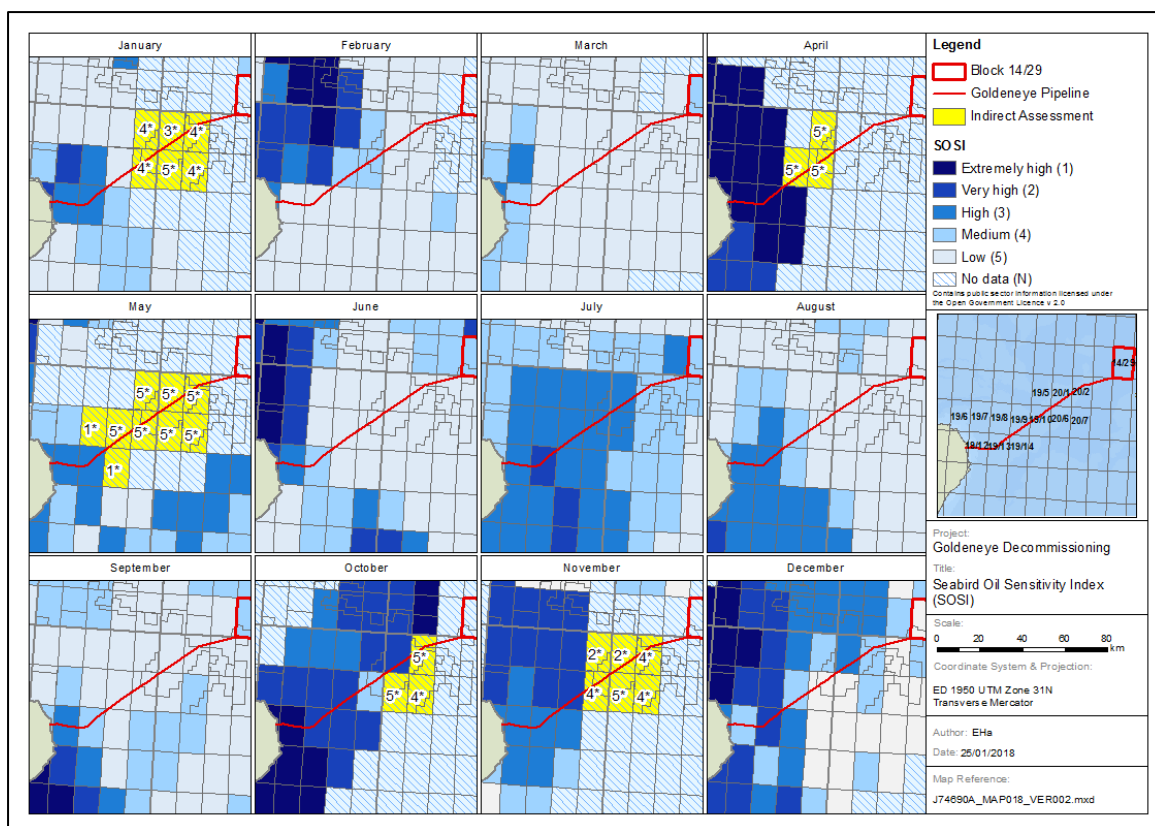


Figure 2-16 SOSI and indirect assessment along the Goldeneye pipeline route (JNCC, 2018d).



## 2.7.5. Marine Mammals

### 2.7.5.1. Pinnipeds

Two species of seal live and breed in UK waters: the grey seal (*Halichoerus grypus*) and the harbour seal (*Phoca vitulina*). Both species are listed under Annex II of the Habitats Directive and have also been assessed by SNH and JNCC to be PMFs in Scottish waters (JNCC, 2012; SNH 2014b) (see Section 2.5.1.1).

Results from telemetry data indicate that harbour seals are unlikely to occur in the vicinity of the Goldeneye platform or pipelines, whilst grey seals have been recorded along the nearshore parts of the pipeline (Figure 2-17).

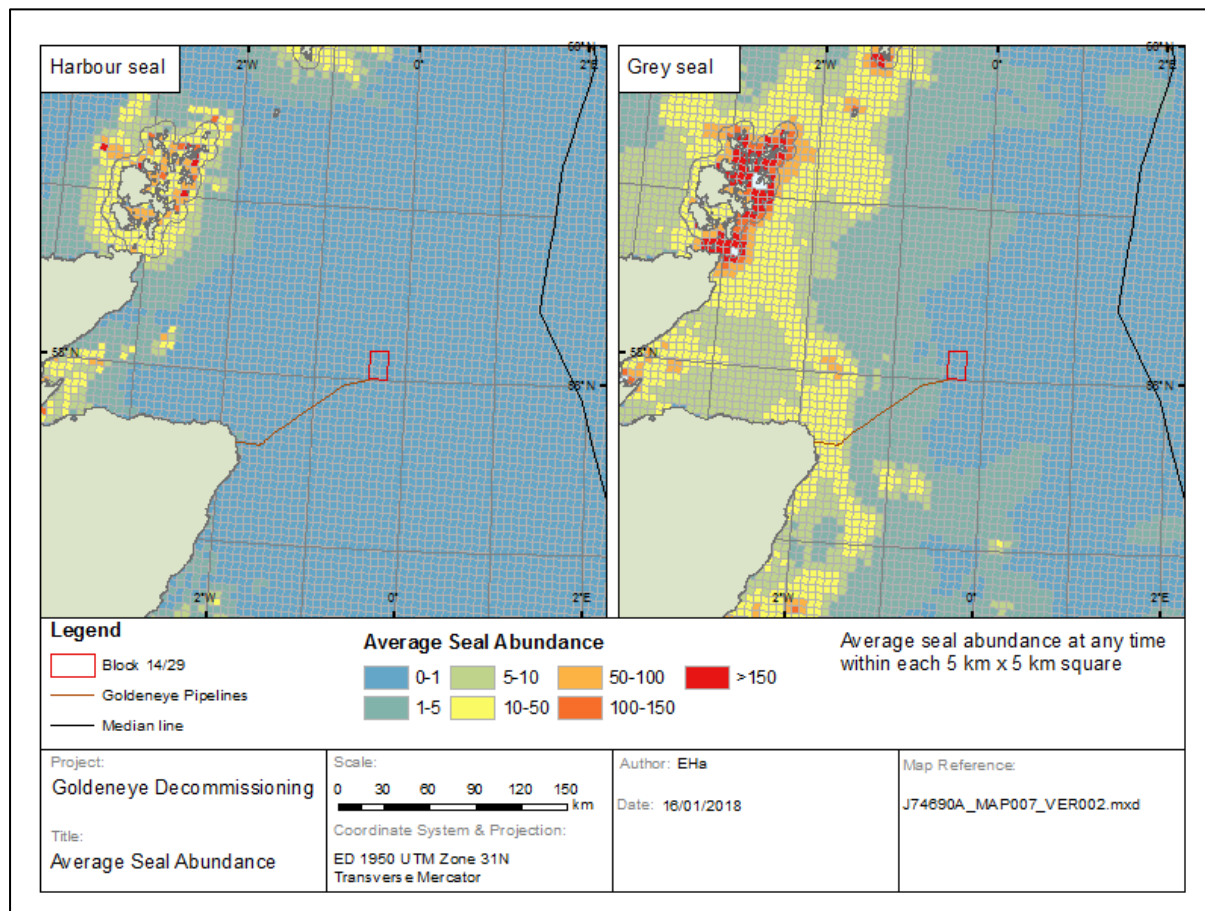


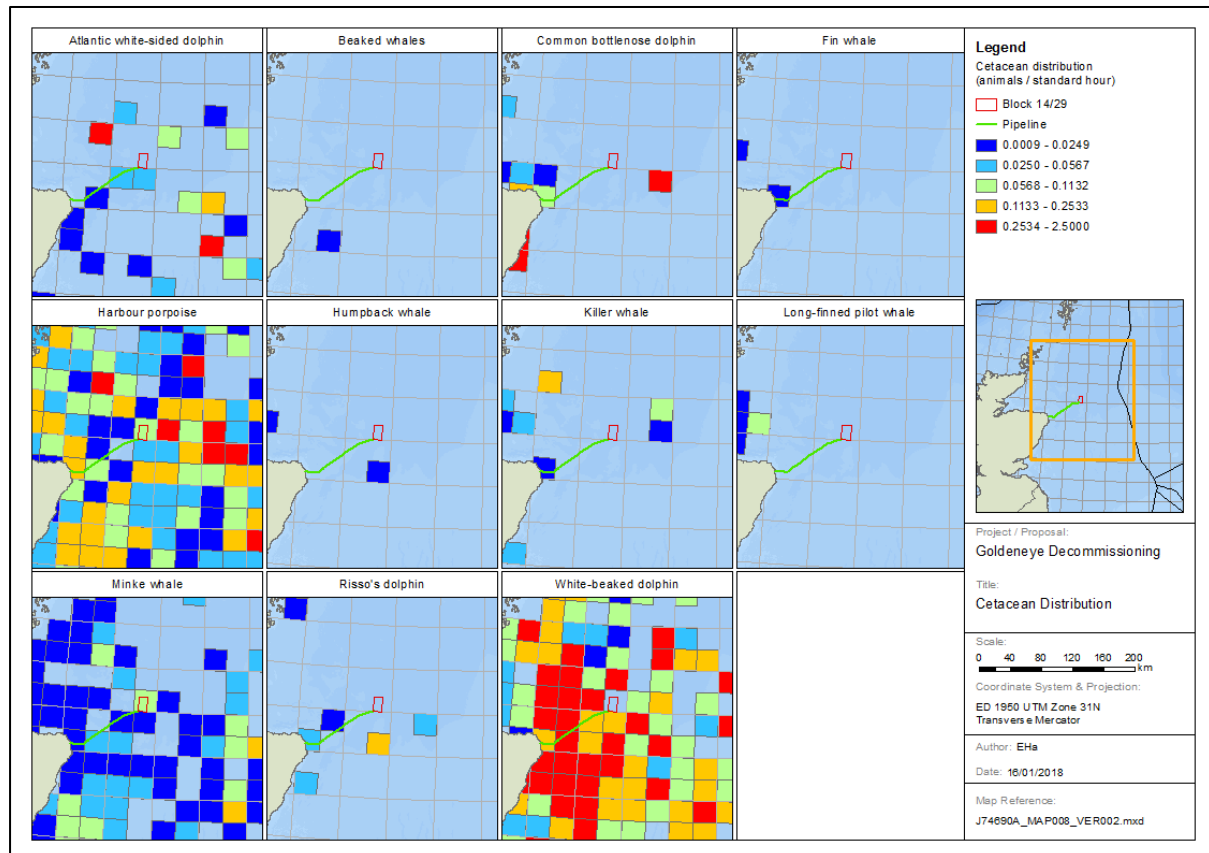
Figure 2-17 Harbour and grey seal distribution in the North Sea (SMRU, 2012; Jones *et al.*, 2013).

### 2.7.5.2. Cetaceans

The JNCC has compiled an Atlas of Cetacean Distribution in Northwest European Waters (Reid *et al.*, 2003) which gives an indication of the annual distribution and abundance of cetacean species in the North Sea. Figure 2-18 shows the annual abundance and distribution of cetacean species likely to occur in the area. The data suggests that moderate densities of harbour porpoise, white-beaked dolphin, Atlantic white-sided dolphin and minke whale have been sighted in the immediate vicinity of Goldeneye (Reid *et al.*, 2003).



These species are assessed to be PMFs and are subject to appropriate protection and conservation measures (Tyler-Walters *et al.*, 2016).



**Figure 2-18 Distribution of North Sea cetacean species (Reid *et al.*, 2003).**

A series of Small Cetacean Abundance in the North Sea (SCANS) surveys have been conducted to obtain an estimate of cetacean abundance in North Sea and adjacent waters, the most recent of which is SCANS-III (Hammond *et al.*, 2017). Aerial and shipboard surveys were carried out during the summer of 2016 to collect data on the abundance of harbour porpoise, bottlenose dolphin, Risso's dolphin, white-beaked dolphin, white-sided dolphin, common dolphin, striped dolphin, pilot whale, all beaked whale species combined, sperm whale, minke whale and fin whale.

Block 14/29 is located within SCANS-III survey block "T" and the pipeline lies within survey block "R". Aerial survey estimates of animal abundance and densities (animals per km<sup>2</sup>) within these areas are provided in Table 2-10, with reference to Figure 2-19.

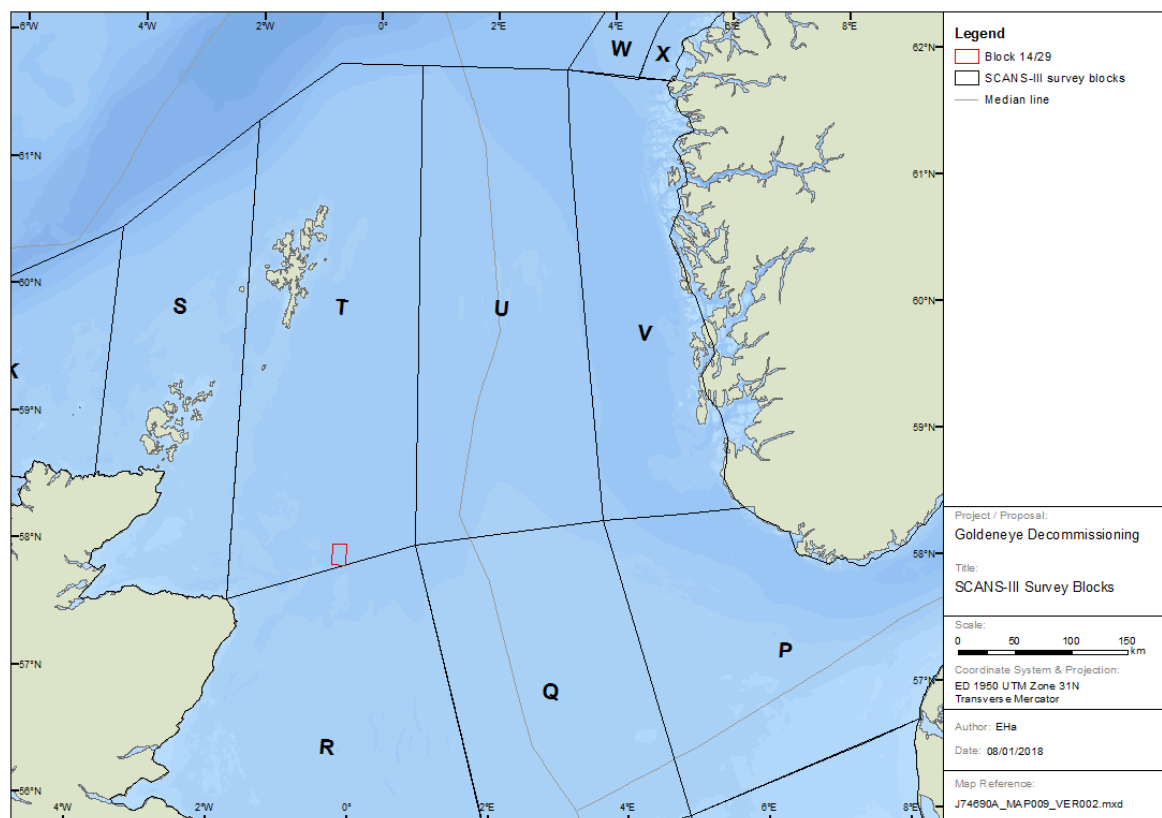
The JNCC published the 'regional' population estimates for the seven most common species of cetacean occurring in UK waters (Inter-Agency Marine Mammal Working Group (IAMMWG, 2015). Divided into Management Units (MUs), the estimated abundance of animals in these MUs are currently considered the reference populations for cetacean species in the North and Celtic Seas. These data are also provided in Table 2-10.



**Table 2-10 Cetacean abundance in SCANS-III survey blocks “R” and “T” (Hammond *et al.*, 2017<sup>1</sup>; IAMMWG, 2015<sup>2</sup>).**

SPECIES	SCANS ABUNDANCE (NUMBER OF ANIMALS)		DENSITY (ANIMALS PER KM <sup>2</sup> )		IAMMWG ANIMAL ABUNDANCE (MU)
	BLOCK “R”	BLOCK “T”	BLOCK “R”	BLOCK “T”	
Harbour porpoise	38,646	26,309	0.599	0.402	227,298
Minke whales	2,498	2,068	0.039	0.032	23,528
Bottlenose dolphin	1,924	-	0.030	-	195*
White-beaked dolphin	15,694	2,417	0.243	0.037	15,895
White-sided dolphin	644	1,366	0.010	0.021	69,293

\* IAMMWG bottlenose dolphin abundance refers to the Coastal East Scotland Management Unit, which is of relevance to impacts from nearshore Goldeneye Decommissioning activities.



**Figure 2-19 SCANS-III survey areas in relation to Block 14/29 and the Goldeneye pipelines**

### 2.7.6. Fishing Activity

The International Council for the Exploration of the Sea (ICES) divides the north-east Atlantic into a number of rectangles measuring 30 nm by 30 nm. Each ICES rectangle covers approximately one half of one quadrant i.e. 15 licence blocks. 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) x



fleet capacity (tonnage and engine power). It should be noted that fishing activity may not be uniformly distributed over the area of the ICES rectangle.

The Goldeneye platform is located within ICES rectangle 45E9 whilst the pipeline traverses ICES rectangles 44E8 (nearshore) and 44E9 (offshore).

Effort and landings data for UK vessels greater than 10 m for each ICES rectangle are available from the Scottish Government (2017). No such statistical data could be sourced for vessels less than this size. However, data collected by Kafas *et al.* (2012) provides spatial information on the fishing activity of Scottish-registered commercial fishing vessels measuring  $\leq 15$  m. Vessel Monitoring Systems (VMS) data made available for fishing vessels  $\geq 15$  m are also presented. Due to the differences in the sources of data and the spatial scale at which the data is collected it is not possible to provide a holistic numerical value in terms of vessel days and landings values for all vessel sizes operating in the area. Rather the information can be used to identify the type of fishing activity (and subsequently the types of gear) in the area and to provide an overall view of the relative importance of the area to the UK fishing industry.

#### *2.7.6.1. Fishing Activity: Vessels $\geq 10$ m*

Using data provided by the Scottish Government fishing effort (vessel days) and quantity data have been plotted for UK vessels  $\geq 10$  m in length.

Based on UK annual fishing effort for vessels  $\geq 10$  m UK annual fishing effort in these ICES rectangles can be considered moderate (Figure 2-20 shows the annual fishing effort for UK vessels  $\geq 10$  m from 2012 - 2016). In the offshore areas gear types associated with this effort include bottom and mid water trawls and seine nets. Closer to shore gear types would include dredges, trawls, seine nets, traps and harvesting machines.

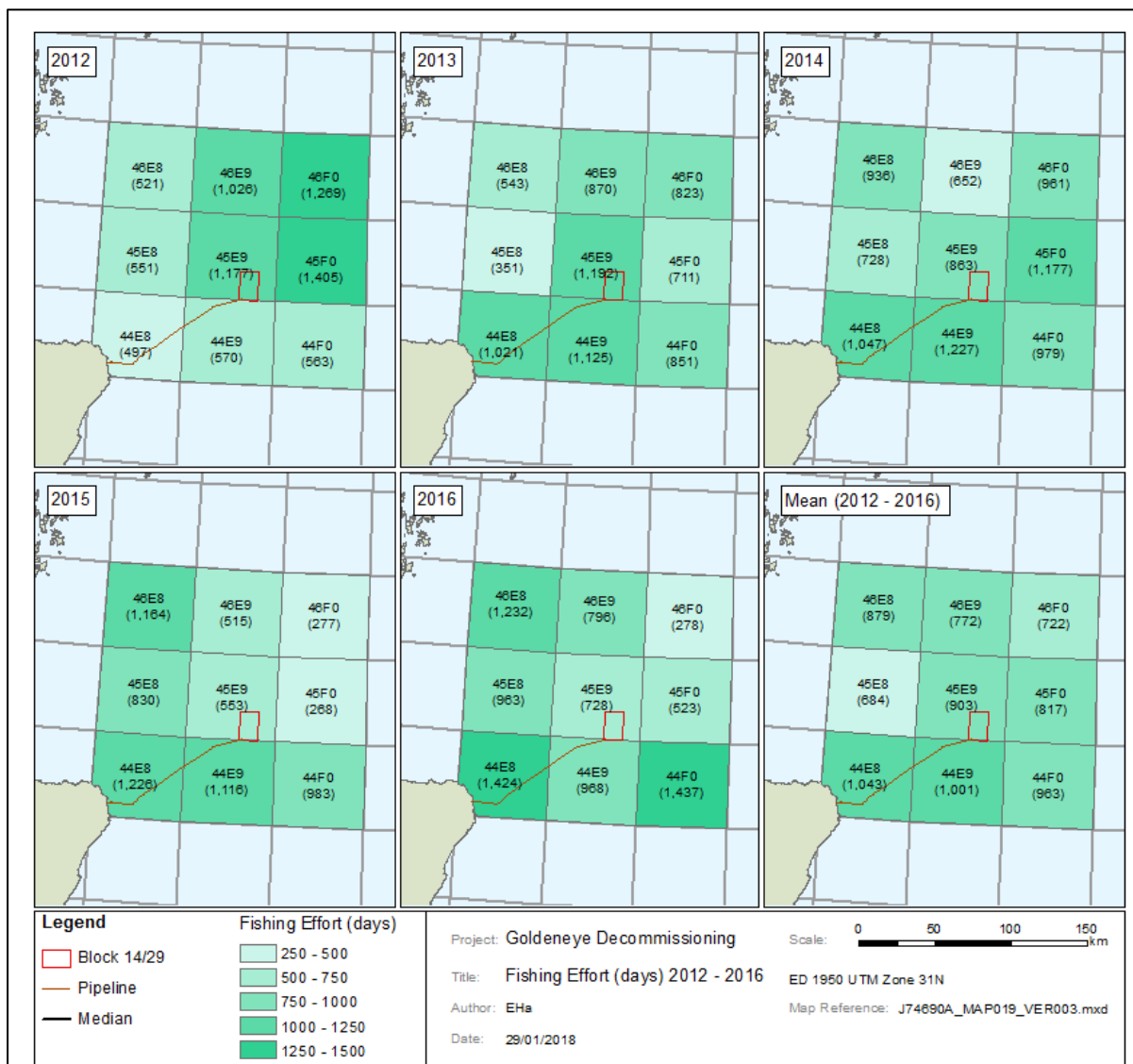
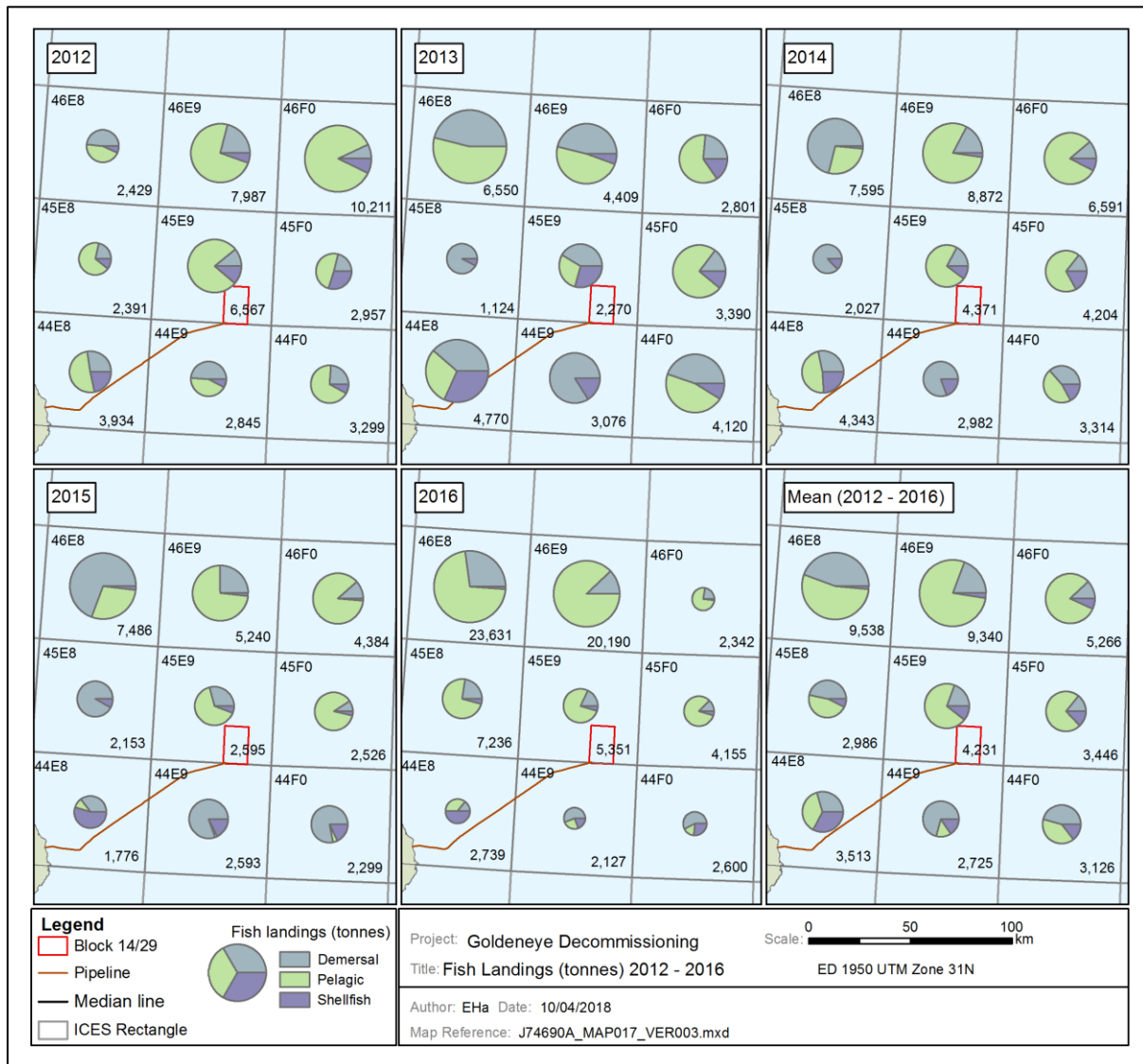


Figure 2-20 Mean UK annual fishing effort 2012-2016 in the vicinity of the proposed project (Scottish Government, 2017).



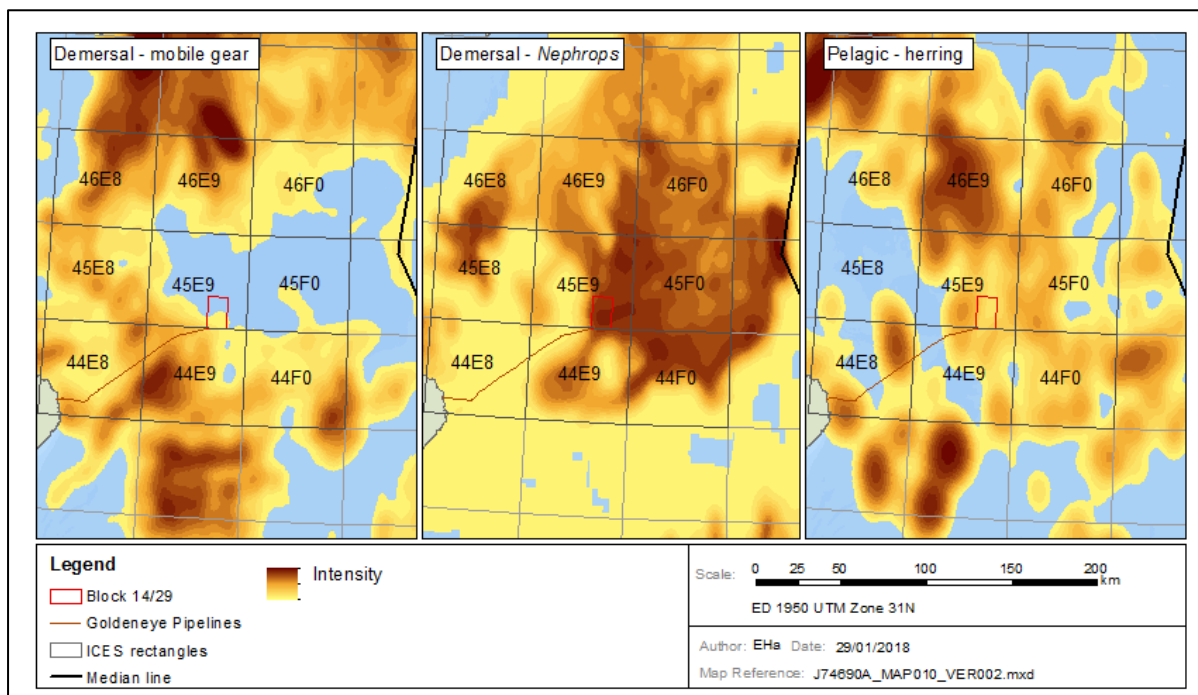
Figure 2-21 shows the annual landings between 2012 – 2016 of demersal, pelagic and shellfish species in ICES rectangle 45E9 and those ICES rectangles through which the Goldeneye pipelines are routed.



**Figure 2-21 UK reported landings by quantity (te) within the region of the proposed project (2012 – 2016) (Scottish Government, 2017).**

Amalgamated Vessel Monitoring Systems (VMS) data (2009 – 2013) for vessels  $\geq 15$  m within the Scottish zone of the UK Fishing limits (200 nm) has been combined with landings data to develop Geographical Information Systems (GIS) layers describing the spatial patterns of landings by the Scottish fleet. The data shows the position, time at a position, and course and speed of fishing vessels (Kafas *et al.*, 2012).

Figure 2-22 shows the fishing intensity by fishing vessels  $\geq 15$  m in length using different types of fishing gear (therefore targeting different species) in the North Sea using VMS data. It can be seen that the most intense fishing effort is concentrated in different areas dependent on the fishing gear used. All three types of fishing gear were used within 45E9, with *Nephrops* fishing being the most intense within Block 14/29.



**Figure 2-22 VMS combined data from 2009-2013 showing the fishing intensity of fishing vessels  $\geq 15$  m in length off the north-east coast of Scotland using a) demersal mobile gears, b) pelagic gears, c) *Nephrops* mobile gears and d) scallop gears (Kafas *et al.*, 2012).**

#### 2.7.6.2. Fishing Activity: Vessels $\leq 15$ m

The Scottish fleet is dominated by vessels with a length of  $\leq 10$  m, with 1,464 vessels falling into this category in 2016 and accounting for 72% of the Scottish fleet. The  $\leq 10$  m fleet is dominated by vessels using creels to fish, namely traps in the form of cages or baskets, typically baited and used to target shellfish species.

ScotMap (Kafas *et al.* 2012) provides a spatial dataset (using grid cells ranging in area from 3.89 km<sup>2</sup> – 4.51 km<sup>2</sup>) of fishing intensity and fishing value in inshore Scottish waters by vessels  $\leq 15$  m for the period 2007 – 2011. The data provided is an annual average across the five years.

Figure 2-23 provides an indication of the fishing intensity in each grid cell. The number of vessels presented captures those vessels associated with active gear e.g. trawls and scallop dredges in addition to static gear e.g. crab and lobster pots. Within 44E8 dredges, trawls, seine nets, traps and harvesting machines were utilised, with 499, 465 and 41 effort in days used for dredges, trawls and seine nets respectively. Data relative to other methods were classified as disclosive in this ICES rectangle (Scottish Government, 2017).

Figure 2-24 shows the value of landings by vessels  $\leq 15$  m. The value of landings by these smaller vessels is highest within 6 nm of the coastline. Landings by fish type suggest the higher values associated with the nearshore section of the pipelines is associated with the crab and lobster fishery and to a lesser extent, mackerel lines.

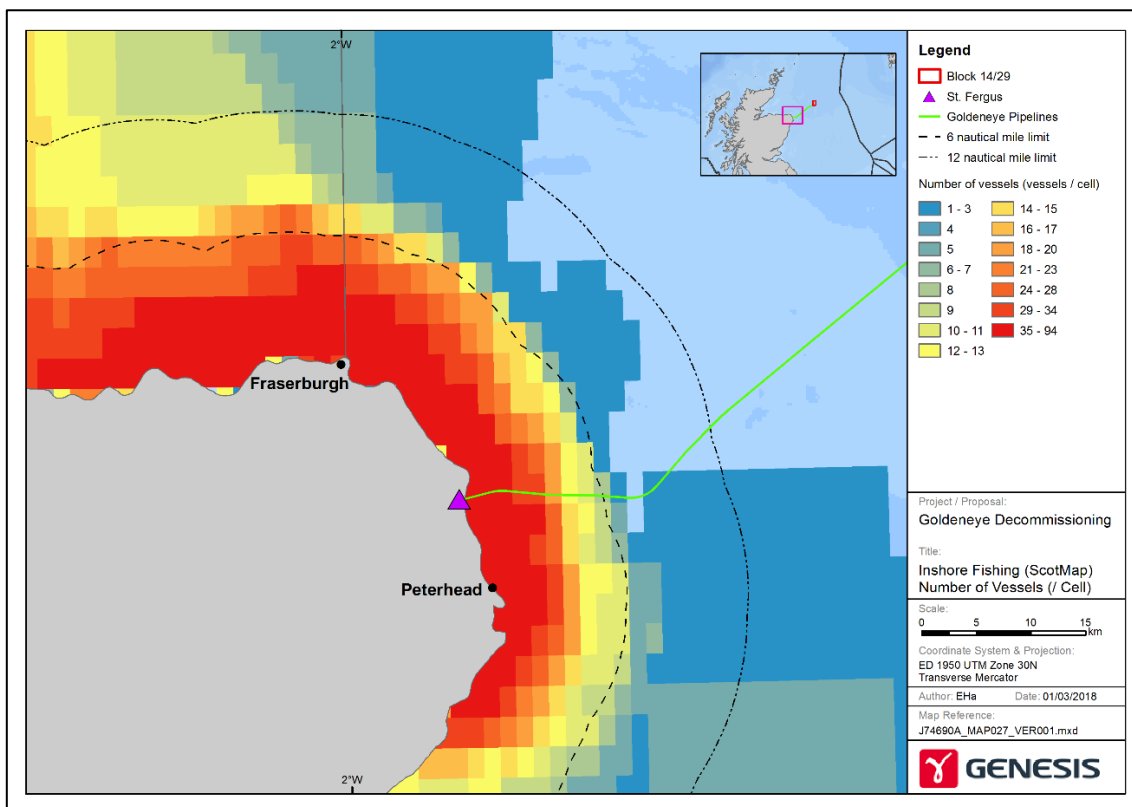


Figure 2-23 Fishing intensity by Scottish vessels  $\leq 15$  m (ScotMap: 2007 – 2011: vessels / cell) (Kafas *et al.*, 2012).

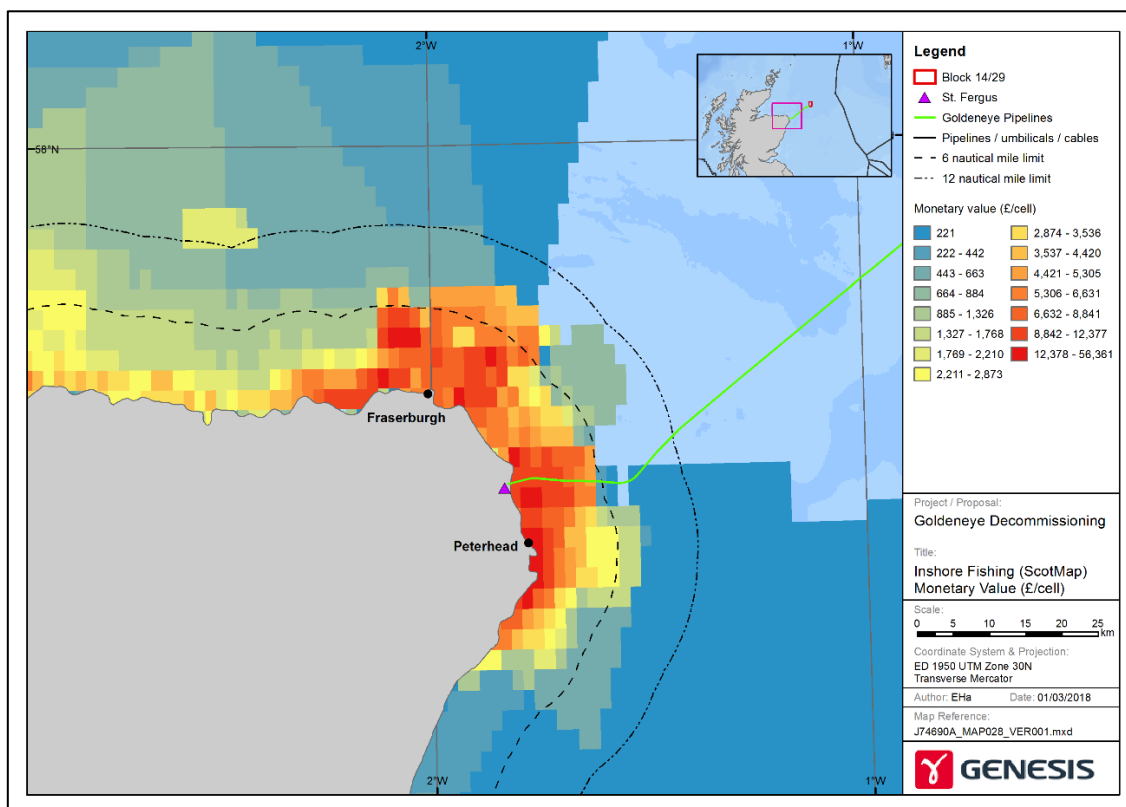


Figure 2-24 Landings value (£ / cell) by Scottish vessels  $\leq 15$  m (ScotMap: 2017 – 2011: vessels / cell) (Kafas *et al.*, 2012).



In summary, a number of gear types are active in the area of the Goldeneye infrastructure including seine nets, demersal trawls, Nephrops trawls, scallop dredges and pots. This section provides an overview of the data sources available however using the different data sources it is difficult to draw conclusions on the relative value of the area to the UK or Scottish fishing industry as a whole. Nevertheless, it can be seen that the nearshore area is an important fishing ground for smaller vessels whilst in terms of effort and landings it is of less importance to larger vessels.

### 2.7.7. Shipping

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, including routes into the Peterhead Port. The Peterhead Port is a major supply base for the offshore oil and gas industry and the most important fishing port in the UK for white and pelagic species. In addition, the port handles tankers, general cargo, ships, cruise liners and leisure craft.

Shipping activities in the North Sea are categorised by the Oil and Gas Authority (OGA) (2017) to have either: very low; low; moderate; high; or very high shipping density. Figure 2-25 shows the level of shipping activity within the area of the decommissioning project which is considered to be moderate offshore but high closer to shore.

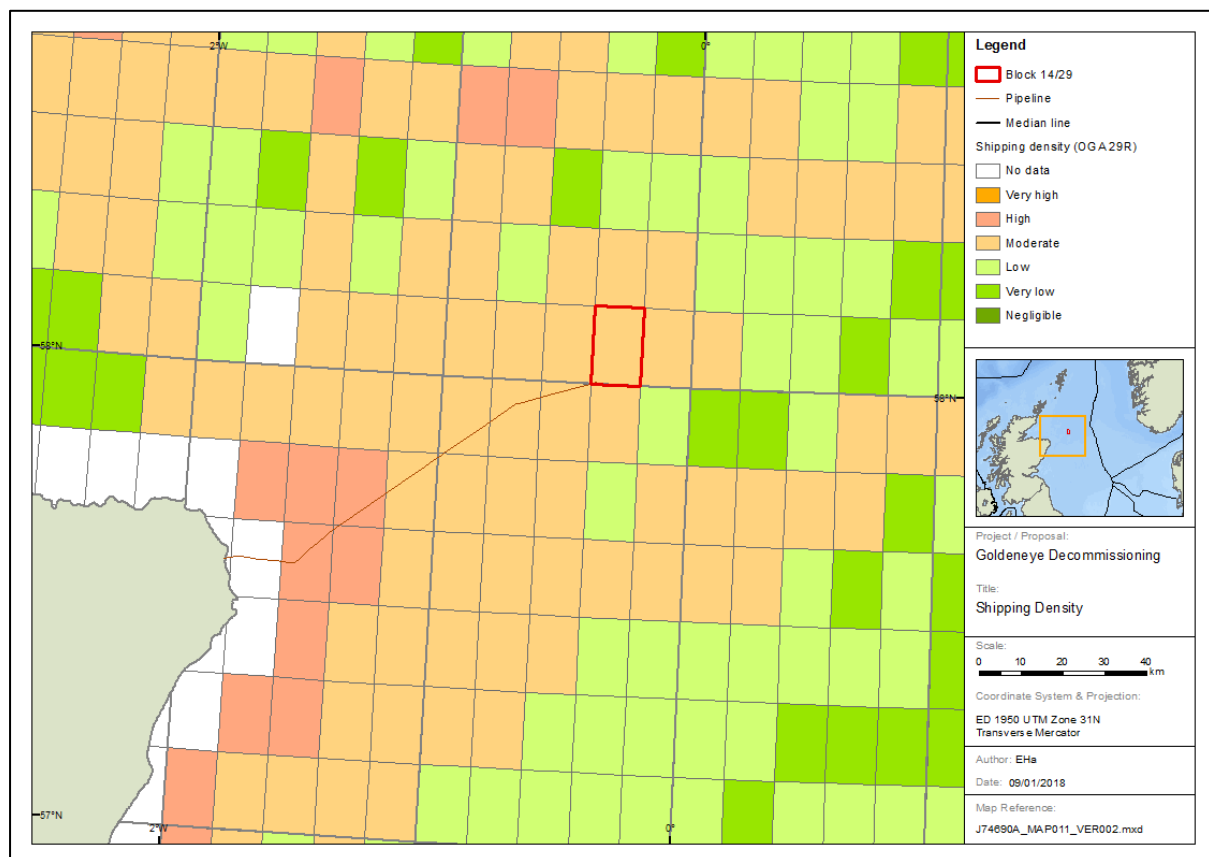


Figure 2-25 Shipping density as categorised by OGA (OGA, 2017).

### 2.7.8. Surrounding Oil and Gas Infrastructure

The Goldeneye platform lies within a highly-developed oil and gas area in the North Sea (Figure 2-26). The closest surface infrastructure to the Goldeneye Platform is the Golden Eagle Platform approximately 32 km to the west, and approximately 9 km from the Goldeneye pipelines. The Buzzard platform is c. 2 km from the Goldeneye pipelines (Figure 2-26).

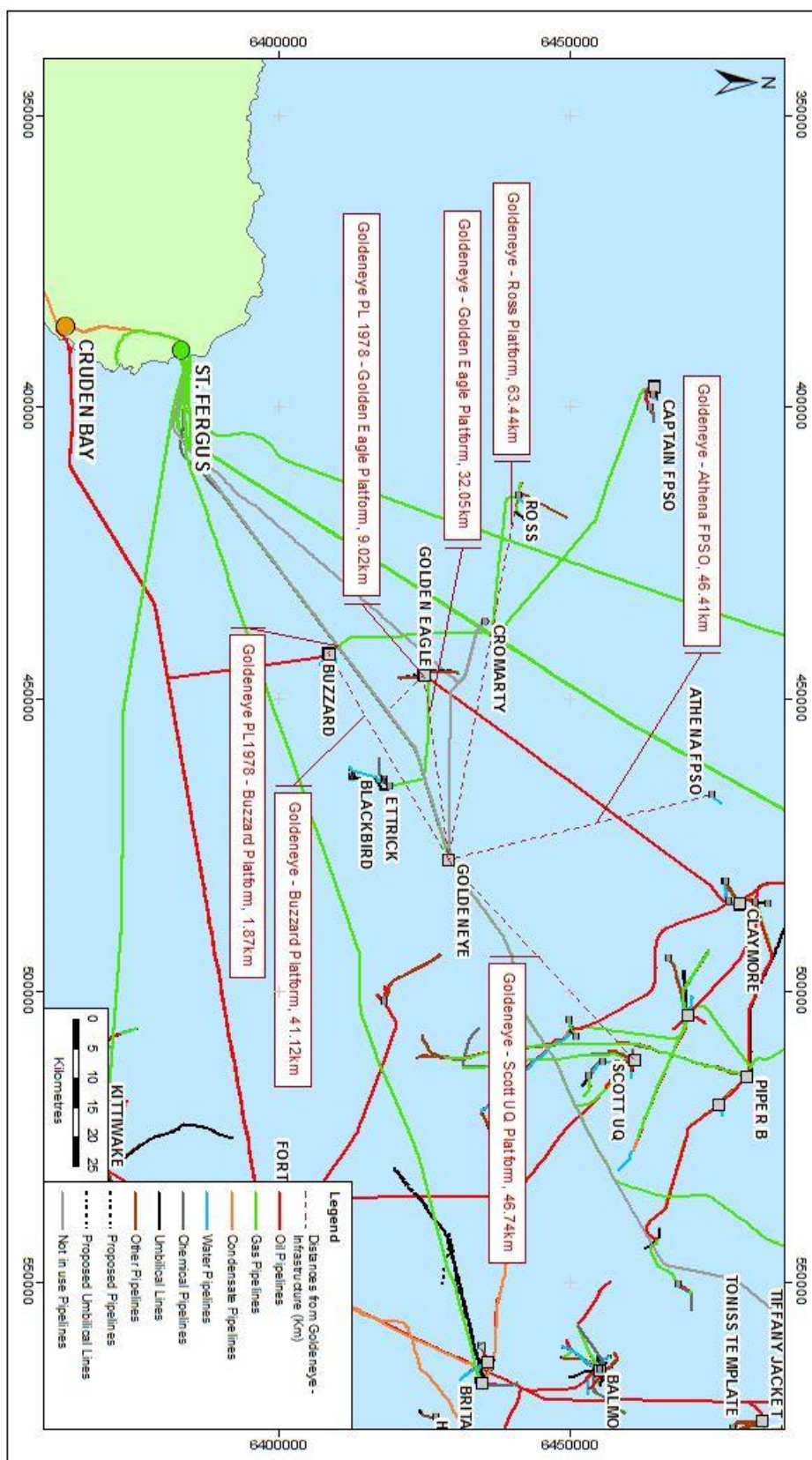


Figure 2-26 Existing oil and gas installations in relation to Goldeneye.



### 2.7.9. Other Industries

There are no renewable developments or industrial aggregate industry activities associated with the decommissioning project area (Scottish Government NMPI, 2018). The closest windfarm development is Hywind Scotland located north of Aberdeen  $\approx$  80 km from the Goldeneye platform and  $\approx$  6 km from the pipeline (Figure 2-27). The windfarm became operational in October 2017.

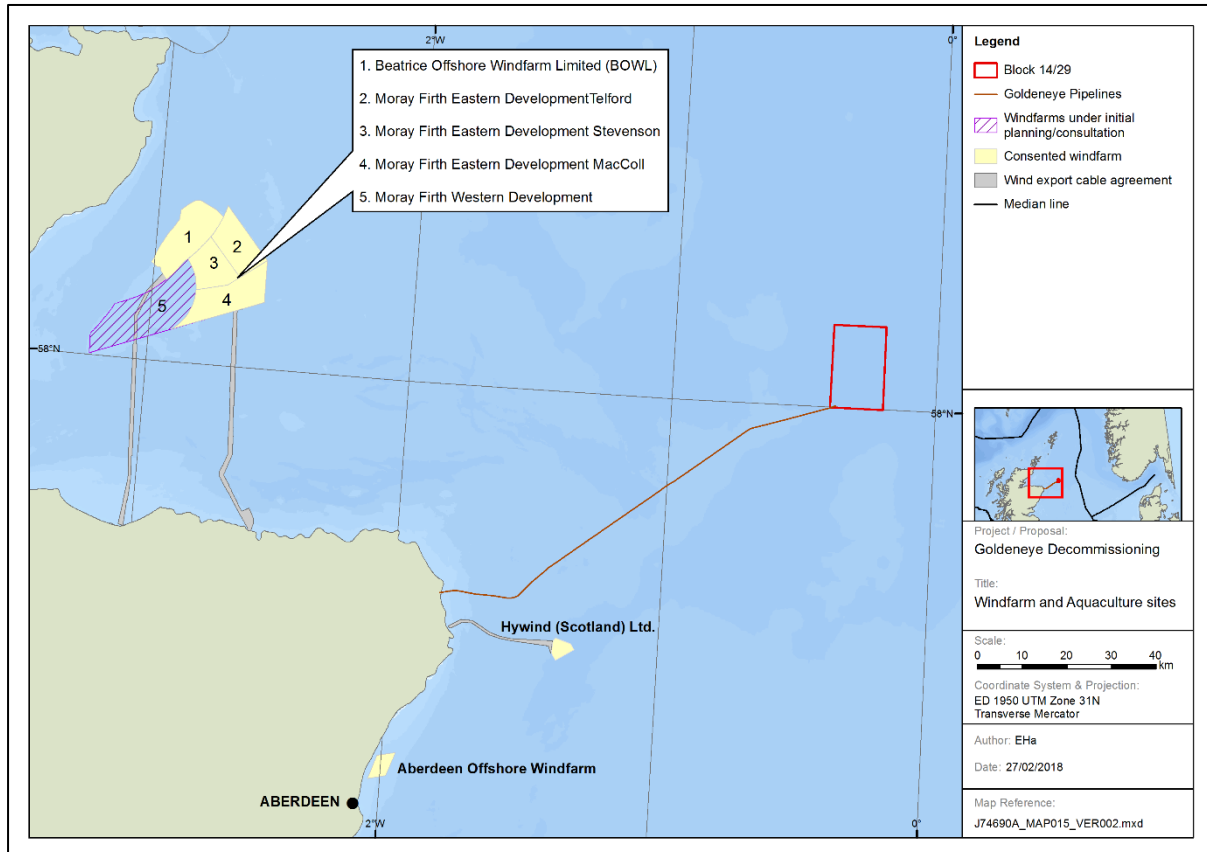


Figure 2-27 Windfarm and aquaculture sites (NMPI, 2018).

### 2.7.10. Submarine Cables

The cable awareness charts (KIS-ORCA, 2014) show that there are no telecommunications cables within the Goldeneye area.

### 2.7.11. Shipwrecks

At approximately KP77 there is a shipwreck 'Harvest Hope'  $\approx$  147 m south of the Goldeneye pipelines.

### 2.7.12. Military Exercise Areas

There are no military exercise areas within Block 14/29 (Scottish Government NMPI, 2018).



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### 3. Identification of Impacts

#### 3.1. ENVID

Potential environmental impacts of the DP were identified through an ENVID workshop. Attendees to the workshop covered all relevant engineering disciplines and included environmental specialists, the decommissioning manager, operating installation manager and risk management consultant. The workshop was chaired by an environmental specialist with experience of multiple field development and decommissioning environmental assessments in the North Sea.

##### 3.1.1. ENVID Approach

Shell ENVID protocol utilises a standard series of guidewords that has been adapted specifically to the consideration of activities encountered for decommissioning projects. The guidewords are used to prompt a thorough discussion about the specific aspects for the present decommissioning project from which the potential for all environmental impacts are identified and noted.

The severity of each impact is scored through a qualitative risk-based approach utilising matrices which consider the sensitivity of the receptor, the scale of the activity and magnitude of impact. For unplanned or accidental aspects, the likelihood of the event occurring is also incorporated into the overall impact evaluation. The impact ratings were determined on the basis that standard mitigation measures required to meet regulatory permitting requirements, Shell Group practices, Industry best practice and regulatory guidance were implemented. These mitigation measures are included through Section 4 of this report and have been recorded as commitments in the project Environment, Social and Health Management Plan.

The methodology used is presented in Appendix A and the outcome of the workshop is presented in Appendix B.

##### 3.1.2. ENVID Conclusions

###### *3.1.2.1. Planned Activities*

The ENVID concluded that the planned decommissioning activities would give rise to no impacts of Major significance.

The ENVID identified the potential for Moderate impact to the seabed within the Southern Trench pMPA due to the following activities:

- Trenching and burial of the export pipeline between the transition point at KP20 and the edge of the pMPA at the limit of nearshore waters, 12 nautical miles from shore, which corresponds approximately to KP25 of the pipeline;
- Overtrawl trials conducted along the pipeline route within the pMPA; and
- If there is a requirement for placement of rock cover within the pMPA over sections of the pipelines where burial is deemed insufficiently deep to prevent risks of snagging.

The Moderate impact rating afforded to these activities reflected the High sensitivity rating of the seabed due to it being within a designated area of conservation.

The ENVID also identified the potential for Moderate impact of underwater noise from vessels using dynamic positioning systems on the minke whale biodiversity feature of the Southern Trench pMPA



All other planned activities were determined to have minor, slight or no impact on the environment or other users of the sea.

#### *3.1.2.2. Unplanned Events*

The DP includes no activities that have High risk to the environment.

Certain scenarios for the accidental loss of fuel from vessels were identified as posing a Moderate environmental risk.

The greatest potential for environmental impact from an unplanned event relates to the loss of the full fuel inventory of a vessel while operating close to shore. This was assumed to give rise to a Major impact although the likelihood of such an event was considered to be remote, based on past statistics.

All other accidental events considered in the ENVID had risk ratings of Minor or Negligible.

Following feedback from Stakeholders, further consideration has been given to the risk of either the topsides or jacket being dropped during transit or while being lifted at, or *en-route* to, the decommissioning yard. This is addressed in Section 4.7.2.

### **3.2. Impact Assessment Scoping**

The output of the ENVID has been used as a scoping tool to identify any aspects for which further environmental impact assessment would be informative and proportionate.

All Minor impacts and risks, or lower, were scoped out from requiring further environmental impact assessment on the grounds that the magnitude of impact does not warrant more quantitative or semi-quantitative study, and that the control measures identified are well established and accepted as means of minimising impacts.

The potential for Moderate impacts within the Southern Trench pMPA is given further consideration in Section 4.2 and Section 4.5, while the risk of impact from fuel spills is discussed in Section 4.7.1. These noted sections draw on existing information to demonstrate that these aspects also do not require further environmental impact assessment.

Consequently, due to the particular characteristics of the Goldeneye decommissioning, no aspects or impacts have been scoped for more detailed assessment. This is shown in the right hand column of the ENVID output tables provided in Appendix B.

The scoping conclusions were presented to statutory consultees and feedback received as described in Section 1.7.



## 4. Environmental Assessment

The evaluation of impacts during the ENVID workshop relied on the expert knowledge of the attendees, based on their understanding of the issues and of relevant published sources of information.

For many aspects considered in the ENVID, the type of activity, mechanism of impact, scale and duration of impact are such that the conclusion reached is clear and can be made with a high degree of confidence. For some other aspects, it is recognised that the ENVID output could be overly concise and may not adequately capture the full justification for the conclusions reached. Further detail is provided in this section in support of the ENVID conclusions for these aspects.

The information is organised under standard headings of receptors or sources of impact, rather than the activity nodes used for the ENVID process. The headings used are:

- Natural Capital and Ecosystem Services (NCES)
- Emissions to Air
- Discharges to Sea
- Seabed disturbance
- Underwater Sound
- Waste Management
- Accidental Events
- Socio-economic Effects
- Designated Sites, Protected & Endangered Species

### 4.1. Natural Capital and Ecosystem Services

The ENVID identified a number of activities that have the potential to affect the productivity of the area either in terms of fishing activity or in terms of ecological abundance. These were due to:

- The physical presence of vessels and obstacles;
- Changes to the seabed substrate type following disturbance of the seabed; and
- Return of the area around the platform for fishing.

Natural capital will also be expended through use of hydrocarbon resource for fuel and quarried material for rock cover.

#### 4.1.1. Physical presence of vessels

Most of the vessel activity will be within the 500 m safety zone for the Goldeneye platform and, as such, their presence will be unlikely to cause an impact on other users of the sea. However, certain activities will be outwith the 500 m safety zone including trenching of the export pipeline and subsequent pipeline depth surveys. These activities have the potential to cause a short term interruption of fishing activities along the pipeline route but are expected to have negligible impact on fishing productivity as a whole due to their short duration and very limited extent.

#### 4.1.2. Disturbance of the seabed

The disturbance of the seabed is assessed under Section 4.2.

#### 4.1.3. Goldeneye safety zone

Following decommissioning, the 500 m safety zone around the Goldeneye platform will no longer exist and the area will be once more available for fishing. This will offset any lost fishing productivity due to rock cover laid during decommissioning.



Prior to surrender of the safety zone, the area will be subject to overtrawl trials to demonstrate a safe seabed. This will cause some temporary disturbance of the seabed.

#### 4.1.4. Materials use

The two natural resources to be consumed in the decommissioning activities cover fuel and rock. While both of these resources are finite, and incur a financial cost, they are extensively abundant and their use in the decommissioning works will not impact their availability.

#### 4.1.5. Controls for the Management of Impacts to NCES

The following mitigation measures, safeguards and controls are proposed to minimise the potential for the Goldeneye decommissioning to erode natural capital and interrupt ecosystem services.

##### MITIGATION MEASURES, SAFEGUARDS AND CONTROLS

- Adoption of a clear seabed policy in line with OSPAR Decision 98/3\*;
- Optimisation of vessel use to minimise disturbance to other users of the sea;
- Minimise disturbance to the seabed (see Section 4.2.7).

\*Except at pipeline crossings and the transition point, where burial is not feasible.

The appraisal of impacts on NCES due to the decommissioning activities supports the conclusion that impacts will be minimal, and constrained to a level that is as low as reasonably and safely practical by adoption of the control measures specified.

## 4.2. Seabed Disturbance

The following activities will cause disturbance of the seabed:

- Trenching and burial of the export pipeline;
- Removal of subsea infrastructure;
- Positioning of vessels/jack-up;
- Laying additional rock cover; and
- Overtrawl trials.

Some of these activities would cause temporary impacts, while others (such as rock cover) would result in lasting localised effects. These are discussed below in the following subsections.

The seabed at Goldeneye and along the export pipeline is described in Section 2.3.4 as being generally typical of the wider CNS area, and with sensitive marine features (pockmarks and *A. islandica*) present.

Along the pipeline, the seabed is of relatively low environmental sensitivity, but with the possibility that there may be isolated, sporadic examples of more sensitive features, and the sensitivity of the seabed as a receptor to disturbance activities has consequently been assumed to be moderate.

The export pipeline is surface laid for approximately 5 km within the Southern Trench pMPA, the offshore bound of which corresponds to KP25 on the Goldeneye pipeline. Three of the sample stations used in the Peterhead CCS environmental survey (CMACS, 2014) lie along the Goldeneye pipeline at approximately KP15, KP19 and KP23. These stations were classified as 'polychaete-rich deep [*Venus*] community in offshore mixed sediments (EUNIS type A5.451). *S. spinulosa* were identified in these samples although, as was also found in the wider area, the majority were juveniles, only a few millimetres in length and did not constitute Annex I habitat. The Burrowed mud biodiversity feature of the pMPA is not present in this part of the site.



#### 4.2.1. Trenching and infill

The trenching of the export pipeline will disturb the seabed over a narrow corridor along 82 km of its length. The width of the corridor depends on the trenching method deployed. The disturbance zone for the jetting technique likely to be preferred for Goldeneye is typically about 5 m wide along the full length of the pipeline to be buried, although some fine-grained silt and clay suspended by the works will disperse further (Carter, 2010). A trencher with a back hoe may result in a worst-case disturbance zone of up to 10 m width.

Jet trenching uses a remotely operated vehicle to apply high pressure water jets below the seabed to collapse the sediment structure, causing the pipeline to sink into the collapsed trench under its own weight, with the disturbed sediment falling in on top of the pipeline.

A back hoe trencher is fixed in position with spud legs which penetrate the seabed to keep it in position. Once the dredger is set up in position the bucket excavates the trench. The backhoe dredger would be spudded approximately every 10 m. Back hoe trenching of a pipeline disturbs the seabed, both along the line of the pipe to create the necessary stable excavation and where the spud legs contact the seabed. The energy to move the sediment is imparted by the dredger bucket and through the bulk mass of the sediment. Although the sediment is sheared and fluidised in the process, little additional water is introduced and upward velocities are very low. The method displaces some sediment into the water column, much of which agglomerates quickly and becomes redeposited in clumps, creating a berm alongside the trench. Finer material creates a plume of suspended solids in the water column which is subsequently re-deposited over a wider area, dependent on current and tidal dispersion.

Either method of trenching physically disturbs the benthic communities and their habitat within the area impacted ( $<0.82 \text{ km}^2$ ) and may cause some smothering of the wider region due to redeposition of disturbed material. Trenching is expected to cause the injury or fatality of some organisms present at the time (mainly epifaunal), while others are likely to be displaced.

The mixing of the surface and shallow sediments caused by the process may leave a modified sediment structure, with potential to affect the subsequent colonisation and productivity of the impacted area. The effect is a change to the baseline but does not necessarily result in a diminishing of productivity nor of biodiversity. The species and habitats determined to be present in the area of the trenching activity (KP 20 – KP 102) are widespread through the CNS, and the area to be impacted represents a very small percentage of that available habitat.

As well as benthic species, the eggs and larvae of fish species (herring and sandeels) which spawn at the seabed are vulnerable to seabed disturbance. The pipeline route traverses the spawning grounds of both these species, although the platform is out with these areas. Sandeels spawn from November to February, while Herring spawn in August and September in this part of the CNS. Marine Scotland has registered a 'period of concern' for seismic activities for blocks traversed by the western half of the pipeline during both these periods (OGA, 2016).

Although impacts on demersal spawning fish would be brought to an absolute minimum were trenching of the pipeline to be undertaken outside of these months (i.e. between March – July or in October), the spawning areas of both species (and of all those shown in Figure 2-14) are extensive in the CNS and the area of the seabed that would be impacted by trenching is a very small fraction of this. The difference in impact to these species from trenching during or outwith the spawning season is not significant and does not warrant restriction of the market to provide the lowest cost decommissioning option.

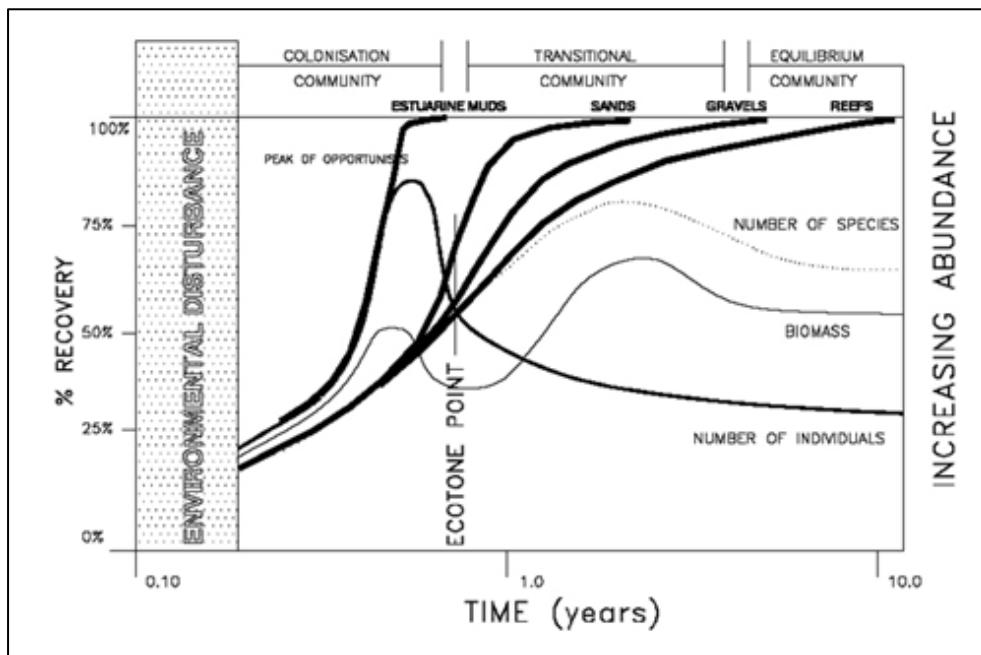


#### 4.2.1.1. Seabed Recovery

It is anticipated that the affected corridor would be recolonised by benthic fauna typical of the area. This will occur as a result of natural settlement by larvae and plankton and through the migration of motile animals from adjacent undisturbed benthic communities (Dernie *et al.*, 2003).

Recovery times for soft sediment faunal communities are difficult to predict, although studies have attempted to quantify timescales. From studies of the impact of dredging on seabed habitats, de Groot (1979, 1986) reported recovery of sandy sediments following within approximately 3 years. An area of benthos that has been disturbed will initially be recolonised by opportunistic species (Figure 4-1). These consist of large populations of organisms that have a high development rate, such as small sedentary tube dwelling deposit feeders. Eventually the area is invaded by a variety of species that have a slower recruitment and growth rate which results in a decline in the population density but increase in diversity. Early colonisers are eventually replaced by more mature communities creating stable climax communities (Rosenberg *et al.*, 2002).

The Minerals Management Service (MMS) (1999) quote various sources and report that recolonisation takes 1-3 years in areas of strong currents but up to 5-10 years in areas of low current velocity. Longer recovery times are reported for sands and gravels where an initial recovery phase in the first 12 months is followed by a period of several years before pre-extraction population structure is attained. Fine sediments such as sands, as found at the pipeline location, tend to recover much more quickly than the biologically controlled communities which characterise coarse deposits.



**Figure 4-1 Schematic time series diagram showing a colonisation succession in a marine environment.**

The rate of recovery has also been found to be fastest in unconsolidated deposits such as muds and sand; these are colonised by ‘opportunistic’ species that are well adapted to rapid recolonisation and growth following episodic mortality. In contrast, more consolidated and coarser deposits are colonised by a wide variety of slow growing ‘equilibrium’ species that may take several years for recolonisation following disturbance. In general, a period of 2-3 years has been commonly recorded for restoration of species composition and benthic biomass in sands and gravels that are exploited by the marine aggregates industry in the U.K (Hitchcock *et al.*, 1998; Newell *et al.*, 1998).



At Goldeneye, and along most of the length of the pipeline, the substrate is of circalittoral mud or circalittoral sand and there is evidence of moderate substrate mobility. For these conditions all information appears to indicate an ecological recovery period of between 1 and 3 years could be expected. Smaller patches of more gravelly substrate along the pipeline may take a little longer for the recolonisation sequence to complete.

#### *4.2.1.2. Impact within the Southern Trench pMPA*

Trenching within the pMPA was identified in the ENVID as one of the activities that could result in a Moderate impact, on account of the higher sensitivity status given to the seabed in this proposed designated site. The area impacted by the trenching ( $<0.05 \text{ km}^2$ ) represents a small fraction (0.002 %) of the overall area of the site ( $2,487 \text{ km}^2$ ) and does not contain the seabed habitat feature for which the MPA is proposed (see Section 2.4.1). As such, and recognising that the impact will be short term, the Moderate rating is seen as an over-estimate of the actual impact.

#### *4.2.1.3. Impact of Suspended Sediments from Trenching*

The other mechanism of impact from trenching is from suspension of trenched material into the water column. Suspended sediment has the potential to cause clogging and abrasion of feeding and respiratory apparatus, particularly of sessile epifaunal species (Nicholls *et al.*, 2003). Larger, more mobile animals, such as crabs and fish, are expected to be able to avoid any adverse suspended solid concentrations and areas of deposition. In the case of filter feeders, such as *Arctica islandica*, an increased suspended sediment concentration could impact the ability to feed. The suspension of some sediment is inevitable during trenching but the impacts will be localised and short term, with minimal lasting impact on fauna populations.

### **4.2.2. Removal of subsea infrastructure**

#### *4.2.2.1. Jacket and SSIV*

Some localised disturbance of sediments will occur as a result of the extraction of the cut piles of the Goldeneye jacket and SSIV. These are expected to be cut internally and sediments will be disturbed over a small area as the upper, cut section of the piles are pulled out during lifting of the SSIV and jacket. The amount would be larger if internal cutting is not feasible and excavation of the piles is necessary to provide access for external cutting.

While mobilised, the suspended sediments will cause impacts as described for trenching. The sediments will disperse due to the action of currents before resettling over the nearby surrounding seabed, with the potential to cause the burial of benthic fauna.

The scale of these activities and the area of impacted is significantly less than that impacted by trenching, and the magnitude of the impact is accordingly lower.

#### *4.2.2.2. Connection Spools and Stabilisation Features*

Surface laid connection spools of both pipelines (approximately 200 m in total) and approximately 50 exposed concrete mattresses and approximately 600 grout bags will be removed which will also result in small scale, short duration disturbance of the sediments. The mechanism of impact from this disturbance is similar to that for the removal of the jacket and SSIV piles, leading to disturbance and possible mortality of fauna that have colonised these features during field operation. Their removal will re-expose the natural substrate beneath them which will be quickly recolonised by the surrounding benthic communities.

Impacts from removal of mattresses and grout bags is small scale, localised and of small effect.



### 4.2.3. Rock Cover Along Pipelines

Rock cover has previously been laid at pipeline crossing points, the transition point (at KP20) and along some sections of the export pipeline to increase burial depth. These will remain in place and may need to be added to to ensure long term protection against snagging.

Decommissioning the pipelines *in situ* will necessitate the placement of additional rock cover at the upstream termination points and along some additional sections of the export pipeline, depending on the outcome of post-decommissioning surveys and subsequent consultations.

The area of the offshore seabed crossed by the pipelines has been noted to have mobile sediments and it is likely that relatively coarse rock material may be needed to provide effective long-term cover. Coarse rock cover can increase the risk of trawl gear snagging, to avoid which it may be necessary to profile the coarser rock with smaller material, increasing the overall area impacted.

Rock cover causes a significant change to the substrate which in turn alters the habitat and ecology, creating preferential areas for benthic organisms that live on hard substrates. This can result in artificially increased local diversity of habitat and fauna.

Areas of rock cover required for the DP will not be fully known until after analysis of the post-decommissioning survey but is expected to be limited to localised points or stretches that, combined, would represent an insignificant proportion of a widespread region of fairly uniform seabed habitat. The scale of the activity will be optimised to leave a seabed that is safe for other marine users, notably fisheries, while minimising the amount of rock used.

Where rock cover is required, the rock mass will be carefully placed over the designated areas of the pipelines and seabed by ROV and/or a controlled fall pipe, equipped with cameras, profilers, pipe tracker and other sensors as required. This will control the profile of the rock covering, thus ensuring rock is only placed within the planned footprint with minimal spread over adjacent sediment, minimising seabed disturbance.

#### 4.2.3.1. Impact within the Southern Trench pMPA

Placement of rock cover within the pMPA was identified in the ENVID as one of the activities that could result in a Moderate impact, on account of the higher sensitivity status given to the seabed in this proposed designated site. Some rock cover will be required at the transition point (KP20) where the two pipelines separate and the trencher is initiated. Other than for this short length, rock cover is not planned to be required within the pMPA, but may be required following consultation with BEIS, MS, SNH and SFF if pipeline depth of burial surveys identify particular sections that are regarded as posing a risk of snagging. The area of the pMPA that would be affected cannot be estimated until after this process, but as the area is currently open to fishing it is not expected that substantial areas will be identified as being a risk. If the surveys show otherwise this will inform the strategy to be agreed with stakeholders.

### 4.2.4. Anchor Scars and Spud Cans

If overtrawl trials find that depressions within the 500 m safety zone (such as anchor scars or spud cans) present a risk to trawl gear, attempts will first be made to smooth out the profile of these features with the dragged chain matts used for the overtrawl trials. If this approach does not adequately reduce the risk of future snagging, rock cover will be applied to make the seabed safe. Where feasible, any such rock cover will infill the depressions to a level approximately 0.5 m below the surrounding seabed level. This will allow subsequent natural infill with fine sediments over time, thereby recreating a more natural habitat than if rock were filled to seabed level.



If external cutting of the jacket or SSIV piles proves to be required the seabed topography left following excavation may require an element of remediation to leave a safe environment to other marine users. This is likely to be achieved through strategic deposition of rock.

As noted in Section 4.2.3, rock cover has a lasting impact on the habitat and ecology of the seabed where it is laid. The affected area is of very limited extent and the severity of the impact assessed to be slight.

#### **4.2.5. Overtrawl trials**

Following recovery of subsea infrastructure and debris, and following trenching and, where necessary, placement of remedial rock cover, the seabed will be subjected to debris sweeps and overtrawl trials to confirm that the seabed is clear and safe for fishing.

Debris clearance trials are conducted running along, and up to 50 m either side of, the pipeline. Snagging trials are 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 would be required along the entire pipeline length of 102 km, giving a maximum impacted area of approximately 80 km<sup>2</sup>. The area of the Goldeneye platform safety zone will also be trawled, and this will be performed in both an east/west direction and a north/south direction. Together with the area required for turning the trawl rig covers a rectangular area of 1,800 m x 1,000 m in each direction, requiring a total swept path that covers approximately 2.6 km<sup>2</sup>.

Disturbance of the seabed is also inherent in ongoing seabed fishing activities and temporary disturbance to the seabed sediments will occur during these operations. Collicie *et al.* (2000) examined impacts on benthic communities from bottom towed fishing gear and concluded that, in general, sandy sediment communities were able to recover rapidly, although this was dependent upon the spatial scale of the impact. It was estimated that recovery from a small scale impact, such as a fishing trawl, could occur within about 100 days.

Fishermen contracted to undertake the overtrawl trials will be advised that impacts to herring and sandeel spawning would be minimised by undertaking the trawls outside of the spawning seasons of January - February for sandeels and August - September for herring.

##### *4.2.5.1. Impact within the Southern Trench pMPA*

Seabed disturbance due to overtrawl trials within the pMPA was identified in the ENVID as one of the activities that could result in a Moderate impact, on account of the higher sensitivity status given to the seabed in this proposed designated site. The trawls would cover up to 1% of the overall area of the site, although the seabed biodiversity feature of the pMPA (burrowed mud habitat) does not extend into this part of the site and consequently there would be no impact to this feature.

#### **4.2.6. Impacts to OSPAR habitat 'Sea-pens and burrowing megafauna communities'**

The goldeneye platform is located in habitat classed as having the potential to host sea-pens and burrowing megafauna communities. It is also possible that this habitat could be encountered within areas of clayey silty fine sand along the pipeline route (i.e. from KP 70 to the platform; see Section 2.3.4.2). Consequently, small areas of sea-pen and burrowing megafauna communities habitat will be lost where placement of rock cover is required – e.g. for infill of spud cans, pipeline ends and burial depth top-up. As described in Section 4.2.4, the method of application of rock cover for spud cans may alleviate some habitat loss. Temporary impacts from the overtrawl trials could potentially impact up to 28.2 km<sup>2</sup>.



This area of impact is considered to be a relatively small when compared to the known widespread distribution, and potential habitat availability, of the sea-pen and burrowing megafauna communities in the CNS (as shown in Figure 2-11). The impact of the Goldeneye decommissioning activities is therefore not considered to have a significant impact on the distribution and viability of this OSPAR priority habitat.

#### **4.2.7. Controls for the Management of Impacts to Seabed Disturbance**

The following mitigation measures, safeguards and controls are proposed to minimise the disturbance of the seabed from the Goldeneye decommissioning.

##### **MITIGATION MEASURES, SAFEGUARDS AND CONTROLS**

- Preference for internal cutting of piles to minimise excavation;
- The extent of rock cover to be deployed will be minimised while ensuring the seabed is left safe for other users of the sea;
- Any requirement for rock cover along the pipeline, particularly within the Southern Trench pMPA, will be determined in liaison with BEIS, SNH, MS and SFF following review of pipeline depth survey and overtrawl trials.

The appraisal of the disturbance of the seabed due to the decommissioning activities supports the conclusion that impacts will be minor, and that adoption of the control measures specified will ensure disturbance will be as low as reasonably and safely practical.

### **4.3. Emissions to Air**

#### **4.3.1. Offshore emissions**

The decommissioning activities will give rise to emissions of a range of gaseous combustion products including carbon dioxide (CO<sub>2</sub>), sulphur dioxide (SO<sub>2</sub>), and oxides of nitrogen (NO<sub>x</sub>) as well as trace quantities of unburned hydrocarbons, including methane (CH<sub>4</sub>), and others collectively classed as volatile organic carbons (VOC). Emissions of SO<sub>2</sub>, NO<sub>x</sub>, CH<sub>4</sub> and VOC reduce air quality locally, including through contributing to low level ozone concentrations. Emissions of SO<sub>2</sub> and NO<sub>x</sub> lead to formation of respective acids, contributing to acid rain on a regional scale. Emissions of CO<sub>2</sub> and CH<sub>4</sub> both contribute to global greenhouse gas (GHG) emissions, and ultimately to climate change.

Offshore emissions to air will be due to vessels' propulsion, their onboard services demand, and from driving of trenching, cutting and lifting equipment. There will be no requirement for flaring as the pipelines are flushed, and the topsides process equipment is flushed, drained and vented.

The DP is estimated to require in the order of 300 vessel days, plus any time a guard vessel may be required on station, and will make small incremental addition to this baseline density. The majority of vessel activity will be at the Goldeneye platform. As noted in Section 2.7.7, vessel density in the area around the Goldeneye platform was categorised as Moderate in 2016 by the OGA, and as High for a substantial length of the pipeline route, including the nearshore sections.

Emissions of SO<sub>2</sub>, NO<sub>x</sub> 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.



Contribution to global GHG emissions is independent of the location of emissions. Experience to date has shown that even for very substantive field-wide decommissioning programmes (e.g. Murchison, CNR International 2013), the principal atmospheric emissions by mass of CO<sub>2</sub> associated with the DP is very small (<1%) relative to the total annual CO<sub>2</sub> emissions from operational and production related emissions on the UKCS. For smaller scale decommissioning programmes, more similar to that for Goldeneye, GHG emissions are substantially smaller, with estimates of 0.08 – 0.2 % contribution to annual UKCS domestic shipping commonly reported for the duration of the programme (e.g. Ettrick & Blackbird, Nexen 2016; Janice, James & Afflick, Maersk 2016; Atlantic & Cromarty, BG 2016; Annabel & Audrey, Centrica 2017). In all precedent decommissioning projects referenced, the impact of emissions to air was assessed to be low.

#### **4.3.2. Onshore emissions**

Onshore emissions are principally a result of the recycling of recovered steel from the Goldeneye platform. The quantity of CO<sub>2</sub> used in the recycling of steel is estimated to be 0.96 te CO<sub>2</sub> per te steel recycled (Institute of Petroleum, 2000). Recycling of the steel effectively reduces the demand for virgin steel to be produced, which is estimated to require 1.9 te CO<sub>2</sub> per te steel (Institute of Petroleum, 2000). The recycling of the platform therefore represents a net saving of CO<sub>2</sub> emissions.

The emission of other atmospheric contaminants from the recycling process will be at an as yet undetermined on-shore recycling facility and will be controlled by the relevant regulatory regime operating in that country (e.g. PPC in Scotland) and will be captured under the operating emissions of the facility.

#### **4.3.3. Controls for the Management of Impacts from Atmospheric Emissions**

The following mitigation measures, safeguards and controls are proposed to minimise the emissions to air associated with the Goldeneye decommissioning.

##### **MITIGATION MEASURES, SAFEGUARDS AND CONTROLS**

- All vessels employed for the decommissioning will meet the requirements of Shell's Group Marine Assurance System (GMAS)<sup>1</sup>; and
- The scheduling of vessels' operations and types of vessels used will be optimised to execute the decommissioning as efficiently as possible.

Note 1: Shell's GMAS adopts and expands on the Oil Companies International Marine Forum (OCIMF) vessel 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 and compliance with the International Convention for the Prevention of Pollution from Ships (MARPOL) and International Maritime Organization (IMO) standards for sewage discharge, garbage management, ballast water management and emissions controls.

Shell is adopting a flexible approach to the timing of different phases of the works to allow decommissioning contractors the opportunity to maximise efficient utilisation of vessels. Shell is also investigating the potential to bundle elements of the decommissioning of Goldeneye with that of other assets to achieve additional vessel efficiencies. These measures have the potential to further minimise the emissions resulting from the decommissioning activities.

The appraisal of the atmospheric emissions from the decommissioning activities supports the conclusion that emissions will have a minor impact, while adoption of the control measures specified will ensure emissions are kept as low as reasonably practical.



## 4.4. Discharges to Sea

The DP activities will result in a small number of minor sources of planned discharges to sea. These are:

- Vessels' sanitary drainage;
- Vessels' ballast water;
- Abrasive cutting compounds;
- Inhibited freshwater within spools and risers; and
- Inhibited freshwater following ultimate degradation of the pipelines.

In addition, there will be a subsea discharge of approximately 20 L of hydraulic fluid if the jacket is recovered in more than one section.

The potential impact from unplanned losses of liquids to water is covered under Accidental Events in Section 4.7.

### 4.4.1. Vessels' discharges

Discharges of vessels' sanitary waters and ballast water are subject to specific requirements under MARPOL (Annex IV) and the International Convention on the Control and Management of Ship's Ballast Water and Sediments. These minimise the potential impact on the water column from shipping activities. All vessels contracted for the DP activities will comply with these requirements, confirmation of which forms part of Shell's GMAS (see Section 4.3.3).

### 4.4.2. Abrasive cutting compounds

Cutting to remove the topsides and to release the jacket legs and SSIV from their piles will involve the release of ground garnet (a natural mineral) used as an abrasive agent, and of metal shavings. These discharges will be released above sea level in the former activity, and will be contained within the jacket piles, below the seabed, for cutting piles. Cutting of connection spools into sections for recovery may also utilise abrasive compounds which would be discharged at the seabed. The discharges will result in suspended solids in the water column which will eventually settle out. Suspended solids have the potential to cause physical stress to organisms within the water column. The activities, and any associated impact, will be short lived and localised.

### 4.4.3. Discharge from spools and risers

Flushing and cleaning of the two pipelines (PL1978 and PL1979) in 2012 achieved an OiW concentration of <5 ppm. Following which they were filled with freshwater dosed with corrosion inhibitor and oxygen scavenger.

Both pipelines will be fitted with blind flange plates following their disconnection from the spools connecting them to the risers. The contents of the spools and risers (*c.* 15 m<sup>3</sup>) will be discharged during their recovery. The discharge is expected to have negligible impact on the water column, partly on account of the small quantities involved and also because the inhibitors originally dosed will have reacted as intended and there is expected to be little active compound still present. 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.



#### 4.4.4. Future discharge from pipelines

Both pipelines will remain buried following decommissioning *in situ*. They will remain available for use as part of a CCS scheme and the disposal of the pipeline contents would be managed under that scheme.

If no CCS opportunities utilise the pipelines, they will remain buried and at some point in the future the steel will degrade and the protective coatings will crack. At this point the contents of the pipelines will start to be released into the sediments, through which there will be migration to the water column. The eventual discharge is expected to have negligible impact on the sediments or water column. This is ostensibly because the OiW content of the water is low (<5 ppm) and the inhibitors originally dosed will have reacted as intended and there would be little if any trace of the active compounds still present.

#### 4.4.5. Discharge of hydraulic fluid

The umbilical consists of two control lines connecting the topsides and SSIV, which were used only for commissioning purposes in 2003. The lines are currently filled with hydraulic fluid and will be recovered and transported to shore for processing. The intention is to recover the subsea section without the release of hydraulic fluid. The riser section will also be recovered without release of hydraulic fluid if the jacket is removed as a single lift. However, should the jacket be cut for recovery in sections, approximately 20 L of hydraulic oil in the riser section would be released. Should this method of jacket recovery be adopted, the release of hydraulic oil will be permitted as appropriate through BEIS.

#### 4.4.6. Controls for the Management of Impacts from Discharges to Sea

The following mitigation measures, safeguards and controls are proposed to minimise the impact of discharges to sea associated with the Goldeneye decommissioning.

##### MITIGATION MEASURES, SAFEGUARDS AND CONTROLS

- All vessels employed for the decommissioning will meet the requirements of Shell's Group Marine Assurance System (GMAS)<sup>1</sup>; and
- Adoption of any controls identified following risk assessment under the Offshore Chemicals Regulations.

Note 1: Shell's GMAS adopts and expands on 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, and compliance with MARPOL and IMO standards for sewage discharge, garbage management, ballast water management and emissions controls.

The appraisal of the discharges from the decommissioning activities supports the conclusion that these will have a minimal impact, while adoption of the control measures specified will ensure emissions are kept as low as reasonably practical.

### 4.5. Underwater Noise

Ambient noise in the ocean is background sound generated by natural (e.g. wind, waves, tectonic activity, rain and marine organisms) and human (e.g. background shipping traffic and onshore and offshore construction) sources (e.g. Hildebrand, 2009; Richardson *et al.*, 1995). The characteristics of the sound produced, in terms of the amplitude, range of frequencies and temporal features, varies with the type of activity and equipment.



Marine fauna use sound for navigation, communication and prey detection (see e.g. reviews in NMFS, 2016; Southall *et al.*, 2007; Richardson *et al.*, 1995). Therefore, the introduction of anthropogenic underwater sound has the potential to impact on marine animals if it interferes with the animal's ability to use and receive sound (see e.g. OSPAR, 2009). Particularly loud sound can disturb marine animals, triggering avoidance response or, in extreme cases, has the potential to cause temporary, or even permanent, auditory threshold shifts (TTS and PTS respectively). In fish, the effects of "excessive" sound include avoidance reactions and changes in shoaling behaviour. Avoidance of an area may interfere with feeding or reproduction or cause stress-induced reduction in growth and reproductive output (Slabbekoorn *et al.*, 2010).

As reported in Section 2.7, a range of fish species use the area for nursery and/or spawning grounds at different times of the year including cod, herring, lemon sole, mackerel, sprat and whiting (Coull *et al.*, 1998). Harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale and grey seals are among the marine mammals that have been observed or identified as likely to be present in the Goldeneye area and/or pipeline route. While minke whale is also a listed feature of the Southern Trench pMPA and bottlenose dolphin associated with the nearby Moray Firth SAC are known to traverse the nearshore waters off Peterhead and Aberdeen.

The Conservation of Offshore Marine Habitats and Species Regulations 2017 make it an offence to injure or disturb European Protected Species (EPS), the list of which includes many marine mammals. The Regulation defines 'injury' as a permanent threshold shift and 'disturbance' as the likelihood of impairing their ability to survive, to breed or reproduce, or to rear or nurture their young, or migrate. It also includes a likelihood of significantly affecting the local distribution or abundance of the species. New developments must assess if their activity, either alone or in combination with other activities, is likely to cause an offence involving an EPS.

The potential for injury or disturbance depends on the amplitude and frequencies of the sound source, the sensitivity of a receptor animal to sounds of the source frequencies, as well as the distance and propagation of sound between the source and the receptor. This section of the report considers the sources of underwater noise associated with the Goldeneye decommissioning activities, the sensitivity of the receptors in the vicinity of those activities and the potential for disturbance and injury due to underwater noise.

#### **4.5.1. Sources of Underwater Noise**

Decommissioning will give rise to sources of noise related to:

- Vessels of various types;
- Cutting tools;
- Pipeline trenching;
- Placement of rock cover; and
- Seabed surveys.

The noise associated with these sources are discussed below.

No high energy noise sources such as the use of explosives, piling or deep sediment penetration seismic equipment will be required for the Goldeneye decommissioning.

##### *4.5.1.1. Vessels*

The Goldeneye decommissioning will mobilise a variety of vessels (e.g. HLVs, ROVSVs, survey vessels etc.) that are typical of routine oil and gas industry operations, some of which will use dynamic positioning systems to maintain and adjust their position when working.



The primary sources of sound from vessels are propellers, propulsion and other machinery (Ross, 1976; Wales and Heitmeyer., 2002), with an estimated 85% of vessel noise resulting from propeller cavitations (Barlow and Gentry 2004), which are particularly prominent for dynamic positioning systems.

In general, vessel sound is continuous and results from narrowband tonal sounds at specific frequencies as well as broadband sounds. Acoustic energy is strongest at frequencies below 1 kHz and is the dominant noise source in deeper water between 20 – 500 Hz (Ulrick 1983). Acoustic broadband source levels typically increase with increasing vessel size, with smaller vessels (<50 m) having a source root mean square (rms) sound pressure level (SPL) of 160-175 dB re 1  $\mu$ Pa at 1 m, medium size vessels (50-100 m) 165-180 dB re 1  $\mu$ Pa at 1 m and large vessels (> 100 m) 180-190 dB re 1  $\mu$ Pa at 1 m (Richardson *et al.*, 1995), although sound levels depend on the operating status of the vessel and can vary considerably in time.

Kyhn *et al.*, (2014) identified noise generation from various activities of a drillship (the *Stena Forth*) equipped with six dynamic positioning thrusters and determined that the dynamic positioning control system generated noise at around 100 dB re 1  $\mu$ Pa (rms) at frequencies between 20 – 35 kHz.

#### 4.5.1.2. Underwater Cutting

Underwater cutting will be required to cut the jacket and SSIV piles and to cut connection spools into sections for lifting.

Mechanical methods of cutting underwater structures use hard cutting tools that produce a sawing or machining action. Examples include hydraulic shears, diamond wire and abrasive water jet cutters. Any or all of these may be employed at Goldeneye.

A recent paper reported that the noise from underwater diamond wire cutting, during the severance of a 0.76 m (30") diameter conductor at a platform in the North Sea, was barely discernible above background noise levels including the noise of associated vessel presence (Pangerc *et al.*, 2016). The cutting noise, an increase of 4 – 15 dB above background levels, was more discernible at higher frequencies, i.e. > 5 kHz, than at low frequencies, and was identifiable in recordings made 800 m from source. Anthony *et al.* (2009) present a review of published underwater noise measurements for various types of diver-operated tools. Several of these are underwater cutting tools, including a high-pressure water jet lance, chainsaw, grinder and oxy-arc cutter. Reported source sound pressure levels were 148-170.5 dB re 1  $\mu$ Pa (it was not indicated whether these are rms or zero-peak). It is possible that larger, Remotely Operated Vessel (ROV) operated cutting tools could generate louder sound levels but no published data are available.

#### 4.5.1.3. Pipeline Trenching

Little information was found to be available on the sound levels generated by a seabed plough or other trenching methods, but it is predicted that sound levels are likely to be comparable to that generated by dredging activities, and that this in turn is dominated by the noise of the vessel itself (Genesis, 2011).

Underwater sound caused by dredging activities is typically low frequency, with strongest sound below 1 kHz (de Jong *et al.*, 2010), although Robinson *et al.* (2011) found higher source frequencies at similar levels. Sound source levels typically range 168 – 186 dB (rms) 1  $\mu$ Pa at 1 m (reviews by WODA, 2013; Genesis, 2011). The levels and frequencies generated depend on the type of dredger, operational status and sediment type, for example Robinson *et al.*, (2011) found that source levels were approximately 5 dB higher during dredging of gravel compared with sand.



#### 4.5.1.4. Rock Cover

Rock cover will be required at the pipeline ends and pipeline crossings. Additional rock cover may be required should the trench and bury operation not be able to achieve an adequate depth of cover. In addition, it may be necessary to use rock cover to mitigate snagging risks at spud cans, anchor chain scars and at the site of the removed jacket footings.

Nedwell and Edwards (2004) reported the sound from a fall pipe vessel *Rollingstone*, a vessel that has a specialised underwater chute to position rock on the seabed. The vessel used dynamic positioning and was powered by two main pitch propellers, two bow thrusters and two Azimuth thrusters. It was concluded that the sound levels were dominated by the vessel and not the rock placement activities.

#### 4.5.1.5. Acoustic Surveying Equipment

Shell routinely carries out surveys and inspections of all their pipelines within the UKCS on a rolling basis. These surveys employ a combination of acoustic surveying devices, including side-scan sonar (SSS) and multibeam echo sounders (MBES) to generate images of the seabed, and sub-bottom profilers (SBP) to determine the burial depth of the pipelines. All of these instruments use electromagnetic sources rather than air guns. The surveys required for the Goldeneye decommissioning will be similar to those routinely undertaken and are anticipated to use the same equipment type.

SSS devices use an acoustic beam to generate an accurate image of a narrow area of seabed to either side of the instrument by measuring the amplitude of back-scattered return signals. The instrument can either be towed behind a ship at a specified depth or mounted on to a remotely operated vehicle. Source levels of side-scan sonars are typically in the range of 200 to 230 dB re 1  $\mu$ Pa-m, although available information and measurements is limited. In order to provide higher resolution imaging of the seabed the frequencies used by side-scan sonar systems are relatively high (100 – 600 kHz).

MBES use multiple transducers to send out a swath of sound covering a large, fan-shaped area of the seabed either side of the vessel track. The width of individual beams transmitted by a multi-beam echosounder are typically in the range of 0.5°-2°. The swath width is typically in the order of two to four times the water depth, but can be up to ten times the water depth in high-performance systems (Danson, 2005). Maximum peak source levels for the most powerful, deep-water systems are 236 – 238 dB re 1  $\mu$ Pa-m. However, systems used in shallower water such as the proposed pipeline inspection survey route are higher frequency and lower power (SCAR, 2005). Similar to side-scan sonar devices, the frequencies used by multi-beam echosounders (particularly in shallow waters) are relatively high (100 – 500 kHz).

Sub-bottom profiling is used to determine the stratification of soils beneath the sea floor. Various types of SBP instrument may be used depending on the required resolution and seabed penetration (King, 2013; Danson, 2005). For pipeline burial depth surveys a Pinger type SBP provides adequate penetration at high resolution. Typical SBP Pingers used by Shell have a peak sound pressure level (SPL) of 220 dB re 1  $\mu$ Pa-m, and a rms SPL of 217 dB re 1  $\mu$ Pa-m, with the sound energy generated being at a peak frequency of 3 kHz. The pulse length is approximately 50 ms and the pulse interval 0.2 s, giving a pulse frequency of 4 Hz i.e. 4 pulses will be transmitted every second. Based on the rms SPL and the pulse length, the sub-bottom profiler is estimated to have a single pulse sound exposure level (SEL) of 204 dB re 1  $\mu$ Pa<sup>2</sup>s-m, and a source SEL over a 1 second exposure of 210 dB re 1  $\mu$ Pa<sup>2</sup>s-m. The majority of sound energy from SBPs is directed vertically downwards and the pulse duration is short (tens to hundreds of milliseconds).



## 4.5.2. Sensitivity of Receptors to Underwater Noise

### 4.5.2.1. Marine Mammals

Different marine mammal species are sensitive to sounds over different frequency ranges. Audiograms, showing the hearing thresholds over a broad frequency spectrum are presented in Figure 4-2 for a selection of mammals known or likely to occur in the area of the Goldeneye decommissioning activities. Audiograms for a selection of fish species are presented in Figure 4-3. Both figures also include indicative source profiles from a merchant vessel, pipelay barge and a dredger. The latter are included as potentially being similar to what might be expected for trenching of the Goldeneye export pipeline.

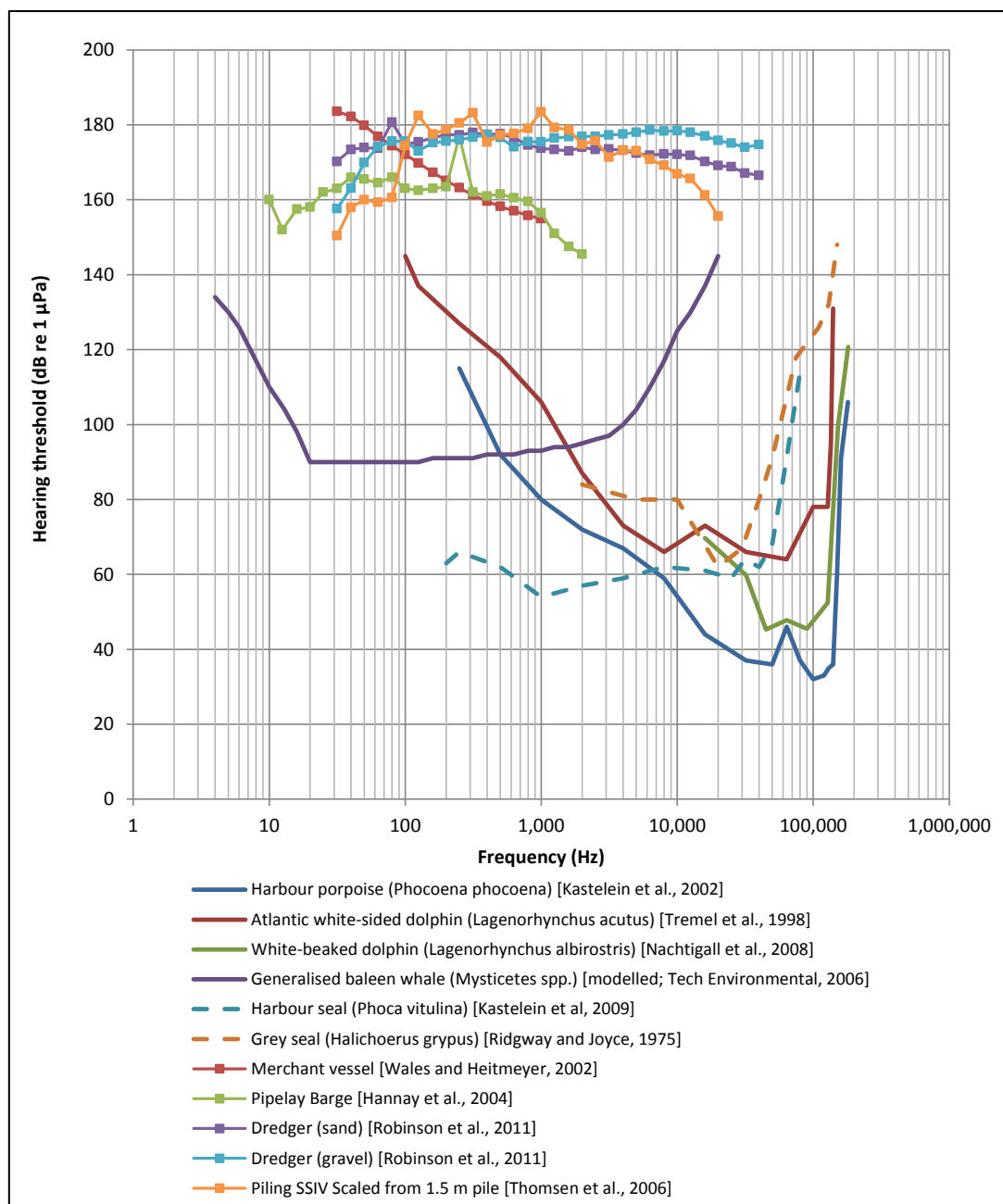


Figure 4-2: Marine mammal audiograms for species occurring in the DP area.



Baleen whales (including the minke whale) are low-frequency hearing cetaceans; the white-beaked dolphin is representative of mid-frequency hearing cetaceans; and the harbour porpoise is representative of high-frequency hearing cetacean species.

The figure indicates that noise from vessels, and activities of a similar nature to trenching, covers frequency ranges that are audible to all marine mammals and that the source noise levels are above the hearing thresholds. It is also evident from Figure 4-2 that noise from SSS and MBES (>100 kHz) is outside the main hearing range of all marine species, as acknowledged by JNCC (JNCC, 2017). SBP pingers, with a peak source frequency of around 3 kHz are within the audible range of many marine mammal species, although at the high frequency end for the baleen whales' spectrum, and outside the hearing range of the white-beaked dolphin.

The accepted method (Marine Scotland, 2014) for determining whether activities cause injury to marine mammals is based on the potential to cause a permanent elevation of the hearing threshold (i.e. a degree of loss of hearing). Southall *et al.* (2007) established thresholds, that has subsequently become widely adopted, for the onset of a permanent threshold shift (PTS) for four groups of marine mammals (Phocid pinnipeds and three groups of cetaceans: those with low-, mid- and high-frequency hearing). Thresholds have been determined for two metrics, peak SPL and M-weighted SEL, which capture different aspects of a sound field. Peak SPL is a measure of the loudest instantaneous sound likely to be generated during an activity. SEL is a measure of the total energy in a sound pulse over a period of time. To apply the SEL thresholds, the SEL is calculated over a 24 hour period and is weighted according to marine mammal hearing sensitivities.

Subsequently published research suggests that marine mammals may be more sensitive to noise than suggested by Southall *et al.* (2007) and a revised set of thresholds has been proposed (NMFS, 2016). These revised thresholds have been adopted by the National Oceanic and Atmospheric Administration (NOAA) in the United States, although to date there has been no official guidance as to whether or not they will be adopted in the UK. Thresholds for the onset of PTS from peak SPL range between 202 and 230 dB re 1  $\mu$ Pa (NMFS, 2016).

#### 4.5.2.2. Fish

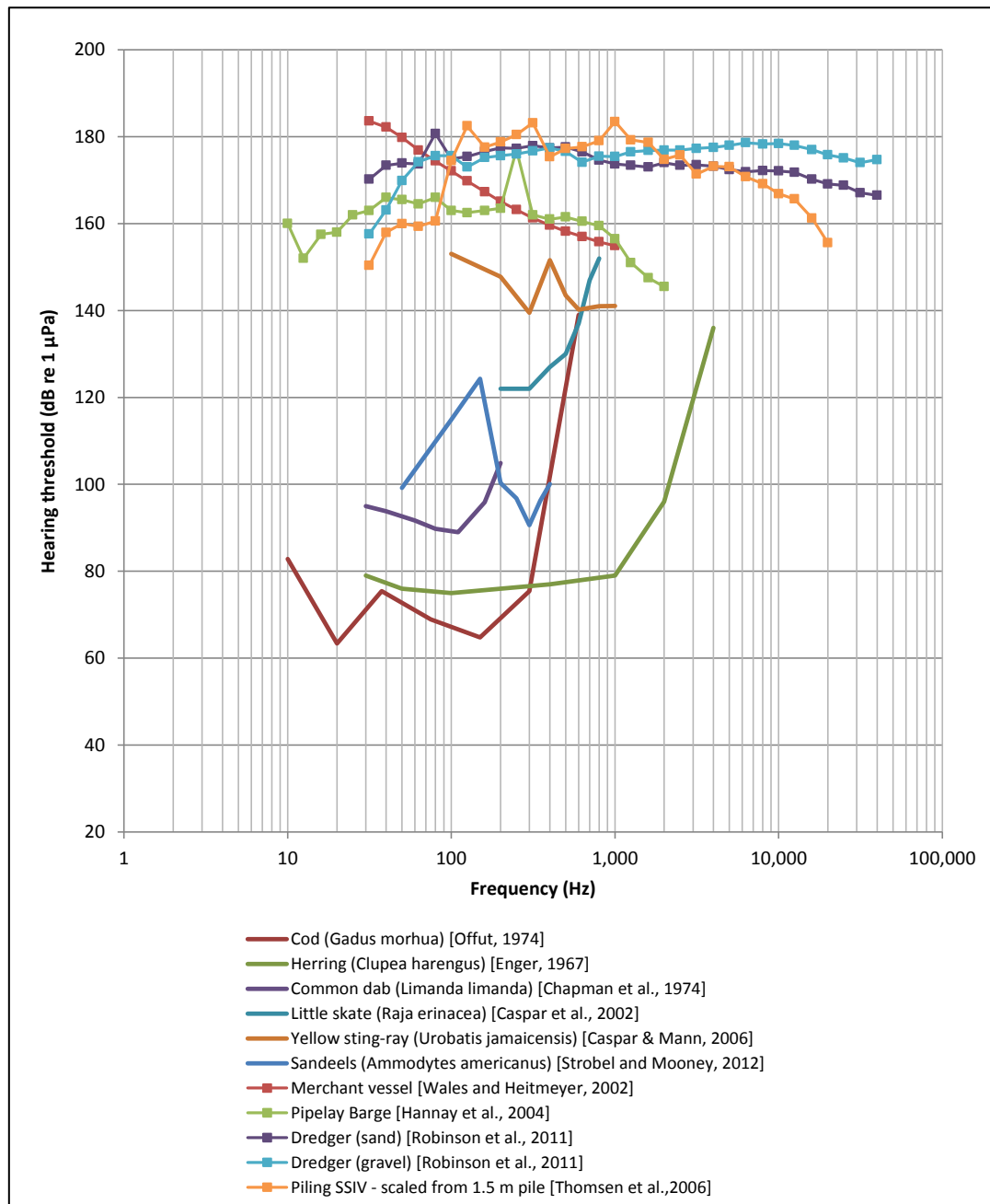
There is limited data available on hearing frequencies for fish species, but those included in Figure 4-3 cover either the species found in the area of DP activities or are representative of most of those species (e.g. yellow sting-ray (for which data is available) is an elasmobranch species, as is the basking shark, which may be present in the area).

The frequency ranges of some of the noise sources identified with the Goldeneye decommissioning activities overlap with the audible ranges of fish, and the source noise levels exceed the hearing thresholds at these frequencies.

Fish are mobile animals that would be expected to be able to move away from a noise source that had the potential to cause them harm. If fish are disturbed by a noise, evidence suggests they will return to an area once it has ceased (Slabbekoorn *et al.*, 2010).

Turnpenny and Nedwell (1994) reviewed published observations of injury to fish eggs and larvae from high-energy sounds. The results of the studies were variable, but no injury effects were observed beyond approximately 10 m of the source or at levels below an SPL of 220 dB re 1  $\mu$ Pa.

Experiments exposing caged fish of various species to mid-frequency (2.8-3.5 kHz) sonar at a received sound pressure levels (SPL) of 210 dB re 1  $\mu$ Pa rms found evidence of temporary hearing damage in fish with hearing sensitivity in the frequency range generated by the source but not those with lower frequency hearing. Hearing damage recovered within 24 hours and no evidence of pathology or mortality was found (Halvorsen *et al.*, 2012).



**Figure 4-3: Relevant fish audiograms and representative sound sources from the DP.**

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



Popper *et al.* (2014) have defined criteria for injury to fish based on a review of impacts to fish, fish eggs, and larvae from various high-energy sources. The most sensitive species are those with a swim bladder that is also used for hearing, for which Popper *et al.* (2014) determined a threshold for mortality, or potential mortal injury, of a peak SPL of 207 dB re 1  $\mu$ Pa.

### **4.5.3. Potential for Impacts from Underwater Noise**

#### *4.5.3.1. Potential for Impacts from Vessel Noise*

The DP will require in the order of 300 vessel days to complete, plus any time that a guard vessel is required to be positioned on station. This will make a small addition to the background vessel density around the Goldeneye platform and along the pipeline corridor, where baseline shipping levels are moderate and high, respectively (see Section 2.7.7). JNCC considers that temporary vessel traffic is unlikely to cause more than trivial disturbance to marine mammals (JNCC, 2010). The increase in underwater sound from vessels mobilised for the Goldeneye decommissioning will therefore be slight and the impact on the environment minor.

#### *4.5.3.2. Underwater Cutting*

There is no published information on the response of marine mammals or fish to sound generated by underwater cutting. However, reported source levels are low compared with those generated by vessels (see Section 4.5.1) and any noise generated from cutting operations is not likely to cause significant disturbance to marine fauna. This is consistent with JNCC guidance which states that non-explosive cutting technology produces relatively little noise (JNCC, 2008).

#### *4.5.3.3. Pipeline Trenching*

No sound source information is available for the trenching of surface-laid pipelines. Noise from dredging activities, taken as a proxy from trenching, generates peak levels similar to that from vessels, for which no significant impact is predicted to marine mammals.

Based on a comparison of the levels on noise thought capable of causing injury to fish and the levels of noise produced by underwater dredging, it is not likely that exposure to dredging noise would injure fish but it may be loud enough to cause a behavioural reaction such as avoidance or a startle response (CEDA, 2011).

#### *4.5.3.4. Placement of Rock Cover*

Where rock cover is required it will be placed on the seabed using a down pipe or similar low-noise method. No noise source levels have been reported for rock cover, but the only available information suggests that levels are lower than that generated by the vessel used. Furthermore, given the short duration of individual rock cover activities, there is only likely to be a low impact on marine mammals or fish associated with the noise generated (JNCC, 2008).

#### *4.5.3.5. Acoustic Surveying Equipment*

A review of the impact of acoustic surveying techniques on marine fauna in the Antarctic concluded that acoustic instruments such as SSS and many echo sounders are of sufficiently low power and high frequency as to pose only a minor risk to the environment. This concurs with a review by Richardson *et al.*, (1995), which found no obvious response to pingers, echo sounders and other pulsed sound at higher frequencies unless the received levels were very high.



The high frequency sound produced by SSS and MBES in relatively shallow waters (<200 m) is outside the hearing range of marine mammals and attenuates rapidly. The risk of injury or disturbance from operation of this type of equipment is considered negligible and no mitigation is required (JNCC, 2017).

Little information is available on the potential effects of SSS and echo sounders on fish (Popper, 2008 and ICES, 2005), but since the sound generated by SSS and MBES are outside the hearing threshold of fish, no effect would be anticipated.

Sound generated by SBP pingers is within the audible range of most marine mammals and sound source levels are at or around the peak SPL threshold for the onset of PTS in some marine mammal species. This raises the potential for disturbance and/or injury.

SBP surveys undertaken in relation to licences issued under the Petroleum Act 1998 (and the Energy Act 2008) require consent under the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001. Applications require consideration of the potential impact of noise from the SBP on the marine environment and such assessments are frequently informed by noise modelling studies. Shell frequently undertakes pipeline surveys using acoustic equipment for its assets throughout the North Sea. Shell's experience is that all modelling studies in support of applications for consents for these surveys identify a near negligible potential for impact on marine mammals and fish from the use of SBP.

An example of particular relevance to the Goldeneye decommissioning is the modelling study undertaken in support of an application for pipeline surveys in nearshore waters off St. Fergus. The survey used a combination of SSS, MBES and SBP pingers and concluded that the maximum distance at which the NOAA (NMFS, 2016) dual metric threshold for the onset of PTS would be exceeded was 1 m for pinnipeds, 18 m for high-frequency hearing cetaceans (such as harbour porpoise), 2 m for low-frequency hearing cetaceans (such as minke whale), while the threshold for mid-frequency hearing cetaceans (such as bottlenose dolphin) would not be exceeded at any distance. The maximum distance at which the threshold (Popper *et al.*, 2014) for fish mortality would be exceeded was 2 m, including for fish eggs and larvae.

The maximum area in which the threshold for disturbance of marine mammals would be exceeded was modelled to be 9.5 km<sup>2</sup>. The density of minke whale in zone R of the SCANS-III surveys was reported as 0.039 animals per km<sup>2</sup>. As an average, the noise from the SBP would therefore disturb (0.37) less than one minke whale. Bottlenose dolphins are of the medium frequency cetacean group and have a lower threshold for disturbance than minke whale.

#### 4.5.3.6. *Impacts on the Southern Trench pMPA*

The minke whale is a proposed feature of the Southern Trench pMPA although, as seen in Section 2.4.1, the activities of the Goldeneye decommissioning do not coincide with areas of high minke whale presence. Data from the Southern Trench MPA proposal Data Confidence Assessment (SNH, 2014a) shows densities are generally in the range 0 – 0.1 animals per km<sup>2</sup> within 10 km of the pipeline where it crosses the pMPA, but with some patches of higher average densities, up to the range 0.2 – 0.5 animals per km<sup>2</sup>. Using these data rather than that from the SCANS-III programme, the use of SBP pingers for the pipeline burial surveys would be expected to cause disturbance to <1 minke whales, with a worst case of 5 animals, for the short duration required to survey the nearshore 25 km of the pipeline route.

The first 5 km (6%) of the trenching of the export pipeline will take place within the Southern Trench pMPA, and is planned to take approximately 3 days. As seen in the preceding sections, the impact of noise from trenching and the presence of vessels for this short period of time will result in a very small increase to the baseline noise levels from the high levels of shipping noted for this



area. For context, a shipping activity survey undertaken in 2013 identified an average of 62 vessels per day passing through the nearshore area off Peterhead in summer and 67 vessels per day in winter (Anartec, 2013).

#### *4.5.3.7. Impacts on bottlenose dolphins*

The area of disturbance for medium frequency cetaceans (which includes the bottlenose dolphin) was not modelled for the previous pipeline surveys and, even had it been, the number of bottlenose dolphins potentially affected by the associated underwater noise could not be determined from applying the SCANS III density estimate for zone R to the area of disturbance. The population of bottlenose dolphins around the northeast coast of Scotland are primarily associated with the waters of the Moray Firth, although they are known to move around the coast, past St. Fergus, and are frequently observed off Aberdeen and further south. During surveying of the nearshore section of the pipeline, there is potential for some disturbance to those bottlenose dolphins transiting this part of the coast but given the short duration of this activity, the effect of the disturbance is anticipated to be minimal.

#### **4.5.4. Controls for the Management of Impacts from Underwater Noise**

Cetaceans, pinnipeds and fish are present in the area around the Goldeneye Field and export pipeline route, and these receptors have been identified to be sensitive to underwater noise. Disturbance of these receptors from noise resulting from the proposed decommissioning activities is expected to be low, and the likelihood of injury from underwater noise is negligible.

The following mitigation measures, safeguards and controls are proposed to minimise the impact of underwater noise associated with the Goldeneye decommissioning.

##### **MITIGATION MEASURES, SAFEGUARDS AND CONTROLS**

- The scheduling of vessels' operations and types of vessels used will be optimised to execute the decommissioning as efficiently as possible.
- JNCC guidelines for minimising the risk of injury to marine mammals will be followed in as much as they relate to the use of SBP for geophysical surveys.

## **4.6. Waste Management**

### **4.6.1. Removed Wastes**

A number of controlled wastes, including hazardous wastes, will be returned to shore for treatment and disposal at licensed dismantling yards in keeping with relevant legislative provisions in the country of destination (e.g. the Environmental Protection Act 1990 (as amended), The Waste (Scotland) Regulations 2011 and 2012 (as amended)). A total of approximately 6,800 te of waste materials has been identified, approximately 74% of which is steel, 16% marine growth, 7% concrete and grout and 2% non-ferrous metals.

The eventual fate of materials will in part be controlled by the type of waste and how it is regulated, and also the potential for material reuse and recycling. All waste will be documented in a waste management plan (WMP), which will be used to record the types, quantities and fate of all waste.

An audit trail will be maintained for waste materials from all vessels, through to the onshore decommissioning yard, and on to the recycling facility or disposal site. The onshore yard contractor will keep an inventory of the types, quantities and dates of waste received and the quantities and dates of dispatch from the site. The recycling facilities and disposal sites will certify the type,



quantity and date the material is received and processed. The onshore yard contractor will report waste quantities by type to Shell.

To limit the quantity of waste requiring eventual landfill disposal, Shell will ensure appropriate waste segregation and treatment is undertaken, and will consider a waste hierarchy whereby opportunities for the reuse or recycling of equipment and materials will be maximised. Should the destination of any part of the facilities be a non-UK yard, Shell will ensure that waste is exported in a manner consistent with relevant waste shipment Regulations (e.g. The Transfrontier Shipment of Waste Regulations 2007 (as amended)).

A hazardous material inspection for Goldeneye identified minimal sources of hazardous waste. The WMP lists each hazardous waste stream identified (e.g. PFOS in insulation, low-level ionising radiation sources in smoke detectors) along with the relevant controlling regulations and special handling requirements. No evidence of asbestos was identified by the hazardous material inspection and there has been no indication of Naturally Occurring Radioactive Material (NORM) at Goldeneye during the operating life of the field. Notwithstanding, the dismantling contractor will have processes in place to aid the identification of asbestos and NORM, and for the treatment of any such materials that are found.

In excess of 97% of the inorganic waste is anticipated to be recycled or repurposed.

Marine growth is typically between 70 – 90% water by weight and is therefore expected to lose a substantial proportion of its weight as it dries out in transit to the dismantling yard. Shell will encourage the dismantling contractor to explore uses for marine growth removed from the structures onshore but it is recognised that there is a shortage of capacity for alternatives to landfill (e.g. composting) for marine growth (BMT Cordah, 2011). Marine growth that is not removed from the structures will become incinerated as part of the steel recycling process.

The risk of the transfer of non-native species of marine growth is considered to be low if the receiving yard is located within the North Sea because no evidence has been found to date that non-native species occur on platforms in the North Sea (BMT Cordah, 2011). If the jacket is to be taken to a yard outwith the North Sea, further assessment of the risk of transfer will be undertaken as part of the vessel transit plan.

Odour from decaying marine growth is a potential source of nuisance and will be managed by the dismantling yard in accordance with their site regulatory requirements.

#### **4.6.2. Materials Left *in situ***

All materials, and their approximate quantities, that will remain on or below the seabed following decommissioning removal activities are listed in Table 4-1.

The ultimate fate of metals will be degradation by oxidation. The ultimate fate of plastic coatings is discussed below.

The external corrosion of coated pipelines is normally restricted to those localised areas where there are defects or damage in the coating, or where the coating has become disbonded from the pipe. Disbondment of the coating may be the result of damage during installation, impacts from trawl boards and dropped objects, abrasion, etc. Corrosion can be expected to be almost negligible in areas, where the coating integrity is intact. Pipeline corrosion is therefore expected in most cases to occur as localised pits, which will eventually result in random perforations throughout the pipeline length.

Structural degradation of the Goldeneye pipelines will be a long-term process caused by corrosion and the eventual collapse of the structures under their own weight and that of any overlying sediment. During this process, degradation products derived from the exterior and interior of the

pipe will break down and potentially become bio-available to benthic fauna in the immediate vicinity. Pathways from the pipelines to the receptors would be via the interstitial spaces in seabed sediments, and overlying rock placement where applicable, and the water column. Degradation of the plastic coating into soluble compounds will be extremely slow and release into the water column will consequently be highly diffuse and is unlikely to result in any adverse impacts. Physical breakdown of the coating (cracking/flaking) will be enhanced by the degradation of the pipeline steel, but the resulting fragments would be expected to remain buried.

**Table 4-1 Materials left on or below the seabed following decommissioning**

ITEM	MATERIALS	QUANTITIES	ON / BELOW SEABED
MEG Pipeline	Steel	3,266 te	Below
	Plastic (FBE)	201 te	
Export Pipeline	Steel	19,797 te	Below
	Concrete	33,268 te	
	Asphalt	1,672 te	
	Plastic (FBE and epoxy)	822 te	
Anodes	Aluminium	90 te	Below
Piles	Steel	1,303 te	Below
	Grout	123 te	
Well Tubing and Conductors	Steel Concrete	4,003 te	Below
Stabilisation Features	Concrete	500 te	On
	Grout	17.5 te	
	Rock <sup>1</sup>	39,602 te	

Note 1: Quantity is estimate of existing rock. The amount required to be added will be determined following post-decommissioning pipeline burial survey.

#### 4.6.3. Controls for the Management of Impacts from Waste

The following mitigation measures, safeguards and controls are proposed to minimise the impact of waste associated with the Goldeneye decommissioning.

##### MITIGATION MEASURES, SAFEGUARDS AND CONTROLS

- The decommissioning project will have in place a WMP that will describe and quantify wastes arising from the decommissioning activities, segregation and storage requirements, and identify available disposal options for each waste stream;
- Achievable recycling goals will be identified and performance monitored;
- Waste management options will take account of the waste hierarchy;
- Contract award will be to a yard with appropriate capability, with relevant licences and consents in place and with established arrangements with facilities for recycling of wastes identified in the WMP;
- Assurance will be carried out at the disposal yard and key subcontractors' disposal sites.



Decommissioning activities generate large quantities of waste that has the potential to place a significant pressure on finite landfill resource and result in a loss of valuable natural resources. With the management measures identified, the overwhelming majority of resources will be recycled, reducing the overall waste burden from c. 6,800 te to <170 te of inorganic waste and approximately 200 te of marine growth.

## 4.7. Accidental Events

Risk assessment of accidental events involves the identification of credible accident scenarios, evaluation of the probability of incidents and assessment of their ecological and socio-economic consequences. Given the nature of the activities which could take place as a result of decommissioning, the following potential sources of accidental risk have been identified:

- Loss of ship's fuel;
- Dropped objects; and
- Liquid discharges.

The potential for impact from these events are considered in the following subsections to the extent feasible based on existing information.

### 4.7.1. Loss of fuel

A variety of vessels will be mobilised for the Goldeneye decommissioning activities, concentrated mainly around the location of the platform, but with trenching and survey work also being undertaken along the length of the pipeline.

#### 4.7.1.1. In Field

The impact from a major loss of fuel in the vicinity of the Goldeneye platform has been assessed as part of the facility Oil Pollution Emergency Plan (OPEP). Spill modelling undertaken in support of the OPEP (last updated 01/02/2018) considered a spill of 2,695 m<sup>3</sup> of diesel from a diesel supply vessel, considered to be the worst case, as this is the largest diesel inventory onboard any infield vessels under contract with Shell. The spill was concluded to have 0% probability of beaching or of reaching the UK – Norway meridian. The properties of diesel are such that the only response options deemed applicable to such a spill within the Goldeneye field would be to monitor and evaluate, and rely on evaporation and natural dispersion to remediate the contamination.

Shell has also undertaken spill risk assessment for the loss of 1,000 m<sup>3</sup> of diesel at the Goldeneye platform as part of an Environmental Impact Assessment (EIA) undertaken to inform the Peterhead CCS project (Shell, 2014; Scenario E.2.3.3). This was deemed to be a conservative worst case diesel spill from a jack-up rig during plugging and making wells safe. The assessment was based on results of spill modelling using the OSCAR modelling package developed by SINTEF. The modelling results confirmed that, in the very unlikely event of such a spill occurring, more than half of the diesel would evaporate within 24 hours and the amount of diesel on the surface would be negligible after 16 days. Approximately one quarter of the diesel spilt was predicted to end up in seabed sediments over a very wide area at concentrations that are not expected to cause a significant impact. The remainder of the spill would disperse within the water column where it readily biodegrades, leaving around 1 % of the volume within 30 days.

#### 4.7.1.2. Nearshore

Vessels will also operate for short periods along the pipeline route, closer to shore. There is no reason to suggest that the activities undertaken by these vessels would render them any more prone



to accident than any other shipping, fishing and service vessels operating off this coastline, but a spill from this part of the decommissioning would cause a higher incidence of beaching, would affect a larger strand area and have a higher potential for impact on a larger number of receptors than an equivalent spill at Goldeneye.

Such a spill was also considered for the Peterhead CCS EIA (Shell, 2014; Scenario E.2.3.1), with spills of around 2,200 te diesel from three locations assessed independently. The spill locations included the closest to shore that a pipe-lay vessel could operate (minimum depth of 12 m, Location 1) and the point where the proposed near-shore CCS pipeline would tie into the Goldeneye export pipeline, 26 km from shore (Location 3). An intermediate point (Location 2) was also modelled.

The model predicted that the diesel would initially be predominantly retained on the sea surface, where it would spread out, with significant proportions evaporating.

Prevailing winds and currents would take the diesel away from shore. However, under unfavourable current and wind conditions from the east, a nearshore spill could give rise to a large quantity of diesel stranding.

Under these unfavourable conditions, the quantity of stranded diesel would peak after approximately two weeks, following which the diesel would gradually become washed off the shore by wave action, where it would continue to evaporate and biodegrade.

A summary of the worst case fate of diesel strandings from each location is provided in Table 4-2.

**Table 4-2: Summary of worst case stranding following nearshore diesel spill scenarios**

SPILL SCENARIO	LOCATION 1	LOCATION 2	LOCATION 3
Max. mass onshore (tonnes)	1,599	1,523	1,073
Min. arrival time (days)	0.1	4.6	4.6
Max length of coastline affected (km)	120	150	40

In each scenario, after 30 days approximately half of the diesel was predicted to have evaporated and a further 15% to have degraded. These two mechanisms would continue to dominate the fate of the spill, with low proportions being dispersed within the water column or on sediments.

The spill would give rise to a surface oil layer which could potentially be found up to 250 km from the spill at some point in time and would give rise to parts of the sea being subject to diesel concentrations of >50 ppb – the threshold below which there is no expectation of significant acute toxic effects.

In the Peterhead CCS EIA, the model results for the extent, duration and magnitudes of diesel in the water column, as a surface layer and from stranding were used to assess the potential for impact to receptors from a nearshore spill. The assessment concluded that, were such an event to occur, there would be a moderate impact to seabirds, marine mammals, protected sites, commercial fisheries, shipping and tourism. Impacts to plankton and fish were identified as being slight, and as being insignificant on other oil and gas operations.

Whereas the spill scenario would result in a significant impact to many of the receptors, it should be stressed that it would be very rare for such an event to occur, and that this is an intrinsic risk that relates to any vessel activity near the coast.

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, fitting the descriptor of 'similar event has occurred elsewhere but is unlikely to occur with current practices' in Table B-5 (Likelihood Category B).

For the short time that trenching and survey vessels will be operating near to shore for the Goldeneye decommissioning programmes they will present a small incremental addition to the existing level of risk of spills from baseline shipping activity in the area.

#### *4.7.1.3. Prevention and mitigation measures for spill impact minimisation*

This level of potential impact and risk is widely recognised and is the basis for the adoption of a suite of prevention and mitigation measures having become routine in the oil and gas industry. Shell will include the following measures for the Goldeneye decommissioning programme.

#### *4.7.1.4. Ship to ship fuel transfer*

No offshore refuelling will be undertaken for any vessels engaged in the recovery of Goldeneye installation and infrastructure, the burying of the pipeline, or for the seabed remediation and surveying activities.

### **MITIGATION MEASURES, SAFEGUARDS AND CONTROLS**

- Avoidance of collision:

Notification of decommissioning activities via publication of Notices to Mariners detailing rig and vessel positions, activities and timing and by full navigation lighting on the vessels.

- Sea worthiness of vessels:

All vessels to be used will be subject to Shell's 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 and emergency preparedness and contingency planning.

- Spill Response:

All vessels will have relevant and current Shipboard Oil Pollution Emergency Plans (SOPEP) which are regularly reviewed with vessel crew.

Co-ordinated industry oil spill response capability will be available round the clock.

### **4.7.2.     Dropped objects**

The potential for impacts from dropped objects during lifting were considered for examples of small objects, such as grout bags, and large, such as the topsides or jacket.

Small objects would cause disturbance to a very small area of the seabed and would be recovered.

If the topsides or jacket dropped during lifting or from the lift vessel or barge while in transit, there would be an immediate impact on the seabed and could also present a source of



contamination. Although, it is anticipated that the object would be recovered, depending on the reason for the original lifting failure, recovery may not be feasible and the dropped object would then present a risk to other users of the sea.

The significance of the hazard caused would in part depend on the location of the incident. This may be during the initial lift at the Goldeneye location, during transit or at the receiving port. Depending on the port selected, there may also be a need for transferring the structures onto a shallow water vessel at a nearshore location close to the port.

At Goldeneye, the impact of disturbance of the seabed would not be significant, and as the topsides has been drained of all liquids there would be minimal potential for contamination. Any part of the structure needing to be left where it fell would present a hazard for snagging of fishing gear and would likely require a safety zone to be established as for derogated installation footings.

The scale of impact would be higher if the incident were to occur within a designated conservation area, in a shipping lane, at the receiving port or in an area of high fishing activity.

Shell will minimise the likelihood of a lifting failure through inclusion of the following measures.

#### **MITIGATION MEASURES, SAFEGUARDS AND CONTROLS**

- Each lifting operation will be managed in accordance with a lift plan that will include:
  - confirmation of the structural integrity of structure and its lifting points;
  - centre of gravity calculation;
  - specification of the sizing of crane and vessel;
  - specification of weather and sea state; and
  - the duration of the weather window required.
- Marine transport of major structures will be managed in accordance with a transit plan that will:
  - stipulate the towing and support vessels required;
  - stipulate the route to be followed;
  - identify sheltered locations along the route which can be used to shelter from storms; and
  - detail emergency response procedures.

### **4.7.3. Liquid discharges**

#### *4.7.3.1. Trapped liquids*

The production facilities on Goldeneye were limited, and these have been flushed and cleaned. All residual fluids on the topsides (such as hydraulic and lubrication fluids) were drained down prior to the installation achieving PUI mode in 2018.

However, Shell understands that there is a precedent decommissioning project where unexpected discharges of liquids occurred when lifting the topsides from the jacket. It is understood that this was due to entrained liquids in piping deadlegs which proved to have been inaccessible to the flushing and cleaning programme. The level of impact that this would cause on Goldeneye would be dependent on the nature of any such liquids.



To minimise the potential for such a discharge, the pipework on Goldeneye will be reviewed to identify any potential deadlegs and ensure they are cleaned (potentially including cutting of pipework) before lifting of the topsides.

#### *4.7.3.2. Hose rupture*

There is the potential for accidental releases of hydraulic fluids, particularly from ROVs and lifting equipment, in the event of a hydraulic hose rupture. The risk of hydraulic fluid releases is managed through standard maintenance and inspection of hoses on all relevant vessels and for the efficacy of the maintenance regime to be tested during vessel audits. These measures will be included within the Environment, Social and Health Management Plan.

### **4.8. Socio-economic Effects**

The socio-economic effects considered in the ENVID related to impacts on the fishing industry and the potential re-use of the export pipeline for a future CCS project.

#### **4.8.1. Pipeline integrity**

The re-use of the pipelines would provide a socioeconomic benefit, which would be compromised if the pipeline was damaged during execution of the DP activities. The principal risk identified was from damage to the pipeline upstream end from dropped objects, and only the jacket itself would have sufficient mass to risk the integrity of the pipeline. The junction between the pipeline and connecting spools lies approximately 100 m from the platform, and therefore could potentially be impacted by the jacket if it were to topple in that direction. Measures presented in Section 4.7.2 will minimise the likelihood of damage to the pipeline.

#### **4.8.2. Impact on fishing industry**

The Goldeneye decommissioning has the potential to impact on fishing through the following mechanisms:

- Restriction of activity;
- Loss of productivity; and
- Risk of snagging.

These have been discussed in the preceding sub-sections under Natural Capital and under Accidental Events and a summary only is presented here.

##### *4.8.2.1. Restriction of activity*

Most of the decommissioning activity will take place within the Goldeneye 500 m safety zone and will therefore not impede fishing. The number of vessels transiting to/from the zone has been seen to be less than 2% of the baseline vessel density at the platform, and considerably less than this closer to shore. Mitigation measures are registered for addressing the extended period (estimated 48 days) that the trenching support vessel will be operating along the pipeline route.

##### *4.8.2.2. Loss of productivity*

Areas of rock cover will have lower potential to support commercial fish species resulting in a minor negative impact. Conversely, decommissioning will result in the re-opening of the Goldeneye 500 m safety zone to fishing, resulting in a minor positive impact. Overall this is expected to result in a small net increase in fishing productivity.



#### 4.8.2.3. Risk of snagging

The decommissioning will result in a clear seabed, with only the buried pipelines remaining *in situ*. The majority of the pipeline will be buried to a depth of 0.6 m with natural fill enhanced as necessary with additional rock cover. The area traversed by the pipeline has a dynamic seabed, as evidenced by mega-ripples observed in surveys along various pipeline routes. Shell will remain responsible for maintaining the safe status of the pipeline, and future remedial action will be informed by surveys of pipeline depth. Remediation planning will include liaison with SFF, SNH, MS and BEIS and will balance risk of snagging with a desire to maintain the seabed in as natural a state as possible.

This will be first evaluated following trenching and burial of the export pipeline by the post-decommissioning survey.

### 4.9. Transboundary Impacts

The main potential for transboundary impacts into Norwegian waters would arise from atmospheric emissions and accidental events leading to an offshore spill during vessel activities. The UK/Norway median line is c. 110 km east of Goldeneye and therefore any emissions resulting from the decommissioning activities would not be measurable at the median line. Similarly, the inventory of fuels carried by any of the vessels during operations would not create a spill sufficient to reach the UK/Norway boundary, even in the unlikely event that the entire inventory is lost to sea.

If the recovered materials were to be sent to a decommissioning yard outside the UK, Shell will require equivalent standards of waste handling and disposal as for UK yards and will ensure that any contracted yard has appropriate experience, capability and holds all relevant licences and permits required of the local regulatory regime.

### 4.10. Cumulative Impacts

The outer Moray Firth is a mature oil and gas exploration and production area, with a number of facilities in late life operations and scheduled for decommissioning in the coming decade.

The nearest developments to Goldeneye are the subsea infrastructure of the Ettrick and the A&C fields. At 15 km from Goldeneye, these are too distant to directly affect the habitat and ecology in the Goldeneye Fields. Given the very limited environmental impact associated with the Goldeneye decommissioning, there is little potential for these to provide an increase to the impacts identified for decommissioning of these neighbouring fields, even if they were undertaken concurrently.

Numerous pipelines from offshore installations are routed to the St. Fergus facility. Some run close together and cross each other. Leaving the nearshore section of the Goldeneye pipelines buried in the seabed avoids the need to work over third party oil and gas pipelines in this area and also minimises the potential cumulative impact of repeatedly disturbing the 'circalittoral mixed sediment' habitat.

The scale of North Sea decommissioning activity envisaged over the coming decade will create a demand for onshore decommissioning yards. This will create employment to construct and operate coastal facilities where structures and materials from offshore assets can be dismantled. The Goldeneye decommissioning project is not large enough to influence the development or location of a new onshore decommissioning yard. Operators of onshore decommissioning yards rightly consider the structures and materials from Goldeneye would make only a small contribution to their operation.

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The Goldeneye decommissioning project will contribute temporarily to the onshore decommissioning contractor's operational issues around noise, traffic and light pollution, but the scale and duration of this contribution will be very limited.



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## 5. Conclusions

This EA confirms that the DP can be executed with minimal impact on the environment. The baseline environment in the affected area is well understood, the potential for impact from the decommissioning activities are known and Shell procedures include robust, well established control measures to reduce the potential for impacts to develop and mitigation of those that are unavoidable.

The development of the decommissioning programmes for the Goldeneye field has been informed by ongoing appraisal of the environmental impacts and risks posed by options under consideration. The environmental appraisal has been based on an understanding of the baseline environment established from multiple web-based sources and seabed surveys. Comparative Assessment established that the most appropriate decommissioning option for the two Goldeneye pipelines was for both to be decommissioned *in situ* below the seabed. This requires the trenching and burial of the export pipeline where it is currently laid on the seabed, approximately 5 km of which lies within the Southern Trench pMPA.

Comprehensive identification of potential impacts from the proposed DP was achieved through ENVID, the output of which was used to scope the requirements for further detailed impact assessment.

The ENVID identified no planned activities that would give rise to impacts of High significance rating. Four aspects were provisionally assigned conservative ratings of Moderate impact, due to the potential for impacts within the Southern Trench pMPA. On further examination, the impact of each of these aspects was re-evaluated as being Minor. Justification for the revised assessments are provided within this report and are summarised as:

- Sources of underwater noise generated within the Southern Trench pMPA would not give rise to injury of minke whale or bottlenose dolphin. Any disturbance to these cetaceans would be limited to very few individuals, would continue for less than 5 days, on two separate occasions, and may result in their temporary movement to alternative grounds for these durations.
- Disturbance of the seabed within the pMPA, from trenching or rock cover, would not impact areas of burrowed mud habitat for which the conservation area is proposed, nor to the Annex I habitat of biogenic reefs. Neither of these features occur within the part of the pMPA effected by the decommissioning works.

It was recognised that there is a remote possibility for a major impact to result from an accidental release of fuel from a vessel operating near shore.

Activity-specific mitigation measures will be planned and managed to avoid adverse environmental and social impacts and, where avoidance is not possible, ensure potential impacts are minimised to a level that is as low as reasonably practicable. This includes management of contractors commissioned to carry out the decommissioning activities, and monitoring and auditing contractor performance during the execution of the work. Agreed mitigation controls, regulatory requirements as well as Shell's standard requirements will be included as terms and conditions in the contract and the measures to be adopted. Monitoring measures required to ensure compliance will form part of the contractors' decommissioning plans and procedures to be approved by Shell prior to mobilisation. Shell will carry out pre-mobilisation audits to assure that effective planning and operational procedures are in place and that all vessels comply with International Maritime Organisation requirements, including MARPOL requirements with regard to emissions, discharges, waste management and collision avoidance.



Mitigation controls have been identified for implementation to ensure that risks to other users of the sea have been reduced to as low as reasonably practicable by implementing routine ship navigation and notification measures. Where rock cover is placed on the seabed, grades will be used that avoid hazards to fishing gear and over-trawl trials will assure that the rock cover does not present a hazard to fishing.



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## Appendix A: ENVID Methodology

The purpose of the ENVID was to identify potential environmental hazards, or ‘aspects’, associated with the different operations involved in the decommissioning of the Goldeneye Field. Prior to the ENVID a Terms of Reference was issued describing the ENVID process, an overview of the project and an overview of the environmental sensitivities in the area.

In summary, the ENVID was structured such that the environmental aspects associated with each activity were considered within primary ENVID Nodes as follows:

- Vessel use;
- Recovery of installations;
- Decommissioning of pipelines and umbilical;
- Decommissioning of protective structures; and
- Debris clearance and over trawl trials.

Within each node, both offshore and onshore activities were considered using the methodology described below. In addition to planned activities, accidental events e.g. dropped objects, vessel collision, and snagging were also considered.

## Impact Identification and Aspects

Potential impacts were identified in the ENVID workshop using Shell’s standard set of environmental impact guidewords (reproduced in Table B- 1) to prompt the discussions. were adopted for the ENVID. A pre-workshop review screened the standard aspect set to be pertinent to Decommissioning projects and matched the relevant aspects to the Goldeneye Decommissioning nodes selected.

**Table B- 1: Shell Environmental Impact Assessment Aspects**

NO	ENVIRONMENTAL ASEPCT	DEFINITION/COMMENTS
<b>EMISSIONS TO AIR</b>		
1	Gaseous emissions	The emission of hazardous gases (such as but not limited to CO <sub>2</sub> , NO <sub>x</sub> , SO <sub>x</sub> , CO, SO <sub>2</sub> , H <sub>2</sub> S, CH <sub>4</sub> ) resulting from flaring off, venting, heating, leaks, transport, etc.  Comment: this concerns both continuous emissions (flares, vents, heating installations, losses through leaks), discontinuous emissions (well tests, depressurising installations), leaks of HCFCs from cooling installations and emissions arising from accidental fires and explosions.
<b>DICHARGES TO WATER</b>		
2	Fluids and other materials into water	The controlled discharge to surface water of production water, household waste water, decontamination water, drainage water at well points, (contaminated) rainwater and discharge to sewer as part of normal operations.  The discharge of oil, chemicals and other materials as a result of incidents including for example vessel collision and dropped objects.  Comment: this concerns both discharges offshore and to surface waters onshore.
<b>EFFECTS ON LAND INCLUDING GROUNDWATER</b>		
3	Fluids into soil	The controlled or uncontrolled discharge of liquids such as rainwater, oil and condensate into the soil (soil and groundwater). Includes discharges and spills arising as a result of accidental events e.g. fire and explosion.



NO	ENVIRONMENTAL ASEPCT	DEFINITION/COMMENTS
		Comment: the surface water can also become contaminated as a result of infiltration and runoff.
4	Waste materials	All materials that the holder disposes of, with the intention of permanent removal. Waste includes hazardous waste, operational waste, office waste, domestic waste, clinical waste, WEEE, batteries and small volumes of chemical waste. Important waste materials are drilling fluid / drilling dust, production water, waste water, contaminated soil and waste contaminated with mercury and LSA.
5	Disruption to the soil and subsoil	Disruption to the subsoil resulting from product extraction with the possible consequence being earth tremors and subsidence. Disruption to soil layers as a result of drilling, pile driving and seismic shot holes with the possible consequence being the lowering of the water table, seepage, etc.
<b>EXTRACTION AND CONSUMPTION OF RESOURCES</b>		
6	Raw materials, additives and materials	The use of (depletable or regulated) raw materials additives and materials for operational purposes. Comment: including chemicals; excluding water.
7	Water consumption	The operational and incidental consumption of water for instance for combating emergencies (killing wells, fighting fires), cooling, rinsing, cleaning activities, catering, making shot holes. Comment: this concerns seawater, fresh surface water, groundwater and mains water.
8	Energy consumption	The use of energy carriers such as natural gas, diesel oil, petrol, kerosene, electricity for operating installations, transport and (office) buildings.
9	Usage of space	The temporary or permanent use of space that has an influence on the flora, fauna and the appearance of the landscape. Also includes physical presence in the context of other stakeholders including fishing vessels and other shipping movements. Examples: installations, pipelines, buildings, transport, survey operations.
10	Product extraction	The extraction of oil, gas, condensate and sulphur (as depletable resources). Comment: subsidence and earth tremors as effects of this are included in a separate environmental aspect (no. 16).
<b>OTHERS</b>		
11	Radiation (heat and ionising)	Disruption to the surroundings resulting from heat radiation and ionising radiation from natural and unnatural sources. Example of heat radiation: flaring during production activities and well testing. Example of ionising radiation: the settling of LSA in sludge and parts of an installation (and as a result in materials and equipment), and radiation emitted by measuring equipment (drilling tools, x-ray equipment).
12	Noise and vibrations	Disruption to the surroundings as a result of operational and incidental noise and vibration resulting from operational activities. Examples: seismic vibration vehicles and explosives, pile driving activities, drilling activities, etc.
13	Smell / odour	Disruption to the surroundings resulting from operational activities. Examples: ammonia, H <sub>2</sub> S, combustion gases, hydrocarbons
14	Light	Disruption to the surroundings (mainly at night) by light radiated from locations and operational activities. Examples: drilling rigs, offshore platforms and seismic vehicles.

NO	ENVIRONMENTAL ASEPCT	DEFINITION/COMMENTS
15	Dust	Disruption to the surroundings from dust particles such as those created by construction and abandoning activities and during the execution of sandblasting and painting activities. Examples: grit, asbestos, blown sand.
16	Materials to subsurface/disturbance to the soil or subsoil	The intended or unintended introduction of liquids and gases in deep layers of the earth, including associated earth tremors and subsistence. For instance: the injecting of production water into layers of the earth intended for it: the undesired leaking into formations of drilling fluid and possibly the future injection of CO <sub>2</sub> .
17	Aesthetics	Disruption to local residents and visitors to an area. Examples: landscape and visual effects.
18*	Biodiversity	Disruption to flora, fauna and ecosystems both onshore and offshore including seabed disturbance. Examples: effects on local, national and internationally important ecological interests including protected habitats and species.

## Assessment of Impact Significance

The significance of environmental impacts were assessed in terms of:

- Magnitude based on the size, extent and duration of the impact;
- The sensitivity of the receiving receptors; and
- The likelihood of an unplanned event occurring.

### Magnitude

Levels of magnitude of environmental impacts were determined in accordance with the definitions outlined in Table B- 2. The magnitude of an impact or predicted change took into account the following:

- Nature of the impact and its reversibility;
- Duration and frequency of an impact;
- Extent of the change; and
- Potential for cumulative impacts.

The impact magnitude is defined differently according to the type of impact. For readily quantifiable impacts, such as discharge volumes, numerical values can be used whereas for other topics (e.g. ecology), a more qualitative definition may be necessary.

**Table B- 2: Definitions of Impact Magnitude**

LEVEL	DEFINITION	ENVIRONMENTAL IMPACT
0	No effect	<ul style="list-style-type: none"> <li>• No environmental damage or effects.</li> </ul>
1	Slight effect	<ul style="list-style-type: none"> <li>• Slight environmental damage contained within the premises. Example: Small spill in process area or tank farm area that readily evaporates;</li> <li>• Effects unlikely to be discernible or measurable;</li> <li>• No contribution to transboundary or cumulative effects;</li> <li>• Short-term or localised decrease in the availability or quality of a resource, not effecting usage.</li> </ul>
2	Minor effect	<ul style="list-style-type: none"> <li>• Minor environmental damage, but no lasting effects;</li> </ul>



LEVEL	DEFINITION	ENVIRONMENTAL IMPACT
		<ul style="list-style-type: none"><li>• Change in habitats or species which can be seen and measured but is at same scale as natural variability;</li><li>• Unlikely to contribute to trans-boundary or cumulative effects;</li><li>• Short-term or localised decrease in the availability or quality of a resource, likely to be noticed by users.</li></ul>
3	Moderate effect	<ul style="list-style-type: none"><li>• Environmental damage that will persist or require cleaning up;</li><li>• Widespread change in habitats or species beyond natural variability;</li><li>• Observed off-site effects or damage, e.g. fish kill or damaged vegetation;</li><li>• Groundwater contamination;</li><li>• Localised or decrease in the short-term (1-2 years) availability or quality of a resource affecting usage;</li><li>• Local or regional stakeholders' concerns leading to complaints;</li><li>• Minor transboundary and cumulative effects.</li></ul>
4	Major effect	<ul style="list-style-type: none"><li>• Severe environmental damage that will require extensive measures to restore beneficial uses of the environment;</li><li>• Widespread degradation to the quality or availability of habitats and/or wildlife requiring significant long-term restoration effort;</li><li>• Major oil spill over a wide area leading to campaigns and major stakeholders' concerns;</li><li>• Transboundary effects or major contribution to cumulative effects;</li><li>• Mid-term (2-5 year) decrease in the availability or quality of a resource affecting usage;</li><li>• National Stakeholders' concern leading to campaigns affecting Company's reputation.</li></ul>
5	Massive Effect*	<ul style="list-style-type: none"><li>• Persistent severe environmental damage that will lead to loss of use or loss of natural resources over a wide area;</li><li>• Widespread long-term degradation to the quality or availability of habitats that cannot be readily rectified;</li><li>• Major impact on the conservation objectives of internationally/nationally protected sites;</li><li>• Major trans-boundary or cumulative effects;</li><li>• Long-term (&gt;5 year) decrease in the availability or quality of a resource affecting usage;</li><li>• International public concern.</li></ul>
* To be used for unplanned events only		

## Receptor Sensitivity

Receptors were categorised into different groups:

- Atmosphere;
- Water (Marine, Estuarine, river or groundwater);
- Habitat or species;
- Community; and
- Soil or seabed.

Receptor sensitivity criteria were 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 Special Area of Conservation (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 recovery:** for instance, certain species could adapt to changes easily or recover from an impact within a short period of time. Thus, as part of the receptor sensitivity criteria (Table B- 3), experts considered immediate or long term recovery of a receptor from identified impacts.

- **Sensitivity of the receptor to certain impacts:** for instance, vessel emissions will potentially cause air quality impacts and do not affect other receptors such as seabed.

**Table B- 3: Definitions of Receptor Sensitivity**

LEVEL	SENSITIVITY	DEFINITION
A	Low	Receptor with low value or importance attached to them, e.g. habitat or species which is abundant and not of conservation significance. Immediate recovery and easily adaptable to changes.
B	Medium	Receptor of importance e.g. recognised as an area/species of potential conservation significance for example, Annex I Habitats of Annex II species. Recovery likely within 1-2 years following cessation of activities, or localised medium-term degradation with recovery in 2-5 years.
C	High	Receptor of key importance e.g. recognised as an area/species of potential conservation significance with development restrictions for example SACs, MPAs. Recovery not expected for an extended period (>5 years following cessation of activity) or that cannot be readily rectified.

## Evaluation of Significance

### Planned Events

The magnitude of the impact and sensitivity of receptor was then combined to determine the impact significance as shown in Table B- 4. Mitigation measures were then identified to reduce the impact. The residual impact following mitigation was then determined.

**Table B- 4: Evaluation of significance – planned events.**

		SENSITIVITY		
		A - Low	B - Medium	C - High
MAGNITUDE	0 - No effect	No effect	No effect	No effect
	1 - Slight effect	Slight	Slight	Minor
	2 - Minor effect	Minor	Minor	Moderate
	3 – Moderate effect	Minor	Moderate	Major
	4 - Major effect	Moderate	Major	Major

### Unplanned Events

For unplanned events, the likelihood of such an event occurring was also considered. For example, based on magnitude and sensitivity alone, a hydrocarbon spill associated with a total loss of fuel inventory could be classed as having major impact significance; however, the likelihood of such an event occurring is very low. Thus unplanned events were also assessed in terms of environmental risk.

As with planned activities, the potential impacts of unplanned events were identified and their magnitude and the sensitivity of the environment defined and combined in order to determine the impact significance. The significance of the impact was then combined with the likelihood of the event occurring (Table B- 5) in order to determine its overall environmental risk, as summarised in

Table B- 6. Mitigation measures were then identified to reduce the risk of such an event occurring in order to determine residual risk.

**Table B- 5: Likelihood criteria.**

LIKELIHOOD	DEFINITION
A	<ul style="list-style-type: none"> <li>Never heard of in the industry - Extremely remote;</li> <li><math>&lt;10^{-5}</math> per year;</li> <li>Has never occurred within the industry or similar industry but theoretically possible.</li> </ul>
B	<ul style="list-style-type: none"> <li>Heard of in the industry – Remote;</li> <li><math>10^{-5} - 10^{-3}</math> per year;</li> <li>Similar event has occurred somewhere in the industry or similar industry but not likely to occur with current practices and procedures.</li> </ul>
C	<ul style="list-style-type: none"> <li>Has happened in the Organisation or more than once per year in the industry – Unlikely;</li> <li><math>10^{-3} - 10^{-2}</math> per year;</li> <li>Event could occur within lifetime of similar facilities. Has occurred at similar facilities.</li> </ul>
D	<ul style="list-style-type: none"> <li>Has happened at the location or more than once per year in the Organisation – Possible;</li> <li><math>10^{-2} - 10^{-1}</math> per year;</li> <li>Could occur within the lifetime of the development.</li> </ul>
E	<ul style="list-style-type: none"> <li>Has happened more than once per year at the location – Likely;</li> <li><math>10^{-1} - &gt;1</math> per year;</li> <li>Event likely to occur more than once at the facility.</li> </ul>

**Table B- 6: Evaluation of significance – unplanned events.**

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



## Appendix B: ENVID Output

ASPECT	PROJECT ACTIVITY / SOURCE OF IMPACT	POTENTIAL IMPACTS / OBSERVATIONS	MITIGATION MEASURES, SAFEGUARDS AND CONTROLS	IMPACT SIGNIFICANCE	ENVIRONMENTAL RISK - UNPLANNED	SCOPED FOR IMPACT ASSESSMENT?
<b>Vessel Use</b>						
Gaseous emissions	Offshore vessel, helicopter, and drilling rig activity	Fuel combustion emissions (CO <sub>2</sub> , CO, SO <sub>x</sub> , NO <sub>x</sub> , etc.) from vessels including Heavy Duty Jack Up (HDJU) drilling rig, Heavy Lift Vessel (HLV), ROV support vessels/dive support vessels, supply vessels / DSV rock dump vessel survey vessels, Emergency Response and Rescue Vessel (ERRV), helicopter etc. UK and EU Air Quality Standards not exceeded.	Minimise use of vessels through efficient journey planning and use of relevant vessels for each activity. Prior to contract award Shell will review vessel Common Marine Inspection Documents (CMID) as part of vessel assurance (evidence of maintenance). All vessels will be in compliance with Shell's Marine Assurance Standards (MAS). Vessels will be MARPOL compliant.	A2 Minor	N/A	N
Usage of space	Vessel and drilling rig activity. HLV anchor points and chains could extend out with the 500 m safety zone. Depending on scheduling, a guard vessel could be put in place after removal of the platform and prior to completion of remediation activities at the pipeline ends. Trenching vessel will be positioned along the 80 km length of offshore pipeline to be trenched and buried.	Potential restriction on navigation and fishing operations.	Minimise use of vessels, through efficient journey planning. Notify other sea users - e.g. Kingfisher, Scottish Fishermen's Association (SFF) etc. Ongoing collaboration with SFF. All vessels engaged in the project operations will have markings and lightings as per the International Regulations for the Prevention of Collisions at Sea (COLREGS) (International Maritime Organisation, 1972). Navigational aids including radar, lighting and Automatic Identification Systems (AIS) will be used. A vessel Collision Risk Assessment (CRA) will be produced if required. Vessels associated with decommissioning of the platform will operate within an existing 500 m exclusion zone.	A1 Slight	N/A	N
Disruption to the soil and subsoil	Lay down of anchors and associated anchor chains on the seabed (HLV) and the spud cans associated with HDJU.	<b>Environmental impacts:</b> Localised seabed disturbance resulting in some lethal/sub-lethal effects on benthic and epibenthic fauna. Possible smothering of some organisms following settlement of re-suspended particles. Rate of recovery dependent on type of seabed and species present. Area of impact is relatively small and out with any designated areas. Potential anchor scarring from anchors and depressions from spud cans.	Anchor pre-lay and rig site surveys will be carried out to help identify lay down areas.	B1 Slight	N/A	N
	Impact of anchor depressions/scars and spudcan depressions on other sea users.	<b>Socio-economic impacts:</b> Potential anchor depressions/scarring from anchors and depressions from spud cans. No impact of the spud can depressions on current fishing activity as disturbance will be within 500 m exclusion zones currently in place. Following decommissioning the exclusion zone will be removed and there may be a risk of trawl gear snagging. Potential anchor depressions out with 500 m exclusion zone.	Overtrawl trials. Remedial action if required following results of overtrawl trials and discussion with the Department for Business, Energy and Industrial Strategy (BEIS) and the SFF. Note: if remedial rock cover required this would have a knock-on environmental impact of B2 (Minor)	A1 Slight	N/A	N
Fluids and other materials into water	Discharge of sewage from vessels used during decommissioning activities; grey and black water macerated to <6 mm prior to discharge and discharge of food waste to sea.	Organic enrichment and chemical contaminant effects in water column and seabed sediments.	Minimise use of vessels, through efficient journey planning. Shell will review vessel CMID as part of vessel assurance and all vessels will be compliant with Shell's MAS. Vessels will be MARPOL compliant. In line with MARPOL Reg 9.1.2 there will be no discharge of treated sewage within 3 nm of land.	A1 Slight	N/A	N
Fluids and other materials into water	Ballast water (important if the vessels were to be brought from the outside of the North Sea)	Water quality in immediate vicinity of discharge may be reduced, but effects are usually minimised by rapid dilution in receiving body of water and non-continuous discharge. Possible introduction of invasive species depending on vessel routes if IMO requirements are not followed.	Shell audit procedures will ensure that the contracted vessels ballasting procedures are in line with the International Maritime Organisation (IMO) Convention aimed at preventing associated harmful effects. All discharges monitored and records maintained.	A1 Slight	N/A	N
Fluids and other materials into water	Biofouling (important if the vessels were to be brought from the outside of the North Sea)	Bioinvasions as a result of biofouling (accumulation of organisms including plants, algae, or animals such as barnacles) on vessels.	Contracts will be awarded to contractors originating from countries signed up to IMO. As part of Shell's auditing process, only vessels adhering to the IMO 2011 Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Species will be used. All member states of IMO are signed up to these Guidelines.	A1 Slight	N/A	N



# Goldeneye Decommissioning Environmental Appraisal Report

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Noise	Vessels using Dynamic Positioning (DP).	Vessels will use DP which has the potential to cause disturbance to marine mammals and fish in the form of temporary displacement from the area.  Worst case sensitivity of High applies to noise within Southern Trench pMPA only. Impact rating beyond 12 nm B2 (Minor) Marine mammals and fish are expected to return once the vessels have left the area. Shipping intensity is considered high in the area.	Minimise use of vessels, through efficient journey planning.	C2 Moderate	N/A	N
Light	Vessels and drilling rig	Possible impact on birds and birds migration, however given proximity to the platform and surrounding infrastructure the lights associated with drill rig and vessels is not expected to have an impact on bird migrations.	Minimise use of vessels, through efficient journey planning.	A1 Slight	N/A	N

ASPECT	PROJECT ACTIVITY / SOURCE OF IMPACT	POTENTIAL IMPACTS / OBSERVATIONS	MITIGATION MEASURES, SAFEGUARDS AND CONTROLS	IMPACT SIGNIFICANCE	ENVIRONMENTAL RISK - UNPLANNED	SCOPED FOR IMPACT ASSESSMENT?
Waste	Vessel waste (solid, vessel operations waste)	General vessel waste returned to shore and treated in line with the waste hierarchy.	Prior to contract award Shell will review vessel Waste Management Plan (WMP). Shell will ensure vessels are compliant with MARPOL and flag state requirements and, as such, meet Shell's MAS.	B1 Slight	N/A	N
Energy Consumption	Fuel use by vessels, drilling rig and helicopters.	Use of a finite resource.	Minimise use of vessels, through efficient journey planning.	B1 Slight	N/A	N
Unplanned event	Loss of fuel during bunkering (offshore for the HDJU rig). No requirement for bunkering operations with the other vessels.	Diesel release could significantly impact on fauna in the area e.g. plankton, fish, marine mammals and birds.	Trained personnel to carry out bunkering operations using established work procedures; bunkering operations are manned continuously with radio contact between vessel and installation at all times. Regular maintenance checks of fuel transfer hose.	B2 Minor Likelihood D	Moderate risk	N
	Loss of fuel inventory due to vessel collision or fire.	Diesel release could significantly impact on fauna in the area e.g. plankton, fish, marine mammals and birds.  Impact significance based on nearshore spill.	Vessel Assurance Inspection. Pre-hire vessel audit shall be used to establish nature of fire fighting systems. Emergency response plans in place including vessel Shipboard Oil Pollution Emergency Plans (SOPEPs). SIMOPs (simultaneous operations) will be managed through bridging documents and communications.	C3 Major Likelihood B	Moderate risk	N

## Recovery of Installations (topsides, jacket and Subsea Safety Isolation Valve (SSIV))

Disruption to the soil and subsoil	Potential jetting and excavation to access jacket and SSIV piles.	Should internal cutting of the jacket legs and SSIV piles not be technically feasible there will be disturbance to the seabed associated with excavation of material to allow access to the jacket piles below the seabed. Increased suspended solids in the water column and dilution and dispersion before settling on seabed.	A suitable tool will be selected for the cutting to ensure that impacts are minimised. Procedures will be in place for the activity.	B2 Minor	N/A	N
	Use of rock cover to fill depressions left on the seabed.	<u>Environmental impacts:</u> Introduction of hard substrate to a sandy habitat, could cause small localised changes to the ecosystem in area impacted.		B2 Minor	N/A	N
		<u>Socio-economic impacts:</u> Potential anchor depressions/scarring from anchors and depressions from spud cans and following recovery of jacket and SSIV (should seabed be excavated prior to cutting). Could impact on fishing activity.	Over trawl trials.	A1 Slight	N/A	N
Fluids and other materials into water	Increased suspended solids in the water column from cuttings activities (shavings). Garment in cutting medium.	Increased suspended solids due to metal shavings from the legs. Garment is inert.	Work procedures in place which include aim to minimise cutting operations.	A1 Slight	N/A	N
	Marine Growth discharge	Marine growth may fall off structure into sea and onto the vessels during transit. It will be naturally dispersed in the marine environment. Marine derived material. Water quality in immediate vicinity of discharge will be reduced, but effects are usually minimised by rapid dilution in massive receiving body of water. Possible localised, short term deoxygenation of seabed. Medium sensitivity assigned on the basis that some material will impact the seabed.		B1 Slight	N/A	N
Noise	Underwater noise from cutting activities	Abrasive water jet cutting or diamond wire cutting, could have potential impact on fish and marine mammals in the area.	Number of cuts and therefore associated noise will be minimised. Studies suggest that there is no significant impact from the noise generated by cutting operations.	B1 Slight	N/A	N
Waste	Disposal of waste fluids. All fluids to be drained and returned to shore as part of preparation activities to achieve permanently unattended installation (PUI) status. Includes small volumes of diesel, hydraulic fluid, lubrication oil etc.	Waste returned to shore and treated in line with the waste hierarchy.	Waste hierarchy will be adhered to: reduce, reuse, recycle and disposal.	A1 Slight	N/A	N
Returning access to fishing area	Removal of 500 m safety zone	Fishing vessels gain access to an area that they have previously been excluded from.		POSITIVE		N



# Goldeneye Decommissioning Environmental Appraisal Report

Revision: A02

Onshore/yard activities	Gaseous emissions	Fuel combustion emissions (CO <sub>2</sub> , CO, SO <sub>x</sub> , NO <sub>x</sub> , etc.) from lorries and cuttings tools and recycling operations. Positive impact of recycling steel given that recycling of steel results in less CO <sub>2</sub> emissions than production of new steel).	Contract award will be to a yard with appropriate capability, licences, consents and community engagement in place.	A1 Slight	N/A	N
	Noise and vibrations	Lorries transporting the recovered infrastructure. Noise associated with the yard activities.	Contract award will be to a yard with appropriate capability, licences, consents and community engagement in place.	A1 Slight	N/A	N
	Odour	Evidence of marine growth on the jackets.	Contract award will be to a yard with appropriate capability, licences, consents and community engagement in place.	A1 Slight	N/A	N
	Waste materials	Minimal waste to go to landfill.	All waste will be handled and disposed of in line with regulations which will be detailed in the WMP. Offshore waste management procedure in place which should allow for effective management of the waste when it arrives onshore. Waste management will follow the waste hierarchy: reduce, reuse, recycle. Shell to audit the disposal yard and key third party sites used.	B2 Minor	N/A	N

ASPECT	PROJECT ACTIVITY / SOURCE OF IMPACT	POTENTIAL IMPACTS / OBSERVATIONS	MITIGATION MEASURES, SAFEGUARDS AND CONTROLS	IMPACT SIGNIFICANCE	ENVIRONMENTAL RISK - UNPLANNED	SCOPED FOR IMPACT ASSESSMENT?
	Hazardous waste.	Hazardous Materials report identified minimal hazardous waste. No asbestos materials identified. No NORM identified during operational life of Goldeneye. Materials identified incl: F-gases (HVAC and white goods) Pb and Cr based paints used on steel Low level ionising sources in smoke detectors	Assessment of potential contaminants prior to arrival onshore. Possible quarantine of contaminated equipment on the barge/vessel for segregation. If returned to shore it will be transported and disposed of in line with the relevant regulations which will be detailed in the WMP. The disposal yard selected will have all the required permits and consents in place to handle, store and dispose of the Goldeneye waste. Shell to audit the disposal yard and key third party sites used.	B2 Minor	N/A	N
Unplanned event	Dropped object during operations: small objects such as a container or module)	Environmental impacts: Seabed disturbance.	Approved lifting plans in place. Experienced contractors will be used. PON2 reporting for dropped object into the sea. Object would be recovered if possible. Debris survey will be carried out.	B2 Minor Likelihood B	Minor risk	N
	Dropped object during operations: small objects such as a container or module).	Socio-economic: potential exclusion of fishing activity from a small area if object cannot be recovered.	Approved lifting plans in place. Experienced contractors will be used. PON2 reporting for dropped object into the sea. Object would be recovered if possible. Debris survey will be carried out.	A1 Slight Likelihood B	Minor risk	N
	Dropped object during operations: large object such as topsides or jacket.	<u>Environmental impacts:</u> Localised seabed disturbance resulting in some lethal/sub-lethal effects on benthic and epibenthic fauna. Risk of dropped jacket increased due to weight of marine growth.	Approved lifting plans in place. Experienced contractors will be used. PON2 reporting for dropped object into the sea. Object would be recovered if possible. But if not, would not comply with OSPAR clean seabed requirement. Debris survey will be carried out.	B2 Minor Likelihood A	Negligible risk	N
	Dropped object during operations: large object such as topsides or jacket.	<u>Socio-economic impacts:</u> Expect that given size the object could not be recovered resulting in fishing vessels being excluded from a very small area.	Approved lifting plans in place. Experienced contractors will be used. PON2 reporting for dropped object into the sea. Object would be recovered if possible. Debris survey will be carried out.	A1 Slight Likelihood A	Negligible risk	N
	Liquid discharges from topsides during lifting	Possibility of small discharges of liquids entrained on the topsides. Impact on water column.	All equipment drained as part of preparatory works prior to lifting.	A2 Minor Likelihood C	Minor risk	N

## Decommissioning of pipelines (PL1978 and PL1979), the SSIV control hoses and spools

Usage of Space	Onshore length of pipelines decommissioned <i>in situ</i> .	Mean low water spring to Valve pit (boundary) minimum depth of burial is at least 1 m. There is no anticipated environmental impacts should the pipeline collapse in the future (discussed with the council and Scottish Natural Heritage (SNH) who are in agreement).	Pipeline is buried to at least 1 m.	B0 No effect	N/A	N
Usage of Space	Nearshore length of pipelines decommissioned <i>in situ</i> (0 to 20 km) with no remediation.	Along the pipeline there are areas with depth of cover less than 0.6 m. No spans or exposures identified along this section in 2009. Evidence of natural backfilling. Area of moderate mobility. Low risk of additional exposures to occur due to depth of trench and that trench continues to be backfilled with mobile sand.  Medium sensitivity assigned due to high density of small boat fishing.	Post decommissioning pipeline status surveys to be carried out.	B0 No effect	N/A	N
Disruption to the soil and subsoil	Nearshore length of pipelines (production and MEG) decommissioned <i>in situ</i> (0 to 20 km) with remediation (addition of rock cover to areas within the Southern Trench pMPA where depth of burial is < 0.6 m).	<u>Environmental impacts:</u> Introduction of hard substrate to a sandy habitat, could cause small localised changes to the ecosystem in area impacted. Environmental sensitivity high as this impact is within the Southern Trench pMPA.	Post decommissioning pipeline status surveys to be carried out and contingency rock placement discussed with BEIS, SNH and SFF. Where rock cover is required this to be minimised through project planning.	C2 Moderate	N/A	N



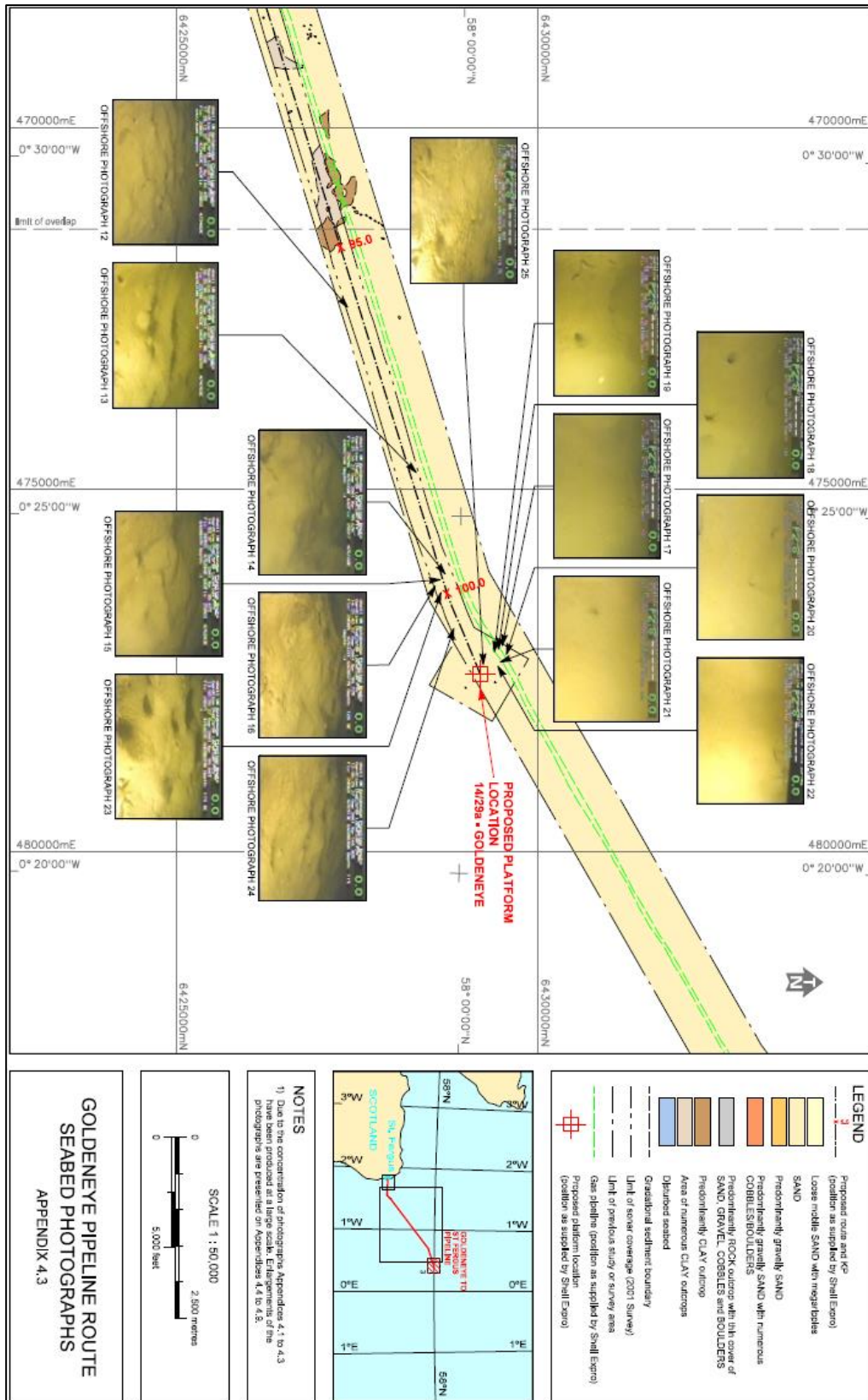
		<b>Socio-economic impacts:</b> This rock could be larger than SFF would recommend due to mobility of seabed, however only associated with small area. Possible exclusion of fishing gear area associated with rock cover.	Post decommissioning pipeline status surveys to be carried out and contingency rock placement discussed with BEIS, SNH and SFF.	B1 Minor	N/A	N
Disruption to the soil and subsoil	Trenching and burying of offshore surface laid section of production pipeline: KP 20 to the platform (82 km section).	Localised seabed disturbance along length of pipeline resulting in some lethal/sub-lethal effects on benthic and epibenthic fauna. Possible smothering of some organisms following settlement of re-suspended particles. Recovery dependent on type of seabed and species present. Area of impact is relatively small.  High sensitivity for section within Southern Trench pMPA. Beyond 12 nm impact rating is B2 (Minor).	Work procedures in place.	C2 Moderate	N/A	N
	Addition of rock cover to three pipeline crossings occurring on the offshore section of the production and MEG pipelines and at the platform end of these pipelines. Existing mattresses at the crossing will be left <i>in situ</i> .	<b>Environmental impacts:</b> Increase to existing area over which hard substrate has been introduced to a naturally sandy habitat, could cause small localised changes to the ecosystem in area impacted.	Minimise volume of rock to be added.	B2 Minor	N/A	N
	Addition of rock cover to three pipeline crossings occurring on the offshore section of the production and MEG pipelines and at the platform end of these pipelines. Existing mattresses at the crossing will be left <i>in situ</i> .	<b>Socio-economic impacts:</b> Localised permanent change of seabed availability to fishing activity. Though increase of footprint of area from which they are excluded will be small.	Minimise volume of rock to be added.	B2 Minor	N/A	N
ASPECT	PROJECT ACTIVITY / SOURCE OF IMPACT	POTENTIAL IMPACTS / OBSERVATIONS	MITIGATION MEASURES, SAFEGUARDS AND CONTROLS	IMPACT SIGNIFICANCE	ENVIRONMENTAL RISK - UNPLANNED	SCOPE FOR IMPACT ASSESSMENT?
Usage of Space	Decommissioning of trenched and buried offshore section of MEG pipeline (from KP 20 to the platform).	No impacts identified as this length of MEG pipeline is currently trenched and buried.		B0 No effect	N/A	N
Disruption to the soil and subsoil	Cut and lift operations to recover the spools (4" and 20") between the platform and the SSIV and the unburi (transition point) platform end of the MEG pipeline.	Cut and lift activities could lead to temporary localised sedimentation with potential to smother some organisms.		B1 Slight	N/A	N
Fluids and other materials into water	Recovery of the SSIV control hoses	Releases of hydraulic fluids (if cut and removed). Localised impact on water column.		B1 Slight	N/A	N
	Decommissioning pipelines <i>in situ</i> could result in small releases of inhibited fresh water at the platform end of the pipelines.	Discharge of flushing fluids (inhibited freshwater containing corrosion inhibitors, biocides etc.) Only at pipeline ends as no cutting of mid line exposed sections. It is expected that by now active components have broken down.  End to be fitted with a blind flange once disconnected from the manifold - small discharge.	Both pipelines have been flushed and cleaned in line with BAT/BEP procedures to minimise contaminant concentrations remaining. Complied with Offshore Chemicals Regulations.	B0 No effect	N/A	N
	Discharges following eventual degradation of the pipeline	Following pipeline degradation, will have release of inhibited freshwater into the surrounding environment. Unlikely to be measurable in sediment, benthic communities or fish.	Chemical use complied with Offshore Chemicals Regulations.	B0 No effect	N/A	N
Use of resources	Production of rock	Use of finite resources.	Optimise rock cover volumes to be used.	B1 Slight	N/A	N
<b>Decommissioning of protective structures</b>						
Disruption to the soil and subsoil	Recovery of mattresses and grout bags within 500m safety zone.	Some localised seabed disturbance at mattress locations resulting in possible smothering of some organisms following settlement of re-suspended particles. Recovery dependent on type of seabed and species present. Area of impact is relatively small and out with any designated areas. Impacted species are generally considered to be widespread throughout the area.	Optimise work procedures.	B1 Slight	N/A	N
Usage of space	Mattresses and grout bags left on the seabed (at crossing and transitions points) and are already covered by rock.	Potential snagging hazard.	Burial status at the crossings and transition point will be monitored as part of the legacy obligations	B1 Slight	N/A	N
Onshore activities	Waste - disposal of recovered grout bags and mattresses (potentially they might be repurposed)	Disposal to landfill - finite resource.	Recovered mattresses and grout bags will only be put to landfill if an alternative use cannot be identified. Waste hierarchy will be followed: reduce, reuse, recycle. All waste will be handled and disposed of in line with regulations which will be detailed in the WMP.	B1 Slight	N/A	N
<b>Overtrawl Trial and Debris Clearance Survey</b>						



Disruption to the soil and subsoil	Debris clearance surveys (chain mats) and overtrawl trials at 500 m exclusion zone. Area impacted will likely extend outside the 500 m zone to allow for turning of fishing vessel (and gear) and also to capture area impacted by HLV anchors which are expected to be positioned out with the 500 m zone.	Seabed disturbance, increased suspended sediment, impact on benthic species, their disturbance and loss.		B2 Minor	N/A	N
	Debris clearance surveys (chain mats) and overtrawl trials along the pipeline routes (whole length).  Impact rating based on High sensitivity seabed within the Southern trench pMPA. Beyond 12 nm impact rating is B2 (Minor)	Seabed disturbance, increased suspended sediment, impact on benthic species, their disturbance and loss.		C2 Moderate	N/A	N



## Appendix C: Seabed Photographs Along Pipeline





## ABBREVIATIONS

A&C	Atlantic and Cromarty
ACOPS	Advisory Committee On Protection of the Sea
BAP	Biodiversity Action Plan
BEIS	Department for Business, Energy and Industrial Strategy
CA	(Goldeneye) Comparative Assessment
CCS	Carbon Capture and Storage
CH <sub>4</sub>	Methane
CNS	Central North Sea
CoP	Cessation of Production
CO <sub>2</sub>	Carbon Dioxide
dB	Decibell
DECC	Department of Energy and Climate Change
DoB	Depth of Burial
DP	(Goldeneye) Decommissioning Programmes
DSV	Dive Support Vessel
EA	(Goldeneye) Environmental Appraisal
EC	European Commission
EIA	Environmental Impact Assessment
ENVID	ENVironmental Impact iDentification
EPS	European Protected Species
ESAS	European Seabirds At Sea
EUNIS	European Nature Information System
F-gas	Fluorinated Greenhouse Gas
FPSO	Floating Production, Storage and Offloading
GHG	Greenhouse Gases
GIS	Geographical Information Systems
GMAS	(Shell's) Global Marine Assurance System
HLV	Heavy Lift Vessel
HSSE	Health, Safety, Security and Environment
Hz	Hertz
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
Kg	Kilograms
kHz	Kilo Hertz
km	Kilometres
KP	Kilometre Point
LAT	Lowest Astronomical Tide
m	Metres
MARPOL	International Convention for the Prevention of Pollution from Ships
MBES	Multi Beam Echo Sounder
MDAC	Methane Derived Authigenic Carbonate
MEG	MonoEthylene Glycol
MLWS	Mean Low Water Springs
MMS	Minerals Management Service
MPA	Marine Protected Area
MS	Marine Scotland
NCES	Natural Capital and Ecosystem Services
NCMPA	Nature Conservation MPA
nm	Nautical Miles
NNS	Northern North Sea
NOAA	National Oceanic and Atmospheric Administration
NO <sub>x</sub>	Nitrogen Oxides
NORM	Naturally Occurring Radioactive Material
NS	North Sea
NUI	Normally Unattended Installation
OBM	Oil Based Mud
OCIMF	Oil Companies International Marine Forum
OGA	Oil and Gas Authority
OGUK	Oil and Gas UK
OiW	Oil in Water
OPEP	Oil Pollution Emergency Plan



OSPAR	Oslo/Paris Convention
OVIQ	OCIMF Vessel Inspection Questionnaire
OVMSA	Offshore Vessel Managers Self Assessment
PAH	Polynuclear Aromatic Hydrocarbon
PFOS	PerFluoroOctyl Sulphonate
PL	Prefix for OGA pipeline numbering system
PMF	Priority Marine Features
pMPA	Proposed MPA
PPC	Pollution Prevention and Control
ppm	Parts Per Million
PSU	Practical Salinity Unit
PTS	Permanent Threshold Shift
PUI	Permanently Unattended Installation
rms	Root Mean Square
ROV	Remotely Operated Vessel
ROVSV	ROV Support Vessel
SAC	Special Area of Conservation
SBP	Sub Bottom Profiler
SCANS	Small Cetacean Abundance in the North Sea
SEL	Sound Exposure Level
SFF	Scottish Fishermen's Federation
SNH	Scottish Natural Heritage
SOPEP	Shipboard Oil Pollution Emergency Plan
SOSI	Seabird Oil Sensitivity Index
SO <sub>2</sub>	Sulphur Dioxide
spp.	Non-determined species
SPA	Special Protection Area
SPL	Sound Pressure Level
SSIV	Sub Sea Isolation Valve
SSS	Side Scan Sonar
te	tonnes
THC	Total Hydrocarbon



TTS	Temporary Threshold Shift
UK	United Kingdom
UKCS	UK Continental Shelf
UKHAP	UK Habitats Action Plan
UKOOA	UK Offshore Operators Association
VMS	Vessel Monitoring System
VOC	Volatile Organic Compounds
WBM	Water Based Mud
WMP	Waste Management Plan
WONS	Well Operations Notification System
μPa	Micro Pascal