Cadet Field

Environmental Statement

Licence P.1758 (UKCS)

Ref No D/4234/2019 - May 2019

			Marten Meynell Digitally signed by Marten Meynell Date: 2019.05.29 09:18:39 +01'00'	Nichola Lacey Digitally signed by Nichola Lacey Date: 2019.05.29 09:02:04 +01'00'	Marten Meynell Digitally signed by Marten Meynell Date: 2019.05.29 09:19:08 +01'00'	
A03	29/05/2019	Issued for use	MM	NL	MM	-
A02	27/05/2019	Issued for use	NL	EH	MM	-
A01	21/05/2019	Issued for use	DR	KC	MM	-
R01	26/04/2019	Issued for Review	DR	KC	MM	-
Rev	**Date**	**Description**	**Issued By**	**Checked By**	**Approved By**	**Client Approval**

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ENVIRONMENTAL STATEMENT DETAILS

Section A: Administrative Information

A1 – Project Reference Number

Number: D/4234/2019

A2 - Applicant Contact Details

Company name: Equinor UK Limited

Contact name: Susannah Betts

Contact title: Lead Environmental Engineer, SSU UKI ENV

A3 - ES Contact Details (if different from above)

Company name:

Contact name:

Contact title:

A4 - ES Preparation

Please confirm the key expert staff involved in the preparation of the ES:

Name	Company	Title	Relevant Qualifications/Experience
Susannah Betts	Equinor UK Limited	Lead Environmental Engineer, SSU UKI ENV	Over 25 years in oil and gas related environmental management on and offshore
David Renner	Xodus Group	Senior Environmental Consultant	10 years' experience working as a marine environmental consultant / environmental scientist BSc (Hons) Marine Biology
Marten Meynell	Xodus Group	EIA Project Manager	IEMA Affiliate 11 years' experience as Environmental Consultant/Environmental Advisor MSc Marine Resource Development and Protection BA (Hons) Sociology with Spanish

A5 - Licence Details

a) Please confirm licence(s) covering proposed activity or activities

Licence number(s): P1758

b) Please confirm licensees and current equity

Licensee	Percentage Equity
Equinor UK Limited	65.1111%
JX Nippon Exploration and Production (U.K.) Limited	20.0000%
Siccar Point Energy U.K. Limited	8.8889%
ONE-Dyas Mariner Limited	6.0000%

Section B: Project Information

B1 - Nature of Project

a) Please specify the name of the project.

Name: Cadet Field Development

b) Please specify the name of the ES (if different from the project name).

Name:

c) Please provide a brief description of the project.

The Cadet Field is an oil field located in the northern North Sea in United Kingdom Continental Shelf (UKCS) Block 8/15a. The target reservoir (Heimdal) extends from the adjacent Mariner Field, which is already being developed as part of the Mariner Area Development. The Project described in this document is essentially the re-targeting of four wells which were previously planned to be drilled into the Heimdal reservoir in the Mariner Field to instead be drilled into the Heimdal reservoir in the Cadet Field. The wells will all be drilled from the existing Mariner A production, drilling and quarters (PDQ) platform in the adjacent Block 9/11a.

Activities within the scope of this ES are the drilling of three production wells and one water injection well, and the operation of the proposed wells until their end of economic life. The wells will be the same design as those currently being drilled in the Mariner Field. Maximum well length is expected to be approximately 5,300 m measured depth (MD). All wells are expected to be directionally drilled into the Heimdal reservoir. All production wells will incorporate electric submersible pumps (ESPs) and may require the injection of a diluent (a lighter oil supplied from tankers and stored on Mariner B) to ensure flow assurance. Reservoir fluids will be routed to the existing production train of Mariner A. Following separation, liquid hydrocarbons will be exported via an existing 2.8 km pipeline to Mariner B, a floating storage unit (FSU) permanently on station in the Mariner Field, and then to shore via tankers. Produced water will be re-injected into several planned water injection wells as well as the proposed Cadet water injector. Gas will be combusted on Mariner A for power generation, replacing some of the expected requirement to import fuel gas. There will be no continuous flaring at Mariner A by the time the Cadet wells come online. It is anticipated that each production well will require two workover operations during its life, the water injector is not anticipated to require a workover.

B2 - Project Location

a) Please indicate the offshore location(s) of the main project elements (for pipeline projects please provide information for both the start and end locations).

Quadrant number(s): 9

Block number(s): 11a

Development wells tophole location

Latitude: 59° 35' 21.03" N Longitude: 01° 03' 25.37" E

Distance to nearest UK coastline: 134 km, Shetland

Distance to nearest international median line: 45 km to UK/Norway median line

B3 - Previous Applications

If the project, or an element of the project, was the subject of a previous consent application supported by an ES, please provide details of the original project

Name of project: Mariner Area Development

Date of submission of ES: 13th July 2012

Identification number of ES: D/4145/2012

NON-TECHNICAL SUMMARY

Introduction

This Environmental Statement (ES) presents the findings of the Environmental Impact Assessment (EIA) conducted by Equinor UK Limited (Equinor (formerly known as Statoil)) on behalf of the licence group for the development of the Cadet oil field in United Kingdom Continental Shelf (UKCS) Block 8/15a in the northern North Sea. The field will be developed with three producing wells and one water injector well. All wells will be extended reach wells drilled and produced from the Mariner A platform located in the adjacent UKCS Block 9/11a. Since the Mariner A platform will be the location of all surface activity, this is the location that is most relevant to the EIA. The platform is located approximately 134 km southeast of the Shetland Islands and 45 km west of the UK/Norway median line. It is planned to produce oil from the Mariner Field which forms part of the Mariner Area Development.

Project description

The first Cadet production well is due to be drilled and completed in Q2 2026, with production starting from this well in Q3 2026. The last well is due to be drilled and completed in Q1 2028. Production is expected to continue from Cadet until 2049.

The extended reach development concept for the four wells was selected over a subsea tieback concept because it is the safest and most economical option as no additional infrastructure is required.

The four wells will be similar in design, with a maximum measured depth of approximately 5,300 m (design will be confirmed at the permit stage). Wells will all be deviated extended reach (long wells that deviate from the vertical). It is likely that some or all of the wells will be drilled from well slots that have already been drilled as part of a previous programme, and in this case the new wells will be started by milling out through the side of the 20" steel casing that lines the existing well. The production wells will be completed with mechanisms to optimise flow, including ESPs. The water injection well will be completed with a downhole safety valve and pressure and temperature gauges and will be capable of injecting water above reservoir fracture pressure.

Wells will be drilled with a combination of water based mud and low toxicity oil based mud. If the wells are drilled with a new tophole section starting at the seabed rather than using a pre-drilled well slot, the water based mud and cuttings from the 34" tophole section will be discharged directly from the wellbore to the seabed. Once the 28" conductor is in place, mud and cuttings will be returned to the platform. If pre-drilled well slots are used, all drilling returns will be to the platform. Mud will be separated from the cuttings using shale shakers and re-used. Cleaned cuttings with residual water based mud adhering to them will be discharged overboard. Cleaned cuttings with residual low toxicity oil based mud, or water based mud that contains reservoir hydrocarbons, will be cleaned using thermo-mechanical desorption. This will reduce the oil on cuttings concentration to <1%, whereupon the cleaned cuttings will be discharged overboard.

If the wells are drilled with a new tophole section rather than using a pre-drilled well slot there will be a minimal discharge of cement at the seabed during cementing of the 28" conductor. In all cases, following cementing operations there will be a discharge of very diluted residual cement slurry from the cement unit on the platform following cleaning.

Chemical use will depend on the final drilling and cement package, will be in line with Equinor's chemical selection policy and will be presented at the permitting stage.

Visibly clean returns from the well will be routed directly overboard via the open drains caisson, which incorporates a skimmer for residual oil removal. Discharged water will be sampled in line with permit conditions and the average oil in water concentration will not exceed 30mg/l. Reservoir fluids produced during final clean up will be routed to the test separator. Separated water will proceed to the recycled oil sump for manual sampling of oil in water, followed by discharge to sea via the open drains caisson, which incorporates a skimmer for residual oil removal.

Production from the Cadet Field will undergo three-way separation (meaning the three fluids produced from the wells (oil, gas and water) will be separated out from each other) on Mariner A. Oil will be exported via pipeline to the Mariner B Floating Storage Unit (FSU), from which it will be exported to shore via shuttle tanker.

Cadet gas will be used on Mariner A for power generation. There will be no flaring on Mariner A by the time the Cadet wells are drilled.

Produced water will be re-injected via the Cadet water injection well and several Mariner Field water injection wells. Produced water reinjection is expected to be online at least 95% of the time. When it is not available, produced water will be cleaned to below 30 mg/l oil in water and discharged to sea.

Production is expected to commence in 2026 and cease in 2049. The production figures presented here include the diluent that will be injected into the wells and will be re-produced from the wells and will be mixed inextricably with the reservoir oil. Oil production is expected to be 634 m^3 (607 tonnes) per day in 2026 and increase to a maximum of 1,306 m^3 (1,245 tonnes) per day in 2028. Production will then decline rapidly to 262 m^3 (249 tonnes) per day in 2030, followed by a more gradual decline to 18 m^3 (17 tonnes) per day in 2049. Oil production from the Cadet Field in combination with the injected diluent and the existing production from the Mariner Field is not expected to exceed the maximum production previously consented for the Mariner Field alone. Gas production will follow the same pattern as oil production, peaking at 26,660 m^3/day in 2028. Produced water is also expected to peak in 2028 at 4,404 m^3/day and then decrease more gradually than oil production until 2049. Barring periods of produced water reinjection downtime, all produced water will be reinjected. If produced water exceeds the capacity of the injection wells, production from wells producing a high proportion of water cut will be reduced to keep produced water below the injection capacity.

As well as the electric submersible pumps previously mentioned, flow assurance measures may include the injection of a diluent (a light oil) into the production wells upstream of the pumps and into the Mariner A production train to improve flow. Scale inhibitor and emulsion breaker may also be injected into the wells. These chemicals will be specified at the permit stage.

Decommissioning of the Cadet Field will likely occur at the same time as decommissioning of the Mariner Area Development as a whole. Decommissioning will be conducted in line with government policy and regulations in force at the time.

There will be a small increase in vessel and helicopter trips to the Mariner Area Development due to the Cadet Field Development. During drilling and completion operations there will be an additional two supply vessel return trips and eighteen helicopter return trips to Mariner A per month. During operation of the field there is no increase in vessel or helicopter trips anticipated, but an additional one supply vessel return trip and two helicopter return trips to Mariner A per month have been assumed as contingency.

Environmental baseline

The environmental baseline conditions at the Mariner A platform (where all Project activities will occur) are summarised in the table below.

Physical environment
The Mariner A platform is located in the open sea in water depth of approximately 105 m below lowest astronomical tide. Seabed sediments comprise fine sand with occasional clay outcrops. Sediment contamination is low and representative of North Sea background levels.
Plankton
The phytoplankton community is dominated by dinoflagellates of the genus *Ceratium* (*C. fusus*, *C. furca* and *C. lineatum*) and diatoms such as *Thalassiosira* spp. and *Chaetoceros* spp. Two main phytoplankton blooms occur annually in May and August. Zooplankton is dominated by calanoid copepods, in particular *Calanus* spp. and *Acartia* spp. The historically abundant *C. finmarchicus* has declined dramatically over the last 60 years likely due to changes in seawater temperature and salinity. It has largely been replaced by boreal and temperate Atlantic and neritic (coastal water) species, in particular *C. helgolandicus*.
Benthos
The benthos at and around Mariner A is characterised by a slightly lower density of individuals but a slightly higher number of species than is typical for the area. The community appears generally homogenous and the most abundant species at most stations sampled were the polychaete *Spiophanes bombyx* and the brittlestar *Ophiocten affinis*. Small variations in community structure across the stations sampled were deemed to be due to natural variation in water depth and sediment type. No evidence of Annex I habitats or communities of conservation value were recorded during any of the surveys conducted close to the Mariner A platform.

Fish
The Mariner A platform is located within spawning grounds for cod, haddock, *Nephrops* (Norway lobster), Norway pout (high intensity), saithe, sandeel and whiting. The area also supports nursery grounds for anglerfish, blue whiting (high intensity), European hake, haddock, herring, ling, mackerel, *Nephrops*, norway pout, sandeel and whiting.
Seabirds
Seabird sensitivity in the region of Mariner A is generally low (Webb *et al*., 2016). There was no data available for some blocks surrounding the platform location for April, May and October to December. Blocks 8/10 and 8/15 (to the west and northwest of Block 9/11 where Mariner A is located) are assigned extremely high sensitivity for December, based on the sensitivity recorded for the two blocks adjacent to the west. The Mariner A platform is located approximately 134 km from the nearest UK coast and is therefore remote from sensitive seabird breeding colonies.
Marine mammals
Harbour porpoise, minke whale, white-beaked dolphin, Atlantic white-sided dolphin and killer whale have been recorded in the vicinity of Mariner A. Seasonal density ranges from high to low for harbour porpoise, minke whale and white-beaked dolphin, from moderate to low for Atlantic white-sided dolphin and is low all year for killer whale. All species are listed as Scottish Priority Marine Features and harbour porpoise is listed under Annex II of the Habitats Directive. The Mariner A platform is located approximately 134 km from the nearest landfall so it is unlikely that significant numbers of seals will be present. Density maps based on tagging telemetry data predict that density of both grey and harbour seals within the vicinity of the platform is between 0 and 1 seals per 25 km^2.
Conservation
There are no protected sites or known sensitive habitats within 40 km of the Mariner area. The closest area of conservation interest is the Braemar Pockmarks Special Area of Conservation (SAC) located 69 km to the south and designated for the Habitats Directive Annex I habitat "submarine structures made by leaking gases". The closest onshore protected site is Sumburgh Head Special Protection Area (SPA), located 132 km to the northwest. This site is designated under the Birds Directive for supporting a population of 700 pairs of Arctic tern, approximately 1.6% of the British breeding population and a population of European importance. The site also qualifies due to regularly supporting at least 20,000 seabirds, and 35,000 during the breeding season. Four Habitats Directive Annex II species are found in UK waters; harbour porpoise, bottlenose dolphin, grey seal and harbour seal. As noted above, seals are not expected to be present in significant numbers and bottlenose dolphin, while resident off the east coast of Scotland around the Moray Firth, has not been recorded at Mariner A. Harbour porpoise is the only Annex II species which is likely to be present in significant numbers.
Other sea users
Commercial fishing effort and catch value in the vicinity is low compared to other areas of the North Sea, with most effort spent on demersal trawling and the highest catch and value contributed by demersal species such as haddock and cod. The pelagic fishery value fluctuates depending on the herring and mackerel catch. The Mariner A platform is located 2.8 km southeast from the Mariner B FSU. Outside of the Mariner Area Development the closest oil and gas infrastructure is the Beryl B platform located 26 km east of Mariner A. There is no known military activity in the vicinity. Shipping density is very low, with 582 vessels per year passing within 10 nautical miles (nm) of Mariner A, and 15 vessels per year passing within 2 nm. Mariner A is linked to the Heimdal platform in the Norwegian sector by fibre optic cable. Aside from this the nearest cable (the TAT 14 seg. (a) cable) is located 36 km away. The closest renewables development is the Nova Innovation Ltd tidal lease site located 160 km to the northwest. The closest known wreck is located approximately 14.3 km to the south.

Environmental impact assessment methodology

The nature and scale of the potential environmental issues due to the Cadet Field Development are well understood since drilling of development wells from the Mariner A platform and subsequent production of oil via the platform have previously been subject to an approved Environmental Impact Assessment and several drilling and production permits.

The known issues were therefore reviewed in order to identify any potential for significant environmental impacts beyond what has previously been assessed and approved. The issues identified as requiring re-assessment were then discussed with the Regulator (the Offshore Petroleum Regulator for Environment and Decommissioning - OPRED) to ensure that all stakeholder concerns were addressed within the impact assessment. An informal scoping meeting with OPRED was held on the 23rd April 2019.

The potential impact sources that were assessed are:

- Discharges to sea;
- Seabed disturbance;
- Underwater noise;
- Interaction with other sea users;
- Waste generation;
- Atmospheric emissions; and
- Accidental events.

The potential for cumulative impacts in combination with third-party projects was assessed, as was the potential for transboundary impacts.

Environmental impact significance was assessed with reference to the following guidance:

- Institute of Ecology and Environmental Management (IEEM) guidelines for marine impact assessment;
- Marine Life Information Network (MarLIN) species and ecosystem sensitivities guidelines;
- Scottish Natural Heritage (SNH) handbook on EIA;
- Institute of Environmental Management and Assessment Guidelines for EIA; and
- OPRED EIA Guidance 'The Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended) – A Guide' (rev 5, February 2019).

Information was provided to allow the Competent Authority to perform an Appropriate Assessment of the implications of the project on a Natura sites (SACs and SPAs) in view of site conservation objectives and the overall integrity.

The following supporting studies were used to inform the assessment:

- Site-specific seabed surveys;
- Drill cuttings dispersion modelling;
- Accidental hydrocarbon release modelling; and
- Underwater noise modelling.

Discharges to sea

Discharges to sea will include mud, cuttings and cement discharges to the seabed and into the upper water column during the drilling phase, and discharges of produced water and production chemicals into the upper water column during the operational phase. Potential impacts could include smothering of benthic fauna and fish spawning grounds in the vicinity of the platform and toxicity to pelagic organisms from water column discharges.

Discharge modelling indicated seabed impacts from drilling discharges would be limited to within approximately 0.5 km of the discharge point. Discharge of thermo-mechanically cleaned cuttings into the water column was predicted to have local and transient impacts. Produced water discharge was not predicted to present a significant risk to environment due to the massive dilution that would occur upon discharge, the lack of sensitive receptors and the produced water re-injection (PWRI) system being expected to achieve 95% uptime.

Due to the limited scale of the predicted impacts, cumulative and transboundary impacts and impacts on protected features were not predicted. Residual impact on the seabed was predicted to be minor, and residual impact on the water column was predicted to be negligible. As such, significant impacts were not predicted.

Seabed disturbance

Aside from the discharge of drill cuttings discussed under discharges to sea section above, the Cadet Field Development will not cause any disturbance to the seabed additional to what has already been assessed for the Mariner Area Development Project. As such, no significant impacts, impacts on protected features, cumulative impacts or transboundary impacts were predicted.

Underwater noise

Noise pollution has the potential to impact upon marine species if it sufficiently exceeds ambient levels by causing changes in behaviour, auditory-induced injury, or, in extreme cases, mortality.

The results of noise modelling previously conducted for the Mariner Field Environmental Statement indicated that noise emissions from Cadet Field Development activity would be too low to cause injury or disturbance to cetaceans, which were the only at-risk receptors. While the Cadet field will be developed at the same time that the Mariner Field development is ongoing, all drilling for both fields will at that time be performed using the single drilling unit on the Mariner A platform. As such there was deemed to be no scope for simultaneous drilling operations and therefore no potential for cumulative impacts from this source. There were no other known drilling programmes identified as occurring in the area at the same time and therefore no cumulative impacts expected.

Due to the lack of significant impacts, no transboundary impact was predicted and there was considered to be no potential for significant impact to European Protected Species (EPS – species listed in Annexes II and IV of the Habitats Directive, including all cetaceans which are the main at-risk receptor for noise impacts), or protected sites for which these species are designated. As such, an EPS licence was considered unnecessary.

Other sea users

Other sea users included in the assessment commercial fishing vessels and commercial shipping vessels. Due to the lack of new surface or seabed infrastructure associated with the Project, the only potential impact was considered to be the increase in vessels visiting the Mariner A platform. Due to the small number of additional Project vessels expected to be required, and the low fishing effort and commercial shipping activity in the area, significant impacts were not expected.

The potential for cumulative impacts due to the existing vessel traffic visiting Mariner A and Mariner B was recognised. It was concluded that this would not be significant due to the low sensitivity of the receptors and the low level of shipping in the area. Cumulative impacts with third party developments were not expected.

There were no transboundary impacts expected or impacts on protected features.

Atmospheric emissions

Atmospheric emissions have the potential to impact air quality on a local and regional scale, increase the prevalence of acid rain and contribute to global greenhouse gas emissions and climate change.

The Cadet Field Development will not result in any increase in flaring at Mariner A or any increased fuel use for power generation. It is likely to result in a small increase in cold venting of gas from crude tanks (due to the increased production), and a small increase in shuttle tanker, supply vessel and helicopter fuel use. However, the additional production from Cadet is not expected to raise the production from the Mariner Area Development as a whole above the maximum that has already been consented from the Mariner Field alone and as such, impacts from increased production are expected to be within the limits of what has already been assessed during the Mariner Field consenting process.

Emissions due to drilling and production operations from the Cadet Field Development are expected to be extremely minor in the context of the wider Mariner Area Development, which was in turn previously assessed to be not significant in terms of wider UKCS emissions. While the emissions from Cadet will act cumulatively with those from Mariner, this is not expected to be significant given small contribution of Mariner and Cadet emissions to the wider UKCS emissions.

As impacts to local air quality, acid rain production and global climate change are all expected to be not significant, there is no potential for significant impacts on protected features, or for transboundary impacts.

Accidental events

The worst case accidental event is considered to be a well blowout, which modelling predicts could result in significant impacts to coastal protected sites on the east of Shetland, as well as crossing the UK / Norway transboundary line. The likelihood of such an event occurring is however remote, and as such the consequence is expected to be low with residual impact therefore considered not significant.

Additional wells being drilled on the UKCS result in a small increase in risk of cumulative impact. This risk is slightly higher for the Cadet wells compared to drilling the wells into the Mariner Field due to the Cadet field being less well explored and therefore reservoir conditions being less well understood. However, given the remote likelihood of a worst case release, cumulative impact was not considered significant.

Given the low likelihood of a well blowout or other major environmental incident occurring, transboundary impacts and impacts on protected features were not predicted.

Environmental Management

Equinor operates an Environmental Management System (EMS) in accordance with the requirements of ISO14001. The Equinor EMS has been independently verified by Lloyd's Register Consulting and was declared compliant with the OSPAR and associated Department requirements on 18th January 2018.

The operations described within this Environmental Statement fall within the scope of the EMS. It is the aim of Equinor to ensure best environmental practices and procedures are followed and that continual improvement in environmental performance is maintained at all times.

Emergency Response Bridging Documents are prepared for all offshore activities involving contractor facilities and vessels. Management System Interfacing and procedural precedence is defined in contract documents, and for high-risk activities is further clarified by preparation of Management System Interface documents. These documents clearly define the interfaces and establish the agreed arrangements including responsibilities, systems, procedures and practices, for managing health, safety and environment during contracted works.

The mitigation and management measures implemented as part of the proposed Cadet Field Development Project will align with those detailed in the existing commitments register for the Mariner Field Development as both fields will be developed together as part of the Mariner Area Development.

Equinor considers that the Project is in broad alignment with the objectives and policies set out in the Scottish National Marine Plan across the following policy topics: natural heritage, air quality, cumulative impacts and oil and gas.

Conclusions

The risks and impacts associated with the Cadet Field Development Project are almost identical to those already assessed as being not significant for the Mariner Field Development. Based on the assessment summarised above, the drilling of the wells into the Cadet field and production of the wells via the Mariner A platform will result in very little net change in impacts and risks across the Mariner Area Development as a whole.

While a major accidental event has the potential to significantly affect protected sites and to cross the UK / Norway transboundary line, the likelihood of such an event occurring is remote and as such the residual impact on these receptors is considered not significant.

It is therefore concluded that there are no significant environmental impacts associated with the proposed Project. In considering the requirements of Scotland's National Marine Plan, this conclusion confirms that the

Project will be consistent with the objectives and policies set out, together with the sectoral policies outlined for the oil and gas sector.

The proposed Project is not expected to have likely significant effects on any Natura site. Similarly, there is considered to be no scope for significant risk to the conservation objectives of any National Conservation Marine Protected Areas or Marine Conservation Zones, which are required to be assessed under the Marine (Scotland) Act and the Marine and Coastal Access Act respectively.

The findings and recommendations of this EIA will be carried through by formal commitments which will provide a transparent and auditable means of ensuring the measures identified will be delivered through Equinor's EMS.

1 INTRODUCTION

This Environmental Statement (ES) presents the findings of the Environmental Impact Assessment (EIA) conducted by Equinor UK Limited (Equinor (formerly known as Statoil)) for the development of the Cadet field. The Cadet Field Development project falls into the mandatory EIA category because production from the field is expected to peak at more than 500 tonnes of oil per day. The purpose of the EIA was to assess the potential for significant environmental impacts due to the proposed field development, and ensure that where significant impacts are identified, these are reduced using appropriate mitigation measures to a level that is not environmentally significant.

1.1 The Cadet Field

Cadet is an oil field located in the northern North Sea in United Kingdom Continental Shelf (UKCS) Block 8/15a. However, the field will be developed by wells drilled from the existing Mariner A platform drill centre in the adjacent UKCS Block 9/11a. Since the Mariner A platform will be the location of all surface activity, this is the location that is most relevant to the EIA. The platform is located approximately 134 km southeast of the Shetland Islands and 45 km west of the UK/Norway median line (Figure 1.1). The water depth at the Mariner A platform is approximately 105 m at Lowest Astronomical Tide (LAT).

1.2 Project background

Equinor and its licence partners were awarded Licence P1758 for Block 8/15a in the 26th Seaward Licensing Round in January 2011. Equinor, as the appointed Operator, plans to develop the Cadet field to exploit commercially available reserves.

The interest in Licence P1758 is split as follows:

- Equinor (65.1111%), operator;
- JX Nippon Exploration and Production (U.K.) Limited (20.0000%);
- Siccar Point Energy U.K. Limited (8.8889%); and
- ONE-Dyas Mariner Limited (6.0000%).

The Cadet Field Development will occur in the context of a broader Equinor development campaign as part of the Mariner Area Development. The Mariner Area Development, centred in the adjacent Block 9/11a, commenced with the installation of the Mariner A platform steel jacket in August 2015. To date a number of appraisal wells have been drilled in the Mariner Field, and the future drilling program for the Mariner and Cadet fields currently comprises 69 production wells and 27 water injector wells, all to be drilled from the platform drill centre. Drilling is initially being conducted by the Noble Lloyd Noble (NLN) jack up rig. In Q4 2019 the Mariner A platform drilling unit is scheduled to come online, meaning the two drilling units will be working simultaneously until Q3 2020 when the NLN contract ends.

Once production begins, three-phase separation will occur on the Mariner A platform. Oil will be exported through a 2.8 km export pipeline to a floating storage unit (FSU) called Mariner B, from which it will be transported to shore by shuttle tankers (Figure 1.2). An ES for the Mariner Area Development (Statoil, 2012a) was approved in January 2013.

Subsequent to the Mariner Area Development ES (Statoil, 2012a) approval in 2013, the Mariner Field Development Plan (FDP) that was initially submitted in 2012 (Statoil, 2012b) was revised in 2016 (Statoil, 2016) and is currently the subject of a FDP Addendum (Equinor, 2019a). The Cadet FDP was submitted in May 2019 (Equinor, 2019b). Three of the production wells and one of the water injection wells that were originally planned to target the Heimdal reservoir in the Mariner Field are now planned to target the Heimdal reservoir in the Cadet field. This change has occurred because it is expected to improve Heimdal drainage and the Cadet field is now considered to be within extended-reach drilling range of the Mariner A platform.

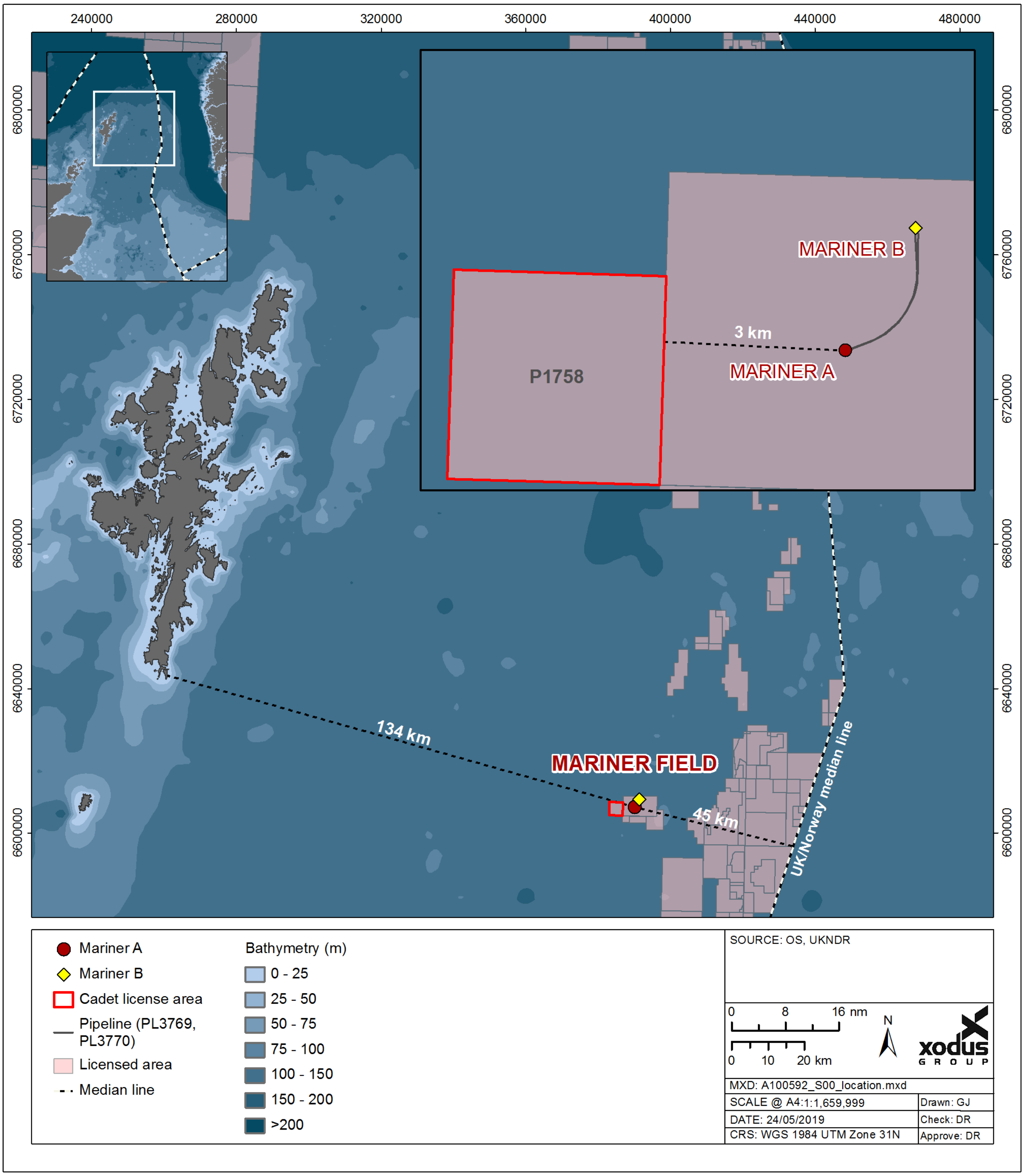

Figure 1.1 Location of the Cadet (P1758) licence area

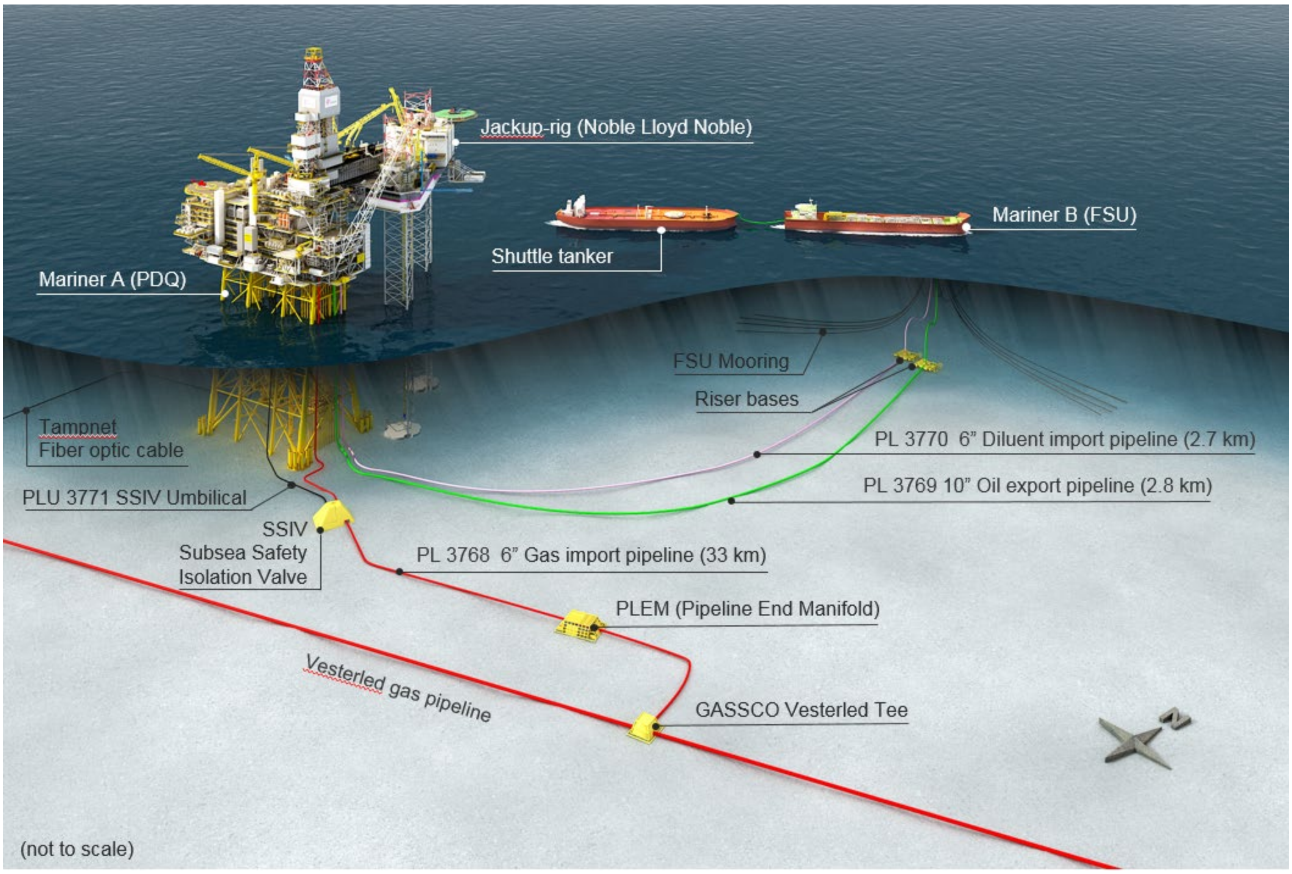

Figure 1.2 Mariner Area development showing crude export line to from Mariner A to Mariner B, and diluent supply line from Mariner B to Mariner A

The P10[1] production forecast from the newly targeted Cadet field exceeds the threshold of 500 tonnes oil per day which triggers the requirement for an EIA (See Section 1.4). While net production across the two fields will be slightly increased by drilling the Cadet wells, production from the Cadet field is likely to be partially offset by three fewer production wells being drilled in the Mariner Field, and a commensurate reduction in peak production from Mariner. Because Cadet is a separate field from Mariner and will have a separate production consent, the decreased production from the Mariner Field cannot be taken into account when assessing the requirement to submit an EIA. An EIA must therefore be submitted to assess the potential environmental impacts associated with the development of the Cadet field.

This ES presents the findings of the EIA conducted for the Cadet Field Development, comprising the drilling of the three production wells and one water injection well, the operation of the wells throughout their predicted lifecycles (including the production that will be routed through the Mariner infrastructure) and the eventual decommissioning of the wells.

1.3 Scope of Environmental Impact Assessment

The EIA that is reported in this ES assessed the potential environmental and socio-economic impacts that could result from development of the Cadet field. The EIA process is integral to the Project and involves: assessing the alternatives considered in Project design, identifying the possible impacts arising from Project activities and developing any control measures necessary to eliminate or minimise such impacts as far as

[1] The P10 production forecast is the result of a probabilistic calculation of the likely hydrocarbon production rate over time that will be achieved from a well or group of wells. It means that there is a 10% chance that the quoted production rate will be exceeded and is therefore a high-case estimate of the likely production.

reasonably practical. The process also provides for stakeholder involvement so that issues can be identified and addressed as appropriate at an early stage, and also ensures that the planned activities comply with environmental legislative requirements and with Equinor's environmental policy.

The EIA considered the risks from both routine activities and accidental events with their possible environmental implications.

Key elements of this ES include:

- A non-technical summary of the ES;
- Description of the background to the Project; role of the EIA and legislative context (this chapter);
- Description of the Project and alternatives considered (Chapter 2);
- Description of the environment and identification of the key environmental sensitivities which may be impacted by the Project (Chapter 3);
- Description of the methods used to identify and evaluate the potential environmental impacts and scope of the EIA (Chapter 4);
- Detailed assessment of key potential impacts, including assessment of potential cumulative and transboundary impacts (Chapter 5);
- Description of the environmental management that will be in place during the Project (Chapter 6); and
- Conclusions (Chapter 7).

The ES is submitted for review to the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED), part of the Department for Business, Energy and Industrial Strategy (BEIS), to inform the decision on whether or not the Project may proceed. As part of the review process, the ES is also subject to formal public consultation.

1.4 Legislation and policy

The EIA reported in this ES has been carried out in accordance with the requirements of the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999, as amended (including by the Offshore Production and Pipelines (Environmental Impact Assessment) (Amendment) Regulations 2017). These Regulations require the undertaking of an EIA and the production of an ES for certain types of offshore oil and gas developments likely to have a significant impact on the environment.

An EIA is mandatory for any offshore oil and gas development that is expected to produce more than 500 tonnes of oil per day or more than 500,000 m^3 of gas per day. An EIA is also required for pipelines greater than 40 km in length or with an overall diameter of more than 800 mm.

The Cadet Field Development is predicted to result in a P10 peak oil production rate exceeding 500 tonnes per day and must therefore be supported by an EIA.

As well as the requirement to carry out an EIA, there are also a number of other key regulatory drivers applicable to the Project, with the key legislation being:

- The Petroleum Act 1998;
- The Petroleum Licensing (Production) (Seaward Areas) Regulations 2008;
- Energy Act 2008, as amended;
- Marine and Coastal Access Act 2009;
- The Conservation of Offshore Marine Habitats and Species Regulations 2017;
- Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001, as amended;
- The Offshore Chemical Regulations 2002, as amended;

- Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005, as amended;
- Pollution Prevention and Control (Scotland) Amendment Regulations 2017;
- The Merchant Shipping (Oil Pollution Preparedness, Response & Co-operation Convention) Regulations 1998;
- The Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008 (as amended);
- The Offshore Installations (Emergency Pollution Control) Regulations 2002;
- Merchant Shipping (Prevention of Oil Pollution) Regulations 1996, as amended;
- Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008;
- International Convention for the Control and Management of Ships' Ballast Water and Sediments; and
- Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015.

1.4.1 Scotland's National Marine Plan

The National Marine Plan (Scottish Government, 2015) provides an overarching framework for marine activity in Scottish waters out to 200 nautical miles (NM), with the aim of enabling sustainable development and the use of the marine area in a way that protects and enhances the marine environment, whilst promoting both existing and emerging industries. This is underpinned by a core set of general policies which apply across existing and future development and use of the marine environment. Policies of particular relevance to the Cadet Project include:

- General planning principle: There is a presumption in favour of sustainable development and use of the marine environment when consistent with the policies and objectives of the Plan;
- Economic benefit: Sustainable development and use which provides economic benefit to Scottish communities is encouraged when consistent with the objectives and policies of this Plan;
- Natural heritage: Development and use of the marine environment must:
    - Comply with legal requirements for protected areas and protected species
    - Not result in significant impact on the national status of Priority Marine Features (PMFs)
    - Protect, and where appropriate enhance the health of the marine area
- Noise: Development and use in the marine environment should avoid significant adverse effects of man-made noise and vibration, especially on species sensitive to such effects;
- Air quality: Development and use of the marine environment should not result in the deterioration of air quality and should not breach any statutory air quality limits;
- Engagement: Early and effective engagement should be undertaken with the general public and interested stakeholders to facilitate planning and consenting processes; and
- Cumulative impacts: Cumulative impacts affecting the ecosystem of the Marine Plan area should be addressed in decision-making and Plan implementation.

Sectoral policies are also outlined in the Plan where a particular industry brings with it issues beyond those set out in the general policies. Policies and objectives relating to the oil and gas sector are detailed in Section 6.6, along with comment on the degree to which the Cadet Project is aligned with these.

1.5 Environmental management

Equinor and its contractors operate their facilities according to the Equinor management system (as modified to reflect local conditions and regulations) and best industry practices. The Equinor UK Health, Safety and Environment (HSE) Policy is presented in Figure 1.3.

Equinor operates an environmental management system (EMS) in accordance with the requirements of ISO14001. The Equinor EMS is subject to biennial, independent verification for alignment with the requirements of ISO14001. The most recent verification for ISO14001:2015 was conducted by Lloyd's Register Consulting Ltd in Q1 2018 and the EMS was declared compliant with the OSPAR and OPRED requirements on 18th January 2018.

The operations described within this ES fall within the scope of the EMS. Equinor aims to ensure best environmental practices and procedures are followed during the proposed operations and that continual improvement in environmental performance is maintained at all times. Further detail on Equinor's environmental management procedures is provided in Section 6.1.

1.6 Stakeholder consultation

Due to the very limited scope of the proposed development, consultation has been limited to one informal meeting with OPRED supplemented by email clarifications. No other stakeholders have been consulted. Further information on the consultation undertaken for the Cadet Project is provided in Section 4.3.

1.7 Data gaps and uncertainties

A number of assumptions have been made to define a basis for impact assessment, since there is still some uncertainty regarding some of the Project specifics. However, the ES has assumed the 'worst case' scenario for impact assessment, and these assumptions are detailed within the Project Description (Chapter 2) and within the relevant assessment chapters. In addition, any gaps in the understanding of the receiving environment have been highlighted in the Environment Baseline in Chapter 3.

1.8 Contact address

Any questions, comments or requests for additional information regarding this ES should be addressed to:

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Direct: +44 (0)7557 970 217

Email: susb@equinor.com

Equinor UK HSE Policy

We aim to always conduct safe, secure operations and respect the environment

We are committed to providing a safe and secure environment for everyone working at our facilities and job sites. Equinor's safety and security vision is zero harm. We provide an environment recognised for its equality and diversity, and we treat everyone with fairness, respect and dignity. We do not tolerate any discrimination or harassment of colleagues or others affected by our operations.

OUR FOCUS AREAS:

- Safety, security and compliance with code of conduct is our priority
- Values, code of conduct and governance framework are integrated into all our activities
- Commitment to continuously improve safety and security culture
- Transparent approach to ethics and compliance

SAFETY IS INTEGRATED IN EVERYTHING WE DO

Every employee and contractor is accountable for safety and security, and it is up to us to demonstrate this commitment every day through our actions. We shall:

- Understand and manage risks
- Look after our colleagues
- Stop unsafe behaviour and activities
- Openly report and learn from all incidents
- Systematically use Compliance and Leadership
- Be visible and engaged in our team's safety and security
- Continuously improve safety and security
- Actively search for weak signals and act

Always Safe
High Value
Low Carbon

Figure 1.3 Equinor's Health, Safety and Environment (HSE) Policy

2 PROJECT DESCRIPTION AND ALTERNATIVES

This chapter describes the proposed production and water injection wells, the production train and the alternatives considered as part of the Project design. The objective of the field development is to exploit hydrocarbon reserves within the section of the Heimdal reservoir located in the Cadet field.

2.1 Consideration of Alternatives

The Mariner Area Development was subject to a multi-stage option selection process as described in the Mariner ES (Statoil, 2012). Development of the Cadet field (then discovery) was not described in Revision 1 of the Mariner Field Development Plan (Statoil, 2016), although the Plan noted that evaluation of the Cadet discovery would continue in order to establish a concept for future development, mentioning the options of direct drilling from Mariner A, a tie-back or a combination of the two concepts.

A separate Field Development Plan has now been submitted for the Cadet Field (Equinor, 2019b). Within Equinor (2019b), the concept for the Cadet Field Development is specified as direct drilling from the Mariner A platform. This is because some of the previously identified resources within the P.1758 (Cadet) licence area are now considered to be within extended reach drilling radius of the Mariner A platform.

Two different development concepts were evaluated for the four Cadet wells - extended reach wells from the Mariner A platform or a subsea tie-back to the Mariner A platform. The selected option is extended reach wells from the Mariner A platform, since drilling from the existing platform is the safest and most economical method to develop the available resources.

2.2 Project overview and schedule

The Cadet Field Development as assessed in this ES will consist of drilling and completing four wells (three production wells and one PWRI well) and operation of the field until its commercially available reserves are exhausted, which is currently predicted to be in 2049.

Additional drilling may occur in future in order to efficiently drain the field. It is likely that the production wells will be sidetracked once their initial completions have stopped producing oil at economically viable rates; there is also potential for new wells to be spudded. These plans are currently speculative however, and as such are not covered in this ES.

As discussed in Section 1.2, the Cadet Field Development comprises a small part of the wider Mariner Area Development. The Mariner Area Development has already been assessed and approved, however because the Cadet Project will be completely dependent on Mariner infrastructure for the drilling of the wells and the subsequent operational period it is not possible to consider the Cadet Development in compete isolation from the Mariner Area Development. Where necessary, this ES will therefore revisit activities that have already been assessed in the Mariner Area Development ES.

The schedule for the proposed Cadet Development is presented in Table 2.1. The Mariner Area hook up and commissioning has been ongoing since July 2017, the current year of activity is shown in the schedule to provide context for the proposed Cadet activities. Likewise, drilling activities have been ongoing at Mariner since 2016, and are expected to continue until 2030. Where continuous activities span several years, the intervening years are denoted in the schedule by double borders which are broken by the activity.

The first of the Cadet wells (COP-01, which will be a producer) is planned to be drilled and completed in Quarter 2 (Q2) 2026 and production from the Cadet field is expected to commence via this well in Q3 2026. The subsequent three wells are planned to be drilled and completed between Q1 2027 and Q1 2028, with each of the wells coming online (either producing or injecting water) in the quarter following completion.

All four wells will be drilled by the drilling unit installed on the Mariner A platform. The well designs for the producers and the injection well will be the same as those used for the Heimdal reservoir production and injection wells being drilled in the Mariner Field, the designs are discussed in Section 2.3.1.

The production wells are each expected to take approximately 36 days to drill and 14 days to complete, the water injection well is expected to take 35 days to drill and 11 days to complete.

Table 2.1 Field development schedule

Project activity		2019				2026				2027				2028				2030				2049			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Mariner hook up and commissioning																									
Drilling and completions of Mariner wells																									
Drilling and completion of Cadet wells	COP-01																								
	CWI-03																								
	COP-07																								
	COP-06																								
Production (Cadet)																									

2.3 Drilling operations

The Cadet wells will be drilled and completed by the drilling units on the Mariner A platform, which is a steel jacket platform permanently installed in UKCS Block 9/11a (Figure 2.1). The platform supports integrated drilling facilities including a blowout preventer deck and a wellhead deck supporting up to 50 wellheads. As such the Cadet wells will be drilled using a platform-mounted blowout preventer and drilling conductor and will be fitted with platform wellheads and xmas trees

Figure 2.1 Mariner A production, drilling and quarters (PDQ) platform with NLN drilling derrick (blue) cantilevered over the drilling deck

2.3.1 Well Design

2.3.1.1 Production wells

The three production wells will be deviated extended reach wells with a maximum MD of approximately 5,300 m (design to be confirmed at permit stage). The reservoir sections will be horizontal and will be approximately 900 m in length, depending on the distance from the platform and the depth of the reservoir target.

It is likely that the production wells will re-use well slots where the top-hole sections have already been drilled as part of a previous drilling programme in the Mariner Field. In this instance, the wells will be sidetracked from the existing 20" surface casing, starting with the 17½" section. However, as a worst case the description below assumes that all well sections will need to be drilled, starting at the seabed. The well design described below may be subject to change as the Project develops.

The wells will be drilled in a series of sections; the first section or top hole is the widest, and each subsequent section below this will be of successively reduced diameter. The first stage is drilling the initial hole through the seabed, a process known as spudding, using a drill string (a section of pipe) that terminates in a drill bit which is rotated to grind down through the seabed and formations beneath. As the well becomes deeper additional pipe sections are added into the drill string. The drill string is hollow, enabling a mixture of chemicals, called drilling fluid or mud, to be passed down into the well to keep the drill bit cool and lubricated and to aid in the suspension and removal of drill cuttings back up the wellbore to the emerge from the hole onto the seabed. The following descriptions assume that new wells are drilled from seabed level. If possible, the Cadet wells will be extended from top-holes that have already been drilled under existing permits, if this occurs the top two well sections described here will already be prepared.

The top hole for each well will be 34" in diameter, and it will be an open hole, meaning the mud and cuttings will be ejected directly onto the surrounding seabed. Once it has been drilled to the desired depth, a 28" diameter conductor pipe will be lowered into the hole and cemented in place. The conductor pipe will extend up to the wellhead deck on the platform. The second well section (24" diameter) will then be drilled. The drill pipe will run through the inside of the 28" conductor, and mud and cuttings will be returned up the annulus between the drill pipe and the conductor to the platform topsides. Once at the desired depth, the 24" hole will then in turn be lined with a 20" diameter surface casing and cemented, which will also extend up to the platform drilling deck. The cemented 28" conductor and 20" casing will provide stability to the well, preventing the walls caving in and preventing any flow of fluids from the wellbore into the surrounding rock formations or into the sea. These casings will also provide a firm anchorage for the installation of the wellhead and the blowout preventer (BOP) safety equipment, which will both be installed before drilling the deeper well sections.

Once the wellhead and BOP have been installed, the deeper 17½" and 12¼" sections of the well will be drilled with the drilling fluids circulated back to the platform. An intermediate casing of 13⅜" diameter and a production casing of 9⅝" diameter respectively will be installed and cemented in place. The 8½" section will then be drilled, and 5½" sand screens will be installed.

The lower completion design will ultimately be determined by well and reservoir performance with complexity increased in a controlled manner. The initial Heimdal wells (which will be drilled in the Mariner Field) are currently planned as standalone screens (SAS) without inflow control devices (ICD's). Later completions (including the Cadet wells) will likely incorporate ICD's, and packers / sealers may be used to help isolate annular flow and optimise the ICD performance if required. However, these decisions are yet to be finalised and will depend on the performance of the initial Mariner Field wells.

All Cadet production wells will be completed with electric submersible pump (ESP) artificial lift systems conveyed on tubing. All Cadet production wells are currently designed with a diluent (consisting of a lighter oil to improve fluid flow) injection point up-stream of the ESP, however, this design will be re-evaluated based on production experience, increased reservoir and reservoir fluid understanding and technological advancements. The proposed upper completion design for the Cadet production wells incorporates a downhole safety valve, ESP and downhole chemical injection valves in the design. The currently proposed completion design for the Cadet production wells is presented in Figure 2.2.

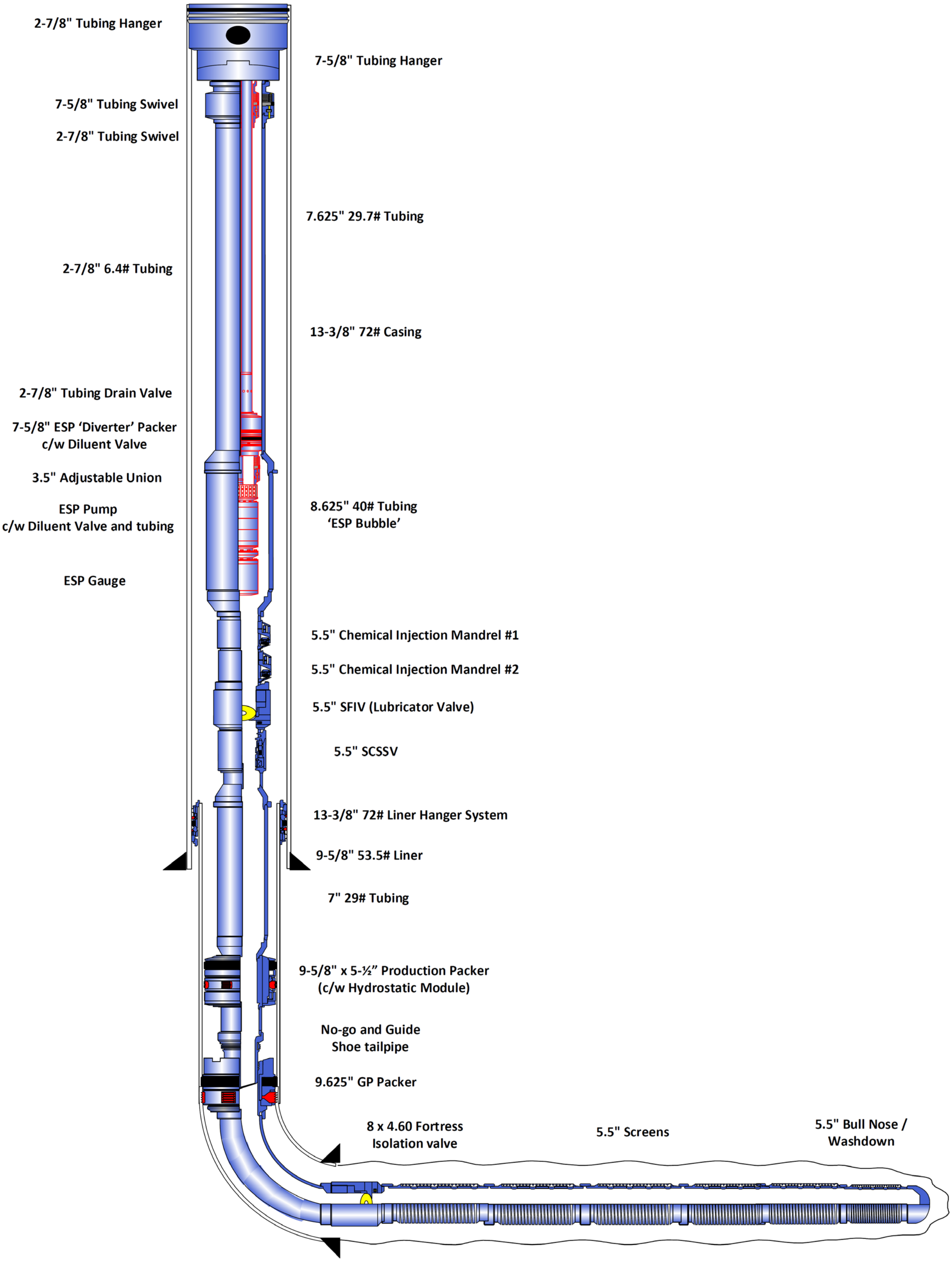

Figure 2.2 Cadet production well completion

2.3.1.2 Water injection well

The water injection well will be slanted or horizontal with a maximum MD of approximately 5,000 m. The drilling process will be similar to that used for the production wells and is currently planned to include well sections of 34", 24", 17½", 12¼ and 8½" diameter.

The lower completion will be a SAS, and the upper completion will be of standard design with a downhole safety valve and downhole pressure and temperature gauges. The well will be designed with high corrosion resistance and the ability to inject above reservoir fracture pressure. It will be designed for a well life of up to 10 years. The currently proposed completion design for the Cadet injection well is presented in Figure 2.3.

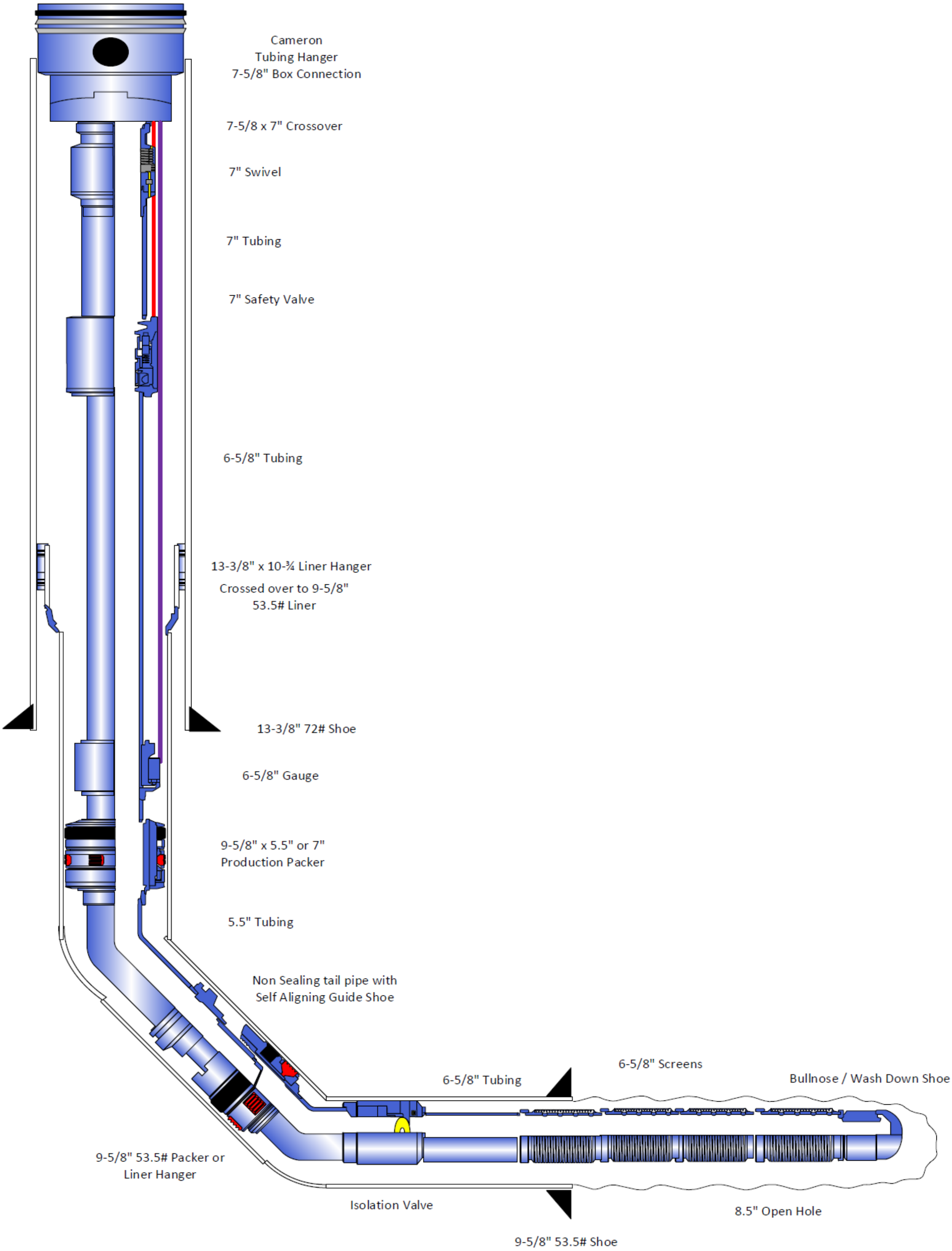

Figure 2.3 Cadet water injection well completion

2.4 Mud system and cuttings discharge

2.4.1 Production wells

Drilling fluid (mud) fulfils a number of functions such as lubrication and cooling of the drill bit, suspension and transport of rock cuttings to the surface, and the provision of 'weight' (hydrostatic pressure) to counter-balance formation pressure and prevent uncontrolled reservoir fluid flow.

The 34" section will be drilled open hole and all drilling fluid and rock cuttings will be discharged directly onto the seabed in the immediate vicinity of the well. This section will be drilled using seawater as the drilling fluid with periodic bentonite and barite sweeps to assist in cuttings removal. Spud mud (a type of water based drilling fluid) will be used for lubrication when running the conductor into the hole.

Once the 28" conductor is installed, drilling mud and cuttings from subsequent sections will be circulated back to the platform via the annulus (the space between the drill string and the conductor). The returned mud and cuttings will pass through a mud recovery system on the platform to clean the cuttings and recover as much of the mud as practicable. Mud cleaned from cuttings will be re-used, minimising waste.

For sections drilled with water based muds (WBMs), cleaned cuttings and whatever mud remains adhering to them will be discharged overboard via a caisson located approximately 97.4 m below mean sea level (MSL).

Cuttings contaminated with low-toxicity oil based mud (LTOBM) will be treated by thermo-mechanical desorption to reduce the oil on cuttings concentration to <1%. Cleaned cuttings will then be discharged overboard. The option to skip and ship contaminated cuttings to shore for disposal will remain available in the event that the desorption equipment fails or the capacity is insufficient; however as the preferred option, the desorption and discharge method has been assessed in this ES.

An estimate of the amount of cuttings, LTOBM and WBM that will be generated/used and subsequently discharged into the sea or disposed of onshore as waste during the drilling of each Cadet production well is presented in Table 2.2.

Table 2.2 Mud and cuttings fates for Cadet production wells (per well)

Section	Mud/fluid (name)	Section length (m)	Cuttings generated (tonnes)	Mud requiring disposal (tonnes)	Fate of mud and cuttings
34"	Seawater with sweeps Spud mud for running casing	100	198	200 of sweeps 100 of spud mud	Discharged to sea at seabed
24"	WBM	500	493	247	Discharged to sea via caisson
17½"	LTOBM	2,400	1,114	390	Primary: thermo-mechanical desorption followed by discharge to sea via caisson Backup: skip and ship to shore
12¼	LTOBM	1,400	403	141	
8½"	WBM	900	128	63	Discharged to sea via caisson

The reservoir sections of the production wells are planned to be drilled with WBM. While it is intended to discharge WBM on cuttings directly to sea, in the event that the cuttings are contaminated with reservoir hydrocarbons they will be treated in the same way as LTOBM contaminated cuttings.

2.4.2 Water injection well

The water injection well will be drilled using the same mud systems as the production wells, although the reservoir section will be drilled with LTOBM rather than WBM as per the production wells. Cuttings and mud on cuttings will be disposed of in the same way.

An estimate of the amount of cuttings, LTOBM and WBM that will be generated/used and subsequently discharged into the sea or disposed of onshore as waste during the drilling of the Cadet water injection well is presented in Table 2.3.

Table 2.3 Mud and cuttings fates for Cadet water injection well

Section	Mud/fluid (name)	Section length (m)	Cuttings generated (tonnes)	Mud requiring disposal (tonnes)	Fate of mud and cuttings
34"	Seawater with sweeps	100	198	200 of sweeps 100 of spud mud	Discharged to sea at seabed
24"	WBM	500	493	247	Discharged to sea via caisson
17½"	LTOBM	2,500	1,160	406	Primary: thermo-mechanical desorption followed by discharge to sea via caisson Backup: skip and ship to shore
12¼"	LTOBM	1,500	432	151	
8½"	LTOBM	400	57	25	

2.5 Cementing

The steel casings run into each of the well sections will be cemented in place by circulating cement down the well, which will then squeeze up through the annulus (gap) between the outside of the casing and the surrounding rock formations. During cementing operations, it is normal practice to use a certain amount of excess cement to ensure the integrity of the cement job. It is therefore likely that a small amount of cement will be deposited on the seabed around the wellhead when cementing in place the 28" conductor, before the wellhead and BOP are installed. However, the amount lost in this fashion will be minimised by the cementing method used, following best practice. During the subsequent cement jobs in the deeper well sections there will be no cement returns to seabed or surface. If the wells are sidetracked from previously used well slots (see Section 2.3.1.1), there will be no cement returns to the surface as the surface casing will already be cemented in place.

When cleaning up the cement unit after each of the cementing operations is completed, heavily diluted residual cement slurry will be discharged to sea via a discharge line from the cement unit.

2.6 Chemical use

The specific chemicals and additives used during drilling and cementing will be dependent upon the drilling mud and cement packages, which will be designed specifically for the wells. Use will also vary depending on the exact down-hole conditions experienced during drilling. There will be contingency chemicals available to deal with any predictable contingencies including stuck drill pipe and lost circulation (where drilling mud is lost into a porous formation). All chemicals will be selected on their technical specifications as well as for their potential environmental impacts, which will be assessed using the Chemical Hazard Risk Management (CHARM) system where appropriate. The results of the well-specific chemical risk assessments will be submitted in a chemical permit subsidiary application template (SAT) at least 28 days before the spud date for each well, in line with the Offshore Chemical Regulations 2002 (as amended).

2.7 Well clean-up

After each well has been drilled and completed, it will be cleaned up. Drilling mud will be displaced from the well by circulating cleaning pills and seawater at a fast pumping rate. The wastewater generated will be of two types: visibly oily and visibly clean.

The clean-up pills, visibly oily water and any residual cuttings solids will be routed to a designated pit on the platform. Here, all solids will be recovered and skipped and shipped to certified disposal sites onshore. Liquids will be routed to the Mariner A test separator to allow hydrocarbons to be separated from the water, which will be discharged overboard or reinjected. Separated hydrocarbons will be routed to the production train.

Seawater returns will be sampled in line with permit conditions and the average oil in water concentration will not exceed 30mg/l. Once the seawater returns become visibly clean, they will be routed directly overboard to sea. Samples of discharged water will be taken at regular intervals for analysis in accordance with Oil Pollution Prevention and Control (OPPC) Regulations.

Once the well is clean it will be filled with a completion fluid comprising chloride brine (NaCl / CaCl / KCl) containing small quantities of chemicals to protect the well. Added chemicals will include a corrosion inhibitor, an oxygen scavenger and a biocide. The exact chemicals to be used will be included in the detailed chemical risk assessment within the chemical permit application which will be submitted to BEIS at least 28 days prior to commencement of drilling activities as required by the Offshore Chemicals Regulations 2002 (as amended).

Each production well will be flowed to clean the wellbore and establish a sand free production rate prior to hook-up to the production facilities. A final clean-up and flow test will be required to remove mud, debris and loose sand particles from the wellbore. Data on productivity will also be gathered. Production fluids from each production well will be routed through the test separator on Mariner A, from whence any water will be routed to the recycled oil sump (ROS). The water leaving the ROS can be manually sampled for oil in water (OIW). From the ROS the water will be discharged to the open drain caisson and be discharged to sea. The open drain caisson is fitted with a skimmer to recover any residual oil routed to the drain and return it to the process.

2.8 Production

The Cadet wells will produce oil, gas and water in varying proportions over the field life. The three phases will be separated in the production train on Mariner A. The oil will be exported via the export pipeline to the Mariner B FSU (Figure 1.2). Any diluent that is injected into the wells and is re-produced will be completely mixed with the Cadet reservoir oil. As such, it will partition with the oil phase during the separation process on Mariner A and be exported to Mariner B as metered production for sale.

Produced water will be reinjected into the various water injection wells spread across the Cadet and Mariner fields. The design specification of the produced water re-injection system is to achieve at least 95% availability, equating to 18 days per year, on average, when water may be discharged overboard. During contingency periods when the PWRI system is unavailable (e.g., equipment downtime) produced water will be disposed to sea via a dedicated caisson. Before disposal, water will be treated to the required oil in water (OIW) standard. Produced water will be subject to secondary treatment (i.e., de-oiling hydrocyclones) in combination with dissolved gas floatation to achieve the required OIW standard. Produced water equipment will be regularly maintained to ensure operational capability. Sampling and monitoring will be carried out in line with OPPC requirements.

Gas will be used as fuel for platform power generation. Continuous flaring on Mariner A will be eliminated by 2025, before the first Cadet well is drilled.

2.8.1 Production profiles

2.8.1.1 Oil

Cadet is expected to commence production in 2026 and is predicted to cease production in 2049. It will not be possible to separate out injected diluent from produced oil, and as such, any diluent that is re-produced will be exported to Mariner B and metered as production. It is not known exactly what proportion of injected diluent will be re-produced from the reservoir, so it is assumed that the full injection volume will be re-produced as a worst case.

The predicted P10 oil production profile (including diluent) is presented in Table 2.4 (in m^3) and Table 2.5 (in tonnes), and is illustrated in Figure 2.4 (in m^3). Production is expected to peak in 2028 when the third production well comes online, and then decline rapidly until 2030 and more gradually until 2049. The totals columns may not exactly reflect the sum of the reservoir oil and diluent columns due to truncation of decimal places.

Table 2.4 Cadet P10 oil production profile (m^3)

Year	Cadet oil production (m^3/day)			Year	Cadet oil production (m^3/day)		
	Reservoir oil	Diluent	Total		Reservoir oil	Diluent	Total
2026	539	95	634	2038	63	13	76
2027	629	129	758	2039	60	12	72
2028	1,084	222	1,306	2040	50	10	60
2029	495	109	604	2041	45	9.2	54
2030	215	47	262	2042	40	8.9	49
2031	167	34	201	2043	35	7.2	42
2032	132	27	159	2044	31	6.4	38
2033	105	22	127	2045	28	5.6	33
2034	89	19	108	2046	25	5.1	30
2035	84	17	101	2047	24	4.9	29
2036	76	15	91	2048	23	4.8	28
2037	66	14	80	2049	15	3.1	18

Table 2.5 Cadet P10 oil production profile (tonnes)

Year	Cadet oil production (tonnes/day)			Year	Cadet oil production (tonnes/day)		
	Reservoir oil	Diluent	Total		Reservoir oil	Diluent	Total
2026	532	75	607	2038	62	10	73
2027	621	102	723	2039	59	10	69
2028	1,069	176	1,245	2040	49	8.1	58
2029	488	86	574	2041	44	7.3	51
2030	212	37	249	2042	40	7.0	47
2031	165	27	192	2043	34	5.7	40
2032	130	21	151	2044	31	5.1	36
2033	103	17	121	2045	27	4.5	32
2034	87	15	102	2046	25	4.1	29
2035	83	13	96	2047	24	3.9	28
2036	74	12	87	2048	23	3.8	27
2037	65	11	76	2049	15	2.4	17

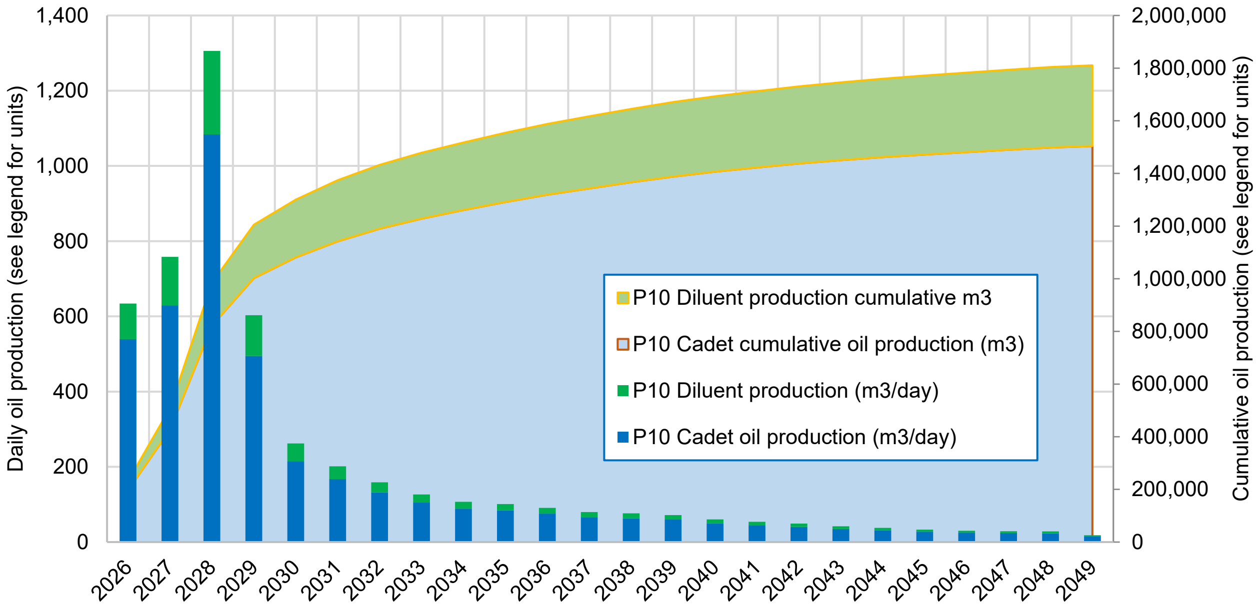

Figure 2.4 Cadet P10 daily and cumulative annual oil production

2.8.1.2 Gas

The predicted P10 gas production profile is presented in Table 2.6 and Figure 2.5. Production is expected to peak in 2028 when the third production well comes online, and then decline rapidly until 2030 and more gradually until 2049.

Table 2.6 Cadet P10 gas production profile

Year	Daily production (m^3/day)	Year	Daily production (m^3/day)
2026	13,262	2038	1,557
2027	15,483	2039	1,468
2028	26,660	2040	1,233
2029	12,168	2041	1,102
2030	5,286	2042	996
2031	4,114	2043	859
2032	3,247	2044	772
2033	2,579	2045	678
2034	2,178	2046	616
2035	2,069	2047	592
2036	1,858	2048	577
2037	1,631	2049	368

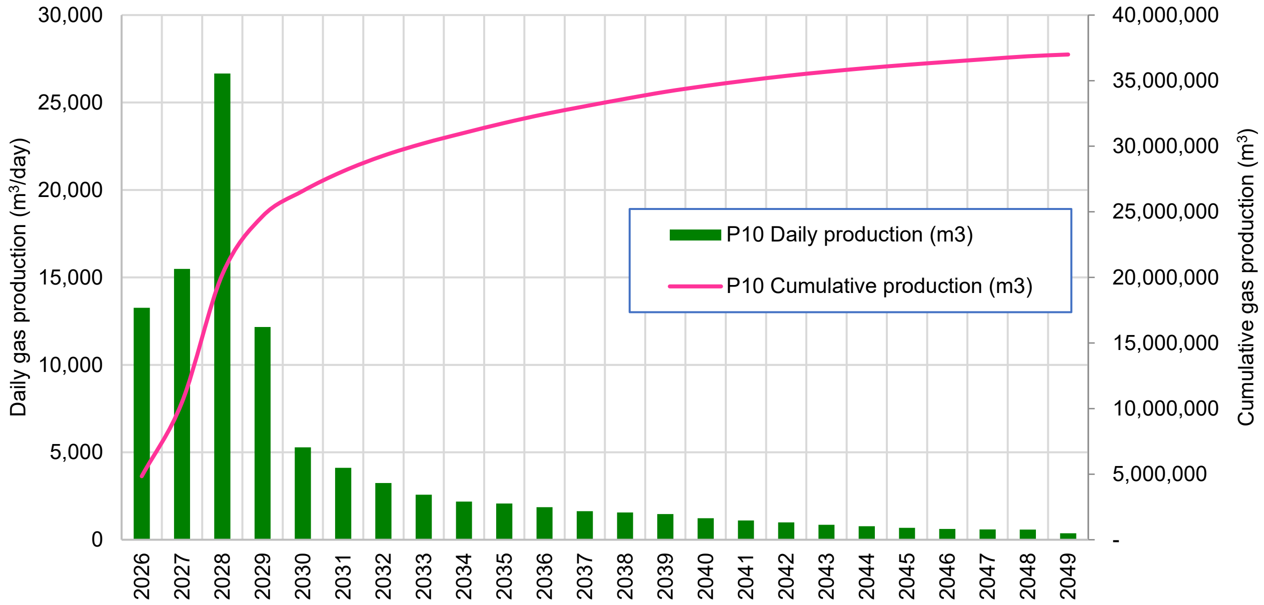

Figure 2.5 Cadet P10 annual and cumulative gas production profile

2.8.1.3 Produced water

The predicted P10 produced water production profile is presented in Table 2.7 and Figure 2.6. Production is expected to peak in 2028 when the third production well comes online, and then decline gradually to 2049. If Cadet has lower water production than expected and more water is needed for pressure support, additional injection water could be supplied from the Mariner wells. Should Cadet water production be higher than expected and exceed water injection capacity for the planned Cadet water injection well, then Mariner injection wells could be utilized. If the total water injection capacity across both fields is insufficient, production from the wells producing high volumes of water could be choked back to a level where total water production remains within PWRI capacity.

Table 2.7 Cadet P10 water production profile

Year	Daily production (m^3/day)	Year	Daily production (m^3/day)
2026	1,051	2038	950
2027	2,833	2039	916
2028	4,404	2040	798
2029	2,912	2041	698
2030	1,755	2042	617
2031	1,638	2043	539
2032	1,456	2044	473
2033	1,261	2045	412
2034	1,123	2046	376
2035	1,111	2047	352
2036	1,038	2048	333
2037	958	2049	211

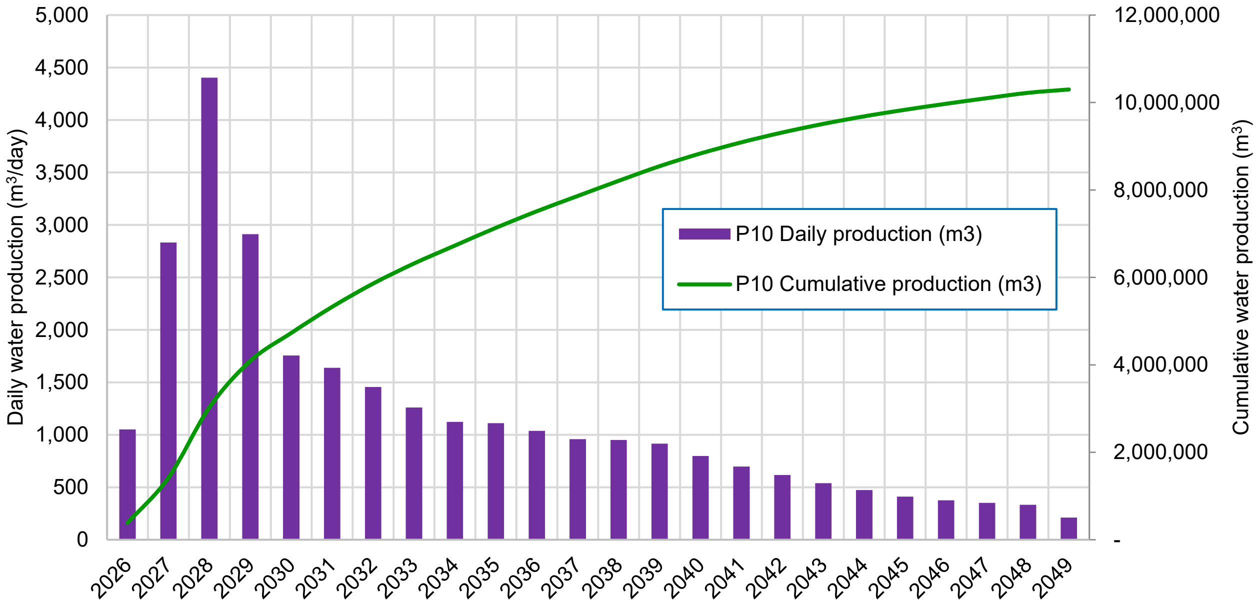

Figure 2.6 Cadet P10 annual and cumulative water production profile

2.8.1.4 Change in production compared to previous Mariner Area Development ES (2012) and current Mariner Field production consent (2018)

The currently predicted combined P10 oil production from the Mariner and Cadet fields (including 100% of the diluent that may be injected into Cadet) is compared with the previously approved 2012 Mariner ES and the current (approved 2018) Mariner Field production consent in Table 2.8.

The same data is presented in Figure 2.7, with predicted Mariner oil production, Cadet reservoir oil production and Cadet diluent production broken out into a stacked area graph, and the 2012 Mariner ES and 2018 Mariner Field production consent presented as smoothed lines.

Table 2.8 and Figure 2.7 show that the highest combined P10 production from Mariner and Cadet will occur in 2028 at 10,151 m^3/day. This is less than the maximum P10 production predicted for Mariner alone, which is 11,196 m^3/day in 2020. This in turn is below the maximum production assessed and approved in the 2012 Mariner ES (12,009 m^3/day in 2019) and the maximum production currently approved in the Mariner Field production consent (11,250 m^3/day in 2024). As such, while the maximum predicted combined production from Mariner and Cadet (including worst case diluent production) will exceed the levels of production that have been previously been approved for the years 2027 to 2031 (see Figure 2.7), at no point will combined production exceed the maximum daily production that has previously been approved for the Mariner Field alone.

Table 2.8 Combined predicted P10 production from the Mariner and Cadet fields (including Cadet diluent production) compared with production stated in the previously approved Mariner Area ES (2012) and the current Mariner Field production consent (approved 2018)

Year	Combined Mariner and Cadet P10 production (m^3/day)	2012 Mariner Area ES (m^3/day)	2018 Mariner Production Consent (m^3/day)
2019	2,867	12,009	10,750
2020	11,196	10,253	11,200
2021	10,490	8,436	11,230
2022	8,837	8,550	11,230
2023	8,204	9,055	11,240
2024	7,934	9,174	11,250
2025	8,204	9,058	10,930
2026	9,292	9,056	10,800
2027	9,625	9,052	9,500
2028	10,151	8,823	7,160
2029	9,876	8,679	-
2030	9,374	8,082	-
2031	7,683	7,387	-
2032	6,272	6,582	-
2033	5,387	5,577	-
2034	4,809	4,825	-
2035	4,502	4,256	-
2036	4,145	3,839	-
2037	3,793	3,490	-
2038	3,550	3,212	-
2039	3,386	2,981	-
2040	3,197	2,792	-
2041	3,005	2,635	-
2042	2,797	2,537	-
2043	2,699	2,406	-
2044	2,574	2,324	-
2045	2,422	2,237	-
2046	2,289	2,184	-
2047	2,073	2,104	-
2048	1,736	2,024	-
2049	1,152	1,942	-

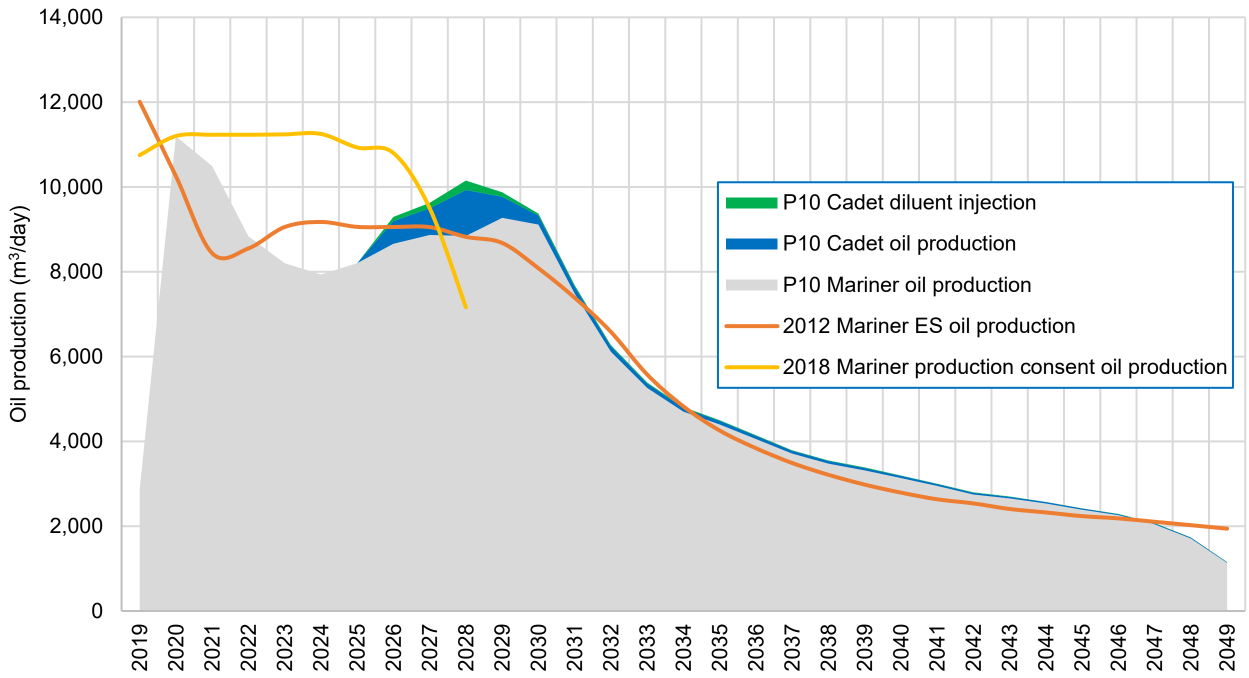

Figure 2.7 Predicted P10 oil production from Mariner (grey fill), Cadet reservoir oil (blue fill) and Cadet diluent (green fill) shown in context of existing Mariner Field production consent (yellow line) and approved Mariner ES (orange line)

2.8.2 Flow assurance

The Heimdal oil is dense and viscous (it has an API gravity of 12.1, corresponding to a specific gravity of 0.985 and a consistency similar to 30-weight motor oil). To improve the flow of the oil from the wells and increase the working life of the pumps, a diluent in the form of a lighter oil may be injected into the production wells upstream of the ESPs. The diluent will be transported to the development area by shuttle tanker and stored on the Mariner B FSU. It will be transferred to the Mariner A platform through a dedicated pipeline (Figure 1.2) before being pumped downhole. The diluent will fully mix with the Heimdal oil in the wellbores, meaning that it will become part of the hydrocarbon phase of the produced fluids, and be re-exported with the reservoir hydrocarbons to Mariner B. Diluent may also be injected into the production train on the Mariner A topsides.

The three production wells may also have injection points upstream of the ESPs to inject scale inhibitor and emulsion breaker as required. The exact chemicals to be used will be included in the detailed chemical risk assessment within the chemical permit application which will be submitted to BEIS at least 28 days prior to commencement of drilling activities as required by the Offshore Chemicals Regulations 2002 (as amended).

2.9 Decommissioning

It is currently assumed that both the Cadet and Mariner Fields will be in production until 2049, although the Mariner Area Development infrastructure has a design life of 40 years, so there is potential for the operational phase to be extended. Because the Cadet field will be produced through the Mariner Area Development infrastructure, the Cadet wells will likely not be fully decommissioned until the end of life for the Mariner Area Development as a whole. It is possible that the Cadet wells will be sidetracked in future to target reserves either elsewhere in the Cadet field, in the Mariner Field or in other fields.

Decommissioning options and the final method will be discussed and agreed with the statutory authorities and will adhere to government policy and regulations in force at the time.

It is anticipated that when the wells are decommissioned they will be plugged and permanently abandoned in accordance with the United Kingdom Offshore Operators Association (UKOOA) guidelines for suspension and abandonment of wells (or applicable guidance at that time). All well programmes will have been reviewed by the HSE Offshore Safety Division as required under The Offshore Installations and Wells (Design and Construction, etc.) Regulations 1996.

On completion of the well abandonment programme, the wellheads will be removed from the conductors on the well deck. The conductors and casings will then be cut at least 3 m below the seabed and the severed upper conductor sections will be recovered leaving a clean seabed.

2.10 Vessel requirements

Vessel and helicopter movements will be required throughout the lifetime of the development to support the drilling and operational phases. Drilling of the Cadet wells will require equipment deliveries, crew changes and waste removal trips which would not otherwise have been required, and these are therefore included in the assessment. Likewise, well workovers and maintenance during the operational phase will be required specifically for the Cadet wells and trips associated with these are also included.

Conversely, maintenance of the Mariner A platform and other field infrastructure such as the Mariner B FSU and the subsea pipelines will be required regardless of the Cadet wells. Vessel movements associated with general Mariner Area Development maintenance activities have been assessed in the Mariner ES and are not included here.

Safety standby vessels will be on station at all times during the Cadet field drilling and operational phases to protect the Mariner A platform and Mariner B FSU. However, these vessels would be present regardless of the Cadet drilling and production operations and are therefore not considered further.

Table 2.9 outlines the anticipated vessel requirements for the duration of the proposed Cadet drilling and operational phases. These durations do not include mobilisation, demobilisation or transit times, and also do not include allowance for weather delays.

Table 2.9 Vessel requirements

Project phase	Activity	Vessel type and number	Duration and timing
Drilling and completion	Supplies delivery and waste removal	2 x supply vessel return trips from Peterhead to Mariner A per month	Approx. 9 return trips in Q1 2026. Approx. 18 return trips between Q1 and Q2 2027. Approx. 9 return trips in Q1 2028.
	Personnel transport	18 x S92 helicopter return trips (2 hours per return trip) Aberdeen to Mariner A per month	Approx. 18 return flights in Q1 2026. Approx. 35 return flights between Q1 and Q2 2027. Approx. 18 return flights in Q1 2028.
Operation	Additional supplies and personnel transport are not expected during operations, but a small increase has been noted as contingency.	1 x supply vessel return trip from Peterhead to Mariner A per month	2026 – 2049
		2 x S92 helicopter return trips (2 hours per return trip) Aberdeen to Mariner A per month	

3 ENVIRONMENT BASELINE

3.1 Introduction

As part of the EIA process, it is important that the main physical, biological and socio-economic sensitivities of the receiving environment are well understood. As such, this section describes the main characteristics of the receiving environment in and around the Mariner A platform (where all impacts will originate from) and highlights the key sensitivities present.

This section draws on a number of information sources including published papers on scientific research in the area and industry-wide information at a strategic or regional level, such as the UK-wide Strategic Environmental Assessment programme being undertaken by BEIS, formerly the Department of Energy and Climate Change (DECC, 2016), the National Marine Plan (Scottish Government, 2015) and associated on-line offshore mapping resource (NMPI, 2019).

3.2 Site-specific surveys

The Mariner A location has been subjected to detailed geophysical and environmental survey as follows:

- Gardline (2009) Mariner regional hazard, obstruction and shallow gas survey conducted between 01/07/2009 and 04/08/2009 acquiring:
  - single- and multi-beam echo sounder (MBES) data to provide seabed bathymetry;
  - side scan sonar (SSS) data to establish seabed conditions including surface sediments and obstructions; and
  - sub-bottom profiler (pinger and mini-airgun) data providing information on sub seabed conditions relevant to anchoring and piling activities.
- Det Norske Veritas (DNV) (2011). Environmental grab sampling survey of Mariner A platform location conducted between 10th and 12th June 2011 which acquired sediment samples for physico-chemicial and macrofauna analysis (Figure 3.1).

The original Mariner Area Development Environmental Statement (Statoil, 2012) has also been used as a data source where appropriate.

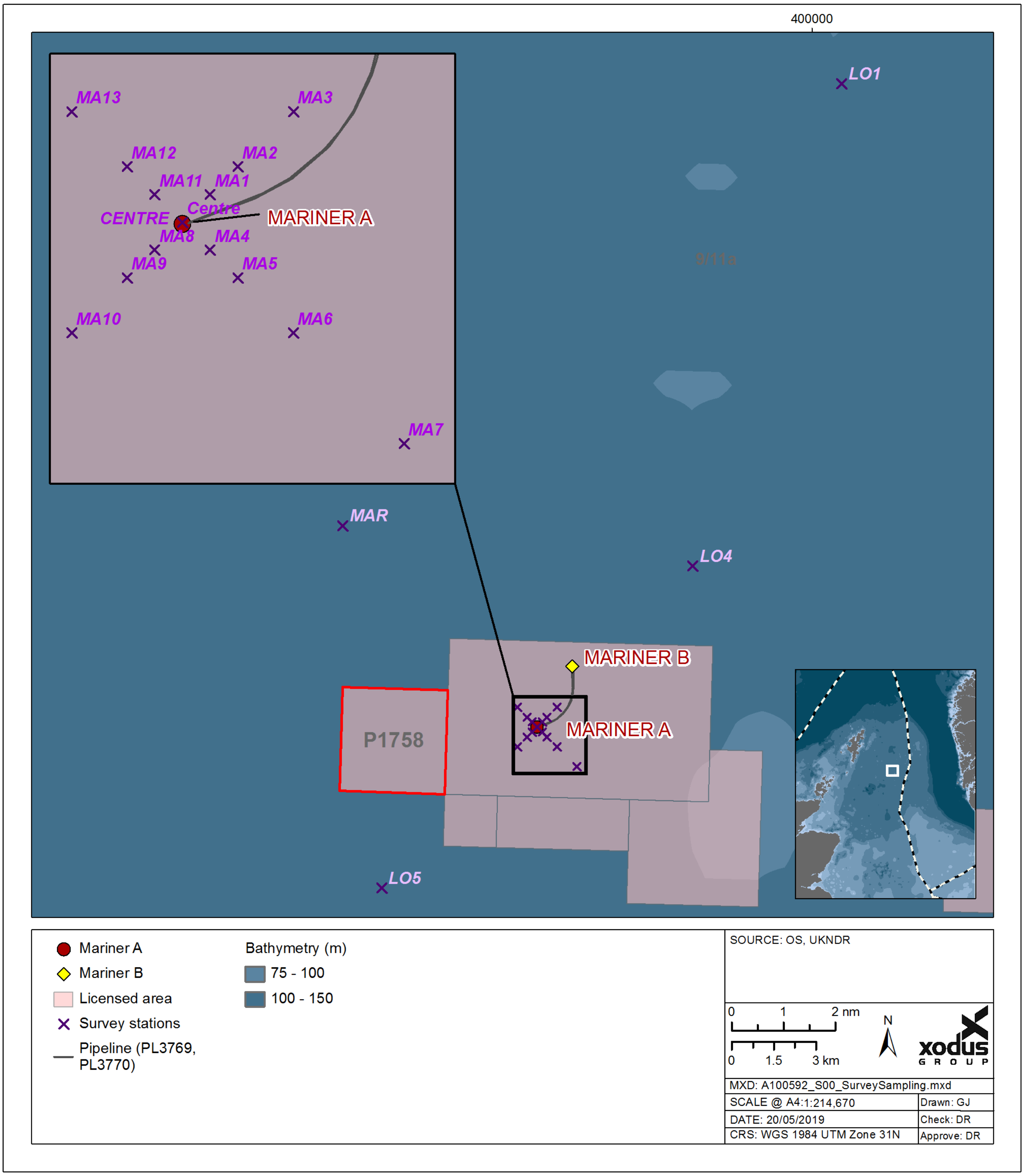

Figure 3.1 Mariner A environmental survey stations (Det Norske Veritas, 2011)

3.3 Physical environment

3.3.1 Weather and sea conditions

The anti-clockwise movement of water through the North Sea and around the northern North Sea (NNS) region originate from the influx of Atlantic water, via the Fair Isle Channel and around the north of Shetland, and the main outflow northwards along the Norwegian coast (DECC, 2016; Figure 3.2). Against this background of tidal flow, the direction of residual water movement in the NNS is generally to the south or east (DTI, 2001; DECC, 2016). The peak flow for mean spring tide ranges between low velocities of 0.01 m/s in open water to 2.5 m/s in the narrow sounds around Orkney (Pentland Firth) (DECC, 2016).

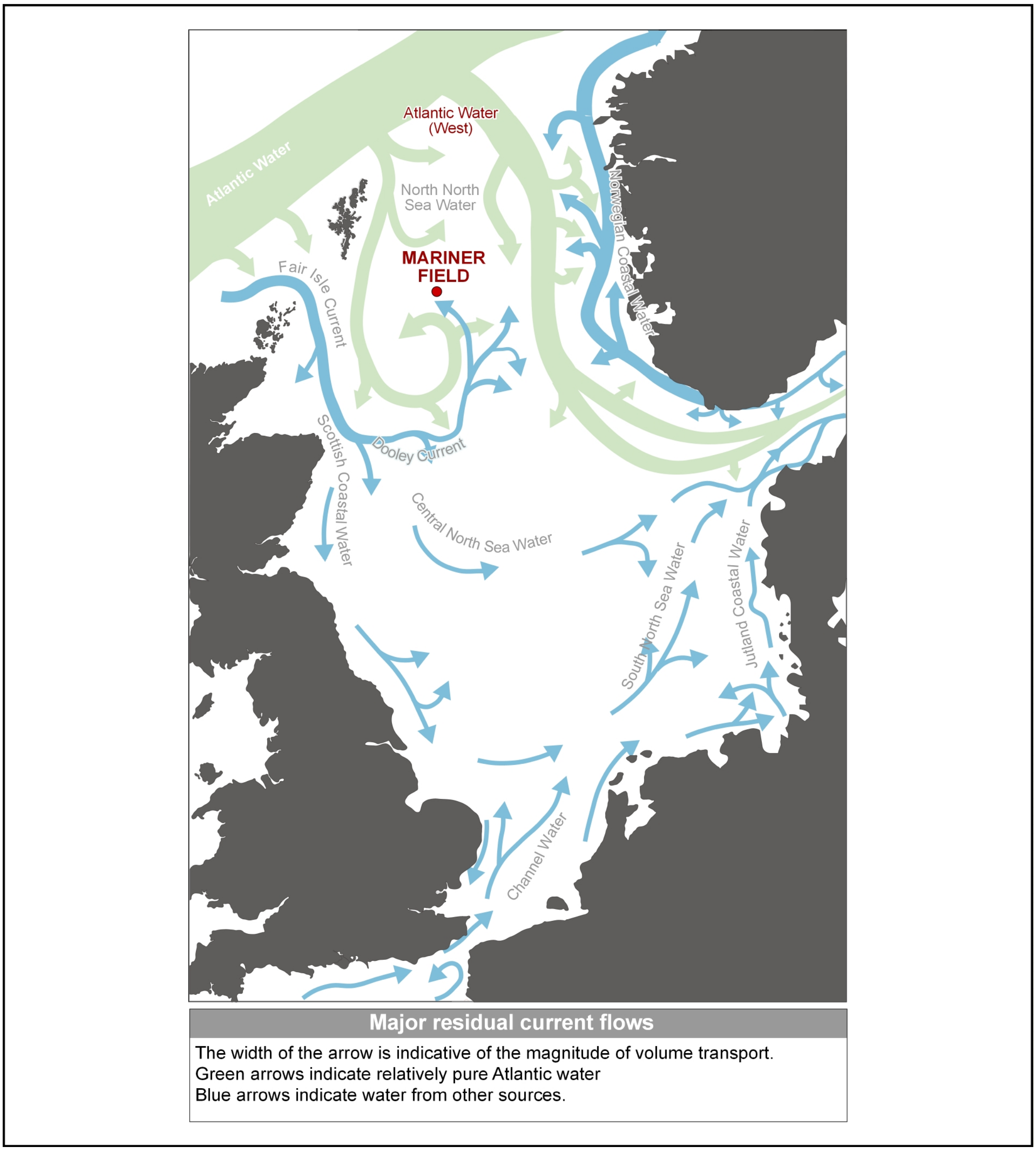

Figure 3.2 Major residual current flows in the North Sea

The NNS is seasonally stratified and the strength of the thermocline is determined by solar energy, tidal and wave forces (DECC, 2016). Distinct density stratification occurs in the NNS region in summer at a depth of around 50 m and the thermocline becomes increasingly distinct towards deeper water in the north of the region (DECC, 2016). This stratification breaks down in September as the frequency and severity of storms increases causing mixing in the water column (DECC, 2009).

The prevailing winds in the NNS are from the south-west and north-north-east. Wind strengths in winter are typically in the range of Beaufort scale force 4-6 (6-11 m/s) with higher winds of force 8-12 (17-32 m/s) being much less frequent. Winds of force 5 (8 m/s) and greater are recorded 60-65% of the time in winter and 22-27% of the time during the summer months. In April and July, winds in the open, central to NNS, are highly variable and there is a greater incidence of north-westerly winds (DECC, 2016).

The annual mean wave height in the NNS region follows a gradient increasing from the southern point in the Fladen/Witch Ground to the northern area of the East Shetland Basin. In the south, the mean wave height ranges from 2.11 - 2.40 m whilst in the north it ranges from 2.41 - 3.00 m (NMPI, 2019). McBreen *et al.* (2011) shows wave energy at the seabed is 'moderate' (0.21 – 1.2 N/m^2) in the vicinity of the Mariner A platform. The wave height ranges from 2.41 – 2.70 m and the annual mean wave power ranges between 30.1 - 36 kW/m (NMPI, 2019).

3.3.2 Bathymetry

The North Sea is a large shallow sea with a surface area of around 750,000 km^2. Water depths gradually deepen from south to north (DTI, 2001; DECC, 2016). The NNS region has a depth ranging from 100 m at the southern point in the Fladen/Witch Ground to as deep as 1,500 m in the Faroe-Shetland Channel.

Water depth at the Mariner platform is 105 m below LAT (DNV, 2011). The seabed is almost flat, with a gentle downward slope to the northwest at a gradient of <0.5°. A minimum depth of 101 m was recorded at Station MA7 located 2 km to the southeast of the platform, and a maximum of 115 m at Station MAR, a reference station located approximately 10 km to the northwest (Figure 3.1).

3.3.3 Sediment type and seabed features

In the NNS, seabed sediments generally comprise a veneer of unconsolidated terrigenous and biogenic deposits, generally much less than 1 m thick, although areas of outcropping rock occur in coastal waters around and between Shetland, Orkney and the Scottish mainland. Sediments are predominantly sand and muddy sand, although the deeper areas within the Fladen Ground consist of mud or sandy mud. Off the edge of the continental shelf to the north of the region, the slope is characterised by areas of mixed and coarse sediments, while the floor of the Faroe-Shetland Channel is classified as mud (JNCC, 2010; DECC, 2016).

Grab sample particle size analysis confirms seabed sediments around the Mariner A location comprise fine sand, with <1% gravel (zero at most stations) and clay content ranging from 0.6% to 5.8%. Station MAR had a higher silt and clay content (11.6%), but this is not representative of conditions at the Mariner A platform.

Survey effort confirmed that the seabed in the vicinity of Mariner A is generally flat and covered with a veneer of fine sand. To the southeast there are outcroppings of the Cape Shore formation (comprising thick dense sand and clay), forming mounds several metres high, including a distinct shoal 12 m high (Gardline, 2009).

Several instances of anthropogenic disturbance were identified, including historic wells, anchor and trawl scars and debris. No evidence of subsurface shallow gas or water flow was identified (Statoil, 2012).

3.3.4 Sediment contaminants

Total organic matter (TOM) in the sampled sediments was low, ranging from 0.64% to 1.08% (DNV, 2011). Total hydrocarbon concentrations (THC) ranged from <1 mg/kg to 5 mg/kg and polycyclic aromatic hydrocarbons ranged from 0.008 mg/kg to 0.016 mg/kg. The total hydrocarbon concentration at all stations was below the UKOOA (2001) 50^{th} percentile for sample stations >5 km from the nearest platform in the northern North Sea.

Trace element (aka heavy metal) concentrations were generally low across the survey area. The UKOOA (2001) 95^{th} percentile concentrations were only exceeded for zinc at Station MA4, where a concentration of

17 mg/kg was recorded versus a UKOOA (2001) 95th percentile value of 13 ppm. As such sediments sampled in the DNV (2011) survey are considered to be generally free of point source contamination and representative of undisturbed northern North Sea sediment.

3.4 Biological environment

3.4.1 Plankton

Planktonic assemblages exist in large water bodies and are transported simultaneously with tides and currents as they flow around the North Sea. Plankton forms the basis of marine ecosystem food webs and therefore directly influences the movement and distribution of other marine species.

In both the northern and central areas of the North Sea, the phytoplankton community is dominated by dinoflagellates of the genus *Ceratium* (*C. fusus, C. furca* and *C. lineatum*) and diatoms such as *Thalassiosira spp*. and *Chaetoceros* spp. In recent years the dinoflagellate *Alexandrium tamarense* and the diatom *Pseudo-nitzschia* (known to cause amnesic shellfish poisoning) has been observed in the area (DECC, 2016). Densities of phytoplankton fluctuate during the year, with sunlight intensity and nutrient availability driving its abundance and productivity together with water column stratification (Johns & Reid, 2001; DECC, 2016). In the 10 year period between 1997 and 2007, two main blooms are seen to occur in the NNS: one in May, and a second in August before levels decrease through the winter months when light and temperature are less abundant (SAHFOS, 2015).

Zooplankton species richness is greater in the northern and central areas of the North Sea, than in the south and displays greater seasonality. Zooplankton in this area is dominated by *calanoid* copepods, in particular *Calanus* spp and *Acartia* spp. Eupahsusiidae (the family containing the majority of krill species) and decapod larvae are also important to the zooplankton community in this region (Decapoda is the order containing crabs, lobsters, prawns, shrimp and crayfish) (DECC, 2016).

Calanus finmarchicus has historically dominated the zooplankton of the North Sea and is used as an indication of zooplankton abundance. Analysis of data provided by the Continuous Plankton Reader (CPR) surveys in the 10 year period between 1997 and 2007 shows a sharper spring increase in *C. finmarchicus* biomass in May in the NNS compared to more southerly areas. This peak in numbers is 70% greater than seen in the central North Sea and 88% greater than the southern North Sea over the same period (SAHFOS, 2015). The increase is likely a reflection of the increased availability of nutrients and food (including phytoplankton) in spring. Overall abundance of *C. finmarchicus* has declined dramatically over the last 60 years, which has been attributed to changes in seawater temperature and salinity (Beare *et al*., 2002; FRS, 2004). *C. finmarchicus* has largely been replaced by boreal and temperate Atlantic and neritic (coastal water) species; in particular a relative increase in the populations of *C. helgolandicus* has occurred (DECC, 2009; Edwards *et al*., 2010; Baxter *et al*., 2011).

3.4.2 Benthos

The biota living near, on or in the seabed is collectively termed benthos. The diversity and biomass of the benthos is dependent on a number of factors including substrata (e.g. sediment, rock), water depth, salinity, the local hydrodynamic regime and the degree of organic enrichment of the sediment (DECC, 2016). The species composition and diversity of the benthos or macrofauna found within sediments is commonly used as a biological indicator of sediment disturbance or contamination.

North Sea sediments can be classified into areas that are characterised by the composition of infaunal assemblages, which themselves are distributed according to the physical and biological characteristics of water masses and sediments (Basford *et al*., 1989). Several different benthic assemblages have been identified and a broad scale distribution pattern has been developed (DTI, 2001). According to the benthic classification scheme of Künitzer *et al*. (1992) the Mariner area falls within category IIIb (fine sediment deeper than 100 m), and would be expected to be characterised by a deep-water infaunal assemblage, which typically has high densities (2,863±1,844 individuals per m^2) and species richness (51±13 species) (North Sea Task Force (NSTF), 1993).

Mariner Field sediment samples contained between 381 and 801 individuals and between 57 and 78 species per 0.5m^2 (DNV, 2011), suggesting a slightly numerically sparse but more taxonomically diverse community than the average for the area recorded in NSTF (1993). The community was fairly homogenous across most stations, with the polychaete *Spiophanes bombyx* being the most or second most abundant species at every station except Station MAR (one of the reference stations) where *Paramphinome jeffreysii* was most abundant. The brittlestar *Ophiocten affinis* was also in the top two most numerous species at several stations. DNV (2011) concluded that sediments at the Mariner A location were undisturbed, and the small differences observed in the infaunal community across the survey area were due to natural variation.

No evidence of Annex I habitats or communities of conservation value were recorded during any of the surveys conducted close to the Mariner A platform (UNI RESEARCH AS, 2014; DNV, 2011).

3.4.3 Fish and shellfish

A number of commercially important fish and shellfish species can be found in the vicinity of the Mariner A platform well. Fish and shellfish populations may be vulnerable to impacts from offshore installations such as hydrocarbon pollution and exposure to aqueous effluents, especially during the egg and juvenile stages of their lifecycles (Bakke *et al.*, 2013).

The Mariner Field is located in International Council for Exploration of the Sea (ICES) rectangle 48F1, in an area of spawning and nursery grounds for several commercially important species. Information on spawning and nursery periods for these species, including peak spawning times (where applicable) is presented in Table 3.1 based on data in Coull *et al*. (1998) and Ellis *et al*. (2012). The area supports high intensity spawning of Norway pout and is a high intensity nursery area for blue whiting. Several species utilising the area are listed as Scottish PMFs, these are: anglerfish, blue whiting, cod, herring, ling, mackerel, Norway pout, saithe and sandeel (SNH, 2014).

The geographical extent of the spawning and nursery areas for species listed in Table 3.1 is illustrated in Figure 3.3 for spawning grounds and Figure 3.4 and Figure 3.5 for nursery grounds. Figure 3.4 and Figure 3.5 also present data from Aires *et al*. (2014) showing the probability of aggregations of “0 group” fish (fish in the first year of their lives), including where these are not captured as nursery areas in the older data.

Table 3.1 Spawning and nursing grounds within ICES Rectangle 48F1 (Coull *et al*., 1998 and Ellis *et al*., 2012)

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Anglerfish	N	N	N	N	N	N	N	N	N	N	N	N
Blue whiting	N	N	N	N	N	N	N	N	N	N	N	N
Cod	S	S*	S*	S								
European hake	N	N	N	N	N	N	N	N	N	N	N	N
Haddock	N	SN*	SN*	SN*	SN	N	N	N	N	N	N	N
Herring	N	N	N	N	N	N	N	N	N	N	N	N
Ling	N	N	N	N	N	N	N	N	N	N	N	N
Mackerel	N	N	N	N	N	N	N	N	N	N	N	N
Nephrops	SN	SN	SN	S*N	S*N	S*N	SN	SN	SN	SN	SN	SN
Norway pout	SN	S*N	S*N	SN	N	N	N	N	N	N	N	N
Saithe	S*	S*	S	S								
Sandeel	SN	SN	N	N	N	N	N	N	N	N	SN	SN
Whiting	N	SN	SN	SN	SN	SN	N	N	N	N	N	N

Key: S = Spawning period, N = Nursery Area, Blank = No data, * Peak spawning; Shaded = Period of proposed operations, Species = High nursery intensity as per Ellis *et al.,* 2012; Species = High concentration spawning as per Coull *et al.,* 1998.

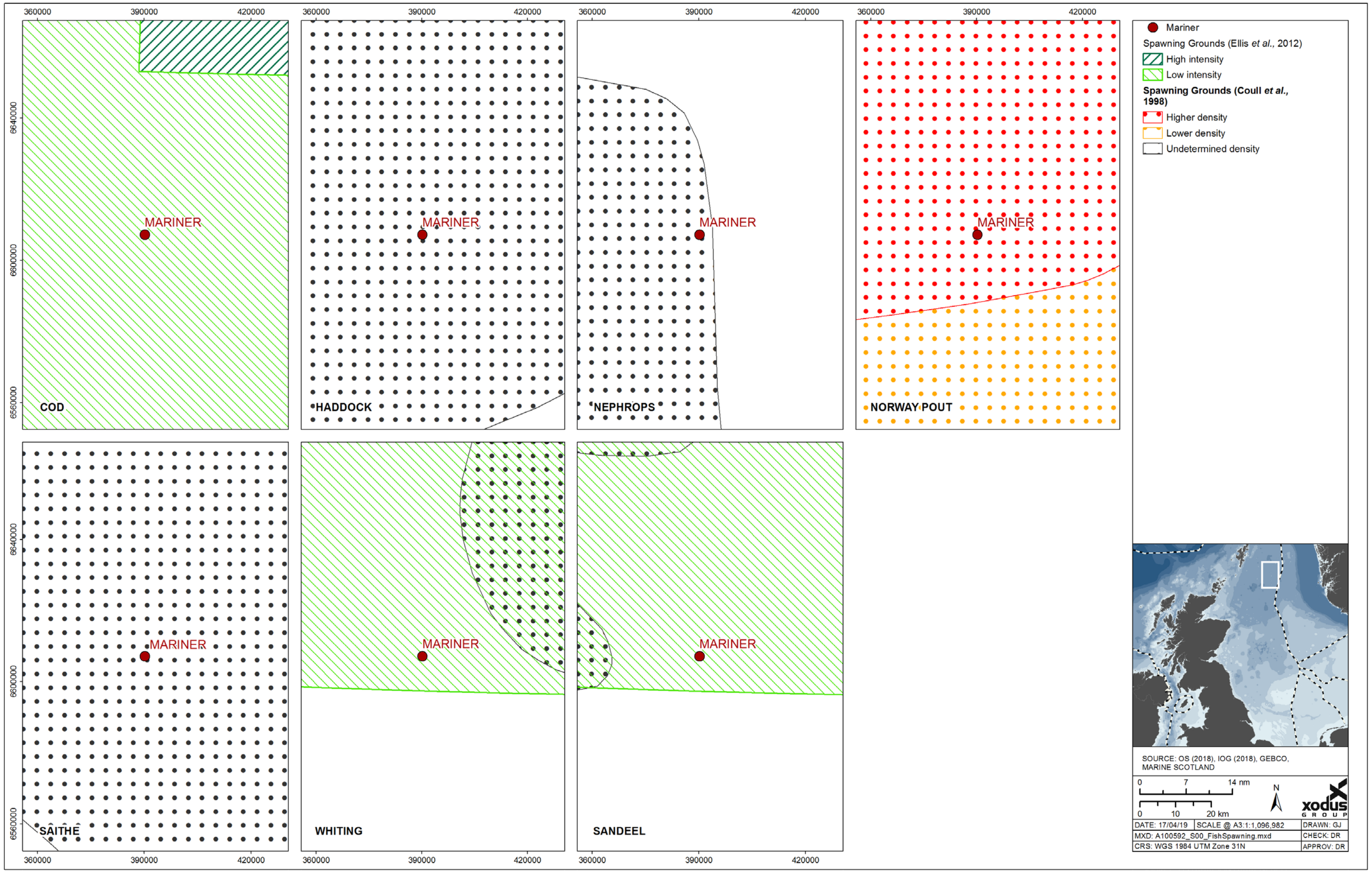

Figure 3.3 Spawning grounds for cod, haddock, *Nephrops*, Norway pout, saithe, whiting and sandeel

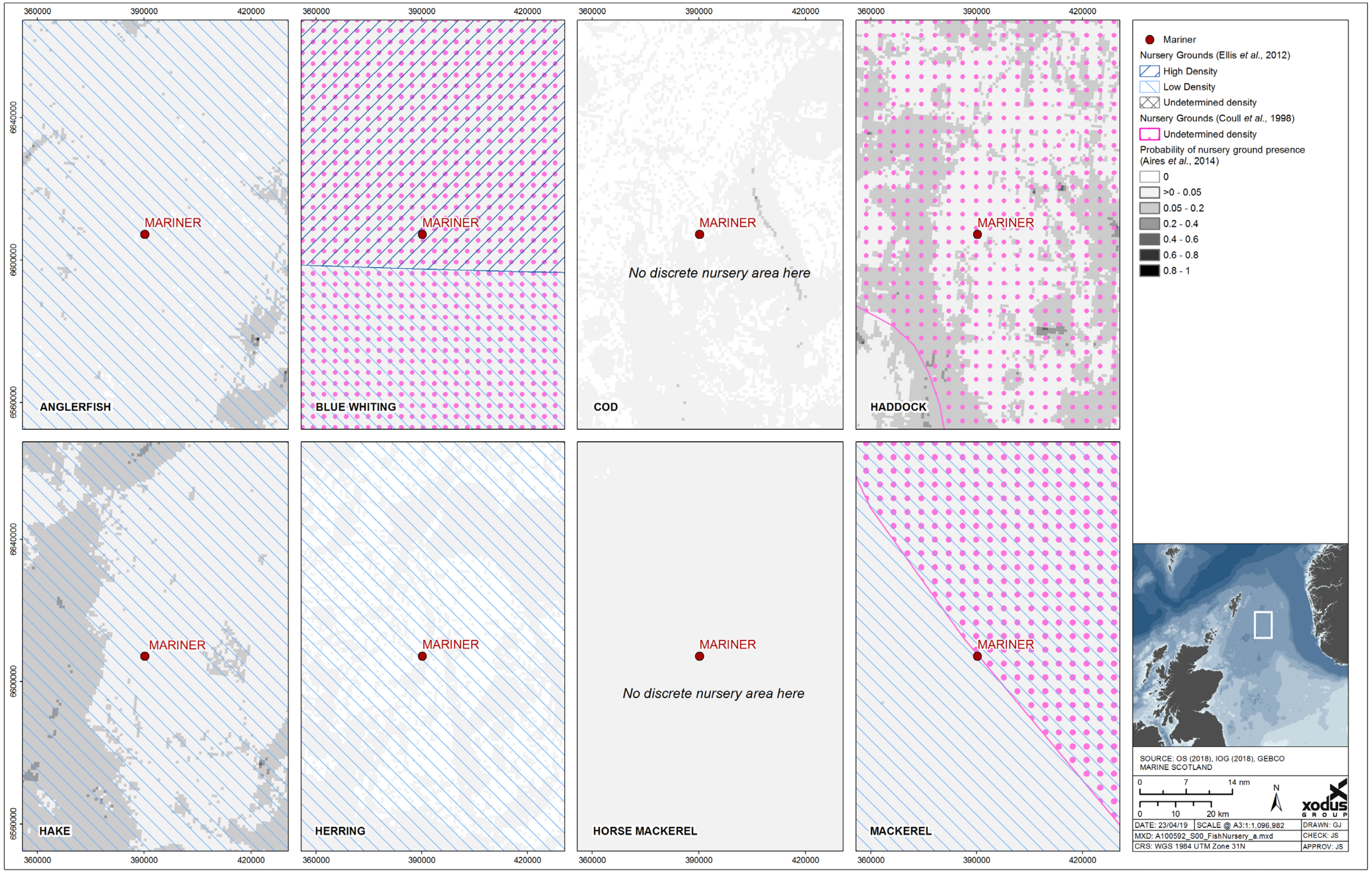

Figure 3.4 Nursery grounds for anglerfish, blue whiting, haddock, hake, herring and mackerel

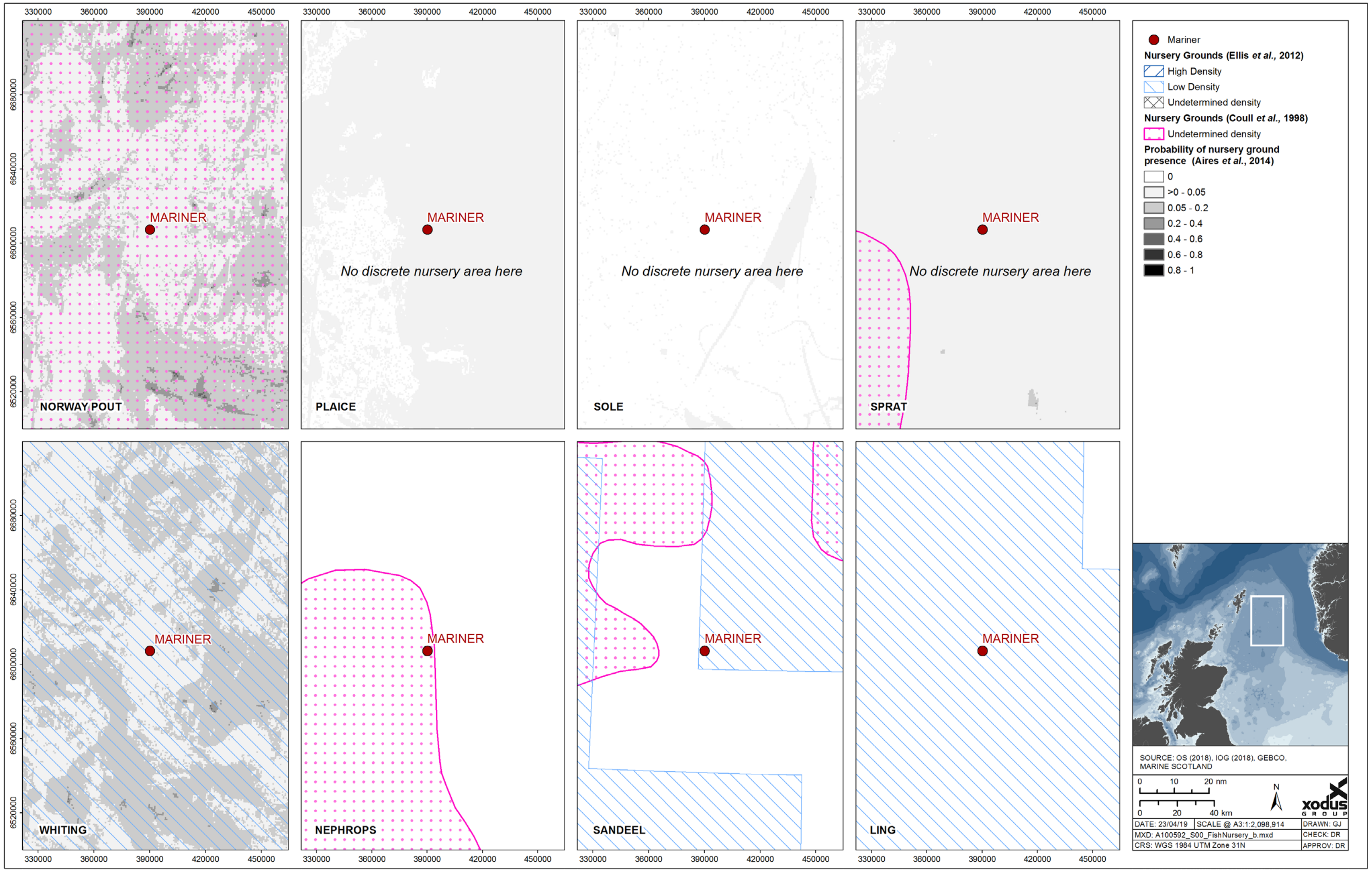

Figure 3.5 Nursery grounds for Norway pout, sprat (note closest spawning is over 40 km from Mariner A), whiting, *Nephrops*, sandeel and ling

3.4.4 Seabirds

Much of the North Sea and its surrounding coastline and offshore waters are internationally important breeding and feeding habitats for seabirds. In the NNS, the most numerous species likely to be northern fulmars *Fulmarus glacialis*, black legged kittiwakes *Rissa tridactyla* and common guillemots *Uria aalge* (DECC, 2009; DECC, 2016).

After the breeding season ends in June, large numbers of moulting auks (common guillemot, razorbill *Alca torda and Atlantic* puffin *Fratercula arctica*) disperse from their coastal colonies and into the offshore waters from July onwards. At this time these high numbers of birds are particularly vulnerable to oil pollution. In addition to auks, black-legged kittiwake, northern gannet *Morus bassanus*, and northern fulmar, are present in sizable numbers during the post breeding season.

The Joint Nature Conservation Committee (JNCC) has released the latest analysed trends in abundance, productivity, demographic parameters and diet of breeding seabirds, from the Seabird Monitoring Programme (JNCC, 2016a). This data provides at-a-glance UK population trends as a % of change in breeding numbers from complete censuses. From the years 1998-2015, the following population trends for species known to use the field area have been recorded: northern fulmars (-31%), black legged kittiwakes (-44%) and common guillemots (+5%). Breeding seabird number of some species have shown a long-term decline, most probably as a result of a shortage of key prey species such as sandeels associated with changes in oceanographic condition (Baxter *et al*., 2011; DECC, 2016).

According to the density maps provided in Kober *et al*. (2010), the following species have been recorded within the Mariner area; northern fulmar *Fulmarus glacialis*, European storm-petrel *Hydrobates pelagicus*, northern gannet *Morus bassanus*, Artic skua *Stercorarius parasiticus*, great skua *Stercorarius skua*, black-legged kittiwake *Rissa tridactyla*, great black-backed gull *Larus marinus*, common gull *Larus canus*, lesser black-backed gull *Larus fuscus*, herring gull *Larus argentatus*, Artic tern *Sterna paradisaea*, common guillemot *Uria aalge*, razorbill *Alca torda*, little auk *Alle alle* and Atlantic puffin *Fratercula arctica*.

The Seabird Oil Sensitivity Index (SOSI) (Webb *et al*., 2016) identifies sea areas where seabirds are likely to be most sensitive to oil pollution. It is an updated version of the Oil Vulnerability Index (JNCC, 1999) as it uses survey data collected between 1995 and 2015 and includes an improved method to calculate a single measure of seabird sensitivity to oil pollution. The survey area covers the UKCS and beyond. Seabird data was collected using boat-based, visual aerial, and digital video aerial survey techniques. This data was combined with individual species sensitivity index values and summed at each location to create a single measure of seabird sensitivity to oil pollution (Webb *et al*., 2016). Results of the assessment for Block 9/11 and the eight surrounding blocks are presented in Table 3.2, Figure 3.6 and Figure 3.7. Block/month combinations that were not provided with data have been populated with the SOSI using the indirect assessment method provided by Webb *et al*. (2016).

Table 3.2 Seabird oil sensitivity at Mariner A (Block 9/11) and surrounding vicinity (Webb *et al*., 2016)

Block	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
8/10	5*	5	5*	N	N	5*	5	5	5*	N	N	1*
09/6	5*	5	5*	N	N	5*	5	5	5*	N	N	N
09/7	5*	5	5*	N	N	5*	5	5	5*	N	N	N
8/15	5*	5	5*	N	3*	5*	5	5	5*	N	N	1*
9/11	**5***	**5**	**5***	**N**	**3***	**5***	**5**	**5**	**5***	**N**	**N**	**N**
9/12	5*	5	5*	N	5*	5*	5	5	5*	N	N	N
8/20	5*	5	5*	3*	3	3*	5	5	5*	3*	3	3*
9/16	5*	5	5*	3*	3	3*	5	5	5*	3*	3	3*
9/17	5*	5	5*	5*	5	5	5	5	5*	5*	5	5*
Key	Extremely high		Very high		High		Medium		Low		No data	
* in light of coverage gaps, an indirect assessment of SOSI has been made												

Seabird sensitivity in the region of Mariner A is generally low. There was no data available for some blocks in April, May and October to December, even when using the indirect assessment method. Blocks 8/10 and 8/15 are assigned extremely high sensitivity for December, based on the sensitivity recorded for the two blocks adjacent to the west.

The Mariner A platform is located approximately 134 km from the nearest UK coast and is therefore remote from sensitive seabird breeding colonies.

Figure 3.6 Seabird Oil Sensitivity at Mariner A between January and June (Webb *et al.*, 2016)

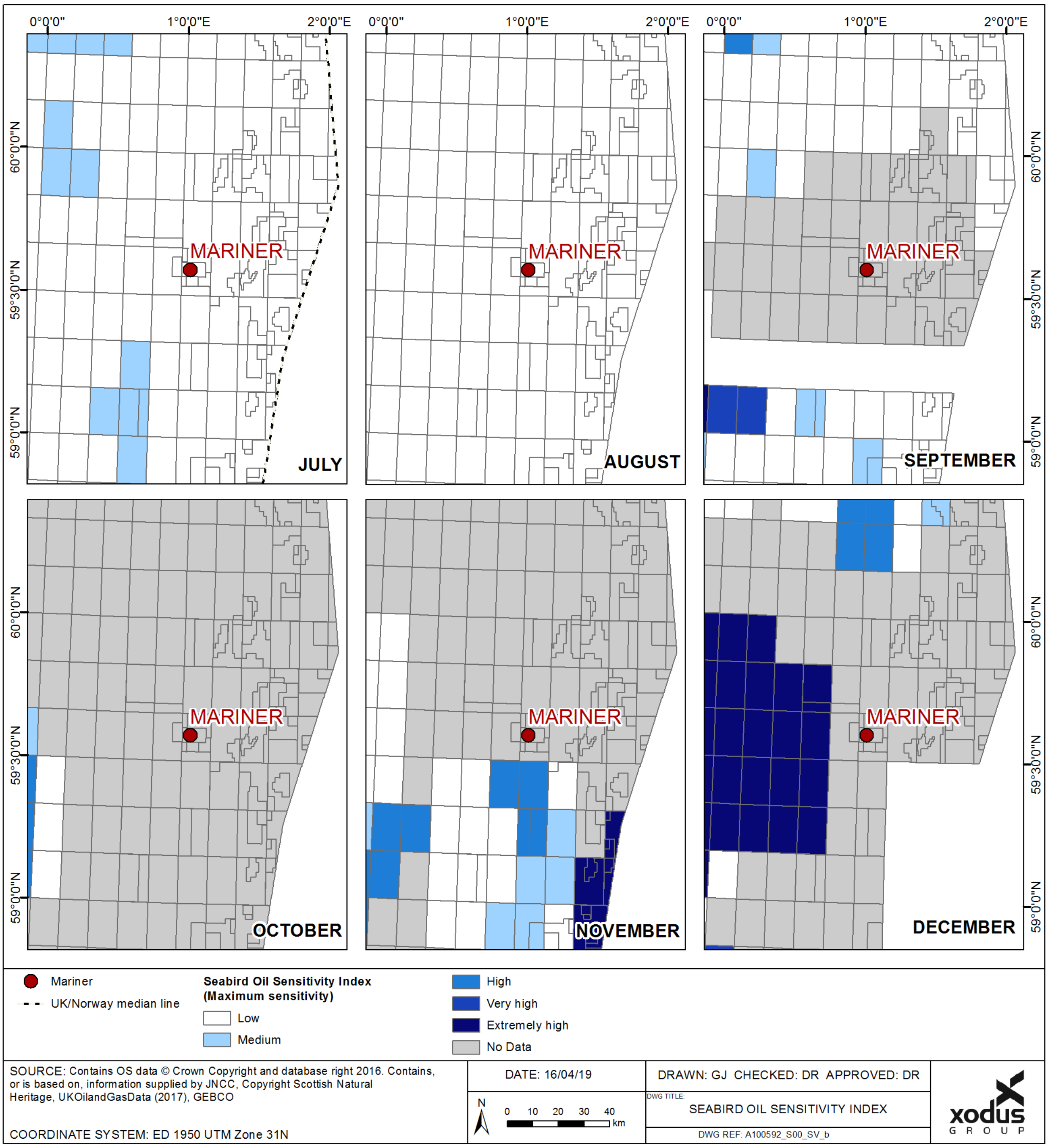

Figure 3.7 Seabird Oil Sensitivity at Mariner A between July and December (Webb *et al.*, 2016)

3.4.5 Marine mammals

3.4.5.1 Cetaceans

The NNS has a moderate to high diversity and density of cetaceans, with a general trend of increasing diversity and abundance with increasing latitude. Harbour porpoise *Phocoena phocoena* and white-beaked dolphin *Lagenorhynchus albirostris* are the most widespread and frequently encountered species, occurring regularly throughout most of the year. Minke whales *Balaenoptera acutorostrata* are regularly recorded as frequent seasonal visitors. Coastal waters of the Moray Firth and east coast of Scotland support an important population of bottlenose dolphins *Tursiops truncatus*, while killer whales *Orcinus orca* are sighted with increasing frequency towards the north of the area. Atlantic white-sided dolphin *Lagenorhynchus acutus*, Risso's dolphin *Grampus griseus* and long-finned pilot whale *Globicephala melas* can be considered occasional visitors, particularly in the north of the area (DECC, 2016).

Harbour porpoise, minke whale, white-beaked dolphin, Atlantic white-sided dolphin and killer whale have been recorded in the vicinity of the Mariner Field (Reid *et al.,* 2003; NMPi, 2019) (Table 4.3). Densities of these species range from high to low throughout the year. All species are listed as PMFs and harbour porpoise is listed under Annex II of the Habitats Directive (SNH, 2014).

Table 3.3 Seasonal density of the most frequently sighted cetaceans in the vicinity of Mariner A (Reid *et al.*, 2003; NMPi, 2019)

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Harbour porpoise	3	3	3	2	2	2	1	1	2	3		2
Minke whale						2	1	3				
White-beaked dolphin		2	2		3	3	1	3	3	3	3	
Atlantic white-sided dolphin			3			3	2					
Killer whale					3	3	3				3	
Key: 1 = High Density, 2 = Moderate Density, 3 = Low Density, Blank = No data;												

3.4.5.2 Seals

Two species of seals live and breed in the UK, namely the grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina* (DECC, 2016). Both grey and harbour seals are listed under Annex II of the European Union (EU) Habitats Directive and are Scottish PMFs. Approximately 38% of the world's grey seals breed in the UK and 88% of these breed at colonies in Scotland with the main concentrations in the Outer Hebrides and in Orkney, while approximately 30% of harbour seals are found in the UK. However, this proportion has declined from approximately 40% in 2002. Harbour seals are widespread around the west coast of Scotland and throughout the Hebrides and Northern Isles (SCOS, 2017).

Grey and harbour seals will feed both in inshore and offshore waters depending on the distribution of their prey, which changes both seasonally and yearly. Both species tend to be concentrated close to shore, particularly during the pupping and moulting season. Seal tracking studies from the Moray Firth have indicated that the foraging movements of harbour seals are generally restricted to within a 40–50 km range of their haul-out sites (SCOS, 2017). The movements of grey seals can involve larger distances than those of the harbour seal, and trips of several hundred kilometres from one haul-out to another have been recorded (SMRU, 2011).

The Mariner A platform is located approximately 134 km from the nearest landfall so it is unlikely that significant numbers of seals will be found in the vicinity of the proposed drilling operations. This is confirmed by a study carried out by the Sea Mammal Research Unit (SMRU), which analysed telemetry data of both grey and harbour seals in the UK spanning 1991 to 2012. The density maps generated from this work predict that the abundance of both grey and harbour seals within the vicinity of the platform is between 0 and 1 seals per 25 km^2 (Russel *et al*., 2017).

3.5 Conservation

There are no protected sites or known sensitive habitats within 40 km of the Mariner area. The closest area of conservation interest is the Braemar Pockmarks Special Area of Conservation (SAC), located 69 km to the south (Figure 3.8). The Braemar Pockmarks are a series of crater-like depressions on the sea floor, two of which contain the Annex I habitat Submarine structures made by leaking gases, and as such have been designated an SAC. Within UK waters these structures are primarily (but not exclusively) associated with large pockmarks such as those found in Fladen and Witch grounds in the NNS and parts of the Irish Sea (Jackson & McLeod, 2002).

Pobie Bank Reef SAC is located approximately 111 km to the northwest of Mariner A (PDQ). The site is designated as of conservation interest due to the presence of a combination of stony and bedrock reef and in the central section of the reef there are very large, rugged bedrock outcrops. Harbour porpoise, grey seal and harbour seal are known to use the site (JNCC, 2012).

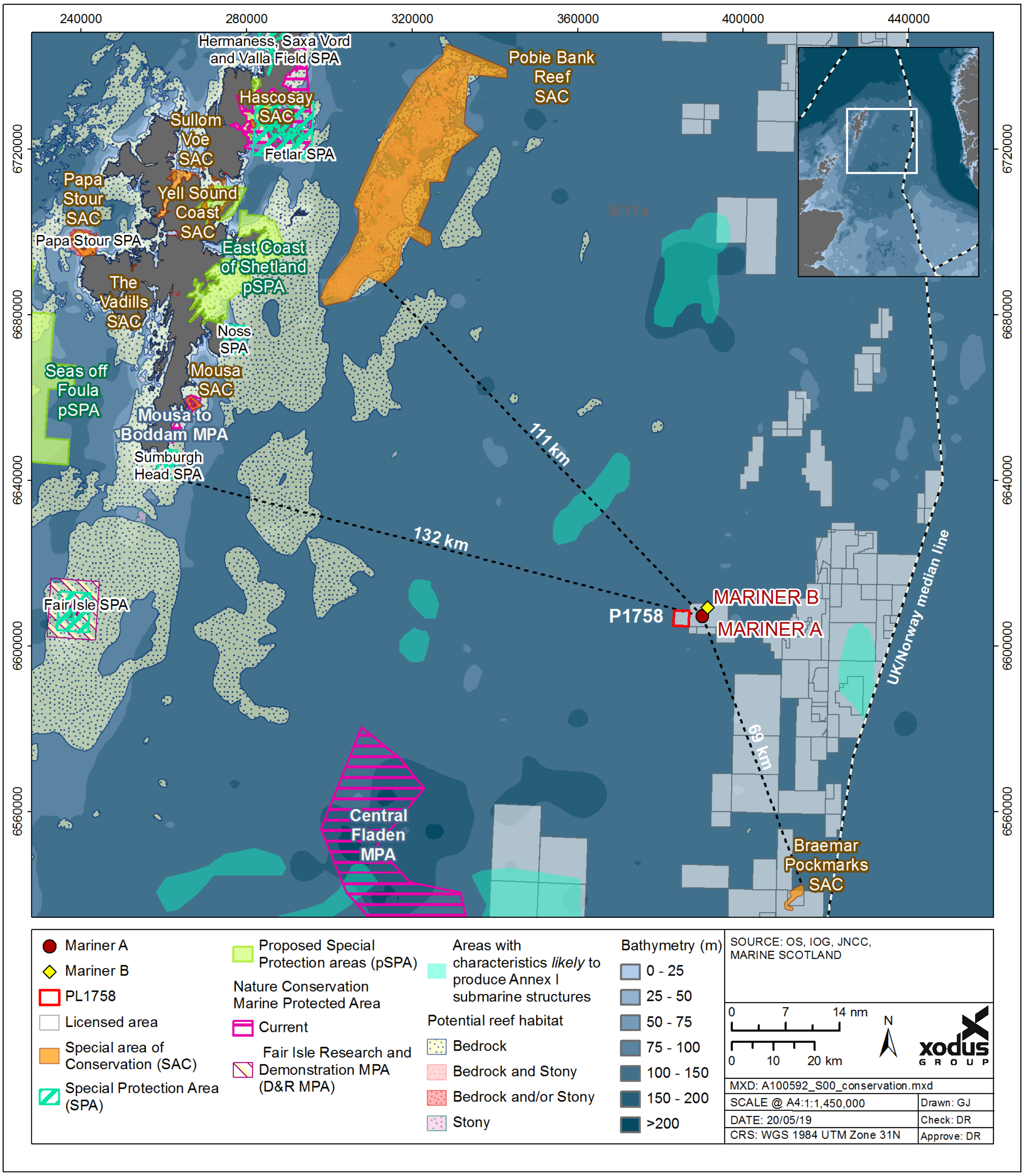

Figure 3.8 Offshore and coastal conservation sites in relation to the Mariner A platform

The closest Marine Protected Area (MPA) to Mariner A is the Central Fladen MPA, which is located approximately 79 km to the southwest. This site is designated for burrowed mud habitat characterised by seapens and burrowing megafauna, such as mud shrimp and Norway lobster.

Four Annex II species are found in UK waters; harbour porpoise, bottlenose dolphin, grey seal and harbour seal. Due to the distance offshore grey and harbour seals are unlikely to be regularly observed in the vicinity of Mariner A (SMRU, 2013). There is a resident population of bottlenose dolphins off the east coast of Scotland around the Moray Firth; this population typically remains close to the coast and individuals are unlikely to be observed as far offshore as the Mariner Field. Harbour porpoise is the only Annex II species which is likely to be present in significant numbers, as this species is common across the northern North Sea (Reid *et al.*, 2003).

The closest onshore protected site is Sumburgh Head Special Protection Area (SPA), located 132 km to the northwest of Mariner A. This site is designated under the Birds Directive (2009/147/EC) for supporting a population of 700 pairs of Arctic tern (*Sterna paradisaea*), approximately 1.6% of the British breeding population and a population of European importance. The site also qualifies due to regularly supporting at least 20,000 seabirds, and 35,000 during the breeding season.

3.6 Socio-economic environment

3.6.1 Commercial fisheries

The North Sea has important fishing grounds and is fished throughout by both UK and international fishing fleets, targeting demersal, pelagic and shellfish stocks. The Mariner platform is located in ICES rectangle 48F1. Fisheries statistics show that ICES rectangle 48F1 is targeted primarily for demersal fishing, which comprised approximately 99% of the value and approximately 99% of the liveweight of landings taken from the rectangle in 2017 (Table 3.4; Scottish Government, 2018).

Haddock was the most valuable species landed in 2017 contributing £1,305,202 (39%) of the total value, followed by cod which contributed £828,599 (25%). Haddock also contributed 43% to the total live weight of fish landed (Scottish Government, 2018).

Table 3.4 Liveweight and value of fish and shellfish from ICES rectangle 48F1 in 2017 (Scottish Government, 2018)

Species Type	2017	
	Liveweight (tonnes)	Value (£)
Demersal	1,935	3,324,172
Pelagic	2	3,854
Shellfish	3	14,029
Total	**1,941**	**3,342,055**

To put these figures in context, approximately 563,712 tonnes of fish and shellfish were landed in 2017 across the North Sea with a total value of £717,531,144. Landings and value of fish and shellfish in ICES rectangle 48F1 therefore represent a very small proportion (0.34% of landings and 0.47% of value) of the totals.

Table 3.4 provides a comparison of the landing tonnages and value of the three different target groups caught between 2013 and 2017. The demersal catch increased from 2013 to 2016 and decreased slightly in 2017. The pelagic fishery value fluctuates considerably and unpredictably, depending on the herring and mackerel catch. The shellfish fishery increased considerably between 2013 and 2015, then declined in 2016 and increased again in 2017.

Table 3.5 Liveweight and value of demersal fish, pelagic fish and shellfish taken from ICES Rectangle 48F1 between 2013 and 2017 (Scottish Government, 2018)

Year	Demersal		Pelagic		Shellfish	
	Liveweight (tonnes)	Value (£)	Liveweight (tonnes)	Value (£)	Liveweight (tonnes)	Value (£)
2017	1,935	3,324,172	2	3,854	3	14,029
2016	2,572	3,943,736	1,917	1,275,598	2	7,556
2015	2,389	3,390,326	259	99,387	4	11,620
2014	1,903	2,793,783	4,134	2,774,617	1	2,405
2013	1,970	2,735,101	932	886,364	1	2,111

Table 3.6 shows days of fishing effort per month between 2013 and 2017. There were 403 days of effort in 2017, which is low compared to other areas of the North Sea (Scottish Government, 2018). Fishing effort occurs throughout the year but peaks during April and May. Trawls were the most utilised gear in 2017,

comprising 89% of fishing effort in ICES rectangle 48F1, with seine nets comprising 10%. The data for hooks and lines is disclosive (Scottish Government, 2018). Fishing effort and landings for demersal species was lower in 2017 than it was in 2013 (Table 3.6), however, the value of landings for demersal species was higher.

Vessel Monitoring System (VMS) data from 2009-2013 for demersal species indicates that fishing intensity within Block 9/11 is moderate in comparison to the wider area. Fishing intensity ranges from low to moderate for pelagic fisheries in comparison with other areas of the North Sea (Kafas *et al.,* 2012).

Overall the fishing effort in ICES rectangle 48F1 is low in comparison to other North Sea areas, making up <1% of the UK total fishing effort, 126,863 days (Scottish Government, 2018).

Table 3.6 Number of days fished per month (all gears) in ICES Rectangle 48F1 between 2013 and 2017 (Scottish Government, 2018)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
ICES Rectangles 48F1													
2017	16	28	44	65	109	56	24	16	27	D[2]	D	7	**403**[3]
2016	22	63	93	72	139	63	73	37	17	27	21	19	**646**
2015	11	35	21	92	153	56	24	50	32	10	32	12	**529**
2014	D	20	88	44	71	97	19	25	25	16	6	13	**429**
2013	D	16	26	43	106	113	54	28	28	25	11	20	**477**

Note: Monthly fishing effort by UK vessels landing into Scotland: green = 0 – 100 days fished, yellow = 101 – 200, orange =201-300, red = ≥301. Source: Scottish Government*,* 2018

3.6.2 Oil and gas activity

Locations of other oil and gas infrastructure are illustrated in Figure 3.9. The Mariner A platform is part of the wider Mariner Area Development, which includes the Mariner B FSU located approximately 2.8 km to the northeast and the oil export and diluent import pipelines connecting the two together. In addition, the NLN jack up rig and the flotel *Safe Boreas* are currently on location in the Mariner Field.

The nearest surface infrastructure outside of the Mariner Area is the Beryl Development. The Beryl B platform is located 26 km east of Mariner A, and Beryl A is located 27 km to the southeast.

3.6.3 Military Activity

Block 9/11 does not lie within a Ministry of Defence (MOD) training area (DECC, 2016), and the Oil and Gas Authority (OGA) reported no regulatory issues (OGA, 2018).

3.6.4 Shipping Activity

The North Sea contains some of the world's busiest shipping routes, with significant traffic generated by vessels trading between ports at either side of the North Sea and the Baltic. North Sea oil and gas fields generate moderate vessel traffic in the form of support vessels, principally operating from Peterhead, Aberdeen, Montrose and Dundee in the north and Great Yarmouth and Lowestoft in the south (DECC, 2016).

The Mariner Field is located in an area defined as having a very low shipping density (OGA, 2016). Anatec conducted a Vessel Traffic Survey to identify the shipping routes within a ten nautical mile (nm) radius of the Mariner A (PDQ) platform and Mariner B FSU, to estimate the shipping constraints/obstructions for navigation in relation to the development, and to identify measures to minimise any risks to shipping. The survey identified 28 shipping routes within this radius, trafficked by an estimated 749 ships per year. This corresponds to an average of around two vessels per day, the largest of which predominantly comprise cargo and offshore support vessels (Anatec, 2014).

[2] Monthly effort data are shown where five or more UK vessels over 10 m undertook fishing activity in a given year. Where less than five such vessels undertook fishing activity in a given month, the data are "disclosive" (D) and not shown.

[3] Does not equate to total of table as includes disclosive data which cannot be provided for individual months for confidentiality reasons

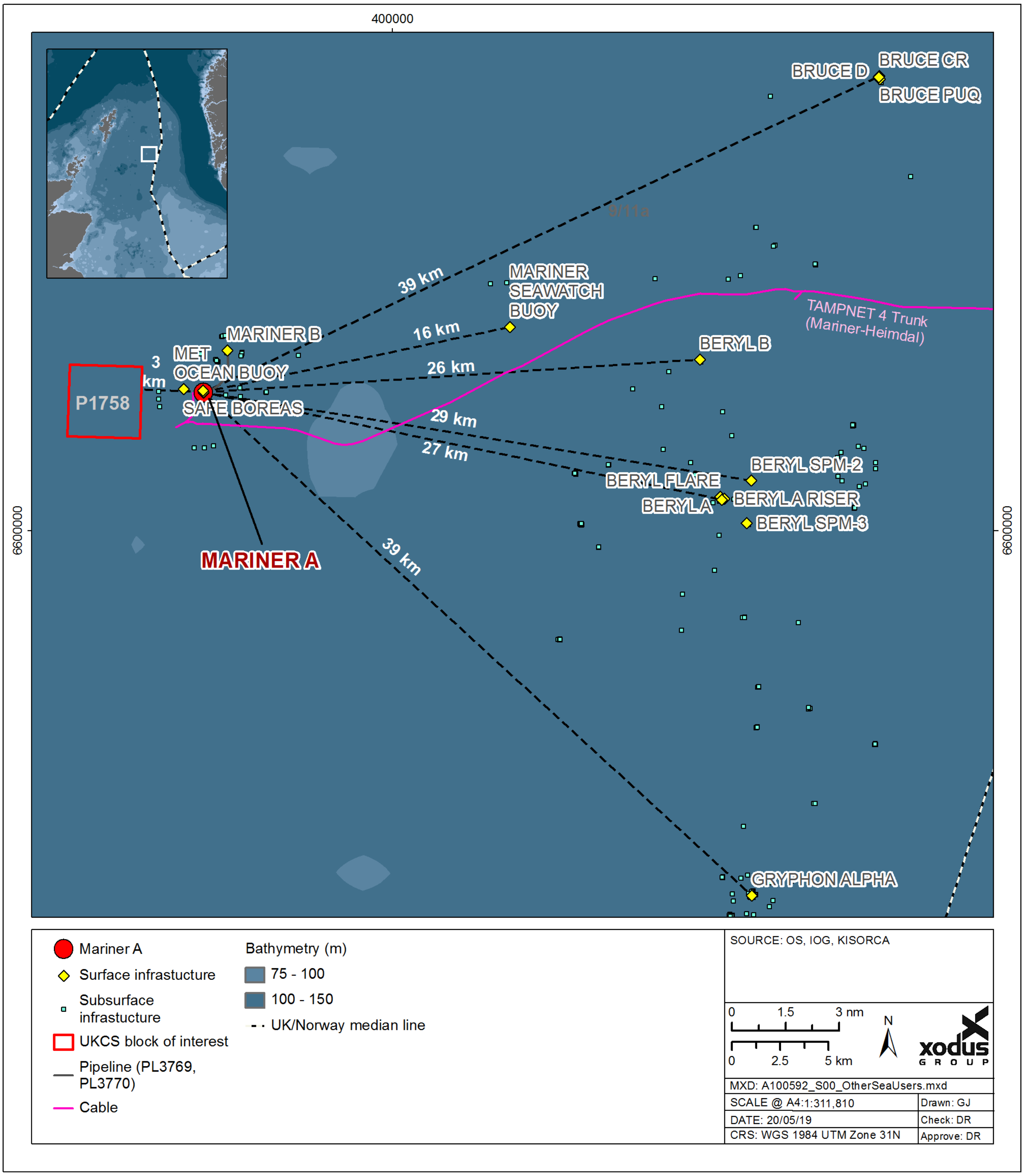

Figure 3.9 Other infrastructure in the vicinity of the Mariner A platform

Anatec conducted another study in 2016 to review the latest shipping data post installation of the Mariner A (PDQ) jacket to present the annual collision frequency based on the current routing of the vessels in the area. Based on the analysis of 3 months of Automatic Identification System (AIS) survey data post installation, the majority of the vessels were observed passing at a distance of greater than 1 nm from the jacket location. It is estimated 582 vessels per year pass within 10 nm of the Mariner A (PDQ) jacket, corresponding to an average of one to two vessels per day. Only one shipping route was identified within 2 nm of the Mariner A (PDQ) jacket trafficked by an estimated 15 vessels per year (Anatec, 2016).

3.6.5 Cables and pipelines

There is a fibre optic cable linking the Mariner A platform to the Heimdal platform in the Norwegian sector (Figure 3.9). There are no other submarine cables in the vicinity of the Mariner Field, the closest being the TAT 14 seg. (a) cable (14th consortium transatlantic telecommunications cable system), which is located approximately 36 km away (KIS-ORCA, 2019).

3.6.6 Renewable Energy

There are no renewable activities in the vicinity of the Mariner Field. The closest site to the Mariner Field is the Nova Innovation Ltd tidal lease site located 160 km to the northwest (NMPI, 2019).

3.6.7 Archaeology

The closest known wreck to the Mariner A platform is located approximately 14.3 km to the south (Statoil, 2012).

4 EIA METHODOLOGY

4.1 EIA Overview

Offshore activities can involve a number of environmental interactions and impacts due, for example, to operational emissions and discharges and general disturbance. The objective of the EIA process is to incorporate environmental considerations into the Project planning, to ensure that best environmental practice is followed and, ultimately, to achieve a high standard of environmental performance and protection. The process also allows for any potential concerns identified by stakeholders to be addressed appropriately. In addition, it ensures that the planned activities are compliant with legislative requirements and Equinor's HSE policy.

4.2 Environmental Issues Identification

The main objective of the environmental issues identification process is to identify the key potential environmental issues requiring discussion and assessment, and to agree practicable measures (mitigation) to eliminate or minimise harm to the environment.

In this case, the nature and scale of the potential environmental issues are well understood, as drilling of development wells from the Mariner A platform and subsequent production of oil via the platform have been assessed in Statoil (2012) and several subsequently approved drilling and production permits.

The known issues were therefore reviewed in order to identify any material changes due to switching drilling of four of the Mariner wells to the Cadet Field that could result in significant environmental impacts beyond what has already been assessed in Statoil (2012).

The issues identified as requiring re-assessment were then discussed with OPRED to ensure that all stakeholder concerns were addressed within the impact assessment.

The potential impact sources that were reviewed are summarised below and described in more detail in Section 4.6:

- Discharges to sea;
- Seabed disturbance;
- Underwater noise;
- Interaction with other sea users;
- Waste generation;
- Atmospheric emissions; and
- Accidental events.

4.3 Scoping and consultation

Considering the limited nature of the scope of the activities described in the ES, no formal scoping was undertaken. Scoping was limited to email discussions with OPRED personnel on the 4th and 16th April 2019 and a face to face meeting on the 23rd April 2019. The issues raised by OPRED during these discussions have been considered and addressed during the course of the EIA.

The issues identification process was kept under review through the EIA, with mitigation revised as understanding of the Project increased and based on consultee feedback.

4.4 Human Health

Human health impacts from routine and accidental events were considered during the EIA and were determined to largely require no further assessment within the EIA process, especially since activities are so far offshore and will be managed to meet industry requirements for safe operations.

4.5 Environmental Significance

4.5.1 Overview

The EIA Regulations require that the EIA should consider the likely potentially significant impacts of a project on the environment. The decision process related to defining whether or not a project is likely to significantly impact on the environment is the core principle of the EIA process. The EIA Regulations themselves do not provide a specific definition of significance. However, the methods used for identifying and assessing potential impacts should be transparent and verifiable.

The method presented here has been developed by reference to the Institute of Ecology and Environmental Management (IEEM) guidelines for marine impact assessment (IEEM, 2010), the Marine Life Information Network (MarLIN) species and ecosystem sensitivities guidelines (Tyler-Walters *et al*., 2001), guidance provided by Scottish Natural Heritage (SNH) in their handbook on EIA (SNH, 2018), by The Institute of Environmental Management and Assessment (IEMA) in their "Guidelines for EIA (IEMA, 2016), and OPRED's updated (rev 5, February 2019) EIA Guidance, 'The Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended) – A Guide' (BEIS, 2017).

The EIA provides an assessment of the environmental effects that may result from a project's impact on the receiving environment. The terms impact and effect have different definitions in EIA and one drives the other. Impacts are defined as the changes resulting from an action, and effects are defined as the consequences of those impacts.

In general, impacts are specific, measurable changes in the receiving environment (volume, time and/or area). Effects (the consequences of those impacts) consider the response of a receptor to an impact. The relationship between impacts and effects is not always so straightforward; for example, a secondary effect may result in both a direct and indirect impact on a single receptor. There may also be circumstances where a receptor is not sensitive to a particular impact and thus there will be no significant effects/consequences.

For each impact, the assessment identifies a receptor's sensitivity and vulnerability to that effect and implements a systematic approach to understand the level of impact. The process considers the following:

- Identification of receptor and impact (including duration, timing and nature of impact);
- Definition of sensitivity, vulnerability and value of receptor;
- Definition of magnitude and likelihood of impact; and
- Assessment of consequence of the impact on the receptor, considering the probability that it will occur, the spatial and temporal extent and the importance of the impact. If the assessment of consequence of impact is determined as moderate or major, it is considered a significant impact.

Once the consequence of a potential impact has been assessed it is possible to identify measures that can be taken to mitigate impacts through engineering decisions or execution of the project. This process also identifies aspects of the Project that may require monitoring, such as a post-decommissioning survey at the completion of the works to inform inspection reports.

For some impacts, significance criteria are standard or numerically based. For others, for which no applicable limits, standards or guideline values exist, a more qualitative approach is required. This involves assessing significance using professional judgement.

Despite the assessment of impact significance being a subjective process, a defined methodology has been used to make the assessment as objective as possible and consistent across different topics. The assessment process is summarised below. The terms and criteria associated with the impact assessment process are described and defined; details on how these are combined to assess consequence and impact significance are then provided.

4.5.2 Environmental characterisation

To assess potential impacts on the environment, characterisation is required of the different aspects of the environment that could potentially be affected (the 'baseline' environment). The environment in and around the Project has been described in Chapter 3, utilising desk studies and additional site-specific surveys. Information obtained through consultation with key stakeholders also helped characterise specific aspects of the environment in more detail.

Where data gaps and uncertainties remained (e.g. where there are no suitable options for filling data gaps), these have been documented and taken into consideration as part of the assessment of impact significance in each impact assessment section.

The EIA process requires identification of the potential receptors that could be affected by the Project (e.g. seabirds, marine mammals, seabed species and habitats). High-level receptors are identified within the impact assessment sections in Chapter 5.

4.5.3 Impact definition

4.5.3.1 Impact magnitude

Determination of impact magnitude requires consideration of a range of key impact criteria including:

- Nature of impact, whether it be beneficial or adverse;
- Type of impact, be it direct or indirect etc.;
- Size and scale of impact, e.g. the geographical area;
- Phase of Project when impact likely to occur (e.g. pre-construction, installation/construction, commissioning);
- Duration over which the impact is likely to occur, e.g. days, weeks;
- Seasonality of impact, i.e. is the impact expected to occur all year or during specific times of the year e.g. summer; and
- Frequency of impact, i.e. how often the impact is expected to occur.

Each of these variables are expanded upon in tables below to provide consistent definitions across all EIA topics. In each impact assessment section, these terms are used in the assessment summary table and are described as necessary in any supporting text. With respect to the nature of the impact (Table 4.1), it should be noted that all impacts discussed in this ES are adverse unless explicitly stated otherwise.

Table 4.1 Nature of impact

Nature of impact	Definition
Beneficial	Advantageous or positive effect to a receptor (i.e. an improvement).
Adverse	Detrimental or negative effect to a receptor.

Table 4.2 Type of impact

Type of impact	Definition
Direct	Impacts that result from a direct interaction between the Project and the receptor. Impacts that are actually caused by the introduction of Project activities into the receiving environment. E.g. The direct loss of benthic habitat.
Indirect	Reasonably foreseeable impacts that are caused by the Project but which occur later in time than the original, or at a further distance from the proposed Project area. Indirect impacts include impacts that may be referred to as 'secondary', 'related' or 'induced'. E.g. The direct loss of benthic habitat could have an indirect or secondary impact on by-catch of non-target species due to displacement of these species caused by loss of habitat.
Cumulative	Impacts that act together with other impacts (including those from any concurrent or planned future third party activities) to affect the same receptors as the proposed Project. Definition encompasses "in-combination" impacts.

Table 4.3 Duration of impact

Duration	Definition
Temporary	Impacts that are predicted to be of short duration (e.g. less than one year) and are temporary or intermittent in nature.
Short-term	Impacts that are predicted to last for a limited period of time (e.g. between 1 and 5 years) and will cease on completion of the Project activities (e.g. installation/construction) or as a result of planned mitigation, reinstatement or natural recovery.
Medium-term	Impacts that are predicted to last more than a few years (e.g. between 5 and 10 years - depending on overall project lifetime). For example, impacts that might occur during construction and installation (e.g. over a couple of years) but may last longer than this until mitigation, reinstatement or natural recovery has taken effect.
Long-term	Impacts that may, but not necessarily, commence during construction/installation and are expected to continue for the duration of the project, or in some cases beyond the lifetime of the project, before eventually ceasing. These include ongoing intermittent or repeated activities e.g. maintenance or seasonal events that are required to take place for the lifetime of the project.
Permanent	Impacts that are predicted to cause a permanent irreversible change and to continue well beyond the planned lifetime of the Project.

Table 4.4 Geographical extent of impact

Geographical extent	Description
Local	Impacts that are limited to the area surrounding the proposed Project footprint and associated working areas. Alternatively, where appropriate, impacts that are restricted to a single habitat or biotope or administrative area or local community.
Regional	Impacts that are experienced beyond the local area to the wider region, as determined by habitat/ecosystem extent or by administrative area boundaries.
National	Impacts that affect nationally important receptors or protected areas, or which have consequences at a national level. This extent may refer to either Scotland or the UK depending on the context.
Transboundary	Impacts that could be experienced by neighbouring national administrative areas.
International	Impacts that affect areas protected by international conventions, European and internationally designated areas or internationally important populations of key receptors (e.g. birds, marine mammals).

Table 4.5 Frequency extent of impact

Frequency	Description
Continuous	Impacts that occur continuously or frequently.
Intermittent	Impacts that are occasional or occur only under a specific set of circumstances that occurs several times during the course of the Project. This definition also covers such impacts that occur on a planned or unplanned basis and those that may be described as 'periodic' impacts.

4.5.3.2 Impact magnitude criteria

Overall impact magnitude requires consideration of all impact parameters described above. Based on these parameters, magnitude can be assigned following the criteria outlined in Table 4.6. The resulting effect on the receptor is considered under vulnerability and is an evaluation based on scientific judgement.

Table 4.6 Impact magnitude criteria

Magnitude	Criteria
Major	Extent of change: Impact occurs over a large scale or spatial geographical extent and /or is long term or permanent in nature. Frequency/intensity of impact: high frequency (occurring repeatedly or continuously for a long period of time) and/or at high intensity.
Moderate	Extent of change: Impact occurs over a local to medium scale/spatial extent and/or has a short to medium-term duration. Frequency/intensity of impact: medium to high frequency (occurring repeatedly or continuously for a moderate length of time) and/or at moderate intensity or occurring occasionally/intermittently for short periods of time but at a moderate to high intensity.
Minor	Extent of change: Impact occurs on-site or is localised in scale/spatial extent and is of a temporary or short-term duration. Frequency/intensity of impact: low frequency (occurring occasionally/intermittently for short periods of time) and/or at low intensity.
Negligible	Extent of change: Impact is highly localised and very short-term in nature (e.g. days/few weeks only).
Positive	An enhancement of some ecosystem or population parameter.
Notes: Magnitude of an impact is based on a variety of parameters. Definitions provided above are for guidance only and may not be appropriate for all impacts. For example, an impact may occur in a very localised area (minor to moderate) but at very high frequency/intensity for a long period of time (major). In such cases expert judgement is used to determine the most appropriate magnitude ranking and this is explained through the narrative of the assessment.	

4.5.3.3 Impact likelihood for unplanned and accidental events

The likelihood of an impact occurring for unplanned/accidental events is another factor that is considered in this impact assessment. This captures the probability that the impact will occur and also the probability that the receptor will be present.

4.5.4 Receptor definition

4.5.4.1 Overview

As part of the assessment of impact significance it is necessary to differentiate between receptor sensitivity, vulnerability and value. The sensitivity of a receptor is defined as 'the degree to which a receptor is affected by an impact' and is a generic assessment based on factual information whereas an assessment of vulnerability, which is defined as 'the degree to which a receptor can or cannot cope with an adverse impact' is based on professional judgement taking into account a number of factors, including the previously assigned receptor sensitivity and impact magnitude, as well as other factors such as known population status or condition, distribution and abundance.

4.5.4.2 Receptor sensitivity

Example definitions for assessing the sensitivity of a receptor are provided in Table 4.7.

Table 4.7 Sensitivity of receptor

Receptor sensitivity	Definition
Very high	Receptor with no capacity to accommodate a particular effect and no ability to recover or adapt.
High	Receptor with very low capacity to accommodate a particular effect with low ability to recover or adapt.
Medium	Receptor with low capacity to accommodate a particular effect with low ability to recover or adapt.
Low	Receptor has some tolerance to accommodate a particular effect or will be able to recover or adapt.
Negligible	Receptor is generally tolerant and can accommodate a particular effect without the need to recover or adapt.

4.5.4.3 Receptor vulnerability

Information on both receptor sensitivity and impact magnitude is required to be able to determine receptor vulnerability. These criteria, described in Table 4.6 and Table 4.7, are used to define receptor vulnerability as per Table 4.8.

Table 4.8 Vulnerability of receptor

Receptor vulnerability	Definition
Very high	The impact will have a permanent effect on the behaviour or condition of a receptor such that the character, composition or attributes of the baseline, receptor population or functioning of a system will be permanently changed.
High	The impact will have a prolonged or extensive temporary effect on the behaviour or condition of a receptor resulting in long term or prolonged alteration in the character, composition or attributes of the baseline, receptor population or functioning of a system.
Medium	The impact will have a temporary effect on the behaviour or condition of a receptor such that the character, composition, or attributes of the baseline, receptor population or functioning of a system will either be partially changed post Project or experience extensive temporary change.
Low	Impact is not likely to affect long term function of system or status of population. There will be no noticeable long-term effects above the level of natural variation experience in the area.
Negligible	Changes to baseline conditions, receptor population of functioning of a system will be imperceptible.

It is important to note that the above approach to assessing sensitivity/vulnerability is not appropriate in all circumstances and in some instances professional judgement has been used in determining sensitivity. In some instances it has also been necessary to take a precautionary approach where stakeholder concern exists with regard to a particular receptor. Where this is the case, this is detailed in the relevant impact assessment section in Chapter 5.

4.5.4.4 Receptor value

The value or importance of a receptor depends on a pre-defined judgement based on legislative requirements, guidance or policy. Where these may be absent, it is necessary to make an expert judgement on receptor value based on the perceived views of key stakeholders, experts and specialists. Examples of receptor value definitions are provided in Table 4.9.

Table 4.9 Value of receptor

Value of receptor	Receptor type	Definition (example only – does not cover all receptors)
Very high	Environmental receptors	Receptor of very high importance or rarity, e.g. species that are globally threatened e.g. International Union for the Conservation of Nature (IUCN) Red List of Threatened Species ('Red List') including those listed as endangered or critically endangered and/or a significant proportion of the international population (> 1%) is found within the Project site.
	Cultural and socio-economic receptors	Receptor has no alternative to utilise an alternative area. Receptor is entirely dependent on the project area for all income/activities. Receptor is the best known/only example to contribute to knowledge and understanding and/or outreach.
High	Environmental receptors	Receptor of high importance or rarity, such as species listed as near-threatened or vulnerable on the IUCN Red List. Habitats and species protected under the EU Habitats Directive. Bird species protected under the EU Birds Directive. Habitats and species (including birds) that are a qualifying interest of a SAC, SPA or Ramsar site and a significant proportion of the national population (>1%) is found within the Project site. Conservation interests (habitats and species) of MPAs, Heritage MPAs and MCZs.
	Cultural and socio-economic receptors	Receptors and sites of international cultural importance (e.g. United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage Sites (WHSs). Receptor has little flexibility to utilise an alternative area. Receptor generates the majority of income from the Project area. Receptor is above average example and/or has high potential to contribute to knowledge and understanding and/or outreach.
Medium	Environmental receptors	Receptor of least concern on the IUCN Red List, listed as a breeding species on Schedule 1 of the Wildlife and Countryside Act 1981, form a cited interest of a Site of Special Scientific Interest (SSSI), are listed in the UK Biodiversity Action Plan or on the Birds of Conservation Concern (BOCC) 'Red list' and a significant proportion of the regional population (>1%) is found within the Project site.
	Cultural and socio-economic receptors	Receptor has some flexibility to utilise an alternative area. Receptor is active in the project area and utilises it for up to half of its annual income/activities. Receptor is average example and/or has moderate potential to contribute to knowledge and understanding and/or outreach.
Low	Environmental receptors	Any other species of conservation interest (e.g. BOCC Amber listed species).
	Cultural and socio-economic receptors	Receptor has high flexibility to utilise an alternative area. Receptor is active in the project area and other areas and is reliant on project area for some income/activities. Receptor is below average example and/or has low potential to contribute to knowledge and understanding and/or outreach.
Negligible	Environmental receptors	Receptor of very low importance, such as those which are generally abundant around the UK and Ireland with no specific value or conservation concern.
	Cultural and socio-economic receptors	Receptor is very active in other areas and not typically present in the project area. Receptor does not generate any income/activities from the project area. Receptor is poor example and/or has no potential to contribute to knowledge and understanding and/or outreach.

4.5.5 Consequence and significance of potential impact

4.5.5.1 Overview

Having determined impact magnitude and the sensitivity, vulnerability and value of the receptor, it is then necessary to evaluate impact significance. This involves:

- Determination of impact consequence based on a consideration of sensitivity, vulnerability and value of the receptor and impact magnitude;
- Assessment of impact significance (in accordance with EIA regulations) based on assessment consequence;
- Mitigation; and
- Residual impacts.

4.5.5.2 Assessment of consequence and impact significance

The sensitivity, vulnerability and value of receptor are combined with magnitude (and likelihood, where appropriate) of impact using expert judgement to arrive at a consequence for each impact, as shown in Table 4.10. The significance of impact is derived directly from the assigned consequence ranking.

Table 4.10 Assessment of consequence

Assessment consequence	Description (consideration of receptor sensitivity and value and impact magnitude)	Impact significance (EIA regulations)
Major consequence	Impacts are likely to be highly noticeable and have long-term effects, or permanently alter the character of the baseline and are likely to disrupt the function and status/value of the receptor population. They may have broader systemic consequences (e.g. to the wider ecosystem or industry). These impacts are a priority for mitigation in order to avoid or reduce the anticipated effects of the impact.	Significant
Moderate consequence	Impacts are likely to be noticeable and result in lasting changes to the character of the baseline and may cause hardship to, or degradation of, the receptor population, although the overall function and value of the baseline/receptor population is not disrupted. Such impacts are a priority for mitigation in order to avoid or reduce the anticipated effects of the impact.	Significant
Low consequence	Impacts are expected to comprise noticeable changes to baseline conditions, beyond natural variation, but are not expected to cause long-term degradation, hardship, or impair the function and value of the receptor. However, such impacts may be of interest to stakeholders and/or represent a contentious issue during the decision-making process and should therefore be avoided or mitigated as far as reasonably practicable.	Not significant
Negligible	Impacts are expected to be either indistinguishable from the baseline or within the natural level of variation. These impacts do not require mitigation and are not anticipated to be a stakeholder concern and/or a potentially contentious issue in the decision-making process.	Not significant
Positive	Impacts are expected to have a positive benefit or enhancement. These impacts do not require mitigation and are not anticipated to be a stakeholder concern and/or a potentially contentious issue in the decision-making process.	Not significant

4.5.5.3 Mitigation

Where potentially significant impacts (i.e. those ranked as being of moderate impact level or higher in Table 4.10) are identified, mitigation measures must be considered. The intention is that such measures should remove, reduce or manage the impacts to a point where the resulting residual significance is at an acceptable or insignificant level. Mitigation is also proposed in some instances to ensure impacts that are predicted to be not significant remain so. Section 6.2 provides detail on these commitments and how any mitigation measures identified during the impact assessment will be managed.

4.5.5.4 Residual impacts

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

4.6 Issues Assessed

The consultation and technical review phases resulted in the following issues being considered and agreed for assessment in the EIA:

- Discharges to sea (Section 5.1)
  - Discharge of WBM, drill cuttings, cementing and completion chemicals from drilling operations into the water column and onto the seabed, resulting in changes in water quality, localised and temporarily increased suspended solid concentrations, and possible impacts to organisms in the water column and on the seabed.
  - Discharge of processed produced water into the water column resulting in changes in water quality and possible impacts on pelagic organisms.
- Seabed disturbance (Section 5.2)
  - Direct loss of benthic species;
  - Direct loss of existing seabed habitat;
  - Wider indirect disturbance to the benthic environment through the suspension and re-settlement of cuttings, mud and cement discharges;
- Underwater noise (Section 5.3)
  - Injury and disturbance to marine mammals through noise from drilling during the Project.
- Interaction with other sea users (Section 5.4)
  - Interference with shipping and fishing activities that may occur in the area;
  - Loss of access to the area for other vessels on a temporary or permanent basis; and
  - Increased risk of vessel collisions through the presence of the drill rig and other vessels during drilling activities.
- Atmospheric emissions (Section 5.5)
  - Climate change due to greenhouse gases (GHGs) including carbon dioxide (CO_2); and
  - Generation of acid rain from oxides of nitrogen (NOx) and sulphur (SO_x).
- Accidental events (Section 5.6)
  - Possible toxicity and smothering impacts to birds, other marine species (e.g. marine mammals) and habitats through the release of hydrocarbons and chemicals from a well blowout or of crude inventory from the Mariner B FSU.

4.6.1 Issues scoped out

During scoping and as the EIA developed the following issues were reviewed, but it was considered that the potential impacts were too small and likely to be insignificant; it was therefore agreed they would be scoped out of further assessment in the EIA.

As the EIA developed the following issues were reviewed, but it was considered that the potential impacts were too small and likely to be insignificant; it was therefore agreed they would be scoped out of further assessment in the EIA:

- Discharges to sea
  - Routine blackwater production (i.e. sewage), grey water (i.e. from showers, laundry, hand and eye wash basins and drinking fountains) and food waste (macerated) disposal (from vessels and drill rig) – scoped out due to existing, effective management controls in place for such discharges;
  - Ballast water – scoped out as no major international movement of vessels expected for construction of the Project; and
  - Routine seawater usage for cooling (e.g. engine cooling) – scoped out due to the highly limited temporal and spatial extent of such discharges.
- Underwater noise
  - As fish utilise sound for various ecological processes, they may have the potential to be impacted by anthropogenic noise emissions through injury and disturbance mechanisms. However, evidence suggests such impacts are largely restricted to impulsive sounds (Popper and Hawkins, 2012; De Robertis and Handegard, 2012) and would be highly unlikely to occur on a scale which would have population-level consequences (Mood and Brooke, 2010). Similarly, should noise emissions disturb fish, the short-term movement away from the short-term activities would not constitute a large-scale movement by individuals of a species and would be highly unlikely to result in population level impacts. On this basis, fish have been scoped out of further assessment.
- Physical presence
  - Direct loss of marine archaeological remains – scoped out since there were no wrecks identified during the survey scope at the proposed well locations;
  - Disturbance to ornithological features from drill rig and vessels – scoped out since there will be no change in lighting compared to the baseline conditions on Mariner A;
  - Disturbance to marine species in the Project area from vessels or collision between vessels and animals – scoped out as the Cadet Field is in open sea and the drilling campaign is a temporary short-term activity, and thus vessel use to support drilling activity will be minimal; and
  - Impact on seascape – scoped out as there will be no change to the baseline surface infrastructure and the limited additional vessel presence will be sufficiently far offshore not to affect visual amenity.
- Waste
  - Routine generation and disposal of non-hazardous waste streams – scoped out due to existing, effective management controls in place for waste;
  - Routine generation and disposal of special/hazardous wastes, e.g. oily rags, medical waste, solvents, batteries, computers, fluorescent tubes, oil/grease/chemical cans/drums/sacks, – scoped out due to existing, effective management controls in place for waste; and
  - Routine generation and disposal of radioactive wastes (disposal onshore) (e.g. naturally occurring radioactive material (NORM), contaminated cuttings, radiation sources in safety/detection equipment etc.) – scoped out as no radioactive waste is expected from the drilling campaign.

- Accidental events
  - Accidental deposit of materials on the seabed (e.g. dropped objects) – scoped out due to existing, effective management controls in place for dropped objects;
  - Limited unplanned operational releases, such as resulting from an overfill of the diesel tank bund – scoped out due to limited volumes and very low likelihood of occurrence; and
  - Natural disasters - it is considered that the implication of any natural disasters affecting the offshore region, such as an earthquake or extreme sea conditions (including tsunami), would most likely be the accidental event scenarios described in Section 5.6. The implication of release of chemicals and hydrocarbons from the Project is assessed within Section 5.6, and natural disasters are therefore not discussed further.
- Recreation and tourism
  - Long-term restriction of access or amenity – scoped out due to absence of sensitive receptors in the area of potential impact.

4.7 Cumulative and In-combination Impact Assessment

The European Commission has defined cumulative impacts as being those resulting “from incremental changes caused by other past, present or reasonably foreseeable actions together with the project” (European Commission, 1999). As outlined in studies by the European Commission (1999) and US CEQ (1997), identifying the cumulative impacts of a project involves:

- Considering the activities associated with the Project;
- Identifying potentially sensitive receptors/resources;
- Identifying the geographic and time boundaries of the cumulative impact assessment;
- Identifying past, present and future actions which may also impact the sensitive receptors/resources;
- Identifying impacts arising from the proposed activities; and
- Identifying which impacts on these resources are important from a cumulative impacts perspective.

To assist the assessment of cumulative and in-combination impacts (where the same receptor is affected by the same scheme in different ways), a review of existing developments (including oil and gas, cables and renewables) that could have the potential to interact with the Cadet Project was undertaken; the output of this review is reported in the Environment Baseline (Chapter 3). The impact assessment has considered these projects when defining the potential for cumulative and in-combination impact (Chapter 5).

4.8 Transboundary Impact Assessment

The impact assessments presented in Chapter 5 identify and where appropriate assess transboundary impacts. For the Cadet Project, the UK/Norway median lies approximately 45 km away.

4.9 Habitats Regulations Appraisal (HRA) and Nature Conservation Appraisal

Under Article 6.3 of the Habitats Directive, it is the responsibility of the Competent Authority to make an Appropriate Assessment of the implications of a plan, programme or in this case project, alone or in combination, on a Natura site (SAC or SPA) in view of the site’s conservation objectives and the overall integrity of the site.

As part of the assessment of impacts on key receptors, for those receptors that are a qualifying feature of a Natura site, relevant information on SACs or SPAs has also been provided as part of the impact assessment process. This information will then be used by the Competent Authority to determine the need for, and subsequently carry out (if required), an appropriate assessment of the Cadet Project.

For offshore areas (12 – 200 NM) the requirements of the Habitats Directive are transposed through the Conservation of Offshore Marine Habitats and Species Regulations 2017. In accordance with these Regulations, the impacts of a project on the integrity of a European site are assessed and evaluated as part of the HRA process. In an analogous process, the Marine (Scotland) Act and the Marine and Coastal Access Act require the potential for significant risk to the conservation objectives of Nature Conservation Marine Protected Areas (NCMPAs) and MCZs (respectively) being achieved to be assessed.

5 IMPACT ASSESSMENT

5.1 Discharges to sea

Drilling and operation of the Cadet wells will result in discharges to sea including mud, cuttings and cement during the drilling phase and discharges of produced water and production chemicals during the operational phase.

5.1.1 Impact mechanism

Statoil (2012) identified that the planned discharge of water based and thermally treated LTOBM residues and drill cuttings will cause smothering of benthic fauna and fish spawning grounds in the vicinity of the Mariner A platform. Water column discharges of drill cuttings and residual water based mud have the potential to cause toxicity to pelagic organisms.

During the operational phase the principal disposal route for formation water produced from the Cadet wells and processed on the Mariner A platform will be re-injection into one of several PWRI wells. However, during periods when the PWRI system is unavailable (e.g. during start up), produced water will be discharged to sea. Before disposal, water will be treated to the regulatory oil-in-water standard of less than 30 mg/l. Chemicals injected into the wells or into the process fluids stream may partition into the water phase and therefore be discharged overboard.

Cement discharges were expected to be restricted to the area immediately around the wellheads and were therefore expected to be not significant, this conclusion remains unchanged and cement discharges are not discussed further.

5.1.2 Scale of impact

Statoil (2012) concluded seabed impacts from drilling discharges were expected to be limited to within approximately 0.5 km of the discharge point based on discharge modelling. The limited extent of the predicted impact area and the widespread spawning distribution of the fish species whose spawning grounds were affected was expected to prevent significant impacts.

Drilling discharges into the water column were predicted to have local and transient impacts. The discharge of thermally treated LTOBM cuttings was shown to increase the short-term risk to the water column, but with a corresponding decreased risk to the sediment when compared to modelled WBM cuttings discharge (Statoil, 2012).

Statoil (2012) found that produced water discharges from the Mariner A process were not predicted to present a significant risk to environment due to the massive dilution that will occur upon discharge, the lack of sensitive receptors in the area and the PWRI system being designed to achieve 95% availability.

The closest protected site to the discharge point is 69 km away, therefore no impacts on protected sites are expected.

5.1.3 Net change compared to approved Mariner ES

The three production wells and one water injection well proposed for the Cadet Field will replace four wells that were originally intended to be drilled in the Mariner Field. The calculated total for mud and cuttings discharge for 50 wells in Statoil (2012) was 156,225 tonnes equating to 3,125 tonnes per well. The total mud and cuttings discharge for the four proposed Cadet wells will be 13,900 tonnes, equating to 3,475 tonnes per well. As such, the Cadet Field Development will result in very little net change in the amount of drilling mud, cuttings and cement discharged from the Mariner A platform compared to what has already been assessed in Statoil (2012). The increase in produced water discharge is also expected to be small when considering that the majority of produced water will be reinjected. There is considered to be no potential for significantly increased risk to the environment due to Cadet well discharges.

5.1.4 Cumulative and transboundary impacts

As discussed above, the Cadet Field Development is expected to result in a small net increase in mud and cuttings discharged to the seabed and water column compared to the previously approved Mariner ES, and this net increase will constitute a small cumulative impact to the benthos and pelagic organisms in conjunction with the ongoing drilling at the Mariner Field. Given the small scale of seabed impacts (restricted to within 0.5 km of the discharge) predicted by the previous cuttings discharge modelling (Statoil, 2012), it is not expected that this cumulative impact will be environmentally significant. Water column cumulative impacts from both drilling and produced water discharges are expected to be negligible and any small increase due to the Cadet Development is not expected to change the expected impact magnitude. The nearest third party infrastructure to the proposed drilling location is the Beryl Development located 26 km away. There is no possibility of Cadet Field discharges interacting with this or any other third party development. As such, significant cumulative impacts are not expected.

The nearest transboundary line is 45 km away and therefore transboundary impacts are not expected.

5.1.5 Residual impacts

Receptor	Sensitivity	Vulnerability	Value	Magnitude	Consequence
Seabed	Low	Medium	Negligible	Minor	Low
Water column	Low	Low	Negligible	Negligible	Negligible

5.2 Seabed disturbance

Disturbance of the seabed can lead to injury or mortality of benthic species, destruction of habitat and indirect impacts on receptors such as demersal fish that rely of the seabed for foraging.

5.2.1 Impact mechanism

Aside from the discharge of drill cuttings assessed in Section 5.1, the Cadet Field Development will not cause any disturbance to the seabed additional to what has already been assessed for the Mariner Area Development Project. All wells will be drilled through an existing well template from an existing platform. No anchors are required and no additional equipment will be installed on the seabed.

5.2.2 Scale of impact

There is no impact expected.

5.2.3 Net change compared to approved Mariner ES

There is no net change to the seabed disturbance assessed in Statoil (2012).

5.2.4 Cumulative and transboundary impacts

There is no impact expected and therefore no scope for cumulative or transboundary impacts.

5.2.5 Residual impacts

Receptor	Sensitivity	Vulnerability	Value	Magnitude	Consequence
Seabed	Low	Medium	Negligible	Negligible	Negligible

5.3 Underwater noise

The ocean is an inherently noisy environment with a highly variable 'soundscape' generated by a range of environmental and anthropogenic sound sources. Rain, breaking waves, currents, communication between animals, and other biotic activities all contribute to the background or 'ambient' sound in the marine environment. Vessels, oil and gas production and exploration, the installation of marine infrastructure, and military activities may generate sounds which exceed ambient noise levels, generating what is termed 'noise pollution' (Peng *et al*., 2015). Noise pollution has the potential to impact upon marine species if it sufficiently exceeds ambient levels by causing changes in behaviour, auditory-induced injury, or, in extreme cases, mortality.

5.3.1 Impact mechanism

There are three primary ways in which marine mammals may be impacted by sound: behavioural change, acoustic response, and physiological effects (Nowacek *et al*., 2007). Behavioural changes may include changes to movement, such as altering direction or dive pattern, whilst acoustic responses may take the form of changing vocalisation patterns or communication with conspecifics. Both of these impact mechanisms are considered "disturbance responses" to anthropogenic sounds, and they may have population-level consequences if it precludes the use of important habitat for prolonged periods or impacts upon their foraging or breeding success (Lusseau and Bejder, 2007; Williams *et al*., 2006).

Physiological responses are generated when noise emissions fall within the hearing frequency-range of an individual. At the very base level, introduced sounds may impact marine mammals by causing auditory fatigue from the repeated focusing of the hearing apparatus on frequencies occurring at the limits of the individual's 'normal' hearing range. Such fatigue may cause a temporary reduction in hearing ability known as a Temporary Threshold Shift (TTS) (Finneran *et al*., 2005; Popov *et al*., 2013). When anthropogenic sounds are sufficiently loud (i.e. at a large enough amplitude to generate intense pressure waves), they have the potential to cause permanent injury to hearing apparatus, and even deafness, through Permanent Threshold Shift (PTS) (Southall *et al*., 2007; NOAA, 2018). In extreme cases, such as exposure to explosive sound, injuries may be sustained despite the sound occurring beyond the range of audibility for the exposed animal.

As noises generated by proposed activities associated with the Cadet Field Development Project will be readily transmitted underwater, there is potential to cause disturbance or injury to marine mammals.

The only noise emissions that will occur due to the Cadet Field Development are drilling noise and noise from vessels and helicopters supplying equipment and personnel for the drilling programme. Mariner A will be producing operational noise throughout the drilling and operational period of the Cadet wells, but this noise is ongoing and would occur regardless of the Cadet Field Development and is therefore not considered further.

5.3.2 Scale of impact

Noise from drilling operations was modelled and assessed in Statoil (2012), although it should be noted that the modelling assumed the presence of a jack-up drilling rig, which will not be required for the Cadet wells. Drilling operations were estimated to produce a combined source sound pressure level (SPL) of 183 dB re 1 μPa (meaning 183 decibels referenced to 1 micro pascal (the reference unit of pressure) at 1 m from the sound source (the calculation assumes the combined sound from all sources emanates from one infinitesimally small point). This noise level was deemed too low to result in either injury or significant disturbance to cetaceans, which were the only at-risk receptors. Since the drilling operations for the Cadet Area Development will be almost identical to those assessed in Statoil (2012), except without the requirement for a jack-up rig, it is expected that the Cadet drilling will not produce significant impacts.

5.3.3 Net change compared to approved Mariner ES

There is no discernible net change in underwater noise impacts between the previously approved Mariner ES (Statoil, 2012) and the proposed Cadet Field Development.

5.3.4 Cumulative and transboundary impacts

The Cadet Field Development works and schedule will be incorporated into the overall Mariner Area Development Project. At the time that the Cadet wells are drilled, all drilling will be conducted from the drilling unit on the Mariner A platform, which will only work on one well at a time. As such there will be no potential for additive impacts due to wells being simultaneously drilled in the Mariner Field. There are no other known drilling programmes in the area that could add to the Cadet drilling impact. As such, no cumulative impacts are expected. The drilling will occur 45 km from the nearest transboundary line (UK/Norway), therefore transboundary impacts are not expected.

5.3.5 EPS risk assessment

For any European Protected Species (EPS), the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended) make it an offence to deliberately or recklessly capture, kill, injure, harass or disturb any such animal. Whilst the injury offence is related to acts against one or more animals, the disturbance offence is related to disturbance of a significant group of EPS. An EPS licence is required for any activity that might result in injury to, or disturbance of, an EPS. There is considered to be no potential for significant impact to EPS in terms of injury or disturbance during the proposed Project. As such, an EPS licence is considered unnecessary.

5.3.6 Residual impacts

Receptor	Sensitivity	Vulnerability	Value	Magnitude	Consequence
Cetaceans	Medium	Low	High	Minor	Low

5.4 Other sea users

The installation of infrastructure and the introduction of additional vessel movements into a sea area have the potential to affect other users of the area, with receptors including commercial fishing, existing oil and gas operations, and commercial shipping.

5.4.1 Impact mechanism

There are three areas of concern with regard to impacts on other sea users.

Installation of surface infrastructure (and some seabed infrastructure such as subsea manifolds) or the presence of mobile drilling units conducting drilling operations necessitates the implementation of a 500 m radius safety zone from which non-project vessels are excluded. This can interfere with fishing activity.

Seabed infrastructure that is not within a 500 m safety zone can present a snagging hazard to demersal fishing gear. Snagging can also occur within any 500 m safety zone that is not respected.

Finally, the presence of additional surface infrastructure and vessels can increase the risk of collision (two moving vessels), allision (one moving vessel and one stationary vessel / structure) or other interactions such as avoiding action. Shipping routes may also need to be changed to divert around new infrastructure, increasing vessel fuel costs due to increases in route length.

5.4.2 Scale of impact

Drilling of the Cadet wells will not introduce any new surface or subsea structures that could exclude other sea users or increase risk of collision. The wells will be drilled from the existing Mariner A platform and the well conductors will be within the existing 500 m safety exclusion zone. There is not expected to be a significant increase in the existing number of vessel movements due to the proposed development. Fishing activity in the area is low (Section 3.6.1) and commercial vessel density is very low (Section 3.6.4). The nearest third party oil and gas development is Beryl, located 26 km away. Taking all this into account, significant impacts on other sea users are not expected.

5.4.3 Net change compared to approved Mariner ES

There is not expected to be any change in fixed infrastructure required compared to that assessed in Statoil (2012). There will be a small increase in vessel movements due to additional supply trips during the drilling phase and the small increase in production that will be achieved (Section 2.8.1.4) requiring slightly more frequent tanker offtake from the Mariner B FSU, but this is not expected to be significant. In summary, there is not expected to be a significant increase in impacts to other sea users due to the Cadet Field Development compared to Statoil (2012).

5.4.4 Cumulative and transboundary impacts

The small increase in shuttle tanker movements will act cumulatively with the existing vessel activity associated with the Mariner Area Development, but this is not expected to result in a significant cumulative impact due to the low sensitivity of the receptors and the very low level of existing shipping in the area. There are no cumulative impacts expected with regard the third part developments and no transboundary impacts or impact on protected features are expected.

5.4.5 Residual impacts

Receptor	Sensitivity	Vulnerability	Value	Magnitude	Consequence
Oil and Gas Developments	Negligible	Negligible	Negligible	Minor	Negligible
Commercial Fisheries	Low	Low	Low	Minor	Low
Commercial Shipping	Low	Low	Low	Minor	Low

5.5 Atmospheric emissions

Gaseous emissions from the Project could result in impacts at a local, regional, transboundary and global scale.

5.5.1 Impact mechanism

Local, regional and transboundary issues include the potential generation of acid rain from NO_X and SO_X released from combustion, and the human health impacts of ground level nitrogen dioxide (NO_2), sulphur dioxide (SO_2), both of which will be released from combustion) and ozone (O_3), generated via the action of sunlight on NO_x and volatile organic compounds (VOCs). On a global scale, concern with regard to atmospheric emissions is increasingly focused on global climate change. The Intergovernmental Panel on Climate Change (IPCC) in its fifth assessment report (IPCC, 2014) states that 'Anthropogenic GHG emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever. This has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented in at least the last 800,000 years. Their effects, together with those of other anthropogenic drivers, have been detected throughout the climate system and are extremely likely to have been the dominant cause of the observed warming since the mid-20th century. Climate change projections included in the IPCC report predict a mean surface temperature change between 2016 and 2035 will likely be in the range of 0.3°C and 0.7°C (medium confidence). GHGs include water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxides (N_2O), O_3 and chlorofluorocarbons (CFC). The most abundant GHG is water vapour, followed by CO_2. IPCC (2014) states that the increase in GHGs emissions since the pre-industrial era has driven large increases in the atmospheric concentrations of CO_2, CH_4 and N_2O and that CO_2 emissions from fossil fuel combustion and industrial processes contributed about 78% to the total GHG emission increase between 1970 and 2010, with a contribution of similar percentage over the 2000–2010 period. Between 2002 and 2011 CO_2 concentrations increased at the fastest ever decadal rate of change (IPCC, 2014).

Drilling and production operations can produce atmospheric emissions from combustion of fuel to run vessels, facilities and equipment, and from flaring of produced gas either during well testing or during the production phase.

5.5.2 Scale of impact

Statoil (2012) calculated that the Mariner Area Development installation activities (including drilling) would produce CO_2 emissions over a 2-year period equating to approximately 2.04% of the total annual CO_2 emissions from UKCS oil and gas exploration and production (E&P) activity in 2010. During the operational year with the highest predicted emissions (then expected to be 2022), the Mariner Area Development was expected to emit CO_2 equivalent to approximately 3% of total UKCS E&P CO_2 emissions in 2010. The Cadet

Field Development will be extremely minor in the context of this large development, which was nevertheless considered not to result in significant impacts to local air quality, acid rain production or global climate change.

5.5.3 Net change compared to approved Mariner ES

Cadet drilling activity will not result in any additional atmospheric emissions above what was assessed in Statoil (2012).

There will be a slight increase in production due to the Cadet wells coming online, but there will be no increase in flaring associated with this increase, since routine flaring is due to be phased out on Mariner A by 2025.

There will be a small increase in the frequency of shuttle tanker visits because the FSU will be filled quicker. This will mean an increase in shuttle tanker fuel use and also an increase in venting of VOCs from the crude tanks during crude offloading. These increases are expected to be very minor however and are not expected to be significant.

The increased production will be within the existing processing capacity of Mariner A and there will be no requirement for extra power generation and associated fuel use on the platform as a result.

As discussed in Section 2.8.1.4, production from the new wells will not increase total production at Mariner A beyond what the maximum already approved in the existing Mariner Field production consent. While the Cadet Field will have a separate production consent, this illustrates that total production and associated atmospheric emissions at Mariner A will remain below the level that is already consented. As such there is considered to be no potential for significant atmospheric emissions impacts.

5.5.4 Cumulative and transboundary impacts

While emissions from the Cadet Field Development will act cumulatively with the existing emissions from the Mariner Area Development, this is not expected to result in significant impacts as discussed in Section 5.5.3. There are no cumulative impacts expected with regard to third party assets.

As impacts to local air quality, acid rain production and global climate change are all expected to be not significant, there no potential for significant impacts on protected features, or for transboundary impacts.

5.5.5 Residual impacts

Receptor	Sensitivity	Vulnerability	Value	Magnitude	Consequence
Local air quality	Low	Low	Low	Minor	Low
Acid rain production	Low	Low	Low	Minor	Low
Global climate change	Low	Low	Low	Minor	Low

5.6 Accidental events

This section focuses on large scale hydrocarbon release as other types of accidental event have been scoped out in Section 4.6.1.

A major hydrocarbon release is the most visible impact arising from oil and gas operations, and the impact that is most likely to have severe acute environmental impacts, especially on seabirds which are extremely vulnerable to hypothermia and drowning due to oiled plumage. There is considerable regulatory, stakeholder and public concern surrounding the possibility of a major release from any UK oil and gas installation and this is reflected in the stringent regulations surrounding oil and gas operations, and the low and decreasing rate of incidents which occur.

Figure 5.1 shows the total mass of oil accidentally released each year on the UKCS from 1975 to 2017. It also shows the number of individual incidents that have occurred each year. From 1997 these incidents are broken down into those involving less than one tonne of oil and those involve one tonne or more. The number of reported accidental hydrocarbon releases increased from 1975 until 2002, most likely due to increased awareness and strengthening of reporting. Between 2002 and 2017, the total number of reported incidents per year has declined.

The annual number of releases of quantities ≥1 tonne of oil has decreased gradually since 1997 (Figure 5.1), however there were large single release events in 2010 (North Cormorant, 131 tonnes crude), 2011 (Gannet F, 218 tonnes crude), 2012 (Elgin, 405 tonnes gas condensate) and 2016 (Clair, currently estimated at 95 tonnes (BP, 2016)), which account for the majority of the elevated total tonnage of oil released in those years.

The annual number of releases <1 tonne increased from the first year of reporting in 1997 to a peak in 2002, after which there was a marked decline in the number of incidents. Figure 5.1 illustrates that the vast majority of incidents involve <1 tonne of oil.

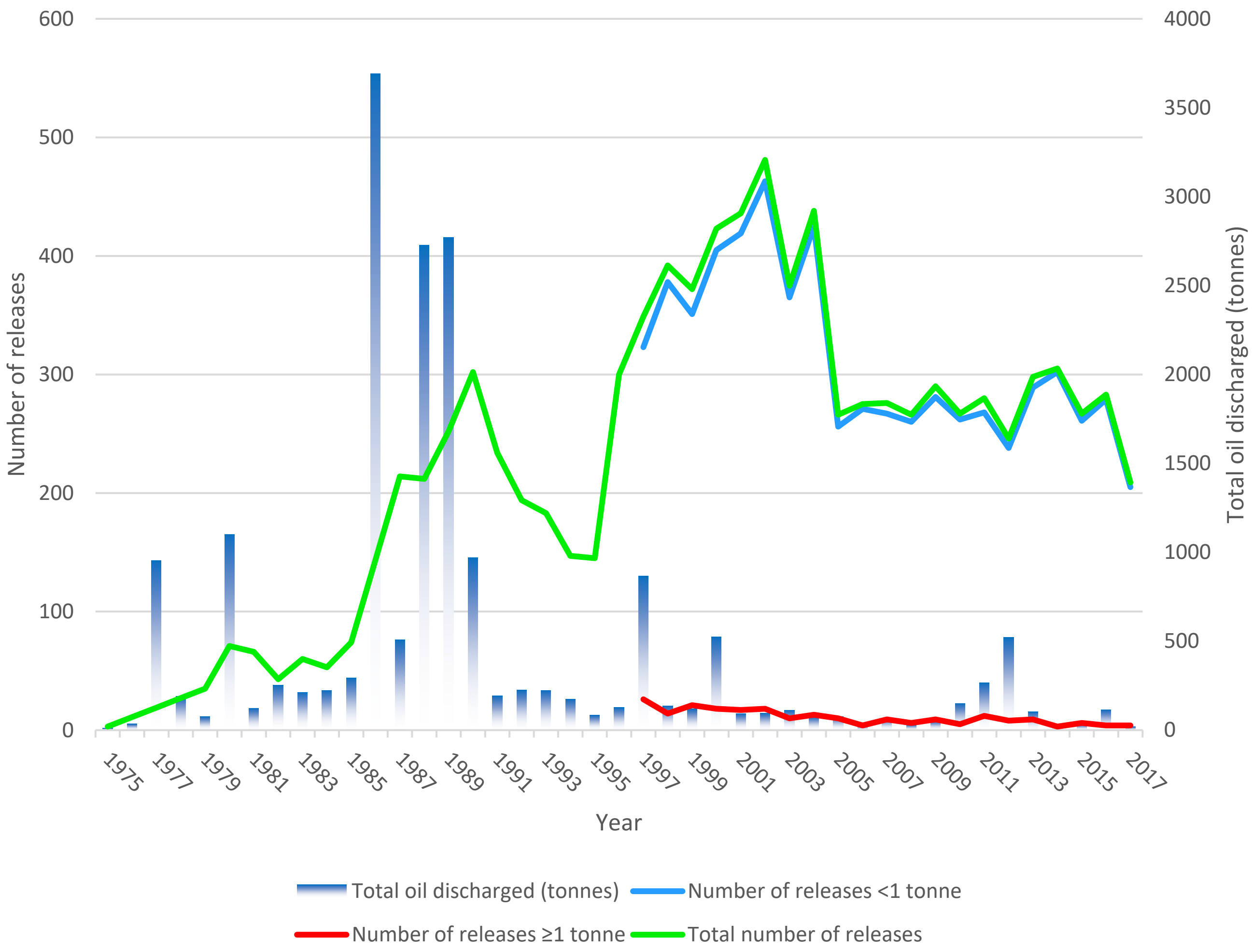

Figure 5.1 Total number of accidental hydrocarbon releases and amounts released (TINA Consultants Ltd pers. comm., 2013; BEIS, 2019a; BEIS, 2019b; National Archives 2012a; National Archives 2012b; BP, 2016)

5.6.1 Impact mechanism

Seabirds are the receptor most at risk due to spilled oil (JNCC, 2011). Due to their habits of sitting on and or diving through the sea surface, many species of seabirds are extremely vulnerable to oiling of plumage which can rapidly result in drowning or fatal hypothermia. Ingestion of oil during attempted preening of contaminated plumage can cause liver and kidney damage (Furness and Monaghan, 1987). Vulnerability varies between species; the Alcidae (auk) species are recognised as particularly at risk due to their frequent interactions with the sea surface.

Other offshore receptors are generally considered to have low vulnerability. In the case of plankton and fish this is due to widespread and numerous populations meaning population level impacts are unlikely. In the case of cetaceans there is conflicting evidence regarding individual vulnerability, but they are considered unlikely to suffer significant long term impacts in the open sea (Aubin, 1990).

Coastal impacts vary widely depending on the type of oil released, the specific habitat (exposed coasts are considered less vulnerable than sheltered coasts) and the weather during the incident (rough weather can help to break up and disperse surface slicks into the water column, reducing the volume of oil that reaches shore).

5.6.2 Scale of impact

A worst case well blowout at the Mariner A platform has previously been assessed (Xodus, 2017) for the potential to comprise a major environmental incident (MEI), which is defined in the Environmental Liability Directive (2004/35/EC) as “an incident which results, or is likely to result, in significant adverse effects on the environment”.

Modelling was conducted for a worst-case well blowout at the Mariner A platform. Deterministic modelling of the release indicated that sediment hydrocarbon concentrations would remain within background levels across much of the affected area but would be elevated along the east coast of Shetland and affect 16 SPAs, SACs and MPAs of which one, Mousa to Boddam MPA was likely to be significantly affected.

A water volume of 46,500 km^3 was predicted to be contaminated with hydrocarbons at a concentration greater than 1 part per billion (ppb). Sea surface oiling more than 0.1 µm thick was predicted to affect a sea area of 559,000 km^2, with surface oiling >2 µm thick affecting 17 SPAs, SACs and MPAs.

Beaching in the UK was predicted to occur on the Shetland, Orkney and mainland Scotland coasts, with the highest concentrations in a protected site predicted in Hermaness, Saxa Vord and Valla Field SPA reaching 13.17 kg/m^2.

5.6.3 Net change compared to approved Mariner ES

The Cadet wells will be drilled into a previously explored reservoir. Cadet has not been explored as thoroughly as Mariner to date so there is a small increase in uncertainty regarding reservoir conditions but this is not expected to comprise a significant increase in risk. The wells will be drilled from the same platform using the same equipment and techniques. As such, the likelihood of a worst case blowout from one of the Cadet wells is considered comparable to the risk for the Mariner wells.

Other sources of significant hydrocarbon releases are damage to the export pipeline or to the Mariner B FSU. These risks are to existing, consented assets which have previously been assessed as not significant.

Equinor will update the Mariner Area Development Oil Pollution Emergency Plan to cover the Cadet Field in accordance with current guidance. Equinor’s existing measures to prevent and mitigate accidental releases will be extended to the Cadet Field Development and continue to ensure that the risk and potential consequences of an accidental release at the Mariner Area as low as reasonably practicable.

Developing the Cadet Field is not expected represent a significantly higher risk than development of the Mariner Field.

5.6.4 Cumulative and transboundary impacts

Drilling of the Cadet wells will result in a slight increase in the risk of an accidental release occurring on the UKCS. Given the remote likelihood of an incident occurring however, this increase is not expected to be significant.

Worst-case well blowout scenario modelling undertaken for the existing Mariner Field indicated that spilled oil would cross the UK / Norway transboundary line, and a similar result is expected in the event of an uncontrolled blowout from one of the Cadet wells. However, based on historical UKCS data, the likelihood of an accidental release large enough to lead to such a transboundary impact is remote to extremely remote. Therefore, consultation under the Espoo Convention is not required for the Cadet Field Development. The Espoo

Convention requires notification and consultation only for developments likely to have a significant adverse environmental impact across boundaries.

The risk of an accidental hydrocarbon release having a transboundary impact, particularly from UKCS operations, is recognised by the UK Government and other governments around the North Sea. Agreements are in existence for dealing with international releases with states bordering the UK (e.g. Bonn Agreement). In the event of a major accidental release which has the potential to drift into Norwegian waters, the Norwegian/British oil spill response (NORBRIT) plan will be activated.

5.6.5 Residual impacts

The MEI assessment of the worst-case well blowout scenario (Xodus, 2017) relating to sediment, water column, surface oiling, and oil beaching concluded the spatial scale would be "regional", the temporal scale "long-term", the reversibility of changes "slightly reversible", and the general assessment was rated as being "moderate", which indicated such a release would constitute an MEI and therefore by definition is predicted to be environmentally significant in the event that it occurs.

When assessing accidental events the likelihood of the event occurring must be taken into account (see Section 4.5.3.3). Based on the historical frequency of uncontrolled development well blowouts on the UKCS and the Project-specific measures that will be employed to further reduce the possibility of a blow-out occurring, the likelihood is expected to be remote. In addition, mitigation measures have been developed to reduce the impact of any release that could occur. Taking into account the remote likelihood of such a release occurring and the mitigation measures in place, the consequence is expected to be low and the residual impact not significant.

Receptor	Sensitivity	Vulnerability	Value	Magnitude	Likelihood	Consequence
Seabirds	High	High	High	Major	Remote	Low
Coastal protected sites	Medium	Medium	High	Moderate	Remote	Low

6 ENVIRONMENTAL MANAGEMENT

6.1 Equinor Management System

Equinor and its contractors operate their facilities according to the Equinor Group's management system (as modified to reflect local conditions and regulations) and best industry practices. Equinor operates an EMS in accordance with the requirements of ISO14001. The Equinor EMS has been independently verified by Lloyd's Register Consulting and was declared compliant with the OSPAR and associated Department requirements on 18th January 2018.

The operations described within this ES fall within the scope of this EMS. It is the aim of Equinor to ensure best environmental practices and procedures are followed and that continual improvement in environmental performance is maintained at all times.

Emergency Response Bridging Documents are prepared for all offshore activities involving contractor facilities and vessels. Management System Interfacing and procedural precedence is defined in contract documents, and for high-risk activities is further clarified by preparation of Management System Interface documents. These documents clearly define the interfaces and establishes the agreed arrangements including responsibilities, systems, procedures and practices, for managing health, safety and environment during contracted works.

Chemicals used and discharged will be controlled in compliance with the Offshore Chemical Regulations 2002 (as amended).

Equinor Oil Spill Response Procedures will continue to be applied during all drilling operations.

6.2 Environmental Management and Commitments

The mitigation and management measures implemented as part of the proposed Cadet Field Development Project will align with those detailed in the existing commitments register for the Mariner Field Development as both fields will be developed together as parts of the Mariner Area Development. The mitigation measures relevant to the proposed Cadet Field Development include:

- Use of thermo-mechanical desorption of contaminated cuttings to reduce vessel trips and onshore cuttings processing while ensuring no contamination of seabed sediments.

Mitigation measures identified are embedded into the following documents, where relevant, to ensure appropriate execution and management:

- Detailed Engineering Statement of Requirements (SOR);
- Engineering Philosophy Documents;
- Contractor Invitation to Tender;
- Contractor Bridging Documents;
- Execution Plans;
- Project HSE Management Plan; and
- Mariner Waste Management Plan.

Commitments will be reviewed periodically to ensure that they are being met. Environmental objectives and targets are used for setting goals for continuous improvement in performance as part of Equinor's EMS. Equinor views environmental management as an ongoing active process and will continue to facilitate continuous improvement beyond implementation of mitigation measures identified in this ES.

6.3 Environmental Monitoring

Monitoring is an important activity for ensuring performance against both the environmental regulatory requirements and the objectives and targets specifically designed for the Project. Monitoring also enables the gathering of information to track overall environmental performance. There are three inter-related drivers for such monitoring:

- Statutory requirements e.g. chemical use and discharge and atmospheric emissions;
- Corporate or Project expectations and targets; and
- The validation of predictions made during the EIA process.

Monitoring of emissions, effluents and waste generation is required for a number of different purposes:

- Monitoring data for compliance with environmental consents and regulatory governmental requirements;
- Environmental data required by the BEIS Oil and Gas Environmental Emissions Monitoring System (EEMS);
- To track performance against Equinor established objectives and targets;
- To monitor against Equinor reporting requirements.

Performance measurement for the Project will include:

- Chemical use and dosing rates of chemicals;
- Drilling mud use;
- Accidental release of hydrocarbons or chemicals; and
- Equinor internal CO_2 targets.

Emissions and discharges data are collated via an Equinor internal system (TEAMS SR) and submitted to the Equinor monitoring system (MiS). They are reported externally via the EEMS portal.

6.4 Interface with contractors

Management of contractors is an essential part of environmental management in order to ensure compliance with regulatory requirements and company policy and to ensure primacy and procedural interfaces, including management of environmental aspects, are identified and managed. The objectives of the Equinor contractor management processes are to ensure that:

- All contractors apply Health, Safety, Security and Environment (HSE) policies and standards that are compatible with Equinor policy;
- All contractors' personnel are competent to perform their tasks;
- HSE responsibilities of both contractor and Equinor are clearly defined; and
- Each contractor has a formal hazard management process to minimise HSE risk.

The above objectives are applicable to all phases of the contracting process and existing contracts are reviewed periodically.

6.5 Environmental awareness and training

All employees, suppliers and contractors of Equinor undergo some training on environmental issues. This may include one or more of the following:

- Induction training:
- Applicable environmental awareness training modules;
- Safety management course (for supervisory and managerial employees);
- Incident investigation training (as required); and
- Risk assessment training.

6.6 Scottish National Marine Plan

The Cadet Field Development Project has considered the objectives and marine planning policies of the Scottish National Marine Plan across the range of policy topics including natural heritage, air quality, cumulative impacts and oil and gas. Equinor considers that the Project is in broad alignment with such objectives and policies; the extent to which the Project is aligned with the oil and gas objectives and policies is summarised in Table 6.1.

Table 6.1 Alignment between the Cadet Field Development Project and the oil and gas objectives and policies of the Scottish National Marine Plan

Objective/policy	Cadet Project details
Maximise the recovery of reserves through a focus on industry-led innovation, enhancing the skills base and supply chain growth.	New oil and gas source making use of up to date and innovative technology, providing jobs and training.
An industry which delivers high-level risk management across all its operations and that it is especially vigilant in more testing current and future environments.	Extensive mitigation measures and response strategies developed for identified risks.
Continued technical development of enhanced oil recovery and exploration, according to the principles of Best Available Technique (BAT) and Best Environmental Practice (BEP).	Use of up to date and innovative technology in the development of a North Sea oil reserve, aligned with the principles of BAT and BEP.
Where possible, to work with emerging sectors to transfer the experience, skills and knowledge built up in the oil and gas industry to allow other sectors to benefit and reduce their environmental impact.	The Cadet Project will draw on experienced engineers, environmental specialists and other groups that are not necessarily limited to oil and gas experience throughout the Project life time.
The Scottish Government will work with BEIS, the new OGA and the industry to maximise and prolong oil and gas exploration and production whilst ensuring that the level of environmental risks associated with these activities are regulated. Activity should be carried out using the principles of BAT and BEP. Consideration will be given to key environmental risks including the impacts of releases to atmosphere, oil and chemical contamination and habitat change.	BAT has been used as a key tool in developing the Cadet Project design. The potentially significant environmental impacts from drilling have been considered within the EIA.
Where re-use of oil and gas infrastructure is not practicable, either as part of oil and gas activity or by other sectors such as carbon capture and storage, decommissioning must take place in line with standard practice, and as allowed by international obligations. Re-use or removal of decommissioned assets from the seabed will be fully supported where practicable and adhering to relevant regulatory process.	Equinor will review decommissioning best practice closer to the point at which the Mariner Area Development is decommissioned. Full consideration will be given to available decommissioning options, including reuse and removal.
All oil and gas platforms will be subject to 9 NM consultation zones in line with Civil Aviation Authority guidance.	Equinor will engage as necessary with any relevant future developments that may be proposed within 9 NM of the Cadet Field Development to ensure all helicopter flight routes remain free of obstacles.
Consenting and licensing authorities should have regard to the potential risks, both now and under future climates, to oil and gas operations in Scottish waters, and be satisfied that installations are appropriately sited and designed to take account of current and future conditions.	The Cadet Project area has been developed in a way that there will not be a significant impact on the physical, biological and socio-economic environment. This demonstrates an appropriate siting within the North Sea.
Consenting and licensing authorities should be satisfied that adequate risk reduction measures are in place, and that operators should have sufficient emergency response and contingency strategies in place that are compatible with the National Contingency Plan (NCP) and the Offshore Safety Directive.	Potential environmental impacts have been reviewed as part of this EIA and relevant mitigation measures developed. The Equinor response strategy to accidental hydrocarbon release has been developed with due reference to the NCP.

7 CONCLUSIONS

7.1 Environmental impacts

The Cadet Field Development consists of drilling and operating four wells which were originally planned and approved to be drilled from the Mariner A platform into the Heimdal reservoir in the Mariner Field. These wells will still be drilled into the Heimdal reservoir, but in the adjacent Cadet Field. The risks and impacts associated with the Cadet Field Development are extremely similar to those already assessed as being not significant for the Mariner ES (Statoil, 2012). The drilling of the wells into the Cadet Field will mean four fewer wells drilled into the Mariner Field, with very little net change in impacts or risks across the Mariner Area Development. It is therefore concluded that there are no significant environmental impacts associated with the proposed Cadet Field Development.

7.2 Protected sites

There are no protected sites within 40 km of the proposed development area. The only Annex II species expected to occur regularly in the area is the harbour porpoise. Drill cuttings discharge modelling and underwater noise modelling indicate that there is no scope for significant impacts on protected sites or Annex II species due to the proposed development.

While a major accidental event has the potential to significantly affect protected sites, the likelihood of such an event occurring is remote and as such the residual impact is considered not significant.

Because the proposed Cadet Field Development is not expected to have likely significant effects on any Natura site, no Appropriate Assessment is required. Similarly, there is considered to be no scope for significant risk to the conservation objectives of any NCMPAs or MCZs, which are required to be assessed under the Marine (Scotland) Act and the Marine and Coastal Access Act respectively.

7.3 Cumulative and transboundary impacts

The proposed Cadet Field Development has been assessed for potential cumulative impacts with other Projects in the region. The Mariner Field Development will be ongoing at the same time as the Cadet Field Development, and from the same platform, Mariner A. However, the Cadet Development comprises drilling and operating four wells that were previously due to be drilled into the Mariner Field, but are now not going ahead. Therefore, it is expected that there will be very little net change in potential for significant impacts when comparing the previously approved Mariner Field Development Plan with the combined impact of the Mariner Field Development Addendum and the Cadet Field Development Plan. As such no cumulative impacts are expected. In addition, no cumulative impacts are expected with other projects in the vicinity, which are too far away to interact with the Cadet Development except in the event of a major accidental hydrocarbon release, the likelihood of which is considered remote.

The Espoo Convention requires notification and consultation for projects likely to have a significant adverse environmental impact across national boundaries. As no transboundary impacts are expected due to the distance to the UK/Norway median line (45 km), consultation under the Espoo Convention is not required for this Project.

7.4 Overall conclusion

Based on the findings of this EIA, it is concluded that the proposed Cadet Field Development Project will not result in any significant environmental impacts. In considering the requirements of Scotland's National Marine Plan, this conclusion confirms that the Cadet Project will be consistent with the objectives and policies set out, together with the sectoral policies outlined for the oil and gas sector.

The findings and recommendations of this EIA will be carried through by formal commitments which will provide a transparent and auditable means of ensuring the measures identified will be delivered through Equinor's EMS.

8 REFERENCES

Aires, C., Gonzalez-Irusta, J.M., Watret, R. (2014). Scottish Marine and Freshwater Science Report, Vol 5 No 10, Updating Fisheries Sensitivity Maps in British Waters' found at: http://www.scotland.gov.uk/Publications/2014/12/3334 with further details at http://www.scotland.gov.uk/Topics/marine/science/MSInteractive/Themes/fish-fisheries/fsm [Accessed on 24/05/2019]

Anatec (2014). Mariner Field (PDQ & FSU) Vessel Traffic Survey.

Anatec (2016). Collision Risk Assessment – Mariner A (PDQ) Jacket.

Aubin St. D. J. (1990). Physiologic and Toxic Effects on Pinnipeds. Chapter 4: J.R. Geraci and D.J. St. Aubin (eds.), Sea Mammals and Oil: Confronting the Risks. San Diego, California: Academic Press, Inc., 103 - 127.

Bakke, T., Klungsoyr, J. & Sanni, S. (2013). Environmental impacts of produced water and drilling waste discharges from the Norwegian offshore petroleum industry, Marine Environmental Research.

Basford, D.J., Eleftheriou, A. and Raffaelli, D. (1989). The Epifauna of the Northern North Sea (56° – 61°N). Journal of the Marine Biological Association, 69, 387 – 407.

Baxter J. M., Boyd I. L., Cox M., Donald A. E., Malcolm S. J., Miles H., Miller B. and Moffat C. F. (Editors) (2011). Scotland's Marine Atlas: Information for the national marine plan. Marine Scotland, Edinburgh. pp. 191. Available online at: http://www.scotland.gov.uk/Publications/2011/03/16182005/0 [Accessed 25/09/2018].

Beare, D.J., Batten, S., Edwards, M. and Reid, D.G. (2002). Prevalence of boreal Atlantic, temperate Atlantic and neritic zooplankton in the North Sea between 1958 and 1998 in relation to temperature, salinity, stratification intensity and Atlantic inflow. Journal of Sea Research, 48, p 29 – 49.

BEIS (2017). The Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended) – A Guide. February 2019.

BEIS (2019a). PON1 data 2011 – 2019. Available at https://itportal.beis.gov.uk/eng/fox/pon1/PON1_PUBLICATION_EXTERNAL/viewCurrent [Accessed 24/04/2019].

BEIS (2019b). PON1 data 2007 – 2010 Available at https://www.gov.uk/guidance/oil-and-gas-environmental-alerts-and-incident-reporting#pon-1 [Accessed 24/04/2019].

BP (2016). Update 1545: Statement regarding Clair oil release. Statement date 3rd October 2016. Available at https://www.bp.com/en/global/corporate/news-and-insights/press-releases/update-1545-statement-regarding-clair-oil-release.html [Accessed 24/04/2019].

Coull, K.A., Johnston, R. and Rogers, S.I. (1998). Fisheries sensitivities maps in British waters. Published and distributed by UKOOA Ltd.

De Robertis, A. and Handegard, M.O. (2012). Fish avoidance of research vessels and the efficacy of noise-reduced vessels: a review. *ICES Journal of Marine Science*, **70**(1), 34-45.

DECC (2009). UK Offshore Energy Strategic Environmental Assessment. Future Leasing for Offshore Windfarms and Licensing for Offshore Oil and Gas and Gas Storage. Environmental Report. 2009. Available at: https://www.gov.uk/government/publications/uk-offshore-energy-strategic-environmental-assessment-oesea-environmental-report [Accessed 25/09/2018].

DECC (2016). UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3). Available online at: https://www.gov.uk/government/consultations/uk-offshore-energy-strategic-environmental-assessment-3-oesea3 [Accessed 25/09/2018].

DNV (2011). Baseline Survey – Mariner and Bressay 2011. Report for Statoil Petroleum AS. Report number: 2012-0329 / 13do3c8-9. Rev 01, 26/03/2012

DTI (2001). Report to the Department of Trade and Industry. Strategic Environmental Assessment of the Mature Areas of the Offshore North Sea SEA 2. Consultation Document. September 2001. Available online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/197798/SEA2_Assessment_Document.pdf [Accessed on 14/06/2016].

Edwards, M., Beaugrand, G., Halaouet, P., Licandro, P., McQuatters-Gollop, A. & Wootton, M. (2010). Ecological Status Report (2010): results from the CPR survey 2009/2010. SAHFOS Technical Report 8 1-8, Plymouth UK.

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

Equinor (2019a) Mariner Field Development Plan Addendum (FDPA), April 2019, submitted to OGA 30th April 2019. Note: final document to be submitted to OGA May 2019.

Equinor (2019b) Cadet Field Development Plan (FDP), submitted to OGA 20th May 2019.

European Commission (1999). Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions. May 1999. Report No. NE80328/D1/3.

Finneran J.J., Carder D.A., Schlundt C.E. & Ridgway S.H. (2005). Temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*) exposed to midfrequency tones. *Journal of the Acoustical Society of America*, 118(4), 2696-2705.

FRS (2004). Zooplankton and climate change – the Calanus story. Available online at http://www.vliz.be/docs/Zeecijfers/zooplankton_and_climate_change.pdf [Accessed on 24/05/2019]

Furness R. W. and Monaghan P. (1987). Seabird ecology (Eds). London: Blackie and Son, 164pp.

Gardline (2009) Mariner regional survey UKCS 9/11 PL726, PL979, PL1278 & PL1282 Interpretation Report for StatoilHydro. StatoilHydro ref. ST09317. Final report, issued 03/11/2009.

IEEM (2010). Guidelines for Ecological Impact Assessment in Britain and Ireland, marine and Coastal. August 2010. Final Version 5.

IEMA (2016). Environmental Impact Assessment Guide to Delivering Quality Development. July 2016.

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

Jackson, D. L. and MacLeod, C. R. (2002). Handbook on the UK status of EC Habitats Directive interest features: provisional data on the UK distribution and extent of Annex I habitats and the UK distribution and population size of Annex II species, revised 2002, JNCC Report No. 312, 180 pages, ISSN 09638091.

JNCC (1999). Seabird vulnerability data in UK waters, block specific vulnerability. Joint Nature Conservancy Committee.

JNCC (2010). Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise. August 2010.

JNCC (2011). UK Deepwater Drilling – implications of the Gulf of Mexico spill. Memorandum submitted by the Joint Nature Conservation Committee. Online at: https://publications.parliament.uk/pa/cm201011/cmselect/cmenergy/450/450i.pdf [Accessed 24/04/19].

JNCC (2012). Inshore and Offshore Special Area of Conservation: Pobie Bank Reef SAC Selection Assessment Document. Available online at: http://jncc.defra.gov.uk/PDF/PobieBankReef_SACSAD_v5_0.pdf [Accessed 24/05/2019]

JNCC (2016). Seabird Population Trends and Causes of Change: 1986-2015 Report. Available online at http://jncc.defra.gov.uk/page-3201 [Accessed 10/09/2018].

Johns, D.G. and Reid, P.C. (2001). An Overview of Plankton Ecology in the North Sea. Technical Report TR_005 produced for Strategic Environmental Assessment-SEA2.

Kafas, A., Jones, G., Watret, R., Davies, I., Scott, B. (2012). Representation of the use of marine space by commercial fisheries in marine spatial planning. ICES CM I: 23.

KIS-ORCA (2019). Submarine cable routes of the Southern North Sea. Kingfisher Information Service - Cable Awareness. Available online at http://www.kis-orca.eu/ [Accessed 01/02/2019].

Kober, K., Webb, A., Win, I., Lewis, M., O'Brien, S., Wilson, L.J. and Reid, J.B. (2010). An analysis of the numbers and distribution of seabirds within the British Fishery Limit aimed at identifying areas that qualify as possible marine SPAs. JNCC report, 431.

Lusseau, D. and Bejder, L. (2007). The Long-term Consequences of Short-term Responses to Disturbance Experiences from Whalewatching Impact Assessment. *International Journal of Comparitive Physiology*, **20**(2): 228-236.

Mood, A. and Brooke, P. (2010). Estimating the Number of Fish Caught in Global Fishing Each Year. Available at: http://www.fishcount.org.uk/published/std/fishcountstudy.pdf [Accessed 3/1/2019].

National Archives (2012a). Oil spills (archived 17th December 2012). Available at https://webarchive.nationalarchives.gov.uk/20121217150945/http://og.decc.gov.uk/en/olgs/cms/data_maps/field_data/oil_spills/oil_spills.aspx [Accessed 24/04/2019].

National Archives (2012b). Oil spills – historical data (archived 17th December 2012). Available at https://webarchive.nationalarchives.gov.uk/20121217152613tf_/http://og.decc.gov.uk/en/olgs/cms/data_maps/field_data/oil_spills/oil_historic/oil_historic.aspx [Accessed 24/04/2019].

NMPI (2019). The Scottish Government National Marine Plan Interactive available at http://www.gov.scot/Topics/marine/seamanagement/nmpihome [Accessed 31/01/2019].

NOAA (National Oceanic and Atmospheric Administration) (2018). Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing, Technical Memorandum NMFS-OPR-55, 2018.

Nowacek D.P., Thorne L.H., Johnston D.W. & Tyack P.L. (2007). Responses of cetaceans to anthropogenic noise. *Mammal Review*, 37(2), 81-115.

NSTF (1993). Quality Status Report of the North Sea 1993.

OGA (2016). Information on levels of shipping activity. 29th Offshore Licensing Round. Available at: https://www.ogauthority.co.uk/licensing-consents/licensing-rounds/offshore-licensing-rounds/#tabs [Accessed 01/02/2019].

OGA (2018). Other Regulatory Issues. 31st Offshore Licensing Round. Available at: https://www.ogauthority.co.uk/licensing-consents/licensing-rounds/offshore-licensing-rounds/#tabs [Accessed 01/02/2019].

Peng, C., Zhao, X., and Liu, Guangxu (2015). Noise in the sea and its impacts on marine organisms. *Journal of Environmental Research and Public Health,* 12(10): 12304-12323.

Popov, V.V., Supin, A.Y., Rozhnov, V.V., Nechaev, S.I., Sysuyeva, E.V., Klishin, V.O., Pletenko, M.G., and Tarakanov, M.B. (2013). Hearing threshold shifts and recovery after noise exposure in beluga whales, *Dephinapterus leucas*. Journal of Experimental Biology, **216**: 1587-1596.

Popper, A.N. and Hawkins, A.D. (2012). The effects of noise on aquatic life. Springer Science + Business Media, LLC, New York.

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

Russell, D. J. F., Jones E. L. and Morris, C. D. (2017). Updated Seal Usage Maps: The Estimated at-sea Distribution of Grey and Harbour Seals. Scottish Marine and Freshwater Science Vol 8 No 25, 25pp. DOI: 10.7489/2027-1.

Russell, D.J.F, Jones E.L. and Morris, C.D (2017). Updated Seal Usage Maps: The Estimated at-sea Distribution of Grey and Harbour Seals. Scottish Marine and Freshwater Science Vol 8 No 25, 25pp. DOI: 10.7489/2027-1

SAHFOS (2015). Sir Alister Hardy Foundation for Ocean Science. CPR Data: Standard Areas. Available from: https://www.sahfos.ac.uk/data/data-charts/ [Accessed on 21/01/2019].

SCOS (2017). Scientific Advice on Matters Related to the Management of Seal Populations: 2017. Report to the National Environment Research Council.

Scottish Government (2015). Scotland's National Marine Plan. March 2015.

Scottish Government (2018). Scottish Sea Fisheries Statistics, 2017. Scottish Government. Available online at http://www.scotland.gov.uk/Topics/Statistics/Browse/Agriculture-Fisheries/RectangleData [Accessed 08/02/2019].

SMRU (2011). Utilisation of space by grey and harbour seals in the Pentland Firth and Orkney waters. Scottish Natural Heritage Commissioned Report No. 441.

SMRU (2013). Grey and harbour seal density maps. Marine mammal scientific support research programme MMSS/001/11. Task MR 5 (part). Sea Mammal Research Unit report to Scottish Government. Version 1500 issue 21/02/2013. Available at http://www.smru.st-andrews.ac.uk/files/2015/10/MR5_Seal_density_maps.pdf [Accessed 23/04/2019].

SNH (2018). Environmental Impact Assessment Handbook Guidance for competent authorities, consultation bodies, and others involved in the Environmental Impact Assessment process in Scotland. Available at: https://www.nature.scot/handbook-environmental-impact-assessment-guidance-competent-authorities-consultees-and-others [Accessed 21/01/2019].

SNH (2014). Priority Marine Features in Scotland’s seas. Available at: https://www.nature.scot/professional-advice/safeguarding-protected-areas-and-species/priority-marine-features-scotlands-seas [Accessed 30/01/2019].

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene, Jr.C.R. & Kastak, D. (2007). Marine Mammal Noise-Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals*, 33(4), 411–521.

Statoil (2016). Mariner Field Development Plan. Revision 1. Oil Field 497, Blocks 9/11a P335, 9/11b P726, 9/11c P979,9/11d and 8/15a P1758, 9/11f P2152, 9/11g P2151. Document last updated 04-07-2016, 10:16 CEST.

Statoil (2012a). Mariner Area Development Environmental Statement. DECC Project Reference D/4145/2012. Document number PM150-PMS-023-002, issued July 2012.

Statoil (2012b). Mariner Field Development Plan. Oil Field 497, Block 9/11a, Licence P335. Revision 0, issued November 2012.

Tyler-Walters, H., Hiscock, K., Lear, D.B. and Jackson, A. (2001). Identifying species and ecosystem sensitivities. Report to the Department for Environment, Food and Rural Affairs from the Marine Life Information Network (MarLIN), Marine Biological Association of the United Kingdom, Plymouth. Contract CW0826. [Final Report.]. Available at http://plymsea.ac.uk/id/eprint/7017/1/DETR_Final_Report.pdf [Accessed 23/04/2019].

UNI RESEARCH AS (2014). Environmental baseline at Mariner and Bressay.

US CEQ (1997). Considering cumulative effects under the National Environmental Policy Act. Council on Environmental Quality, January 1997. Available at https://www.energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/G-CEQ-ConsidCumulEffects.pdf [Accessed 24/05/2019].

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

Williams, R., Lusseau, D., and Hammond, P. (2006). Estimating relative energetic costs of human disturbance to killer whales (Orcinus orca). Biological Conservation, 133(3): 301-311.

Xodus (2017). MEI support – Mariner MEI Assessment. Technical note for Statoil UK Limited. Report number A-301943-S00-TECH-001. Revision A01 issued 31/07/2017.

9 ACRONYMS

µm	Micrometre
ACOPS	Advisory Committee on Protection of the Sea
AIS	Automatic Identification System
API	American Petroleum Institute
BA	Bachelor of Arts
BAT	Best Available Technique
BEIS	Department of Business, Energy and Industrial Strategy
BEP	Best Environmental Practice
BOCC	Birds of Conservation Concern
BOP	Blowout Preventer
CaCl	Calcium Chloride
CH_4	Methane
CHARM	Chemical Hazard Risk Management
CO_2	Carbon Dioxide
COP	Cadet Oil Producer (well)
CPR	Continuous Plankton Reader
CWI	Cadet Water Injector (well)
dB	Decibel
DECC	Department of Energy and Climate Change
DNV	Det Norske Veritas
DTI	Department of Trade and Industry
E&P	Exploration and Production
EC	European Community
EEMS	Environmental Emissions Monitoring System
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
EPS	European Protected Species
ES	Environmental Statement
ESP	Electric Submersible Pump
EU	European Union
FDP	Field Development Plan
FRS	Fisheries Research Scotland
FSU	Floating Storage Unit
GHG	GreenHouse Gas
HRA	Habitats Regulations Appraisal
HSE	Health, Safety & Environment
ICD	Inflow Control Device
ICES	International Council for Exploration of the Sea
IEEM	Institute of Ecology and Environmental Management

IEMA	Institute of Environmental Management and Assessment
ISO	International Organization for Standardization
IUCN	International Union for the Conservation of Nature
JNCC	Joint Nature Conservation Committee
KCl	Potassium Chloride
LAT	Lowest Astronomical Tide
LTOBM	Low Solids Oil Based Mud
MarLIN	Marine Life Information Network
MBES	Multibeam Echo Sounder
MD	Measured Depth
MiS	Equinor Monitoring System
MMO	Marine Mammal Observer
MOD	Ministry of Defence
MPA	Marine Protected Area
MSL	Mean Sea Level
N_2O	Nitrous oxide
NaCl	Sodium Chloride
NCMPA	Nature Conservation Marine Protected Area
NCP	National Contingency Plan
NLN	Noble Lloyd Noble
NM	Nautical Miles
NMPI	National Marine Plan Interactive
NNS	Northern North Sea
NORBRIT	Norwegian / British Oil Spill Response
NORM	Naturally Occurring Radioactive Material
NO_X	Oxides of Nitrogen
NO_2	Nitrogen dioxide
NSTF	North Sea Task Force
O_3	Ozone
OCR	Offshore Chemicals Regulations
OGA	Oil & Gas Authority
OIW	Oil in Water
OPPC	Offshore Petroleum Activities (Oil Pollution Prevention and Control)
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSPAR	Oslo Paris Convention
Pa	Pascal
PDQ	Production Drilling and Quarters
PMF	Priority Marine Feature
Ppb	Parts per billion
PTS	Permanent Threshold Shift
PWRI	Produced Water Re-injection
ROS	Recycled Oil Sump

SAC	Special Area of Conservation
SAHFOS	Sir Alister Hardy Foundation for Ocean Science
SAS	StandAlone Screen
SAT	Subsidiary Application Template
SBP	Sub Bottom Profiler
SCOS	Special Committee on Seals
SINTEF	Scandinavian Independent Research Organisation Stiftelsen for industriell og teknisk forskning
SMRU	Sea Mammal Research Unit
SNH	Scottish Natural Heritage
SOR	Statement of Requirements
SOSI	Seabird Oil Sensitivity Index
SO_X	Oxides of sulphur
SO_2	Sulphur dioxide
SPA	Special Protection Area
SPL	Sound Pressure Level
SSS	Side Scan Sonar
SSSI	Site of Special Scientific Interest
THC	Total Hydrocarbon Concentration
TOM	Total Organic Matter
TTS	Temporary Threshold Shift
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
UKOOA	United Kingdom Offshore Operators Association
UNESCO	United Nations Educational, Scientific and Cultural Organisation
US	United States
VMS	Vessel Monitoring System
VOC	Volatile Organic Compounds
WBM	Water Based Mud
WHS	World Heritage Sites