	DOCUMENT NO:	REV:
	M3281-ENQ-EAG-EN-00-ENS-0001	01

Eagle Development Environmental Statement

Document Review Cycle

REVIEW PERIOD	NEXT REVIEW	DOCUMENT OWNER

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Revision History

YYYY	MMM	DD	Issued By	Rev	Detail
2019	Aug	08	RPS	00	Issued for Comment / Review
2019	Sep	05	RPS	01	For Issue

Revision Change Notices

Rev	Location of Changes	Brief Description of Changes

Document Sign-Off

Signature	Print Name	Position	Date
	Checked By Garron Owen	Environmental Lead	3/9/19
	Approved By George Tulloch	Eagle Project Manager	3/9/19

Environmental Statement Details

Section A: Administrative Information

A1 – Project Reference Number

Please confirm the unique ES identification number for the project.

Number: D/4239/2019

A2 - Applicant Contact Details

Company name: EnQuest Heather Limited

Contact name: Garron Owen

Contact title: Environment Lead

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
Garron Owen	EnQuest Heather Limited	Environment Lead	Chartered Environmentalist, CIWEM, Chartered Water and Environmental manager, CIWEM. 14 years' experience in Environmental Engineering/Management MSc GIS and Remote Sensing BSc Environmental Geography
Steve Saunders	RPS Energy	Senior Environmental Consultant	IEMA Practitioner Member 11 years' oil and gas consultancy experience MSc Integrated Environmental Studies
Lizzie Whiteley	RPS Energy	Senior Environmental Consultant	11 years in the environmental industry. ISO 14001:2015 Internal Auditor

A5 - Licence Details

a) Please confirm licence(s) covering proposed activity or activities
Licence number(s): P238

b) Please confirm licensees and current equity

Licensee	Percentage Equity
EnQuest Heather Limited	100%

Section B: Project Information

B1 - Nature of Project

a) Please specify the name of the project.

Name: Eagle 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.

EnQuest is planning to develop the Eagle field in the CNS under Licence P238. The Eagle field is located in Block 21/19a. The viability of the Eagle field was proven by the Eagle 21/19-13 discovery well, drilled from May to July 2016, the top-hole location of which lies at 57° 22' 58.219 North, 0° 43' 6.792 East. The Eagle field will be developed by a single well, with a tieback to the existing Gadwall pipeline to the north via a *circa.* 5.5 km production pipeline and onward transport of production fluids via the existing pipeline infrastructure to the EnQuest operated Kittiwake platform in Block 21/18. There will also be a *circa.* 16.0 km umbilical from the Eagle development well to the Kittiwake platform. If the Eagle development is successful, there is the potential for a larger field development involving additional wells and tiebacks. However, this ES will assess the initial Eagle development only; any further potential extension to the Eagle development will be assessed in a future ES or ES Addendum.

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): 21

Block number(s): 18, 19a

Latitude: Longitude (W / E): 57° 22' 58.219 North, 0° 43' 6.792 East (Eagle development well)

Distance to nearest UK coastline (km): 140 (from Kittiwake platform)

Which coast? ~~England / Wales /~~ Scotland ~~/ NI~~

Distance to nearest international median line (km): 80

Which line? UK / Norway

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:

Date of submission of ES:

Identification number of ES:

Quality Management

This Environmental Statement (ES), and the Environmental Impact Assessment (EIA) carried out to identify the significant environmental effects of the proposed Eagle Development, was undertaken in accordance with the RPS Energy Integrated Management System (IMS).

RPS Risk and Environmental Management (REM) has both an ISO 9001 Quality Management System (QMS) and an ISO 14001 Environmental Management System (EMS) in place. Collectively these are referred to as the Integrated Management System (IMS). The IMS ensures that project requirements are met in an efficient, timely and cost-effective manner by personnel that are committed to quality management.

The IMS also implements procedures for auditing, continual improvement, and document/ data control.

NON-TECHNICAL SUMMARY

Introduction

EnQuest is planning to develop the Eagle field, located in Block 21/19a. The Eagle development lies wholly within International Council for the Exploration of the Sea (ICES) rectangle 43F0. The viability of the Eagle field was proven by the Eagle 21/19-13 discovery well, drilled from May to July 2016, the top-hole location of which lies at 57° 22' 58.219 North, 0° 43' 6.792 East.

The Eagle field will be developed by a single well (side-tracked from the existing Eagle 21/19-13 discovery well, the top-hole location of which lies at 57° 22' 58.219 North, 0° 43' 6.792 East), with a tieback to the existing Gadwall pipeline to the north via a *circa.* 5.5 km production pipeline, and onward transport of production fluids via existing infrastructure to the EnQuest operated Kittiwake platform in Block 21/18. There will also be a *circa.* 16 km umbilical from the Eagle development well to the Kittiwake platform.

The exact type of rig to drill the Eagle development well is yet to be confirmed, however it is likely that either a jack-up or semi-submersible rig will be used. The expected hydrocarbon is oil with associated gas. Once drilled, the development well will be logged and cored before being prepared for production. The development well will be drilled with low toxicity oil-based mud (LTOBM) targeting the Fulmar formation. All drill cuttings will be retained on board the drilling rig and shipped to shore for treatment and disposal.

The Kittiwake platform can accommodate production fluids from Eagle with some minor modifications. This along with the final field layout will be further defined during project development and Front-end Engineering Design (FEED).

If the Eagle development is successful, there is the potential for a larger field development involving additional wells and tiebacks. However, this ES will assess the initial Eagle development only; any further potential extension to the Eagle development will be assessed in a future Environmental Statement (ES) or ES Addendum.

Environment Description

Physical Environment

The generalised pattern of water movement in the North Sea is forced by a combination of tides, wind patterns, density gradients (caused by freshwater input) and pressure gradients (*Howarth, 2001*, in: *DECC, 2016*). Maximum tidal rates in the region are 0.31 and 0.10 metres per second for spring and neap tides respectively (Chart 2182C, Tidal diamond T: *Hydrographer of the Navy, 2009*). Average salinity levels of 35.0 and 34.9 are found at the sea surface and seabed, respectively in the vicinity of the Eagle development (*NMPi, 2019*).

The predominant wind direction in the area is from the south-west and west, but winds tend to veer northwards during the summer in June and July, and to the south in August (*NOGAPS, 2015*).

The Central North Sea (CNS) to the east coast of Shetland, Orkney and the Scottish mainland is more sheltered and less frequently exposed to large, powerful waves than the west. However, North Sea storms and swells can result in relatively large wave heights. The annual mean significant wave height in the vicinity of the Eagle development is 2.19 m (*NMPi, 2019*).

EnQuest commissioned survey work in 2019 in support of the Eagle development. The survey scope included the umbilical route corridor from the Eagle well to the Kittiwake platform, and revisiting areas identified as possible Methane Derived Authigenic Carbonate (MDAC) in the previous 2016 survey along the Eagle to Gadwall pipeline route.

Along the Eagle to Gadwall pipeline route, water depth ranged from a minimum of 90.6 m Lowest Astronomical Tide (LAT) at the end of the route (at the Gadwall manifold), to a maximum of 91.7 m LAT at Kilometre Point (KP) 1.516. The seabed was observed to be flat along the route, deepening slightly in the central part, and with observed seabed gradients of not more than 0.5° (*Gardline, 2019a*). Along the Eagle to Kittiwake umbilical route, water depth surrounding the Eagle well (at KP0.000) was 90.9 m LAT, with the seabed gently shoaling to 85.7 m LAT at the end of data coverage near the Kittiwake platform. Throughout the length of the umbilical route, the seabed generally shoals gently from south-east to north-west (Eagle to Kittiwake), with seabed gradients of less than 0.5° (*Gardline, 2019b*).

Along the Eagle to Gadwall pipeline route, the seabed sediments predominantly comprised of silty sand. Areas of MDAC were confirmed to be present along the proposed pipeline route (*Gardline, 2019a*).

Along the Eagle to Kittiwake umbilical route, seabed sediments predominantly comprised of silty sand (*Gardline, 219b*).

At the time of drafting the ES, the environmental baseline survey results were not available, therefore reference has been made to previous surveys in the area for sediment hydrocarbons and heavy/trace metals analysis.

A 2016 pipeline route survey sampled 6 environmental stations along a potential pipeline route from the Kittiwake platform to the Mallard well. Mean metal concentrations in these sediments were all below their respective background concentration values typically expected for the area. The exception was a sampling station near to the Kittiwake platform which had a high barium concentration when compared against expected background values, possibly indicating the presence of a historical cuttings pile. Total hydrocarbon (THC) concentrations ranged from 1.8 μgg^{-1} to 4.4 μgg^{-1} with a mean value of 2.8 μgg^{-1}; below the expected average background concentrations (*Fugro, 2016c*).

Rig site surveys at the Eagle well location were conducted in 2013 by Centrica and in 2014 by EnQuest, which both involved seabed environmental sampling. THC concentrations across the survey area in both years were low compared to the United Kingdom Offshore Operators Association (UKOOA) mean concentration for the CNS area. Mean concentrations of the majority of metals were found to be similar to comparable datasets and lower than the mean UKOOA background concentrations expected for the CNS (*Fugro, 2014c*).

Biological Environment

Plankton

The distribution and abundance of plankton is heavily influenced by water depth, tidal mixing and thermal stratification within the water column (*Edwards et al., 2010*). In the CNS, phytoplankton production increases during spring between mid-March and mid-April, reaching a peak or 'bloom' in May, often followed by a smaller peak in autumn. Plankton species of interest found in the vicinity of the proposed Eagle development are typically temperate shelf sea species and are indicative of the presence of relatively unmixed Atlantic water due to the influence of the North Atlantic Drift (*BODC, 1998*).

Benthos

The scope of work for the 2019 survey required investigation of locations along the Eagle to Gadwall pipeline route, to target potential areas of MDAC identified in previous surveys. Overall, a total of 25 stations were selected for investigation using a drop-down camera. Video transects were predominantly focused on confirming the presence of MDAC, as well as investigating the predominant sediment type.

Along the Eagle to Gadwall pipeline route and the Eagle to Kittiwake umbilical route, the most frequently observed epifaunal taxon was Scaphopoda, followed by *P. phosphorea* (phosphorescent sea pen). There were several observations of the bivalve mollusc *Arctica islandica* (the ocean quahog), in the form of broken shells at the majority of stations where camera investigations were undertaken (*Gardline, 2019d*).

Three separate broadscale European Nature Information System (EUNIS) habitat categorises were identified during the survey activities: A5.27 (deep circalittoral sand), A5.44 (circalittoral mixed sediments), A5.71 (seeps and vents in sublittoral sediments) (*Gardline, 2019d*).

Macrofaunal samples were taken from 23 grab sample stations during the 2019 survey, however the environmental baseline results were not available at the time of drafting of the ES. The previously conducted 2016 pipeline route survey identified the echinoderm, *Echinocyamus pusillus* as the dominant species across five survey stations, and polychaetes *Paramphinome jeffreysii* and *G. oculata* found in the top ten at four of the stations. Two adult specimens of *Arctica islandica* were also recorded in the macrofaunal data (*Fugro, 2016c*). In the 2013 and 2014 rig site surveys, the most common taxa were also polychaetes; the most abundant species in both surveys being the amphinomid polychaete *Paramphinome jeffreysii*, which is a widely distributed species and thought to be one of the most abundant infaunal taxa of the CNS where it is associated with muddy and sandy sediments (*Fugro, 2014c*).

Fish and Shellfish

The proposed Eagle field development lies within the spawning and nursery grounds of cod (*Gadus morhua*), mackerel (*Scomber scombrus*), Norway pout (*Trisopterus esmarkii*), *Nephrops* (*Nephrops norvegicus*) and sandeel (*Ammodytidae*) (*Coull et al, 1998*; *Ellis et al., 2012*). ICES rectangle 43F0 is partially within an area of higher egg concentrations for Norway pout and sandeel (*Coull et al., 1998*). The proposed development also falls within the nursery grounds for anglerfish (*Lophius Piscatorius*), blue whiting (*Micromesistius poutassou*), European hake (*Merluccius merluccius*), haddock (*Melanogrammus aeglefinus*), herring (*Clupea harengus*), ling (*Molva molva*), plaice (*Pleuronectes platessa*), spurdog (*Squalus acanthias*) and whiting (*Merlangius merlangus*) (*Coull et al, 1998*; *Ellis et al., 2012*).

Block 21/19 has a special condition with regards to herring spawning grounds (*Oil & Gas Authority, 2018*). However, no evidence of herring spawning activity was found during any of the previous surveys (*Fugro, 2016c*; *Fugro, 2014c*) or the current 2019 survey (*Gardline, 2019c*). The available data indicate that herring spawning areas are located further to the west in ICES Rectangle 43E9 (*Coull et al., 1998*).

Seabirds

Seabird species in the vicinity of the Eagle development are likely to include Fulmar (*Fulmarus glacialis*), Kittiwake (*Rissa tridactyla*), Northern Gannet (*Morus bassanus*), Guillemot (*Uria aalge*), Razorbill (*Alca torda*), Black Guillemot (*Cepphus grille*), Herring Gull (*Larus argentatus*), and Atlantic Puffin (*Fratercula arctia*) (*DECC, 2016*).

Seabird vulnerability to oil pollution within Block 21/18 is rated as ‘extremely high’ in April and May on the Joint Nature Conservation Committee (JNCC) Seabird Oil Sensitivity Index (SOSI). At all other times of the year, seabird vulnerability is rated as low in Block 21/18. Seabird vulnerability to oil pollution within Block 21/19 is rated as ‘low’ throughout the year. However, no sensitivity data exists for November for neither Block 21/18 nor Block 21/19 (*Certain et al., 2015*).

Marine Mammals

The CNS generally has a higher density of cetaceans than the southern North Sea. In the vicinity of the proposed Eagle development, Atlantic white-sided dolphin, white-beaked dolphin, minke whale and harbour porpoise have all been sighted (*Reid et al., 2003*).

Grey and harbour seals feed both in inshore and offshore waters depending on the distribution of their prey, which changes both seasonally and annually. 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, 2014*). 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 proposed Eagle development is located approximately 140 km offshore, so although these species may be encountered in the vicinity of the Eagle development from time to time, it is not likely that they use the area with any regularity or in great numbers.

Socio-Economic Environment

Commercial Fisheries

According to Scottish Government 2018 statistics, ICES rectangle 43F0 is mainly targeted for both demersal and pelagic fish, but also comprises shellfish fisheries (*Marine Scotland, 2019a*). In 2018, pelagic fisheries accounted for 65% of the liveweight and 49% of the value in rectangle 43F0, whilst demersal species accounted for 35% of the liveweight and 50% of the value. In 2017, tonnage for demersal fish recorded in ICES rectangle 43F0 was much higher than pelagic species; 96% and less than 0.1%, respectively (90% and less than 0.1% of the value, respectively).

Between 2014 and 2017, the pelagic fish landed from ICES rectangle 43F0 was virtually non-existent, with only 1 tonne recorded in 2017. The trend indicates that demersal species are primarily targeted in ICES rectangle 43F0, with 2018 marking a departure from this trend with a vastly increased amount of pelagic landings than any of the previous years. Demersal fish have historically always been caught from ICES 43F0, although in slightly reduced masses than 2014 and 2015 (1,018 and 1,004 tonnes respectively, compared to 392, 572 and 760 tonnes for 2016, 2017 and 2018 respectively). Shellfish species have been caught consistently in ICES 43F0 however 2018 marks the lowest landing of shellfish species out of the five years of historic data. The historic fishing data for ICES 43F0 indicates that fishing activity in the area is comparable to other areas in the vicinity (*Marine Scotland, 2019a*).

Aquaculture

The closest active shellfish site to the proposed Eagle development is Lamb Holm on the Orkney Islands approximately 250 km to the north-west. The closest finfish production site is located in Aberdeen approximately 150 km to the west (*NMPi, 2019*).

Oil and Gas Activity

The proposed Eagle development lies in the vicinity of the Greater Kittiwake Area (GKA). The GKA comprises five oil fields: Kittiwake, Mallard, Gadwall, Goosander and Grouse (*EnQuest, 2019*). The Gadwall, Mallard and Cook oil fields all lie to the north (4.1 km), north-west (2.3 km) and west (5 km) of the Eagle well respectively. The Kittiwake platform lies 15.7 km to the north-west of the Eagle well (*UK Oil & Gas Data, 2019*).

Shipping and Military Activity

Shipping traffic within Blocks 21/18 and 21/19 is rated as low (*BEIS, 2016*). UK ports in the area include Sullom Voe, Scalloway and Colgrave Sound (*DECC, 2016*) with vessels mainly supporting the oil & gas and local fishing industries.

Aircraft, surface craft and submarines from many countries use the North Sea as a training ground and for routine operations but the distribution and frequency of these activities is unknown. However, there are no charted military exercise areas in the vicinity of Blocks 21/18 and 21/19 (*Hydrographer of the Navy, 2009*), nor are there any Ministry of Defence (MOD) conditions attached to the Blocks (*Oil & Gas Authority, 2018*).

Wrecks and Archaeology

No wrecks were identified along the proposed pipeline route from Eagle to Gadwall or in the vicinity of the Kittiwake platform during the 2016 site survey (*Fugro, 2016a*). Similarly, no wrecks were identified in the 2019 site survey from Eagle to the Kittiwake platform (*Gardline, 2019a*; *2019b*; *2019c*). There is one charted wreck to the south-west of the Kittiwake platform however this does not lie within the Eagle development project area (*Hydrographer of the Navy, 2009*).

Communications

There are no submarine cables in the vicinity of the proposed Eagle field development, the closest of which is the CNS fibre optic cable that lies over 30 km to the north (*KIS-ORCA, 2019*).

Other Activities

There is no commercial or capital dredging presently undertaken and no sites are licensed for disposal of dredged material within or in the vicinity of the proposed Eagle development (*The Crown Estate, 2018a*).

There are no existing or proposed Round 1, Round 2 or Round 3 offshore wind-farm sites that lie within or around the proposed Eagle development (*The Crown Estate, 2018b*).

Tourism and Leisure

The coasts of Scotland, Orkney and the Shetland Islands and the wild natural scenery attract tourists in pursuit of a wide range of activities including walking, bird and cetacean watching, wildfowling, sailing, fishing, diving and the maritime and wartime history of the region (*DECC, 2016*). The tourism industry will not be impacted by normal offshore oil and gas operations, but leisure activities could be threatened in the event of a major accidental oil spill approaching the coast.

Conservation

Offshore Conservation

The closest offshore protected site to the proposed Eagle development is the East of Gannet and Montrose Fields Nature Conservation Marine Protected Area (NCMPA), which lies approximately 11.5 km to the south-east. The site is designated for the habitat '*offshore deep-sea muds*'. The site boundaries of this NCMPA confine the full extent of an area of this habitat and it is one of only a few examples of Atlantic-influenced offshore deep-sea mud habitats on the continental shelf in this region. The East of Gannet and Montrose Fields NCMPA is also designated for '*ocean quahog aggregations, including sands and gravels as their supporting habitat*' (*JNCC, 2016a*).

Annex 1 Habitats

Methane Derived Authigenic Carbonate (MDAC)

The main potential Annex I habitat that may occur within the vicinity of the proposed Eagle development are '*submarine structures made by leaking gases*'. This habitat comprises rocks, pavements and pillars made of carbonate cement. Such cement is mostly made by microbial oxidation of methane and is commonly known as MDAC. MDAC forms within the sediment at the sulphate-methane transition zone (SMTZ), within a few metres of the seabed (*Judd, 2005*).

The site surveys undertaken over the previous years have identified a number of occurrences of MDAC across the survey area. Of relevance to the Eagle development, possible MDAC was observed along the Eagle to Gadwall pipeline route. 2019 survey activities were tasked to survey the proposed umbilical route from Eagle to the Kittiwake platform and to re-visit areas of possible MDAC along the proposed Eagle to Gadwall pipeline route. The investigated pockmarks on the Eagle to Gadwall pipeline route were all confirmed to contain MDAC, although none was identified along the proposed umbilical route.

Along the proposed Eagle to Gadwall route, potential MDAC was identified at six stations/transects (ENV3 to ENV7 and ENV23) and accounted for 21% of all photographs acquired. Bacterial mats were identified in 14% of photographs at the six stations/transects where potential MDAC was noted and 15% of photographs across all stations/transects along the Eagle to Gadwall proposed pipeline route. The presence of bacterial mats further indicated the presence of a chemosynthetic community associated with the MDAC structures (*Gardline ,2019d*).

Sea-pens and Burrowing Megafauna

Sea-pen and burrowing megafauna communities is included as a habitat on the OSPAR list of threatened and/or declining species and habitats. The habitat is characterised by plains of fine mud of depth between 15 m and 200 m, which are heavily bioturbed by burrowing megafauna.

As part of the 2019 survey work, an assessment of the sea-pen and burrowing megafauna community was undertaken, referring to the Marine Nature Conservation Review (MNCR) SACFOR abundance scale (JNCC, 2013, In: *Gardline, 2019d*). Burrows were only classified as 'frequent' at one observed station (ENV1) (*Gardline ,2019d*). The assessment concluded there is limited potential for the sea-pens and burrowing mega fauna community along the Eagle to Gadwall pipeline route and Eagle to Kittiwake umbilical route.

The 2016 survey results from Kittiwake to Gadwall/ Mallard reached a similar conclusion and indicated that although some evidence of burrows and sea-pens was seen, the habitat assessment concluded that they did not constitute the habitat (*Fugro, 2016c*).

Species

Marine Mammals

Grey seals, harbour seals, harbour porpoise and bottlenose dolphin are currently protected under Annex II of the EU Habitats Directive. Harbour and grey seal, which are both listed as Scottish Priority Marine Features (PMFs), have the potential to be present at the Eagle field, but their presence is likely to be in low numbers. The only Annex II species regularly recorded in the vicinity of the Eagle development area is the harbour porpoise. Harbour porpoise, minke whale, white beaked dolphin and Atlantic white-sided dolphin, are all listed as PMF in Scottish waters (*Tyler-Walters, 2016*). However, due to their mobile nature marine mammals are likely to move away from areas of disturbance.

Fish

Some commercially important fish species in the vicinity of the Eagle development area are listed as Scottish PMFs: anglerfish, blue whiting, cod, herring, ling, Norway pout, sandeel and whiting (*SNH, 2014*).

Sandeels were identified in two photographs at Station ENV14 and observed in grab samples from Station ENV17; both stations were situated along the Eagle to Kittiwake proposed umbilical route. The sediment Particle Size Analysis (PSA) indicated that the sediments at Stations ENV14 and ENV17 were "suitable" for sand eel spawning according to the criteria defined by Latto *et al.*, (2013). A single station had 'prime' sediments, ten stations had 'sub-prime' sediments while six were 'suitable' for sand eel spawning. No stations were considered 'unsuitable' for sand eel spawning according to the assessment (*Gardline, 2019d*). The assessment therefore suggests that the area is suitable for sandeel spawning, although only one station was identified as consisting of 'prime' sandeel spawning sediments. The available data suggests that the area of higher sandeel spawning activity is located to the west of the proposed Eagle development.

Ocean Quahog

The bivalve *Arctica islandica*, commonly known as the Icelandic cyprine or ocean quahog, inhabits sandy and muddy sediments from the low intertidal zone to around 500 m and is notable for its longevity and large size (*Sabatini, et al., 2008*). *A. islandica* is listed on the OSPAR (2008) '*List of threatened and declining habitats and species*'.

Evidence of the occurrence of ocean quahog was found during the recent survey work, where individual shells were recovered from grab samples (*Fugro, 2016c*) and broken shells were observed at the majority of camera stations in the spring 2019 survey work undertaken along the Eagle to Gadwall pipeline route and Eagle to Kittiwake umbilical route, although no live individuals were observed (*Gardline, 2019d*). There was no suggestion that the observed evidence of this species constituted aggregations of the species, particularly as no live specimens were observed. Therefore, the seabed habitat in the Eagle development area is not considered of significant conservation importance for this species. Ocean quahog is commonly found within this area of the North Sea (*Oil & Gas UK, 2017*).

Impact Assessment

The decision on which issues required further assessment was based on the specific proposed activities and environmental sensitivities, a review of industry experience of Environmental Impact Assessment (EIA) outcomes and on an assessment of wider stakeholder interest. The topic areas selected for further assessment included:

- Physical Presence;
- Atmospheric Emissions;
- Underwater Noise;
- Accidental Events.

Physical Presence

The proposed Eagle development activities will cause disturbance to the seabed, causing re-suspension of and re-settling of sediments. The Eagle development also has the potential to impact other users of the sea through the presence of the drilling unit and vessels used for installation of the subsea infrastructure.

The impact assessment found that, although the Eagle development will directly impact an area of seabed (1.72 km^2), The sensitivity of seabed habitats and species to direct long-term disturbance and indirect temporary disturbance due to sedimentation is low. The footprint of the Eagle development is small relative to the available habitat and associated species present in the CNS. The habitats in the vicinity are also considered to have some tolerance to the potential impacts of the development. It is considered that species present will be able to accommodate a particular effect or where a long-term impact is predicted, such as long-term exclusion from a habitat as a result of new infrastructure, species will be able to adapt by finding new habitat in the large amount of available undisturbed habitat in the immediate vicinity.

MDAC was identified along the proposed Eagle to Gadwall pipeline route, and therefore significant effects on this Annex 1 habitat are possible without proper mitigation. Other benthic features found across the area are considered highly representative of the wider environment and no species are considered to be solely dependent on the development area for suitable habitat. Some evidence of the possible presence of the habitat 'sea pens and burrowing megafauna' was seen based on burrows observed on seabed imagery (*Gardline ,2019c*), however, burrows were not present in high enough numbers to definitively classify the area as consisting of this habitat.

Evidence of *Arctica islandica* was recorded at several stations, although no live specimens were observed and there was no evidence of aggregations of the species. This species and habitat (not including the MDAC) are commonly found within this area of the North Sea (*OSPAR, 2009*; *2010*) and given the evidence from the survey results, this area is not considered of conservation importance for these species and habitats.

The key mitigation measures include:

- Undertaking a rig mooring study (for a semi-submersible rig) or rig positioning study (for a jack-up rig), which will examine the MDAC features identified and provide a plan to avoid it.
- Incorporating fishing-friendly protection structures on relevant subsea infrastructure and limiting the use of protection structures placed on the seabed (concrete mattresses, grout bags and potential rock dump) to reduce fishing gear snag risk;
- Consultation with the Scottish Fishermen's Federation (SFF) will continue to take place throughout the project;
- Routing the export pipeline around the MDAC features identified during the 2016 and 2019 site survey operations, using an 80-metre-wide installation corridor; and
- Ensuring that no sandbags for use as turning bollards will be deployed in the vicinity of MDAC features.

The impact magnitude is considered to be minor due to the short length of time any impacts will occur and the estimated recoverability of the species present, together with the MDAC avoidance mitigation proposed. The Eagle development activities are expected to be negligible in terms of cumulative and in-combination impacts, and mitigation measures will be used to reduce the potential impact to an acceptable level. The overall consequence is therefore considered to be low and the impact is not considered to be significant.

Atmospheric Emissions

Gas emissions as a result of the construction of the Eagle development could result in impacts at a local, regional, transboundary and global scale. On a global scale, concern with regard to atmospheric emissions is increasingly focused on global climate change (*IPCC, 2007*). Greenhouse Gasses (GHGs) include water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxides (N_2O), O_3 and chlorofluorocarbons (CFCs). The most abundant GHG is water vapour, followed by CO_2.

The Eagle development is located remotely from potentially sensitive receptors, and there are no impacts from atmospheric emissions on the seabed. Any changes to the atmospheric baseline conditions are expected to be virtually undetectable within a few kilometres of the source. In addition, there are no concerns over the status of local air quality in the vicinity of the Eagle development. The magnitude of the impact is considered to be minor as although Eagle activities (life of field) will occur over a relatively long period of time (anticipated to be three years in the high production case), the actual changes to air quality are predicted to be very small.

The key mitigation measures include:

- Careful planning of operations to reduce vessel numbers and the duration of operations;
- The duration of any clean-up and well testing, if applicable, will be limited as far as is practicable to reduce the requirement to flare. The latest 'green burner' technology will be used if flaring occurs;
- Various processes (i.e. maintenance procedures, ongoing monitoring, competent personnel, internal/external auditing) to optimise energy efficiency; and
- Regular monitoring and inspections of combustion equipment to ensure an effective maintenance regime is in place to ensure efficiency.

In terms of global climate change (i.e. cumulative and transboundary impacts), the Eagle development will add a relatively small increment to the overall offshore emissions of the UK and the release of GHG into the environment and their contribution to global warming will be negligible or minor in relation to those from the wider offshore industry and outputs at a national or international level. Any cumulative impact is therefore considered to have a very limited contribution to climate change.

Considering all of the above, including that there will be no impact on protected features, protected sites or on species from protected sites, the residual consequence of atmospheric emissions is ranked as low and therefore not significant.

Underwater Noise

The Eagle development has the potential to cause underwater noise disturbance, mainly during installation of subsea infrastructure. Underwater noise can cause disturbance to marine mammal species in particular. For this reason, an underwater noise study has been undertaken.

The noise propagation and sound exposure modelling study carried out concluded that there is potential for mild disturbance to marine mammals within up to 1.4 km of piling operations, although strong disturbance is only likely within approximately 145 m of the sound source. This equates to an area of approximately 6 km^2 for mild disturbance and 0.1 km^2 for strong disturbance.

Assuming a swimming animal, it is likely that potential injury zones for high frequency cetaceans during piling operations could be up to 10 m from the sound source. Injury is unlikely for other hearing groups of marine mammal.

Assuming that an animal stays within that radius continuously for 24 hours, it is possible that injury could occur to some marine mammals within 58 m of some installation activities. However, this is considered a highly unlikely scenario as it is unlikely that an animal would stay within this radius continuously over a 24-hour period.

Disturbance to marine mammals could occur within 8.3 km of some vessels. However, this is also considered as highly unlikely, as it is unlikely that an animal would stay within this radius continuously over a 24-hour period (for example, if the animal was to only spend 1 hour near the vessel then the injury range would decrease to 5 m).

The key mitigation measure is to adhere to JNCC guidelines for reducing the potential for injury and disturbance to marine mammals (*JNCC, 2017*) which include:

- A suitably trained marine mammal observer (MMO) to conduct a pre-shooting search within a 500 m monitoring zone over a 30-minute period prior to the commencement of piling.
- Should any marine mammals be detected within 500 m of the piling operations, operations will be delayed until marine mammals have moved outside of the mitigation zone. In this case, there will be a 20-minute delay from the time of the last marine mammal sighting to the commencement of activities.
- A 'soft start' procedure; The piling hammer power will be ramped up slowly over 20 minutes in order to give marine mammals time to leave the area.
- If piling is required to commence in sub-optimal conditions for visual monitoring, consideration will be given to using passive acoustic monitoring (PAM) in addition to MMOs.

It is therefore concluded that it is unlikely that marine mammals will be injured as a result of the proposed activities associated with the Eagle development, and considering all the above, the residual consequence of underwater noise is ranked as low and therefore not significant.

Accidental Events

The potential impact of any accidental hydrocarbon and chemical release will be determined by the characteristics of the release of hydrocarbons or chemicals, its weathering properties, the direction of travel and whether environmental sensitivities lie in its path. A worst-case well blow-out scenario was taken forward for further assessment as it was considered that this worst-case (albeit highly unlikely) scenario has the greatest potential for environmental impacts.

One worst-case hydrocarbon release scenario was defined and modelled based on the Major Accident Hazard (MAH) scenario (loss of well control) during drilling: Uncontrolled flow of oil from the well due to a loss of well control which has the potential to reach the coastline. Oil spill modelling was conducted to assess the fate of this worst-case blow-out release from the Eagle development well during drilling, using the SIMAP oil spill modelling software.

SIMAP is designed to simulate the fate and effects of spilled hydrocarbons for both the surface and subsurface releases. A variable release rate blow-out scenario was modelled, starting at 22,170 stb/day on day 1 to 17,507 on day 73, with a 30-day observation time. 73 days was chosen as this is the time estimated to drill a relief well should one be required. The same model was re-run over four temporal periods to gauge the effect of seasonality.

Modelling indicated that there was a worst-case probability of 100% crossing the UK/Norway median line within 3 days of release start during the autumn and winter scenarios. The modelling predicted that the release would reach as far as German and Faroese waters. The probability of shoreline oiling is highest in the autumn and winter scenarios, where Norway has 100% and 99% predicted probability of beaching in 21 days and 17 days, respectively. For the UK, the probability of shoreline oiling is highest in the winter and spring scenarios, with the Shetland and Orkney Islands predicted to be impacted, as well as areas along the Scottish and English coastlines.

Given the possibility of interaction between a range of potential receptors following a release of hydrocarbons from a well blow-out, the sensitivity has been assigned as Major. Similarly, it is anticipated that some features could exhibit high vulnerability and value (e.g. sites of conservation importance) and rankings have been assigned as such. Should a hydrocarbon release make landfall, it is expected that there could be potential impacts on local habitats and species and therefore magnitude has been ranked as Moderate.

It is recognised that a hydrocarbon release from a well blow-out could result in demonstrable change in some receptors. However, for this type of accidental event, it is especially important to assess the likelihood of the impact occurring. Review of United Kingdom Continental Shelf (UKCS) historical data relating to well blow-out events confirm that the likelihood of a blowout is remote.

The key mitigation measures to reduce either the probability of an accidental release, or the consequences in the event of a release, include:

- Implementing an independent well examination scheme to ensure there is an independent check on well design, construction, maintenance and operations;
- Design of the well and infrastructure as per Oil and Gas UK best practice;
- Drilling rig to have a minimum 10,000 psi Blow-out Preventer (BOP) stack (standard for drilling rigs);
- A verification scheme for Safety and Environmentally Critical Elements (SECEs), plus SECEs to be identified in future design stages;
- A simultaneous operations (SIMOPs) report will detail the precautions and controls to be implemented during the installation of the pipeline, umbilical and subsea infrastructure;
- Development of, and conformance to, appropriate equipment containment maintenance procedures;
- Relevant installation and vessel personnel given full training in release prevention and actions to be taken in the event of an accidental hydrocarbon/ chemical release;
- Shipboard Oil Pollution Emergency Plans (SOPEPs) will be in place for all relevant vessels involved in the operations;
- An Oil Pollution Emergency Plan (OPEP) will be in place prior to the start of both drilling and production operations;
- The drilling rig will be subject to an environmental containment audit prior to drilling operations commencing, which will cover oil spill response, procedural controls, bunkering and chemical storage arrangements.

Based solely on the residual risk of the expected impact should a well blow-out occur, the magnitude would be considered moderate. However, given the mitigation measures (aligned with improved industry standards for well design) and the remote likelihood of a well blow-out occurring, the impact is significance is considered not significant.

Conclusions

The topic areas taken forward for further assessment in the EIA included physical presence, atmospheric emissions, underwater noise and accidental events.

Key Findings

The EIA has found that there will be no significant impacts on the seabed as a result of the Eagle development, given the control measures in place, which include routing the export pipeline around the Annex I MDAC features found on the seabed during the site survey activities. The EIA has also found that there will be no significant impact on other sea users, namely commercial shipping and fishing;

detailed analysis of historical vessel activity in the area strongly suggests that the area is not located within busy commercial shipping lanes and is not fished extensively.

There will be some atmospheric emissions released due to the Eagle development during its installation and across its lifetime. The assessment has placed the atmospheric emissions in the context of UK emissions from offshore (installations and shipping activities) and highlighted that the Eagle development will add a relatively small increment to the overall offshore emissions of the UK and the release of GHGs into the environment and their contribution to global warming will be negligible or minor, in relation to those from the wider offshore industry and outputs at a national or international level. The Eagle development will be subject to the relevant emissions permitting at the host installation throughout its lifetime.

The EIA found that there is some potential for impacts from underwater noise, however the underwater noise modelling study predicts that potential areas of injury to marine mammals and fish are limited to within very short distances from the noise sources. Potential effects on marine mammals during any piling activities can be mitigated appropriately using recognised industry mitigation measures. The potential impacts from underwater noise due to the Eagle development are therefore not considered to be significant.

To assess the potential impact of a worst-case hydrocarbon release from the Eagle development, a worst-case blowout scenario was modelled. The impact assessment has highlighted in the event of such a release, there is the potential for significant effects on coastal protected sites due to the potential for beaching, and therefore such a worst-case hydrocarbon release could give rise to a Major Environmental Incident (MEI). However, it should be noted that blow-outs are extremely rare events. Given the control measures that EnQuest will have in place for hydrocarbon releases, the risk of hydrocarbon spills occurring is reduced to acceptable levels.

Scottish National Marine Plan

The Eagle development has considered the objectives and marine planning policies of the Scottish National Marine Plan (NMP) across the range of policy topics including natural heritage, air quality, cumulative impacts and oil and gas. EnQuest considers that the Eagle development is in broad alignment with such objectives and policies.

Protected Sites and Species

The site survey results have shown that there are sensitive MDAC features present within the vicinity of the proposed export pipeline location. However, EnQuest has proposed a pipeline routing to avoid these MDAC features with a suitable installation corridor and route design.

EnQuest is confident that the export pipeline can be installed without disturbing these features, having executed similar operations during other pipeline installation works in the GKA. Therefore, there will be no significant impact on any Annex I habitat or species highlighted in the Habitats Directive from the Eagle development.

The presence of species within the Eagle development area protected under Annex II of the Habitats Directive is limited to marine mammals. Based on the available data, marine mammal species that may be present in the area occur in relatively moderate to low densities, or occur only occasionally, or as casual visitors. This assessment concluded that there is a very limited area of potential injury (such as temporary or permanent hearing loss) or disturbance as a result of the activities associated with the Eagle development. The risks during piling operations (which pose the greatest potential impact in terms of impulsive underwater noise) can be mitigated to acceptable levels using the appropriate industry recognised JNCC Guidelines (*JNCC, 2017*). Therefore, potential impacts from underwater noise due to the Eagle development are not considered to be significant and unlikely to result in any population level impacts.

There are a number of offshore and coastal conservation areas on the Scottish mainland that have been designated under the Habitats Directive as Special Areas of Conservation (SACs), under the EU Birds Directive as Special Protection Areas (SPAs) and under the Marine Scotland Act 2010 and Marine and Coastal Access Act 2009 as NCMPAs. The potential for significant impacts on any such site has been considered within each impact assessment, with particular focus given to the potential for an accidental hydrocarbon release to interact with such sites.

Given the remote location of the Eagle development, the relatively short-term duration of drilling and installation activities and the mitigation and management measures in place (including for a worst-case accidental hydrocarbon release), the development is considered unlikely to affect the conservation objectives or site integrity of any SAC and SPA and neither is there a significant risk to the conservation objectives of an NCMPA being achieved.

Considering all of the above, no significant impacts are expected upon protected species and habitats from the Eagle development.

List of Abbreviations

ACOPS	Advisory Committee on Protection of the Sea
AIS	Automatic Identification System
API	American Petroleum Institute
AUV	Autonomous Underwater Vehicle
BAT	Best Available Technique
BC	Background Concentration
BEIS	Department for Business, Energy and Industrial Strategy
BEP	Best Environmental Practice
BHA	Bottom Hole Assembly
BMS	Business Management System
BOP	Blow Out Preventer
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CEMP	Coordinated Environmental Monitoring Programme
CEO	Chief Executive Officer
CEQ	Council on Environmental Quality
CIEEM	Charted Institute of Ecology and Environmental Management
CIP	Continual Improvement Plan
CH_4	Methane
CHARM	Chemical Hazard and Risk Management
CMAPP	Corporate Major Accident Prevention Policy
CNS	Central North Sea
CO_2	Carbon Dioxide
CO2eq	Carbon Dioxide Equivalent
CPA	Closest Point of Approach
CPT	Cone Penetration Test
DECC	Department of Energy and Climate Change
DEFRA	Department of Environment, Food and Rural Affairs
DP	Dynamic Positioning
DSV	Diving Support Vessel
DTI	Department of Trade and Industry
EA	Environmental Appraisal
EC	European Commission
EIA	Environmental Impact Assessment
EEMS	Environmental and Emissions Monitoring System
EFL	Electrical Flying Lead
EMS	Environmental Management System
ERL	Effect Range Low
ES	Environmental Statement
EUNIS	European Nature Information System
EU	European Union

FEAST	Feature Activity Sensitivity Tool
FEED	Front End Engineering Design
FDP	Field Development Plan
FOCI	Feature of Conservation Importance
FPF	Floating Production Facility
FPS	Forties Pipeline System
FPSO	Floating Production, Storage and Offloading
GHG	Greenhouse Gas
GKA	Greater Kittiwake Area
HF	High Frequency
HFL	Hydraulic Flying Lead
HMCS	Harmonised Mandatory Control Scheme
HP/HT	High Pressure / High Temperature
HPU	Hydraulic Power Unit
HRA	Habitat Regulation Appraisal
HSE&A	Health, Safety, Environment and Assurance
IEMA	Institute of Environmental Management and Assessment
ICES	International Council for the Exploration of the Seas
IMO	International Maritime Organisation
IOGP	International Association of Oil and Gas Producers
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation Nature
JNCC	Joint Nature Conservation Committee
KOP	Kick-off Point
KP	Kilometre Point
KPI	Key Performance Indicator
LAT	Lowest Astronomical Tide
LF	Low Frequency
LOT	Leak-off Test
LSE	Likely Significant Effect
LTOBM	Low Toxicity Oil-Based Mud
MarLIN	Marine Life Information Network
MAH	Major Accident Hazard
MAT	Master Application Template
MCA	Maritime and Coastguard Agency
MCO	Marine Conservation Order
MCZ	Marine Conservation Zone
MDBRT	Measured Depth Below Rotary Table
MDAC	Methane Derived Authigenic Carbonate
MEG	Monoethylene Glycol
MEI	Major Environmental Incident

MF	Mid Frequency
MMO	Marine Management Organisation
MOD	Ministry of Defence
MODU	Mobile Offshore Drilling Unit
MPA	Marine Protected Area
MSFD	Marine Strategy Framework Directive
MSL	Mean Sea Level
MW	Megawatt
NCMPA	Nature Conservation Marine Protected Area
NMP	National Marine Plan
NMPI	National Marine Plan Interactive
NNS	Northern North Sea
NOAA	National Oceanic and Atmospheric Association
NORBRIT	Norway-United Kingdom Joint Contingency
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxide
N_2O	Nitrous Oxides
NTS	Non-Technical Summary
OBM	Oil-Based Mud
OCNS	Offshore Chemical Notification Scheme
OD	Outside Diameter
OESEA	Offshore Energy Strategic Environmental Assessment
OGA	Oil and Gas Authority
OGUK	Oil and Gas UK
OPEP	Oil Pollution Emergency Plan
OPRC	Oil Pollution Preparedness, Response & Co-operation Convention
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSPAR	Oslo-Paris Convention
OW	Otariid Pinnipeds
O_3	Ozone
PAH	Polycyclic Aromatic Hydrocarbon
PID	Project Information Document
PMF	Priority Marine Feature
PLONOR	Pose Little Or NO Risk
POB	Persons on Board
PON	Petroleum Operations Notice
PSD	Particle Size Distribution
PTS	Permanent Threshold Shift
PW	Phocid Pinnipeds
RMS	Route Mean Squared
ROV	Remotely Operated Vehicle

RSD	Relative Standard Deviation
SAC	Special Area of Conservation
SAT	Subsidiary Application Template
SAST	Seabirds at Sea Team
SCANS	Small Cetacean Abundance in the North Sea and Adjacent waters
SCOS	Special Committee on Seals
SCM	Subsea Control Module
SD	Standard Deviation
SDU	Subsea Distribution Unit
SEA	Strategic Environmental Assessment
SECE	Safety Environmental Critical Element
SEL	Sound Exposure Level
SEMS	Safety and Environmental Management System
SFF	Scottish Fishermen's Federation
SIMOPs	Simultaneous Operations
SNH	Scottish Natural Heritage
SMRU	Sea Mammal Research Unit
SMTZ	Sulphate-Methane Transition Zone
SO_2	Sulphur Dioxide
SO_X	Sulphur Oxide
SOPEP	Shipboard Oil Pollution Emergency Plan
SOSI	Seabird Oil Sensitivity Index
SPA	Special Protection Area
SPL	Sound Pressure Level
SSS	Side Scan Sonar
SSSV	Sub Surface Safety Valve
TD	Total Depth
THC	Total Hydrocarbon Content
TOC	Top of Cement
TTS	Temporary Threshold Shift
TUTU	Topsides Umbilical Termination Unit
TVDSS	True vertical depth subsea
UCM	Unresolved Complex Mixture
UKBAP	United Kingdom Biodiversity Action Plan
UKCS	United Kingdom Continental Shelf
UK	United Kingdom
UKOOA	United Kingdom Offshore Operators Association
US	United States
UTA	Umbilical Termination Assembly
VMS	Vessel Monitoring System
VOC	Volatile Organic Compound

VSP	Vertical Seismic Profiling
WBM	Water Based Mud
WMP	Waste Management Plan
XT	Xmas Tree

CONTENTS

1 Introduction

This Environmental Statement (ES) presents the findings of the Environmental Impact Assessment (EIA) conducted by EnQuest Heather Limited (EnQuest) for the development of the Eagle field under licence P238. EnQuest is a 50% partner with Dana Petroleum in the production area of Licence P238. The non-production area of Licence P238 is held 100% by EnQuest, which covers the Eagle field.

EnQuest engages in various exploration, production and development activities throughout the northern and central North Sea. EnQuest intends to deliver sustainable growth by focusing on exploiting its existing reserves, commercialising and developing discoveries, converting contingency resources into reserves and pursuing selective acquisitions and disposals. As part of this strategy, EnQuest proposes to develop the Eagle field. This is termed the 'Eagle development' in this ES.

1.1 Eagle Development Overview

The Eagle field is located in Block 21/19a. The development lies wholly within ICES rectangle 43F0. The viability of the Eagle field was proven by the Eagle 21/19-13 discovery well, drilled from May to July 2016, the top-hole location of which lies at 57° 22' 58.219 North, 0° 43' 6.792 East.

The Eagle field will be developed by a single well, with a tieback to the existing Gadwall pipeline to the north via a *circa.* 5.5 km production pipeline, and onward transport of production fluids via existing pipeline infrastructure to the EnQuest operated Kittiwake platform in Block 21/18. There will also be a *circa.* 16 km umbilical from the Eagle development well to the Kittiwake platform.

The Eagle production well (21/19-13 Eagle P1) will be a side-track well from the existing Eagle wellbore. The proposed spud date of the well is summer 2021. A side-track well (for optimised recovery of hydrocarbons) will then be drilled with low toxicity oil-based mud (LTOBM) targeting the Fulmar formation. All drill cuttings will be retained on board the MODU and shipped to shore for treatment and disposal.

The Kittiwake platform can accommodate production fluids from Eagle with some minor modifications to the existing platform topsides. This along with the final field layout will be further defined during project development and Front-end Engineering Design (FEED).

The water depth across the proposed Eagle development ranges from approximately 85 m to 92 m lowest astronomical tide (LAT). The development well will be drilled with a Mobile offshore Drilling Unit (MODU). The exact type of MODU is yet to be confirmed, however it is likely that either a jack-up or semi-submersible MODU will be used. The expected hydrocarbon from the Eagle development is oil with associated gas. Once drilled, the development well will be logged and cored before being prepared for production.

If the Eagle development is successful, there is the potential for a larger field development involving additional wells and tiebacks. However, this ES will assess the initial Eagle development only; any further potential extension to the Eagle development will be assessed in a future ES or ES Addendum.

1.2 The Eagle Field

The Eagle field lies in Block 21/19a. The existing Gadwall manifold lies in Block 21/19a and the existing Kittiwake platform lies in Block 21/18 (Figure 1.1). The proposed development lies in Scottish waters, approximately 140 km from the nearest landfall at Peterhead on the east coast of Scotland (measured from the Kittiwake platform), and approximately 80 km west-south-west of the UK/Norway trans-boundary line (measured from the Eagle well location). The Eagle development will become part of the Greater Kittiwake Area (GKA) once it is tied back to Kittiwake via the Gadwall manifold.

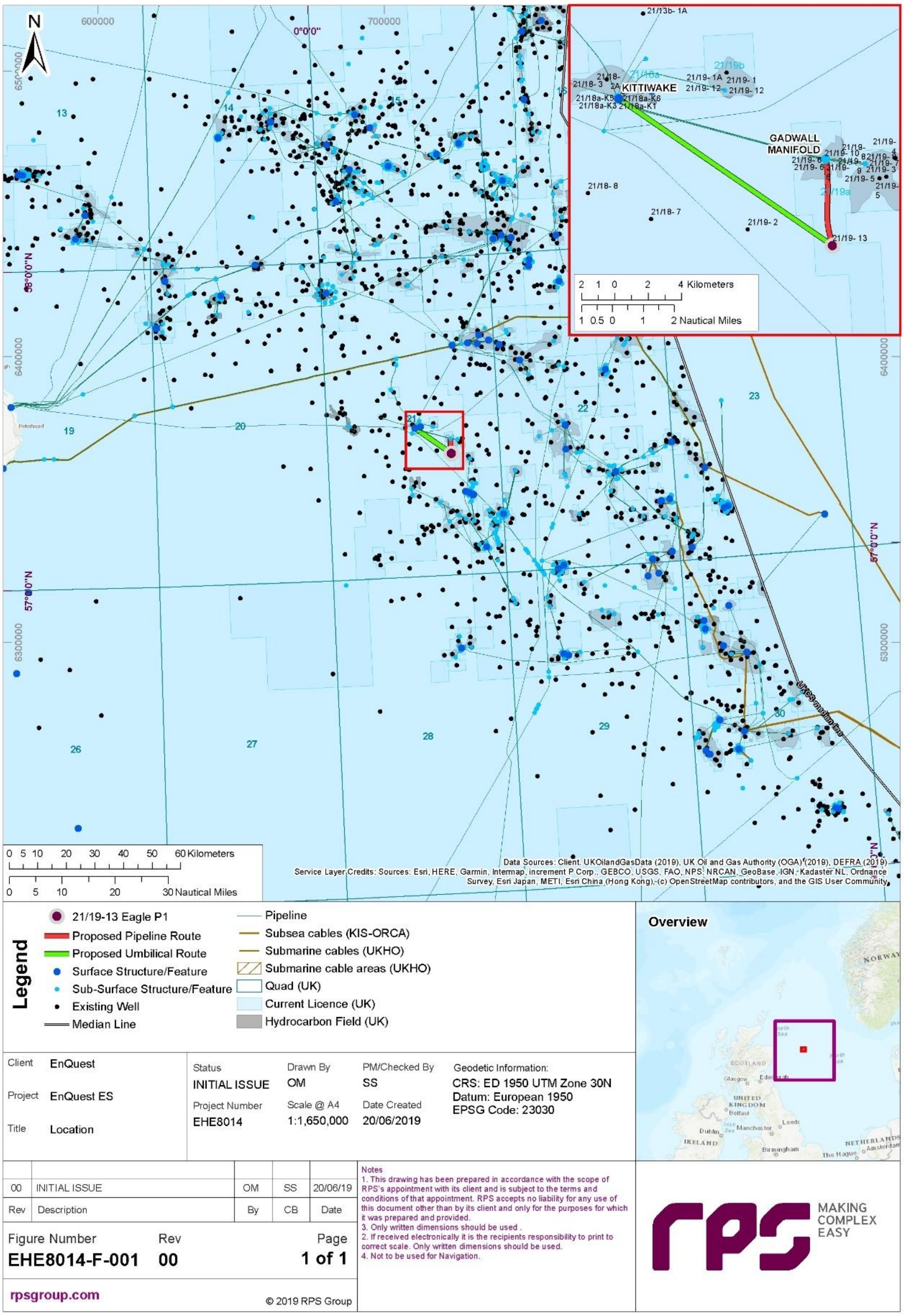

Figure 1.1: Location of the proposed Eagle development

EnQuest owns 100% of the Eagle field and will act as the Operator of the proposed Eagle development.

The Eagle development has a number of potential economic benefits for the UK:

- Generation of additional revenue to the UK Government from increased oil and gas production;
- Contribution to the security of the UK's future energy supply; and
- On a local and national scale, the development may secure or add to the offshore employment in the area, in particular during the drilling and installation phases of the development.

1.3 Scope of the EIA

The overall aim of the EIA is to assess the potential environmental impacts that may arise from the Eagle development and to identify the measures that will be put in place to reduce these potential impacts.

The EIA process is integral to the development, assessing potential impacts and alternatives, and identifying design and operational elements to help reduce the potential impacts of the development as far as reasonably practical. The process also provides for stakeholder involvement so that issues can be identified and addressed, as appropriate, at an early stage, and helps the planned activities comply with environmental legislative requirements and with EnQuest's environmental policy.

The EIA scope includes drilling, installation, commissioning, operational and decommissioning activities of the Eagle development over which EnQuest has operational control. The main elements of the Development programme are:

- Drilling and completion of a development well (21/19-13 Eagle P1) at the existing 21/19-13 well, including installation of a subsea xmas tree (XT) and wellhead protection structure;
- Installation of a *circa.* 5.5 km export pipeline from the Eagle well to the existing Gadwall manifold;
- Installation of a *circa.* 16 km control umbilical from the Eagle well to the existing Kittiwake platform;
- Installation of production spools at the Eagle well location and Gadwall tie-in location, and replacement of existing Gadwall tie-in spools;
- Installation of a subsea distribution unit (SDU) located adjacent to the Eagle XT and associated Hydraulic Flying Leads (HFLs) and Electrical Flying Leads (EFLs) circa. 100 m long to connect the Eagle XT to the SDU;
- Installation of protection, i.e. concrete mattresses/ rock dump for the pipeline system;
- Decommissioning of the Eagle field (including the well and subsea infrastructure).

It should be noted that:

- There will be no change in fuel use or produced water discharges at the Kittiwake platform as a result of Eagle coming online, as existing producing fields (namely Gadwall and Mallard) will be backed out to free up space in the Kittiwake production systems to accommodate the Eagle field;
- Only limited modifications are required on the Kittiwake platform in order to receive produced fluids safely from the Eagle development;
- The Eagle development will not include any new combustion plant installation at the Kittiwake facilities;
- Oil from the Eagle development will be exported from the Kittiwake platform via the existing 10" main oil export line to the existing Ineos Unity installation, and ultimately to the Forties Pipeline System (FPS). Gas produced from Eagle will be used as fuel gas to power the existing gas compression units and/ or be used for gas lift in the existing GKA gas lift systems and/ or

exported via the existing 4” gas export line to the existing receiver tee on the Fulmar to St. Fergus 20” gas line.

The EIA considers both routine and accidental events where there are potential environmental impacts. The following Eagle development components are outside the scope of this EIA:

- Transport of hydrocarbons following processing at Kittiwake;
- Pre-construction, maintenance and transport of infrastructure outside the development area; and
- Further activities that might be undertaken at the Eagle field (e.g. future developments) for which the Eagle development could act as an enabler. Such a development, should it occur, would be the subject of any necessary additional environmental assessment and approval from the Department of Business, Energy and Industrial Strategy (BEIS).

This ES reports the EIA process and the results of the assessment. The scope of the EIA was developed during scoping and wider consultation (refer to section 4). Full details of the method applied during the EIA process are described in section 4.

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 Pipe-lines (Environmental Impact Assessment) (Amendment) Regulations 2017*) and the accompanying BEIS OPRED published guidance (Revision 5, February 2019). 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 Eagle development triggers an EIA on the grounds of oil production.

There are a number of other key regulatory drivers applicable to the Eagle development, with the key legislation being:

- *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*;
- *The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended)*;
- *The Offshore Chemical Regulations 2002 (as amended*);
- *The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended)*;
- *The Offshore Combustion Installations (Prevention and Control of Pollution) Regulations 2013*;
- *The Greenhouse Gas Emissions Trading Scheme Regulations 2005 (as amended)*;
- *The Fluorinated Greenhouse Gases Regulations 2015*;
- *The Pollution Prevention and Control (Scotland) Amendment Regulations 2017*;
- *The Ozone-Depleting Substances Regulations 2015*;

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

1.4.1 Scotland's National Marine Plan

The National Marine Plan (NMP) (Scottish Government, 2015) provides an overarching framework for marine activity in Scottish waters out to 200 nautical miles, 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 Eagle development 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 NMP;
- **Economic benefit:** Sustainable development and use which provides economic benefit to Scottish communities is encouraged when consistent with the objectives and policies of the NMP;
- **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 NMP area should be addressed in decision-making and Plan implementation.

Sectoral policies are also outlined in the NMP 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 7, along with comment on the degree to which the Eagle development is aligned with these.

1.5 Data Gaps and Uncertainties

The North Sea has been extensively studied, meaning that this EIA has been able to draw on a significant volume of published data. This bank of published data has been supplemented by site survey studies that have previously been undertaken within the Eagle development area. Specifically, a survey was commissioned in 2019 to support this EIA (*Gardline, 2019*).

At time of writing the EIA, Front End Engineering Design (FEED) was still progressing with certain specifics of the development not fully defined or confirmed. Therefore, there are a number of areas within the ES where the project lacks definition and where certain assumptions have been necessary, e.g. to timescales or project specifications, in order to enable the impact assessment to take place.

These include the following:

- **Drilling unit:** The drilling rig contract is yet to be finalised and as such, EnQuest have yet to make a final rig selection for the drilling operations. However, for the purposes of the ES, and specifically for the seabed impact assessment, it has been assumed that either a jack-up drilling unit or an anchored semi-submersible drilling unit will be used to drill the proposed 21/19-13 Eagle P1 well (both have been included in the assessment).

- **Site survey:** At the time of writing, the environmental baseline survey report for the 2019 site survey was not available. The draft site survey field report and habitats assessment, however, were available and have been included within the ES. The full environmental baseline survey report will be sent to interested parties once this becomes available and will be reported during future submissions (e.g. through the Master Application Template (MAT)/Subsidiary Application Template (SAT) applications). Reference has also been made to previous environmental baseline survey work in the wider area in section 3.

- **Installation of SDU:** At the present time, the installation method of the SDU is not confirmed; either a gravity-based structure could be used, or a structure that requires piling into the seabed. For the purposes of the EIA it is assumed that piling of the SDU will be required during installation and therefore piling operations have been included within the noise impact assessment.

- **Final chemical selection for pipeline commissioning, drilling operations and production:** Though the types of chemicals to be used can be outlined for the purposes of this ES, final chemical selection will be subject to assessment and permitting as part of the environmental permitting process (e.g. through MAT/ SAT systems.).

- **Final vessel selection for installation of the subsea facilities:** Generic information has been used to estimate the emissions from installation activities (section 5.2), based on a high-level understanding of the types of vessels required. The specific vessels to be used may differ in some characteristics from those assumed, but they will be broadly comparable to those used as the basis for the assessment, therefore emissions to air are unlikely to be significantly different from those estimated in this ES.

1.6 Stakeholder Consultation

The ES is submitted 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 development may proceed, based on the residual levels of potential impact. As part of the EIA process, a scoping consultation was undertaken, which is described in Section 4.3.

This ES is subject to formal public consultation.

1.7 The Environmental Statement

Key elements of this ES include the following:

- A non-technical summary (NTS) of the ES, located at the beginning of this report;
- Description of the background to the Eagle field development; the purpose of the EIA, it's legislative context and the scope covered (this section);
- Description of the Eagle development and alternatives considered (section 2);

- Description of the environment and identification of the key environmental sensitivities which may be impacted by the Eagle development (section 3);
- Description of the methods used to identify and evaluate the potential environmental impacts, including consultation undertaken during the EIA (section 4);
- Detailed assessment of key potential impacts, including assessment of potential cumulative and transboundary impacts (section 5);
- Description of the environmental management measures (section 6); and
- Conclusions (section 7).

2 Project Description

2.1 Consideration of Alternatives

2.1.1 Approach

The various options for developing the Eagle field have been evaluated in terms of technical feasibility, health and safety, best environmental practice, best available technique, reputation and cost. The Environmental Assessment process was initiated early in the planning stage in order to support the option selection process.

2.1.2 Selection of Development Concept

Alternative development schemes to the subsea tie-back approach proposed herein have been considered. However, a new production platform or Floating Production Facility (FPF) is not economically viable and is considered to result in a greater environmental impact than the proposed development option.

The development selection process aimed to limit environmental impact through utilisation of existing subsea infrastructure wherever feasible, and the utilisation of existing processing facilities on the Kittiwake platform and onward export infrastructure. This approach of utilising existing infrastructure as much as possible minimises both environmental impact and cost.

2.1.3 Selection of Well Strategy

The basic concept is to drill at least one development well (21/19-13 Eagle P1) associated with the Eagle development.

Two well designs were considered, a directional well drilled by re-entering the existing wellbore (21/19-13) and a new vertical well. The vertical well would be drilled above the target location, with a pipeline tie-back.

Both well options were reviewed technically, environmentally and commercially. The discovery well drilled in May/June 2016 established that the reservoir was entered in a relatively thin area of the Fulmar isochore, and that the reservoir structure is understood to thicken away from the discovery well. This lends itself well to a directional wellbore to maximize the recovery potential from the Fulmar zone. Given that a vertical wellbore over the target location would not provide optimized recovery potential when compared to a directional well and would also result in increased environmental impact to the seabed, the directional well side tracked from the existing discovery well was selected as the preferred Eagle Phase 1 development option.

Wellbore stability is now well understood following the previous discovery well operations, which confirmed that the Fulmar reservoir was not high pressure and was of a similar pressure to the Gadwall field. This lends itself to greater flexibility of casing shoe depths and directional well design for optimisation of the 8 ½” reservoir section.

The directional well option also gives a quicker route to production as it negates the need to construct an additional well from scratch, significantly reducing MODU time. Both well options (directional well and vertical well), and the final development drilling decision, were reviewed within the EnQuest Well Engineering Department and the relevant gate process was followed to ensure that the design and well philosophy was robust.

2.1.4 Selection of Tieback Option

Several tie-back options were evaluated for the Eagle development:

- (1) Tieback via a *circa.* 5.5 km flowline to the existing Mallard/Gadwall 8” production flowline (with tie in at either the Mallard manifold or Gadwall manifold), then via existing infrastructure to the Kittiwake platform. Subsea controls and chemicals via a new umbilical direct to/from Kittiwake platform;
- (2) Direct tieback from Eagle to the existing Kittiwake platform via a new *circa.* 15 km production flowline and new riser with new control umbilical;
- (3) Tieback to the existing Cook subsea infrastructure via a *circa.* 5 km production flowline, then via existing infrastructure to Anasuria Floating Production, Storage and Offloading facility

(FPSO). Subsea controls and chemicals via a new umbilical direct to/from Anasuria infrastructure;

- (4) Tieback to the existing Teal subsea infrastructure via a *circa.* 12 km pipeline, then via existing infrastructure to Anasuria FPSO. Subsea controls and chemicals via a new umbilical direct to/from Anasuria infrastructure.

During the design selection stage, control umbilicals of existing sub-sea infrastructure were considered not suitable for inclusion of Eagle due to uncertainties related to age and integrity which posed an unacceptable risk. Therefore, the option selection base-case was that a new control umbilical would be installed direct from Eagle to the preferred tieback location.

The subsea infrastructure consideration is strongly influenced by the tie-back option selected. Hence the amount of new subsea infrastructure required for each option was a key consideration in the option selection process.

Option 2 was not selected as it involved investment in, and installation of, all-new infrastructure, including a new production riser at Kittiwake, which went against the development concept. This also presented the longest tieback option and hence represented additional disturbance to the seabed through production flowline trenching and ploughing.

Options 3 and 4 were not selected as these options represented additional contractual commitments for tie-in to operator infrastructure. Additionally, both involved similar umbilical tie-in lengths to Anasuria (*circa.* 15 km) when compared to Eagle - Kittiwake.

The selected option was option 1, which was further refined to tie-in to the existing Gadwall pipeline system. The option best fitted the overall design concept, making best use of existing infrastructure. This option was also the most attractive in terms of contractual arrangements and compatibility of existing infrastructure, as the Kittiwake platform, Mallard and Gadwall fields are all EnQuest operated.

All tieback options, and the final tieback selection decision, were reviewed within the EnQuest Subsurface Department and the relevant gate process was followed to ensure that the final selected design philosophy was robust.

2.1.5 Selection of Drilling Rig

The selection of a drilling rig and the exact timing of the operations strongly depends on the technical requirements of the operation and rig availability. At the time of ES submission, a drilling rig has not yet been selected. EnQuest can confirm that the drilling rig selected will be either a jack-up type or a semi-submersible type. The conditions in the region of the central North Sea (CNS) are well understood and therefore a harsh environment type MODU is not an essential requirement. This ES has assumed that the drilling rig will maintain position over the drilling location at 21/19-13 Eagle P1 for the duration of the drilling activity using either:

- In the case of the use of a jack-up MODU, direct placement on the seabed via the drilling unit's spud cans; or
- In the case of the use of a semi-submersible MODU, a spread of anchors on the seabed and mooring lines.

Maintaining position on station using dynamic positioning (DP) is not proposed, given the relatively shallow water depth and in the interests of reduced atmospheric emissions.

2.1.6 Future Expansion

If the Eagle development is successful, there is the potential for future expansion of the field, involving additional wells and flow lines. The scale of any potential future development will depend on the volumes proven by the Eagle development well, along with consideration of the potential need for water injection following an assessment of the Eagle reserves post start-up. There are large uncertainties associated with Eagle due to the nature and scale of the potential reservoir, which has resulted in large differences in the predicted production profiles. The need for water injection for example, is dictated by the water cut achieved by Eagle, along with understanding of how the stratigraphic trap will flow in relation to the wider field, which is potentially significant in size and is understood to be thickening away from the Eagle well. This makes the placement of a water injection well site very difficult to define at this stage, in the event that water injection is required at all.

Due to the uncertainties associated with any future development of Eagle or the exact scale and nature of a larger initial field development, it is not possible to provide any such options within this ES, as the uncertainties are too great to define in acceptable EIA terms. Therefore, this ES will assess the initial Eagle development only; any further potential extension to the Eagle development will be the subject of a future ES or ES Addendum.

2.1.7 Decommissioning

The future decommissioning activities that will be required for the Eagle development will depend on the regulatory regime in place at the time of decommissioning. To that end, the specific decommissioning requirements cannot be known during design work. However, it has been EnQuest's approach to the option selection process that no design decisions would knowingly prohibit EnQuest from meeting its decommissioning obligations, as much as they can be known at the point of option selection.

2.2 Development Schedule

A Field Development Plan (FDP) will be compiled and submitted in parallel of this ES. Offshore activities are scheduled to begin with drilling the Eagle development well (21/19-13 Eagle P1) in summer 2021. First oil is expected to be produced in Q3/4 2021. The preliminary schedule for the Eagle development is summarised as follows:

- Drilling of development well (21/19-13 Eagle P1) – commencing summer 2021;
- Installation of subsea pipeline infrastructure – April – August 2021;
- Tie-in of 21/19-13 Eagle P3 well – August 2021; and
- First Oil – September 2021.

2.3 Drilling

2.3.1 Nature of the Reservoir

The Eagle field comprises of the Fulmar reservoir which is wholly comprised of the Fulmar sands. It is a stratigraphic trap bound by the Kimmeridge clays and sealing faults. Fulmar was drilled by EnQuest with the Eagle exploration well in 2016, which encountered a vertical thickness of 67ft of oil-bearing sands with excellent reservoir properties, with 15% porosity, 85% Net Volume/Gross Volume and 18% water saturation. Data indicate that Fulmar is comparable in quality to the nearby Gadwall field.

The discovery well established that the reservoir was drilled in a relatively thin area of the Fulmar isochore, with the reservoir structure thickening away from the discovery well. No oil/water contact was encountered in the discovery well. The reservoir pressure is 485.5 bara at 3,316 m (7,040 psia at 10,880 ft) and reservoir temperature is 137.8°C (280°F). The Eagle discovery/development well is not classified as a high temperature/high pressure (HP/HT[1]) well. The estimated oil volume in place has a large range, from 3.2MMstb up to 125MMstb.

2.3.2 Drilling Strategy

The Eagle development well will be drilled from the existing 21/19-13 wellbore. It will be a deviated wellbore targeting the fulmar sands with a trajectory set for optimised reservoir fluids recovery. The anticipated spud date for the 21/19-13 Eagle P1 well is summer 2021, with first oil expected in September 2021.

2.3.3 Drilling Rig

Given the water depth at the Eagle development well (93.0 m [305ft]), the well will be drilled with either a jack-up MODU or with a semi-submersible MODU anchored to the seafloor. If a semi-submersible

[1] A high pressure well is generally considered as any well where the maximum anticipated pore pressure of the porous formation to be drilled exceeds a hydrostatic gradient of 0.8 psi/ft, or the well requires pressure control equipment with a rated working pressure in excess of 10,000 psi or 69 MPa.

A high temperature well is generally considered as any well where the anticipated undisturbed bottom hole temperature is greater than 300°F or 150°C.

unit is used, it is anticipated that the anchor spread on the seafloor will be in the region of 1,500 m radius. The use of a DP MODU is not proposed in the interests of reduced atmospheric emissions. It is anticipated that the drilling rig will be on location for 46 days.

The drilling rig utilised will have a blowout preventer (BOP). The function of the BOP is to prevent uncontrolled flow from the well by closing in the well at the seabed if required. The BOP is made up of a series of hydraulically operated rams that can be triggered remotely to close the well from the drilling rig.

2.3.4 Well Design

The well design is for a deviated wellbore targeting the fulmar sands. The 21/19-13 P1 well will be side-tracked from the 9-5/8" casing, above the abandonment cement plugs (TOC at 10,085 ft MDBRT tagged and pressure tested). The planned trajectory kicks off at 9,000ft MDBRT in the Chalk formation and consists of a single 8-1/2" hole section to well TD at 13,000 ft MDBRT. Figure 2.1 shows the provisional planned well trajectory.

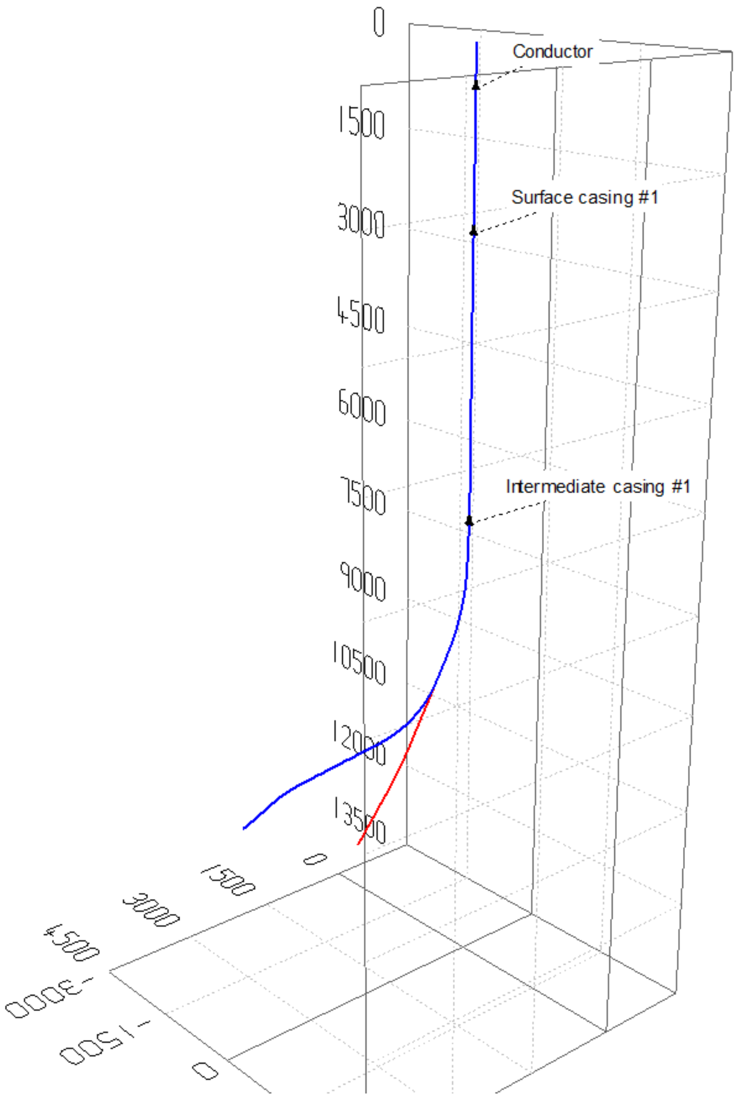

Figure 2.1: 21/19-13 Eagle P1 planned well trajectory in relation to 21/19-13 existing wellbore

The 21/19-13 Eagle P1 well will utilise the existing 21/19-13 wellbore, consisting of 36"x30" conductor, 20" surface casing, 13 3/8" intermediate casing and 9 5/8" production casing. The in place and proposed well casing setting depths are provided in Table 2.1.

Table 2.1: Production well casing setting depths

Casing String	Size	MDBRT	TVDBRT	Criteria
Conductor	36" x 30"	581 ft	581 ft	In place
Surface Casing	20"	2,485 ft	2,485ft	In place
Intermediate Casing	13-3/8"	6,596 ft	6,596 ft	In place
Production Casing	9-5/8"	9,000 ft	8,930 ft	In place
Production Liner	7"	13,000 ft	11,400 ft	To be constructed

The well lower completion will consist of the cemented and perforated 7" production liner. The well upper completion will consist of a 7" production packer and tubing-retrievable Sub-Surface Safety Valve (SSSV). The upper completion will also include an unloader valve, downhole chemical injection and a dual downhole pressure/ temperature gauge. A standard subsea xmas tree (XT) will be installed on the 13⅜" casing wellhead.

Produced water requirements will be managed within the existing Kittiwake and Gadwall/Mallard system capability and compression capacity. The well will be designed with the ability to perform scale dissolver treatments, scale squeezes and clean-out and to have continuous chemical injection.

2.3.5 Drilling Operations

Only the reservoir section is to be drilled, which will be a deviated 8-½" well section with 7" production liner. On arrival at 21/19-13, the XT will be run onto the existing wellhead prior to the BOP being installed. A marine riser will also be installed, thus providing a conduit to return the mud and cuttings from the well back to the drilling rig.

The Eagle development well kick-off point (KOP) is set well above the exiting cement plugs, and therefore the existing plugs will not be drilled and will remain in place. Directional drilling equipment will be run into the wellbore, consisting of a whipstock to kick the deviated well off in the original wellbore to the planned azimuth. The deviated wellbore angle will then be built gradually and held at the planned inclination. Drilling mud will be circulated during drilling to return drill cuttings to the rig. Once the 8-½" well section has been drilled, the 7" production liner will be run into hole and set into place. The upper completion will then be run prior to the liner being perforated, with the perforating guns run with the upper completion. The proposed 21/19-13 Eagle P1 well profile is shown in Figure 2.2.

2.3.6 Mud System and Cuttings

The Eagle development well will be drilled entirely with LTOBM. Drill cuttings will be returned to the surface for treatment on the drilling rig. The cuttings will be removed from the LTOBM in the shale shakers, contained and shipped to shore for further treatment and disposal. The recovered LTOBM will be treated and recycled back into the LTOBM drilling system. The Eagle development well is therefore a 'zero discharge skip and ship' well.

An estimate of the amount of drill cuttings that will be generated for the Eagle development well and subsequently skipped and shipped is presented in Table 2.2.

Table 2.2: Eagle Development Well Estimated Cuttings Generation

Section	Section length (ft (m))	Cuttings volume generated (m^3)	Cuttings mass generated (tonnes)*	Cuttings discharged (tonnes)
8½"	4,000 (1,219.20)	44.63	116.03	N/A – zero discharge ship and ship

* Assumes density of 2.6 tonnes / m^3

2.3.7 Cementing and Other Chemicals

The 7" steel production liner will be installed in the Eagle development well and cemented into place to provide a structural bond and an effective seal between the casing and formation. During the cementing operations, excess cement may be generated and will be discharged to sea.

The specific chemicals and additives used during drilling will be dependent upon the mud composition, which in turn, will be determined by the down-hole conditions encountered whilst drilling. Additional chemicals will be stored on the drilling rig to deal with any contingencies such as stuck drill pipe or lost-circulation. 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 and risk management (CHARM) risk assessment model where appropriate. The results of this process will be submitted in a chemical permit SAT subsequent to this ES under the *Offshore Chemicals Regulations 2002 (as amended)*.

2.3.8 Well Evaluation

During the drilling programme, a wire-line logging programme may take place. However, no Vertical Seismic Profiling (VSP) programme is planned.

2.3.9 Well Completion, Clean-up and Testing

After drilling operations are completed, a well test may be conducted. If a well test is conducted, it will not last for longer than 96 hours or involve the production of more than 2,000 tonnes of oil (i.e. will not be classified as an extended well test).

Following well clean-up/ testing, the completion will be run where the well will be converted to completion brine. The well will then be suspended, awaiting flowback to the Gadwall tie-in point and subsequently to the Kittiwake platform.

2.3.10 Well Workovers and Interventions

The well has been designed with a minimum planned intervention philosophy for the life of the development. However, it is recognised that unplanned well maintenance could be necessary in the case of equipment failure. Chemical use and discharge associated with well workovers and interventions will be assessed in more detail as part of the environmental permitting process throughout the life of the field (e.g. through MAT/SAT). Discharges associated with future well workovers and interventions are not assessed further in this ES.

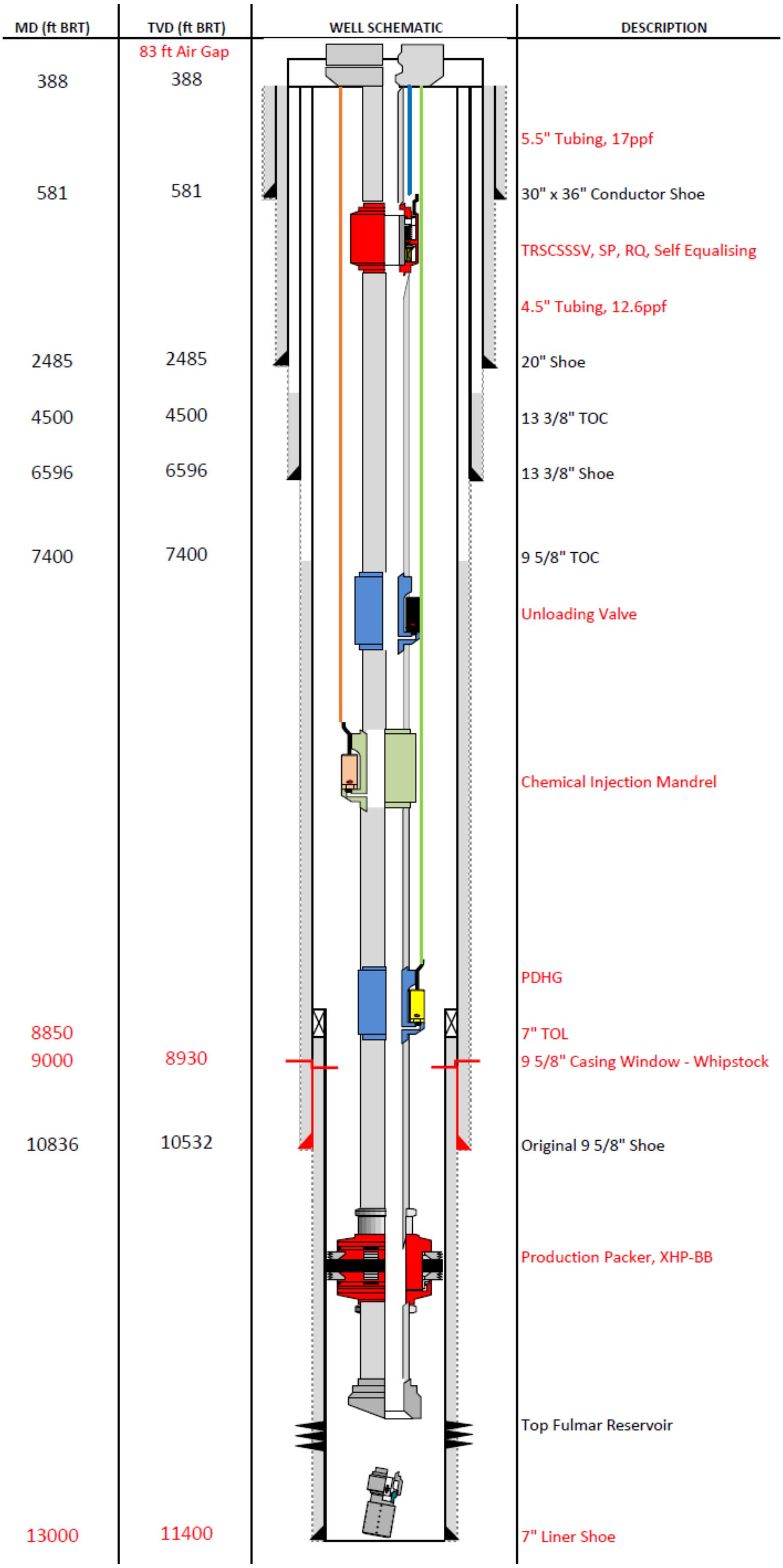

Figure 2.2: Proposed 21/19-13 Eagle P1 Well Schematic

2.4 Subsea

This part of the project description provides the subsea infrastructure that will be required for the Eagle field development.

2.4.1 Overall Subsea Layout

An overview of the proposed Eagle development subsea layout is shown in Figure 2.3. A 500 m safety exclusion zone exists at the Kittiwake platform. The Kittiwake platform is connected to Gadwall and Mallard by existing pipelines and manifolds.

The overall subsea field system of the Eagle development will consist of the following components:

- Subsea production XT, located on top of the Eagle wellhead, incorporating fishing-friendly protection system;
- Tie in spool – 8”, up to 100 m long complete with double-isolation valve to connect the XT to the Eagle pipeline system;
- Eagle production pipeline *circa.* 5,500 m long; insulated pipe-in-pipe design (12” outer, 8” inner pipe) to connect the Eagle well back to the tie in point at the Gadwall drill centre manifold;
- Tie in spool – 8”, up to 100 m complete with double-isolation valve to connect the Eagle pipeline into the Gadwall/ Mallard to Kittiwake pipeline system; valve to be housed in a small fishing friendly structure;
- Replacement 8” spools at the tie in to the Gadwall system, complete with double-isolation valve to isolate the Mallard production XT;
- Control umbilical *circa.* 16,000 m long, running from the Kittiwake platform to the Eagle well; providing power, signal, hydraulics and chemicals to the Eagle field;
- 1 x Subsea Distribution Unit (SDU) housed in a gravity-based or piled into the seabed fishing friendly protection structure located adjacent to the Eagle XT; will provide reception facilities for the Umbilical Termination Assembly (UTA) and connection point(s) to supply power, signal, hydraulics and chemicals to the Eagle XT.
- 1 x tie-in manifold, housed in a gravity-based or piled into the seabed fishing friendly protection structure located adjacent to the Gadwall manifold; will provide the tie-in facility to the Gadwall manifold;
- Hydraulic Flying Leads (HFLs) and Electrical Flying Leads (EFLs) up to 100 m long to connect the Eagle XT to the SDU.

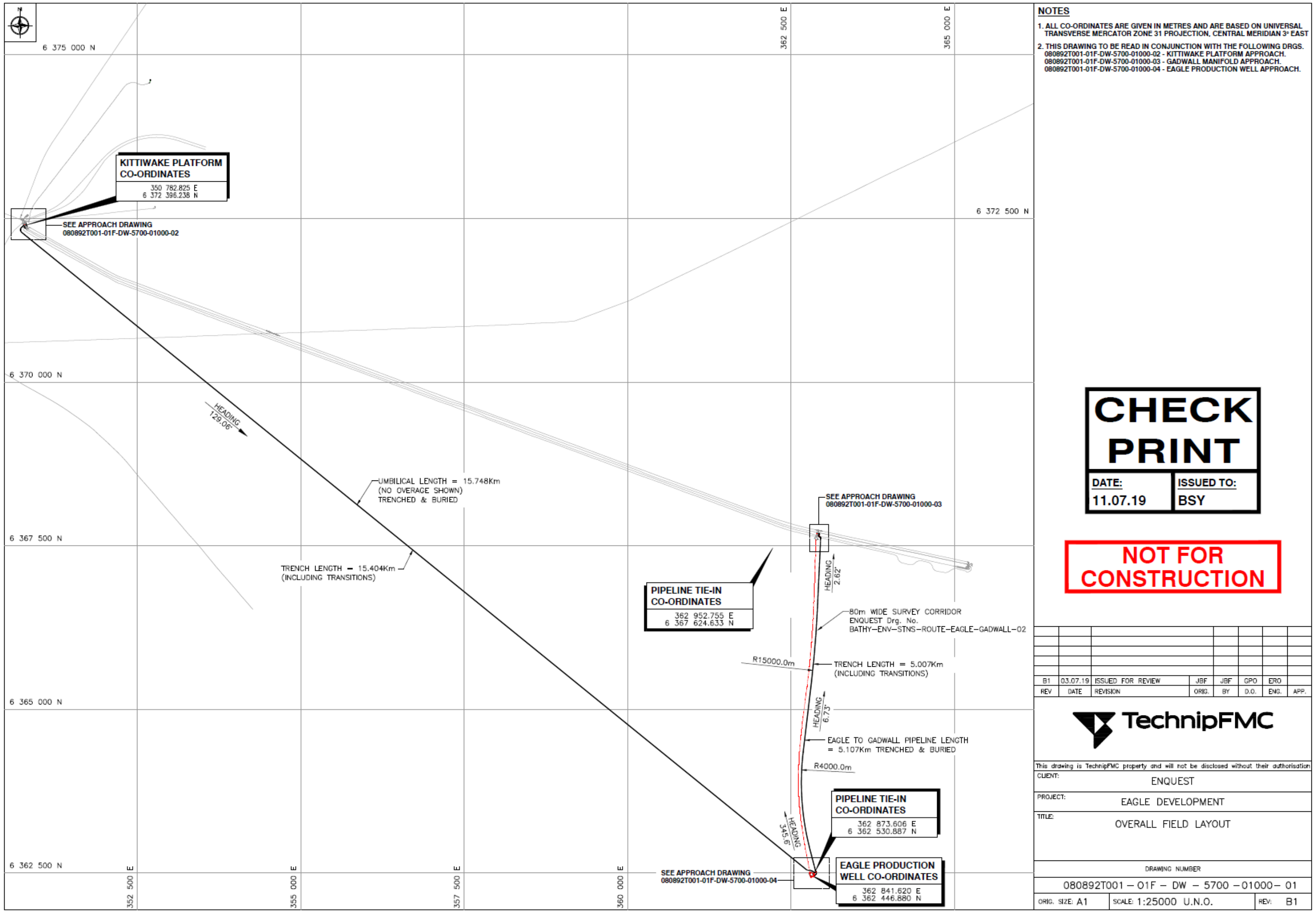

Figure 2.3: Proposed Eagle Field Layout

2.4.2 Subsea Tree and Wellhead

A subsea tree (or xmas tree), designed to control production flow, will be installed on top of the wellhead at Eagle 21/19-13 P1 by the drilling rig (Figure 2.4). The subsea tree is the main barrier between the reservoir and the environment, and also provides a mechanism for flow control and well entry.

During completion operations, the subsea tree will be controlled from the drilling unit. During production the subsea tree will be remotely controlled from the Kittiwake platform. The valves will be controlled using a Subsea Control Module (SCM), which will be mounted on the subsea tree. As the system will be open loop (i.e. fluids are discharged on each actuation), hydraulic fluid will be selected with due consideration to the potential environmental impact.

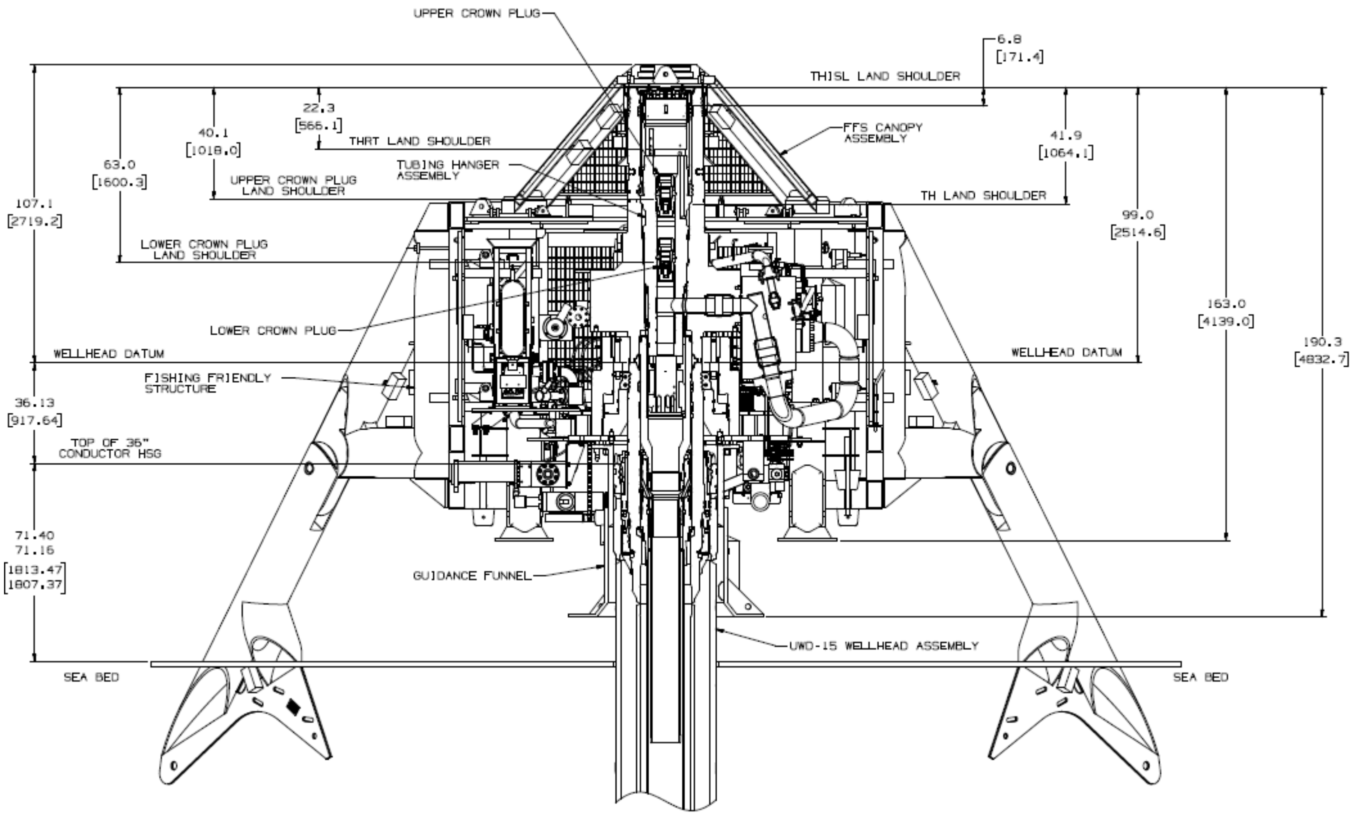

Figure 2.4: Subsea Xmas Tree to be Used at 21/19-13 Eagle P1 (TechnipFMC, 2015)

2.4.3 Pipeline

The Eagle development will require the installation of a new production pipeline from Eagle to the existing Gadwall drill centre manifold. The pipeline will be approximately 5.5 km in length and will be of dry insulated pipe-in-pipe design, with a 12" outer diameter and 8" inner pipe diameter.

The pipeline from Eagle to the Gadwall tie-in point will either be trenched and backfilled or surface laid and rock-dumped along its entire length following installation, with the exception of the transitions at both ends. The preferred option of trenching and backfilling is in keeping with the pipeline installation methods previously used in the area for the Kittiwake to Mallard control umbilical, Mallard to Kittiwake oil bundle and Mallard to Kittiwake water injection line, and in the wider area the Nelson to Fulmar gas line, which have all been trenched and buried, or buried (refer to Table 3.1 in Section 3). The option of rock-dump is retained as a contingency.

There are no crossings on the proposed pipeline route. The pipeline will tie into the existing Mallard/Gadwall production system and therefore no new risers are required at Kittiwake.

2.4.4 Umbilical

The Eagle development will require a new control umbilical to be installed between Eagle and the Kittiwake platform. The umbilical will be approximately 15.5 km in length and will provide electrical power, control signal, hydraulics and chemicals to the Eagle field.

The control umbilical from Eagle to Kittiwake is to be jet trenched along its entire length following installation, with the exception of the transitions at both ends. The Eagle control umbilical will cross the Goosander umbilical and spools adjacent to the Kittiwake platform jacket, and the 10" Nelson gas pipeline (PL934). The new Eagle umbilical will be connected via an existing J-tube on the Kittiwake jacket.

2.4.5 Tie-in Spools

The Eagle development will require short sections of pipe (called spools) to connect the Eagle well to the production pipeline and to connect the pipeline to the existing Gadwall manifold.

An 8" tie-in spool will be required to connect the Eagle XT to the Eagle pipeline. This spool will be up to 100 m long and will include a double isolation valve.

An 8" tie-in spool will also be required to connect the Eagle pipeline into the Gadwall to Kittiwake pipeline system. This tie-in spool will be up to 100 m in length and will incorporate a double isolation valve, which will be housed within a small fishing-friendly protection structure.

Replacement 8" tie-in spools will also be required at the Mallard tie in points to the Gadwall system, in order to isolate the Mallard production XT. These spools will also incorporate a double isolation valve.

A Diving Support Vessel (DSV) will carry out the installation of the spools used to tie-in the Eagle well to the Gadwall flowline. Each spool will be transferred by vessel crane to the seabed, where divers will then connect the sections of spools together. Once all the spools and jumpers are laid, the route of each will be visually inspected by an ROV to confirm the as-built locations of the newly installed infrastructure.

2.4.6 Subsea Distribution Unit / Tie-in Manifold

A Subsea Distribution Unit is required at the Eagle well location. This will provide reception facilities for the Umbilical Termination Assembly (UTA), and will provide the connection points for power supply, communications signal, hydraulic power and production chemicals to the Eagle XT. The SDU will be located adjacent to the Eagle XT and will be housed within a fishing friendly protection structure. Hydraulic Flying Leads (HFLs) and Electrical Flying Leads (EFLs) will connect the SDU to the Eagle XT and will be up to 100 m in length.

There may also be a requirement for a separate tie-in manifold at the Gadwall manifold location, to tie the pipeline into the Gadwall manifold system. The tie-in manifold will be located adjacent to the existing Gadwall manifold and will be housed within a fishing friendly protection structure.

The SDU, tie-in manifold and associated HFLs/EFLs will be installed by DSV; the equipment will be lowered to the seabed by crane and will then be installed by divers. The SDU and tie-in manifold will be either gravity-based structures, or structures piled into the seafloor. If piled structures are selected, the SDU and tie-in manifold will be fixed to the seafloor using 8 x 610mm outside diameter (OD) piles (4 piles for each structure), each approximately 24 m in length. The piling operations will be undertaken by a piling vessel.

2.4.7 Seabed Preparation

Prior to pipelay, umbilical lay and subsea structure installation, a pre-lay Remotely Operated Vehicle (ROV) survey will be carried out to check for obstructions. While there are no specific requirements to prepare the seabed prior to installation activities, during all phases of the Eagle development, any boulders that are identified as obstructions may need to be moved away from the proposed activities. Site environmental survey operations have also confirmed the presence of sensitive seabed features which require the pipeline to be routed accordingly to avoid disturbance (refer to section 3.3.2).

2.4.8 Protection and Crossings

No pipeline crossings will be required along the Eagle export pipeline route. However, there are crossings along the umbilical route; the Nelson to Fulmar receiver tee 10" gas pipeline (PL934) operated by Shell, and also the Goosander umbilical and spools adjacent to the Kittiwake platform jacket.

The subsea tree on the well (Figure 2.4) will incorporate a fishing-friendly protection system designed to minimise the risk of snagging of fishing gear but shall be also be capable of withstanding horizontal snag loads up to 65 tonnes. The telescopic legs of the protection system are designed to deflect fishing gear and limit it from passing under the tree structure. The debris cap provides a smooth transition over the top of the tree and also provides dropped object protection. The tree, including the protection structure, will have a seabed footprint of 9.5 m x 9.5 m and a height above the seabed of 5.5 m.

The SDU at the Eagle well and the Gadwall isolation valves located at the tie-in spools will also be fitted with fishing-friendly protection structures.

The tie-in spools, HFL/EFLs, pipeline and umbilical transitions will all be protected by concrete mattresses and grout bags, in order to protect the infrastructure and also to minimise the risk of snagging fishing gear. The concrete mattress requirements are presented in Table 2.3.

Table 2.3: Concrete Mattress and Grout Bag Requirements

Location	Size	No. off	Area (m^2)	Area (km^2)
21/19-13 Eagle P1: Pipeline transition	6 m x 3 m x 0.15 m	8	144.00	0.000144
21/19-13 Eagle P1: Tie-in spool	6 m x 3 m x 0.15 m	21	378.00	0.000378
Eagle SDU: Umbilical transition	6 m x 3 m x 0.15 m	20	360.00	0.000360
Gadwall Manifold: Pipeline transition and tie-in spools	6 m x 3 m x 0.15 m	36	648.00	0.000648
Kittiwake jacket: Umbilical approach	6 m x 3 m 0.15 m	35	630.00	0.000630
	Total:	**120**	**2,160.00**	**0.00216**
Grout bags[1]	0.9 m x 0.9 m x 1.2 m	15	12.15	0.0000215
	Total:	**15**	**12.15**	**0.0000215**

Notes: 1 – Dimensions from Subcon (2019)

The pipeline and umbilical will be trenched and back-filled / jet-trenched (respectively), but rock dump may be used as a contingency to mitigate the risk of upheaval buckling, protect crossings and to provide protection in areas where sufficient burial depth has not been achieved. The contingency rock dump volume assumes that the export pipeline will not be trenched and backfilled and instead will be rock-dumped along its entire length. The worst-case rock dump quantity is estimated to be 40,000 tonnes with a berm width of 8 m.

2.4.9 Pre-Commissioning Activities

Following installation of the pipeline, umbilical, tie-in spools, SDU and HFL/EFL connections, and in advance of the Eagle well being brought online for the first time, a series of pre-commissioning activities will be undertaken.

The umbilical cores will be pressurised during installation, which will be monitored from the installation vessel. Once topside and subsea connections have been made, the hydraulic control and chemical systems will be leak tested via the Topsides Umbilical Termination Unit (TUTU) to prove integrity. Electrical and signal connections will also be tested to prove integrity prior to production.

The pipeline will be flooded post installation, and hydrotested with inhibited seawater to prove integrity. Tie-in spools will be installed filled with 50:50 monoethylene glycol (MEG)/ water to protect them from seawater during tie-in.

Once the pipeline and spools are tied-in at both the Gadwall manifold and at the Eagle XT, the whole system will be leak tested with inhibited seawater to prove all connections are tight. This water will be returned to the Kittiwake topsides during pipeline system commissioning/ dewatering operations, for disposal through the process separator on Kittiwake.

Final selection of the inhibition chemical products to be used will be made during detailed design and will consider a site usage specific risk assessment of the chemicals. All chemical use and discharge associated with pipeline pre-commissioning activities will be assessed in detail as part of the environmental permitting process (e.g. through MAT/ PL-SAT). Discharges associated with pre-commissioning are not assessed further in this ES.

2.4.10 Operations and Maintenance

During its operational life time, the subsea infrastructure will be subject to inspection. External inspection will most likely be completed using a survey vessel with a combination of remotely operated vehicle (ROV) and/or autonomous underwater vehicle (AUV) and towed sonar. The frequency of such maintenance will be determined by ongoing risk assessment but may be up to once every two years. Surveys will likely be undertaken in conjunction with ongoing inspection and maintenance of the existing GKA subsea infrastructure.

Chemical use and discharge associated with operation and maintenance will be assessed in more detail as part of the environmental permitting process (e.g. through MAT/SAT) throughout the life of the field. Discharges associated with operation and maintenance are not assessed further in this ES.

2.5 Production

Reservoir fluids from the Eagle well will be flowed back to Kittiwake via the existing Gadwall/ Mallard pipeline and riser system.

2.5.1 Production Profiles

The Eagle field reserve estimations are subject to some uncertainty and therefore there are large variances in the low, mid and high cases. The production profiles presented herein are the highest predictions (P05 case) for the oil and gas rates and the low (P90 case) for the water rates (Table 2.4).

Total production from the well is expected to achieve the maximum production rate as soon as the well comes online in September 2021 at an oil rate of 8,500 barrels per day (1,126 tonnes per day) and a gas rate of 3.0 million standard cubic feet per day (MMscf) (84,756 m^3/day). Eagle is expected to produce at the same maximum rate until August 2022 when both the oil and gas rates will steadily decline over the life of the well (Table 2.4, Figures 2.5 and 2.6). The low (P90) case is the worst-case in terms of produced water production (Table 2.4 and Figure 2.7), which is predicted to reach a maximum of 1,669 bpd (265 m^3) in April 2022.

In order to maximise production and reserves, Gadwall and Mallard will be choked back to free-up space in the production line for the new Eagle production. Kittiwake will therefore not operate outside of its existing subsea and topsides operating and design envelopes as a result of accommodating production from the Eagle field.

Table 2.4: Eagle Production Figures (high [P05] case for oil and gas rates, low [P90] case for water rates), assumed start September 2021)

MM/YY	Oil rate (tonnes/day)*	Gas rate (m^3/day)**	Produced water rate (m^3/day)
09/2021	1,126	84,756	0.0
10/2021	1,126	84,756	24.8
11/2021	1,126	84,756	141.8
12/2021	1,126	84,756	209.1
01/2022	1,126	84,756	243.7
02/2022	1,126	84,756	257.7
03/2022	1,126	84,756	265.1
04/2022	1,126	84,756	265.4
05/2022	1,126	84,756	262.4
06/2022	1,126	84,756	256.8
07/2022	1,105	84,756	250.0
08/2022	1,008	76,281	242.0

MM/YY	Oil rate (tonnes/day)*	Gas rate (m^3/day)**	Produced water rate (m^3/day)
09/2022	910	67,805	232.1
10/2022	821	62,155	222.1
11/2022	737	56,504	211.5
12/2022	655	50,854	200.7
01/2023	581	45,203	190.0
02/2023	514	39,553	178.3
03/2023	449	33,903	167.4
04/2023	387	28,252	156.8
05/2023	331	25,427	147.1
06/2023	270	19,776	137.6
07/2023	229	16,951	128.6
08/2023	96	8,476	122.7
09/2023	0	0	111.9
10/2023	0	0	24.8
11/2023	0	0	141.8

Notes:
* : Conversion to tonnes using SG of 0.833
** : Conversion to m^3 using 1 MMscf/d at 15°C = 28,252.14 m^3/d

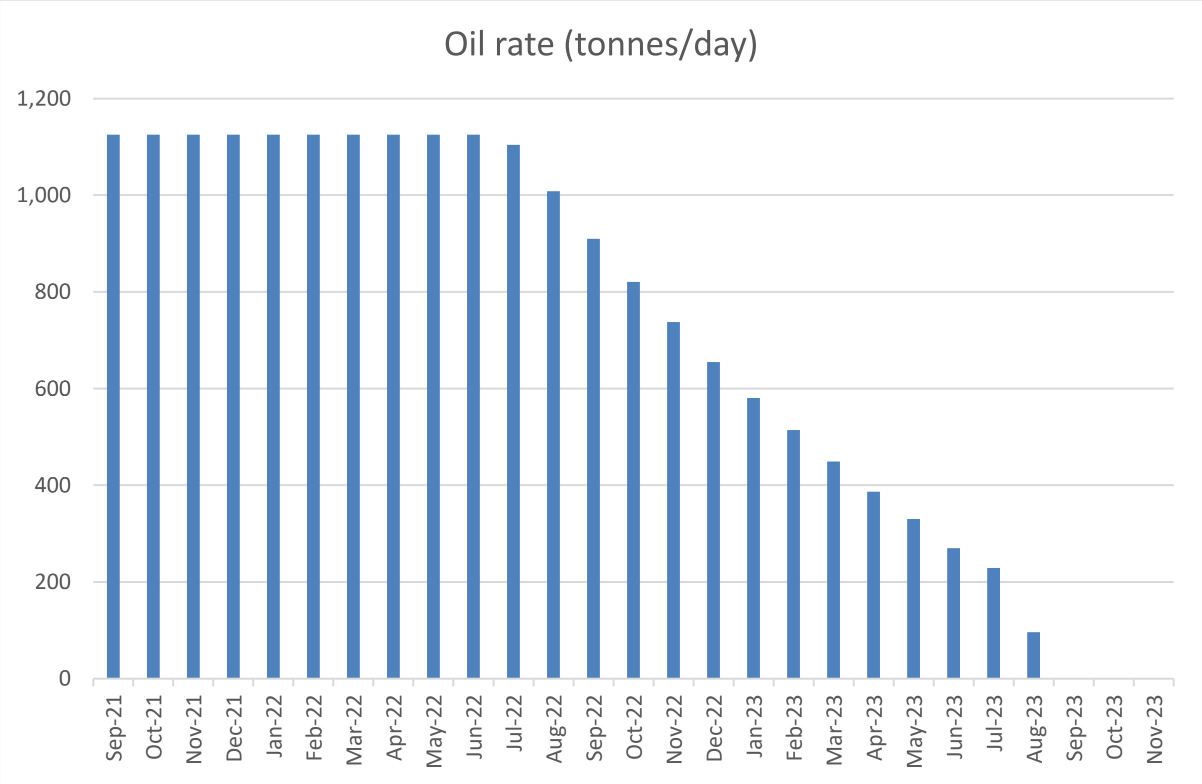

Figure 2.5: High Case (P05) Oil Production Profile for the Eagle Development; 21/19-13 Eagle P1 Well

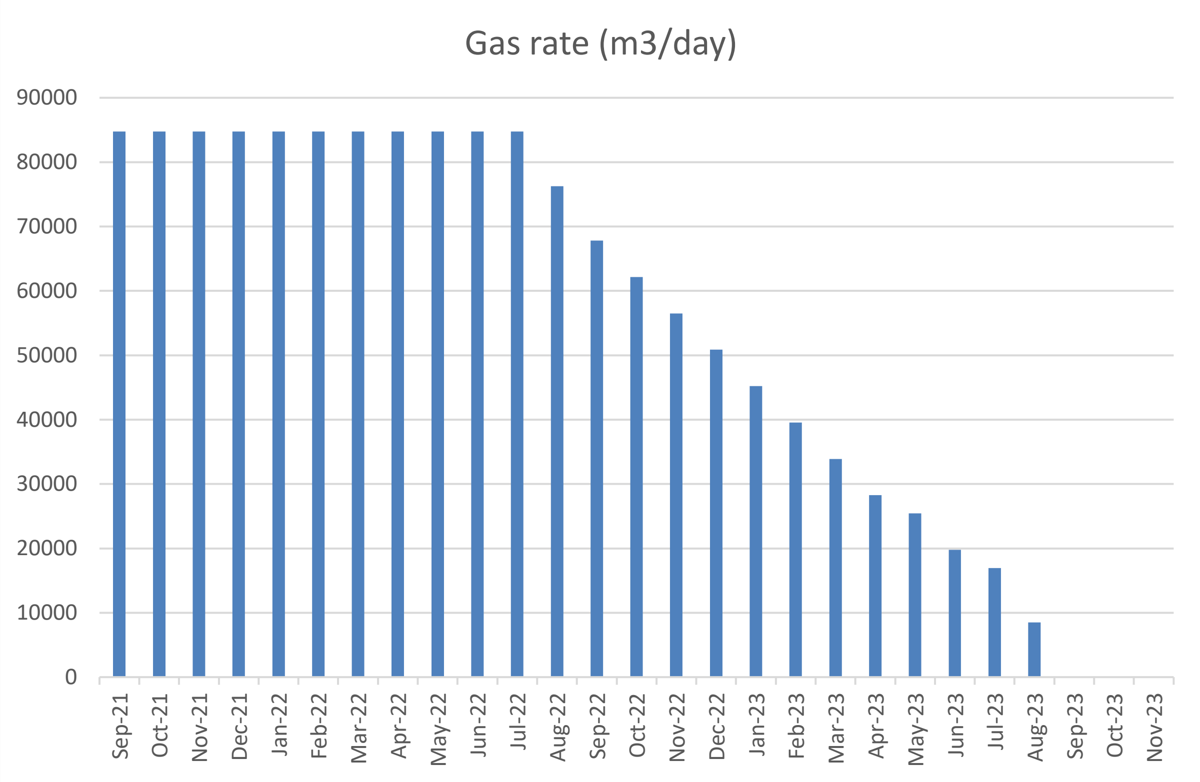

Figure 2.6: High Case (P05) Gas Production Profile for the Eagle Development; 21/19-13 Eagle P1 Well

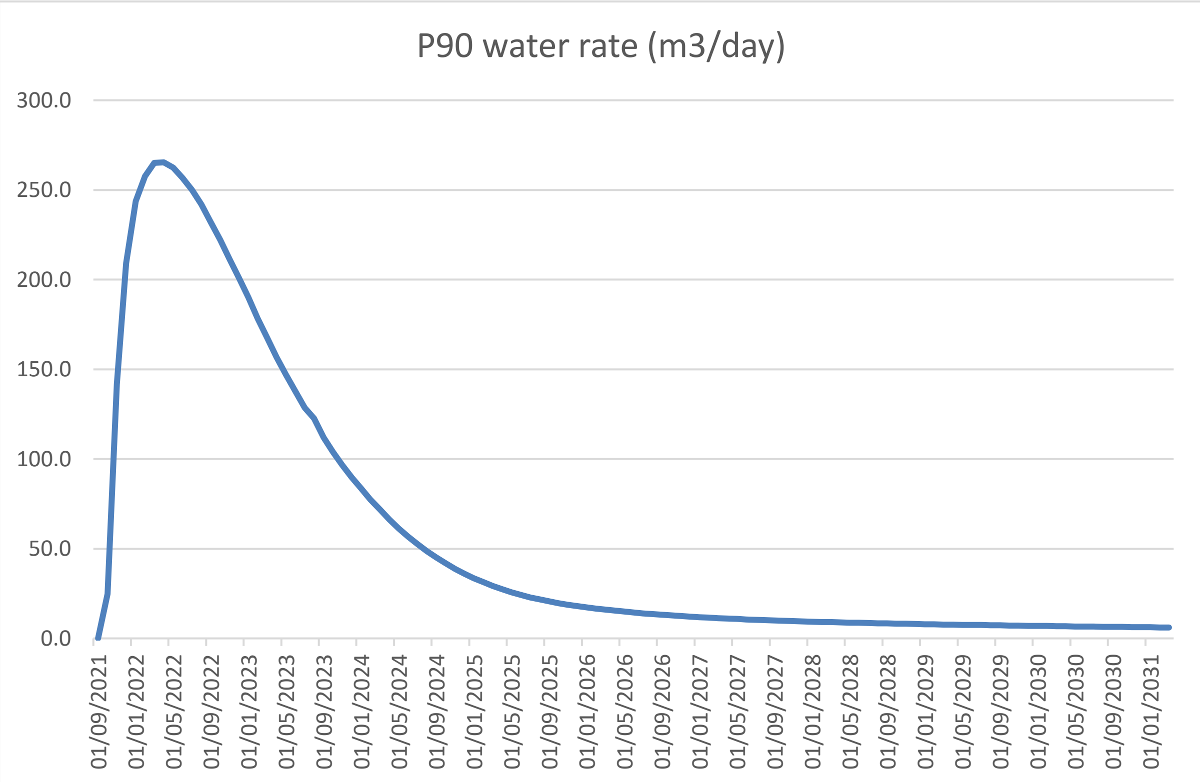

Figure 2.7: Low Case (P90) Water Production Profile for the Eagle Development; 21/19-13 Eagle P1 Well

2.6 The Kittiwake Platform

The Kittiwake Alpha platform (Figure 2.8) is a normally manned integrated oil and associated gas production facility, utilising a modular drilling rig. The average number of persons on board (POB) is 60 with a possible maximum of 79 POB.

Currently, the Kittiwake installation receives fluids from the Crathes, Gadwall, Goosander, Grouse, Mallard and Crathes fields, which are collectively referred to as the Greater Kittiwake Area (GKA). The Kittiwake field itself is no longer producing fluids back to the installation. Kittiwake has the following facilities on board:

- Accommodation;
- Oil, produced water and gas separation;
- Metering, pumping and compression equipment;
- Water and gas injection equipment;
- Low-pressure flare header and flare system.
- Emergency facilities;
- Full life support facilities;
- Helicopter landing and refuelling facilities.

Figure 2.8: The Kittiwake Alpha platform

2.6.1 Host Modifications

Kittiwake requires only minor modifications to prepare it for accommodation of fluids from the Eagle field. This will include:

- A new TUTU for the Eagle control umbilical;
- A new Hydraulic Power Unit (HPU) to provide the additional hydraulic power needed for the Eagle subsea equipment;
- New chemical pump skid / tanks on Kittiwake for production chemicals (although there may be the potential to share Methanol and biocide with the existing systems).

At this stage, no upgrades to Kittiwake produced water systems are anticipated to accommodate Eagle, however this will be confirmed by detailed studies during FEED.

2.6.2 Process and Export

The Kittiwake platform is designed for production fluids from the GKA subsea wells and fields, namely, Kittiwake, Mallard, Gadwall, Grouse, Goosander, Scolty and Crathes. Kittiwake is designed to export gas and partially stabilised crude. Oil, gas and water are separated in process separators on board Kittiwake.

Kittiwake can handle a crude oil throughput of 28,368 bbls/day (4,510 m^3/day), a gas throughput of approximately 13 MMscf/day (368,116 m^3/day) and a water treatment rate of 19,000 bbls/day (3,021 m^3/day) through the Kittiwake produced water plant, and 13,707 bbls/day (2,179 m^3/day) through the Mallard produced water plant. A separate production train for Crathes and Scolty fluids was installed in 2016 and included a degasser unit, with 60,000 bpd design throughput capacity. All produced water generated on Kittiwake is routed to this degasser prior to discharge.

Crude is processed through a separation train that incorporates multi-stage separators. Produced fluids from Mallard are combined at the production manifold and passed to the Mallard separator. From there they pass through the Mallard crude heater and then join the other fluids at the 2nd and 3rd stage separators. In order to improve oil in water management on Kittiwake, produced water from the Kittiwake separation system is routed into the Scolty Crathes separation system, upstream of the Scolty Crathes degasser.

Crude oil from the final separator is then pumped through the coalescer, which reduces the water content to the required export specification for the Forties Pipeline system. Oil is then exported via the to the Ineos FPS Ltd. Unity installation via the existing 10” main oil export line (PL-2403) and ultimately, to the existing Forties Pipeline System.

Gas produced from the separators passes into the gas process system, passing through suction coolers, scrubbers and is compressed and dehydrated, prior to export, gas lift or use as fuel gas. Some gas is routed to the low-pressure flare for use as pilot and purge gas. Eagle gas will be suitable for compression via the existing Kittiwake gas compression units, allowing associated gas to be reused as fuel gas or for gas lift and/or exported back onshore, thus minimising gas wastage. Produced gas will be exported via the existing 4” gas export pipeline (PL-673) to the existing receiver tee on the Fulmar to St. Fergus 20” gas line.

To maintain reservoir pressure, some wells in the GKA require injection. However, the Eagle development well will not use seawater injection in this Phase 1 development.

2.6.3 Power Generation, Flaring and Venting

Power generation requirements on Kittiwake are met by the operation of 2 (out of 3) dual fuel Tornado SGT-200 turbines, each with a maximum thermal input of 22.5 MW(th). Fuel gas is used predominately, with diesel used as a back-up when the fuel gas system is unavailable (for example, during maintenance).

There will be no change in fuel use or to the operation of the gas turbines as a result of the Eagle development coming online.

There is no routine flaring of gas onboard Kittiwake; all gas is either used as fuel gas, lift gas or is exported. Only a small amount of gas is used as pilot and purge gas in Kittiwake’s low-pressure flare system. Gas is only sent to the flare header in the event of operational changes (e.g. system start-up or shut-down for planned maintenance), system upset or emergency conditions.

No venting takes place on board Kittiwake and Kittiwake does not currently have a vent consent in place.

2.6.4 Produced Water

Produced water removed from produced fluids returned to Kittiwake is cleaned and discharged to sea via a produced water caisson. The produced water handling system on the Kittiwake platform has the capacity to handle up to 3,021 m^3/day.

Eagle production fluids will be routed to the existing V1200 Mallard separator, where fluids undergo 3-phase separation. Produced water from the V1200 unit will then be routed to the existing Mallard high-pressure hydrocylones (S-4017 and/or S-4018). After the hydrocyclone process, produced water is routed to a degasser unit (V-94000) which is the last point of treatment prior to the overboard discharge of produced water from Kittiwake from the produced water caisson located 3 m above the sea surface.

The following specifications of the produced water system will continue to be met at the Kittiwake platform once Eagle is brought online:

- The use and/or discharge of all production chemicals will be subject to risk assessment and permitting under the Offshore Chemicals Regulations 2002 (as amended); and
- Oil in water discharge via the produced water system will be within the existing approved limits, which currently include:
    - A maximum monthly average of oil (dispersed) in water content of 30 mg/l or less;
    - The maximum concentration not to exceed 100 mg/l at any one time; and
    - Quantity of dispersed oil in produced water discharged must not exceed 1 tonne in any 12-hour period.

The wells that currently produce through Kittiwake are depleted to various extents meaning that water production is currently higher than would be expected were production to be coming from new wells. When the Eagle field comes online through 21/19-13 Eagle P1, production from some other wells currently producing through Kittiwake will be deliberately constrained to 'make space' in the processing facilities for the new produced fluids from the Eagle field. Kittiwake will not operate outside of its existing operating and design envelopes as a result of accommodating production from the Eagle field.

2.7 Integrity of Infrastructure

The Eagle Phase 1 development (outlined and assessed within this ES) will operate within the existing subsea operating and design envelopes. The pipeline annual integrity assessment, carried out routinely on infrastructure operated as part of the GKA, confirmed the existing infrastructure integrity is fit for use in the immediate term. Maintenance for the new Eagle development associated infrastructure will follow existing philosophies for existing subsea facilities.

There is the possibility that the flowlines and associated infrastructure that accommodate the Eagle fluids may be required to operate beyond their current design life. The infield pipeline integrity is subject to the ongoing EnQuest integrity management and inspection programme.

2.8 Vessel and Helicopter Requirements

The vessels expected to be involved in the drilling, installation and commissioning activities, and their anticipated number of days at sea, are described in Table 2.5. Helicopters will also be required for transportation of personnel during drilling of the Eagle production well, during installation and commissioning. However, there will be no additional ongoing operational helicopter requirement beyond current demand at Kittiwake as a result of bringing Eagle production online when in operational mode. The durations presented in Table 2.5 do not include mobilisation, demobilisation, or transit times, or allowance for weather delays.

Table 2.5: Estimated Vessel Types and Number of Days Required

Operation	Support type	Number of days
		2021
Drilling		
Drilling	MODU (either jack-up or semi-sub)	46
Debris Survey	Survey Vessel	2
Anchor handling	Anchor handling vessel	4
Standby vessel	Standby vessel	46
Supply vessel	Supply vessel	25
Helicopters (assumes two flights per week)	Helicopter	14 return flights
Hook up and pre-commissioning		
DSV trip #1 – Gadwall spool and valve structure installation	Dive Support Vessel (DSV)	14
Pipelay	Pipelay Vessel	7
Pipeline trench and backfill	Pipeline burial/ trenching vessel	14
Pipelay support / survey / pre-commissioning	Pipelay support vessel	28
Umbilical installation	Umbilical installation vessel	14
Jet trenching	Jet trenching vessel	14
DSV trip #2 – Umbilical hook up / tie-in spool and SDU structure installation / EFL installation / system leak test / protection installation (concrete mattresses)	DSV	21
Kittiwake topsides modifications		
Pull-in of control umbilical, installation of TUTU	Dive support vessel (DSV)	2
Operation		
Inspection and maintenance of subsea infrastructures	Survey vessel	2 yearly survey taking 0.5 day

2.9 Decommissioning

Once production from the well is no longer economic, permission will be sought for production to cease. The future decommissioning activities that will be required will depend on the regulatory regime in place at the time. To that end, the specific decommissioning requirements cannot be assessed during the current design stage. However, it has been EnQuest's approach to the option selection process, that no design decisions would knowingly prohibit EnQuest from meeting its likely decommissioning obligations.

Decommissioning of oil and gas facilities in the UK is regulated under the *Petroleum Act 1998*, as amended by the *Energy Act 1998*. The UK's international obligations on decommissioning are governed principally by the Oslo-Paris Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention).

BEIS (2018) provides specific guidance on decommissioning activities and the process leading to approval of a decommissioning programme. At the onset of the decommissioning phase, EnQuest will adhere to the decommissioning guidance that is current at the time. The well will be abandoned at the end of field life as per applicable well abandonment legislation and guidelines.

While the OSPAR provisions do not apply to pipelines, BEIS (2018) guidance sets out UK policy on pipeline decommissioning. The decommissioning strategy will depend on a number of factors, including the availability of suitable technology and the potential environmental, safety and cost implications of decommissioning methods at the end of field life. The ultimate intention is to leave the seabed of the development area in such a condition that it will pose no risk to the marine environment or to other sea users, and the development has been designed with this intention in mind. No decisions relating to the development have knowingly been taken that will preclude this goal.

The pipeline system and deposited materials (concrete mattresses) can be recovered during decommissioning from the seabed, dependent on their integrity. The final decision on whether or not to recover, or to make safe on the seabed, will be subject to comparative assessment.

Prior to the end of field life, changes may occur to the statutory decommissioning requirements, and advances may occur in technology and knowledge. EnQuest will aim to utilise recognised industry standard environmental practice during all decommissioning operations, in line with applicable legislation and guidance. Discussions on what may be required will be held with the Regulator as early as possible before decommissioning commences.

Prior to the decommissioning process, re-use and recycling alternatives will be considered where feasible, to reduce materials sent to landfill. In advance of the decommissioning process an inventory of equipment will be made and the potential for further reuse will be investigated. As an integral component of the decommissioning process, EnQuest will undertake a study to comparatively assess the technical, financial, health, safety and environmental aspects of decommissioning options, for which a further Environmental Appraisal (EA) may be required.

3 Environment Description

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 environment in and around the Eagle development and highlights the key sensitivities.

This section draws on a number of information sources including published papers, relevant Strategic Environmental Assessments (SEAs) and site-specific investigations.

Specifically, route surveys have previously been undertaken between the Kittiwake platform and Mallard, and from Eagle to Gadwall and Mallard in 2016 (*Fugro, 2016a*; *2016b*; *2016c*). Figure 3.1 delineates the 2016 survey coverage. Rig site surveys were also conducted at the Eagle development well in 2013 and 2014 (*Fugro, 2014*); Figure 3.2 delineates the 2013 and 2014 site surveys coverage.

A route survey from Eagle to Kittiwake, which also included further environmental work from Eagle to Gadwall, was also undertaken in the spring of 2019. Figure 3.3 delineates the 2019 survey coverage. The preliminary results of the 2019 survey work are reported within this ES, along with the draft habitats assessment report (*Gardline, 2019d*). The environmental baseline survey report associated with this survey work will be made available once the environmental analyses are completed and the report becomes available. The full survey reports will be presented in future environmental submissions for the Eagle development (i.e. within MAT/ SAT submissions).

The Offshore Energy Strategic Environmental Assessment 3 (OESEA3) gathers information from surveys carried out in UK waters to help inform licensing and leasing decisions by considering the environmental implications of the proposed plans and the potential activities which could result from their implementation (*DECC, 2016*). It provided baseline information for the environment in Regional Sea 1, which covers the CNS and NNS where the Eagle development is located.

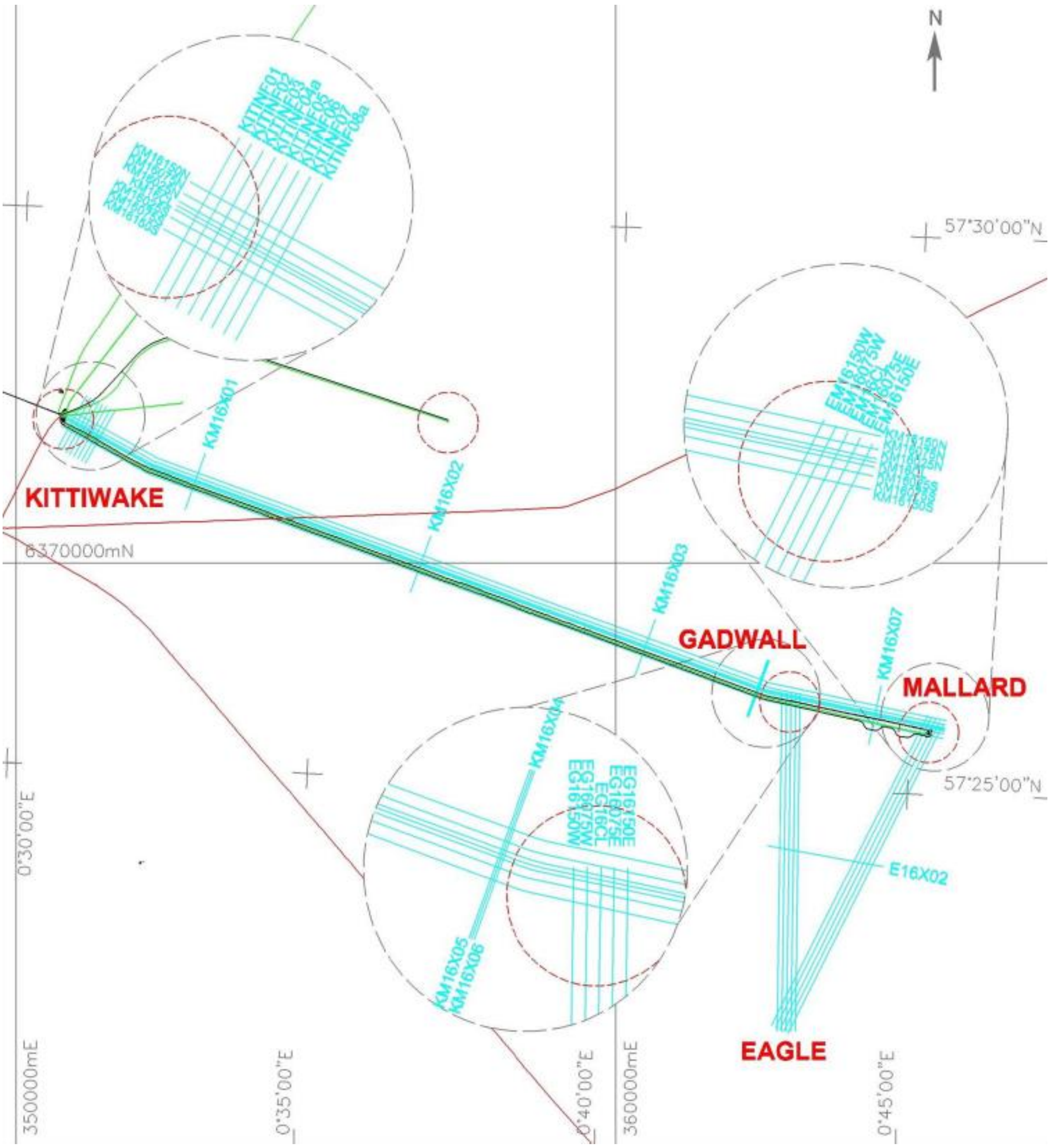

Figure 3.1: Geophysical pipeline route survey lines undertaken in 2016 (Fugro, 2016a)

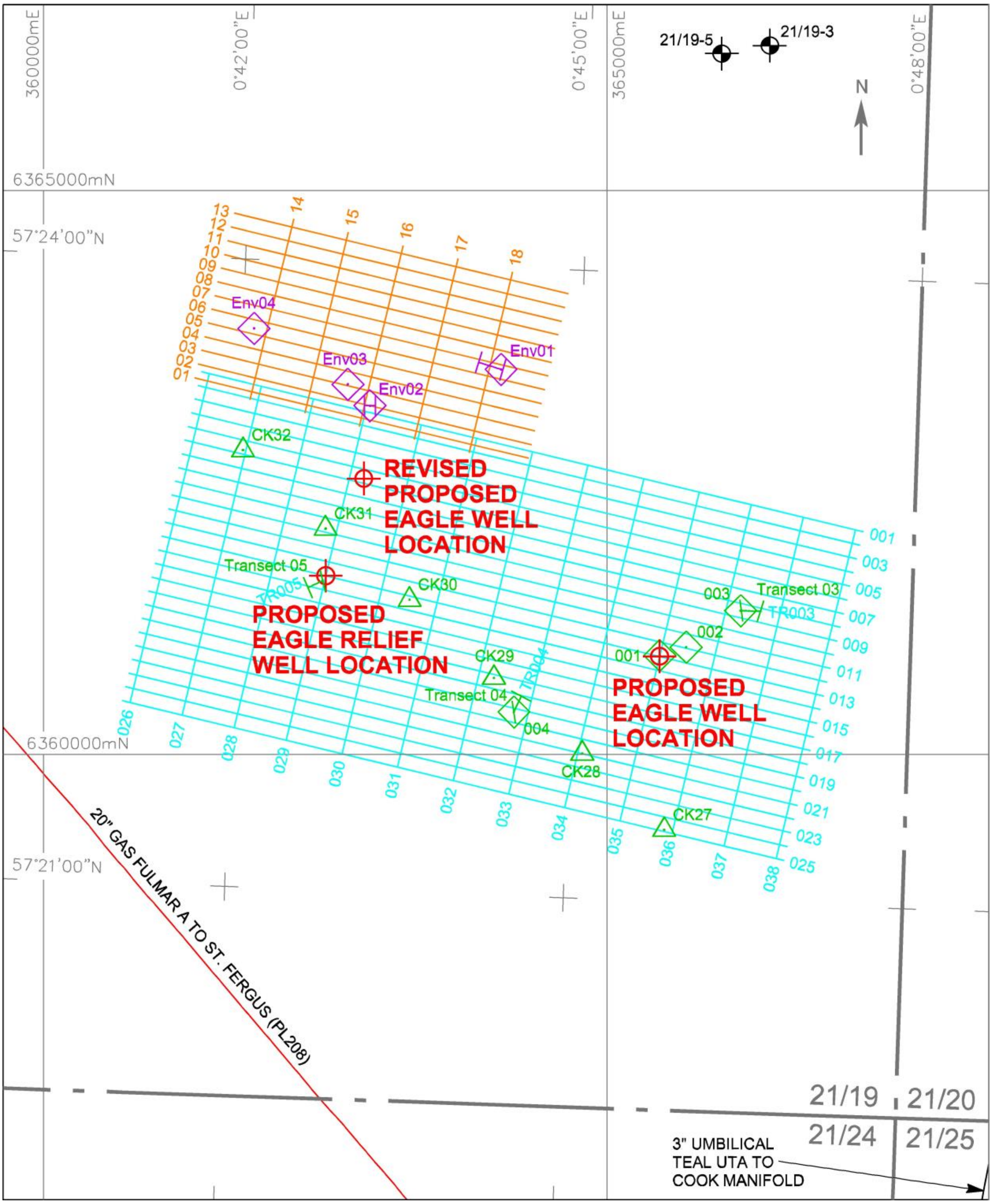

Figure 3.2: Rig site survey lines run in 2013 (blue) and 2014 (orange) using single and multibeam echo sounders, dual frequency side scan sonar, magnetometer and hull-mounted chirp and mini airgun at the Eagle well location [2013 environmental sampling stations and transects shown in pink, 2014 in green] (Fugro, 2014)

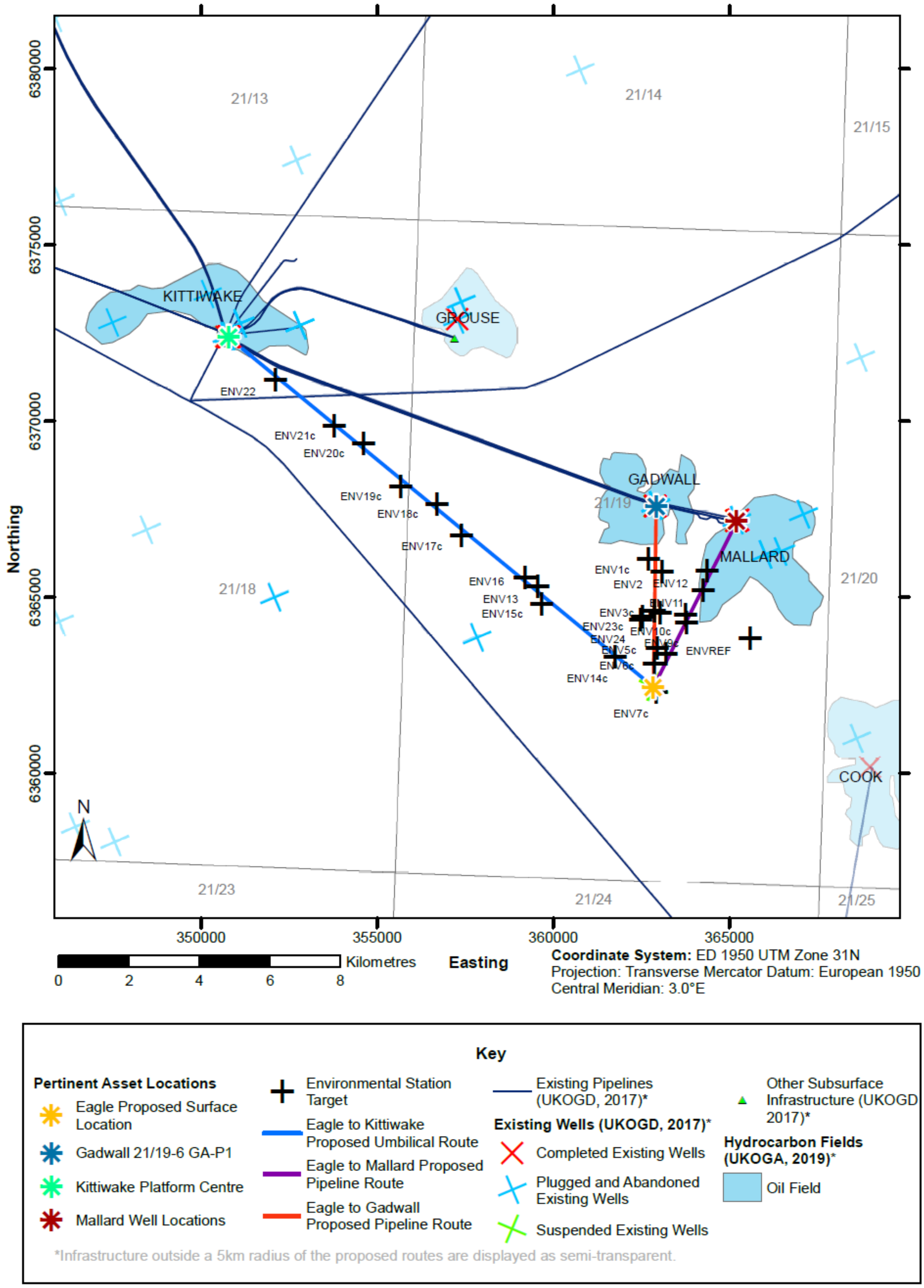

Figure 3.3: Pipeline route survey work undertaken in 2019, including as sampled environmental stations (Gardline, 2019d)

3.2 Physical Environment

3.2.1 Weather and Sea Conditions

The generalised pattern of water movement in the North Sea is forced by a combination of tides, wind patterns, density gradients (caused by freshwater input) and pressure gradients (*Howarth, 2001*, in: *DECC, 2016*). Waters may also be strongly influenced by short-medium term weather conditions, resulting in considerable seasonal and interannual variability.

The main inflow to the North Sea occurs along the western slopes of the Norwegian Trench, around Shetland and between Orkney and Shetland (*Winther & Johannessen, 2006*, in: *DECC, 2016*). Most of this water however recirculates around the northern and eastern North Sea and exits via the surface Norwegian Coastal Current back into the North Atlantic. Only a small percentage of Atlantic-origin inflow flows southwards along the coast of Scotland and England (*Howarth 2001*, in: *DECC, 2016*). In the vicinity of the Eagle development waters are influenced mainly by the Fair Isle/ Dooley current (*DECC, 2016*).

Maximum tidal rates in the region are 0.31 and 0.10 m per second for spring and neap tides respectively (Chart 2182C, Tidal diamond T: *Hydrographer of the Navy, 2009*).

Density stratification is well developed in the summer months of most years in the CNS, with the relative strength of the thermocline determined by solar heat input and turbulence generated by winds and tides (*DECC, 2016*). Average salinity levels of 35.0 and 34.9 are found at the sea surface and seabed, respectively in the vicinity of the Eagle development (*NMPi, 2019*).

Sea surface temperature and salinity values in the North Sea are to a large extent influenced by the flow of oceanic Atlantic waters into the North Sea through the Fair Isle Channel (*Turrell 1992*, in: *DECC, 2016*). Yearly sea temperatures at the proposed Eagle development range from 5°C to 14°C at the surface and from 6°C to 9°C at the seabed (*NMPi, 2019*).

The prevailing winds in the CNS 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 northern North Sea, are highly variable and there is a greater incidence of north-westerly winds (*DECC, 2016*). The predominant wind direction in the area is from the south-west and west, but winds tend to veer northwards during the summer in June and July, and to the south in August (*NOGAPS, 2015*).

The CNS to the east coast of Shetland, Orkney and the Scottish mainland is more sheltered and less frequently exposed to large, powerful waves than the west. However, North Sea storms and swells can result in relatively large wave heights. The wave climate in the North Sea is strongly seasonal with maximum mean wave heights peaking around January, although extreme waves may be encountered at other times, most notably between November and March (*DECC, 2016*). The annual mean significant wave height in the vicinity of the Eagle development is 2.19 m (*NMPi, 2019*).

3.2.2 Bathymetry and Seabed Conditions

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*). The CNS region has a depth ranging from around 80 to 100 m. The CNS contains a large area known as the Fladen Ground which is bounded by the 100-metre depth contour.

Across the North Sea, seabed sediments generally comprise a veneer of unconsolidated terrigenous and biogenic deposits, generally much less than 1 metre thick, although areas of outcropping rock occur in coastal waters around and between Shetland, Orkney and the Scottish mainland. Sediments in the CNS area are predominantly sand and muddy sand, although the deeper areas within the Fladen Ground (to the north of the Eagle development) consist of mud or sandy mud (*JNCC, 2010*; *DECC 2016*).

The EUSeaMap2 (2016) is a broad-scale predictive habitat map which covers the seabed in European waters. It is based on the European Nature Information System (EUNIS) and Marine Strategy Framework Directive (MSFD) habitat classification system. The predicted seabed type in the vicinity of the Eagle field development (Blocks 21/18 and 21/19) is A5.27 '*offshore circalittoral sand*' (*NMPi, 2019*).

2019 Survey Work

EnQuest commissioned survey work in 2019 in support of the Eagle development. The survey scope included the umbilical route corridor from the Eagle well to the Kittiwake platform, and revisiting areas identified as possible MDAC in the previous 2016 survey along the Eagle to Gadwall pipeline route. The survey included geophysical, geotechnical and environmental elements (refer to section 3.3.2 for details on the environmental survey). At the time of writing this ES, only the preliminary field reports were available plus the habitat assessment report (*Gardline, 2019a*; *2019b; 2019d*). Full details of the survey results will however be included in future environmental submissions (i.e. MAT/ SAT applications) when the full survey reports become available.

The Eagle to Kittiwake umbilical route survey covered 16.5 km x 0.44 km and consisted of 9 main survey lines totalling 15 km, and 25 cross-lines totalling 0.54 km. Along the Eagle to Gadwall route, 3 main survey lines totalling 4.9 km of shallow geophysical data were acquired (*Gardline, 2019a*).

Along the Eagle to Gadwall route, water depth along the proposed pipeline route centreline ranged from a minimum of 90.6 m LAT at the end of the route (at the Gadwall manifold) at KP4.398, to a maximum of 91.7 m LAT at KP1.516 (refer to alignment charts in Appendix A). The seabed was observed to be generally flat along the route, deepening slightly in the central part, and with observed seabed gradients of not more than 0.5° throughout the pipeline route (*Gardline, 2019a*).

Along the Eagle to Kittiwake route, water depth surrounding the Eagle well (at KP0.000) was observed to be 90.9 m LAT, with the seabed gently shoaling to 85.7 m LAT at the end of data coverage near the Kittiwake platform (refer to alignment charts in Appendix A). A route maximum water depth of 91.8 m LAT was recorded at KP0.500. Throughout the length of the umbilical route, the seabed generally shoals gently from south-east to north-west (Eagle to Kittiwake), with seabed gradients of less than 0.5° (*Gardline, 2019b*).

Along the Eagle to Gadwall route, the seabed sediments predominantly comprised of silty sand, confirmed by the geotechnical results (CPTs and vibro-cores). Significantly, areas of possible MDAC were present to the east of the proposed route near the Eagle well location. They appeared as small, irregular areas of increased reflectivity on sonar data and were investigated and confirmed during environmental camera operations. MDAC was also confirmed at station ENV23; no significant features were observed at this location on the bathymetry or sonar data, although a minor area of increased reflectivity was apparent. This area lies >50 m west of the proposed route. The existing Eagle well lies on a mound within a surrounding area of disturbed sediment and radiating anchor scars (*Gardline, 2019a*).

Along the Eagle to Kittiwake route, seabed sediments predominantly comprised silty sand, which was confirmed by the environmental samples and geotechnical results. No potential MDAC was observed along the route from Eagle to Kittiwake however, areas of possible MDAC are present within the route corridor to the south-east of the Eagle Well. They appear as small, irregular areas of increased reflectivity on sonar data and were investigated and confirmed during environmental camera operations (Station ENV7 – refer to alignment sheets in Appendix A) (*Gardline, 2019b*).

Four pipeline crossings are present along the proposed umbilical route (Table 3.1). Occasional objects were interpreted at the seabed within the umbilical route corridor, becoming more prevalent beyond KP4.5. This is due to the presence of Fisher Formation sediments just beneath the seabed veneer in this area; numerous boulders are expected within this formation. Occasional linear debris items, interpreted to represent lengths of cable, were found within the route corridor. One lies on the proposed route between KP10.825 and KP10.835. All interpreted contacts lying within 25 m of the proposed umbilical route are detailed in Table 3.2 (*Gardline, 2019b*).

Further information on the MDAC encountered is given in section 3.4.1.

Table 3.1: As-found pipeline crossings along the Eagle to Kittiwake umbilical route (Gardline, 2019b)

Name	Easting	Northing	KP	Status	Burial Depth
PL934 (Nelson to Fulmar receiver tee 10" gas)	352 835	6 370 680	12.955	Trenched and Buried	0.6 m
PL1458 (Kittiwake to Mallard 6" control umbilical)	351 061	6 372 146	15.259	Buried	*Outside survey data coverage*
PL1456 (Mallard to Kittiwake 16" Oil Bundle)	350 952	6 372 244	15.405	Trenched and Buried	
PL 1457 (Mallard to Kittiwake 8" water injection)	350 887	6 372 303	15.493	Trenched and Buried	

Table 3.2: Interpreted objects within 25 m of the proposed umbilical route centreline (Gardline, 2019b)

Description	Easting	Northing	Height/ Length	KP	Distance/ Direction
Linear debris	361 765	6 363 306	10 m long	1.376	21m SW
Object	**359 338**	**6 365 327**	**0.3m**	**4.534**	**3m SW**
Object	357 738	6 366 672	0.3m	6.624	20m NE
Object	357 397	6 366 903	0.7m	7.034	18m SW
Object	**357 256**	**6 367 047**	**0.4m**	**7.235**	**3n NE**
Object	**356 857**	**6 367 374**	**0.3m**	**7.75**	**2m NE**
Object	356 790	6 367 442	0.3m	7.845	13m NE
Object	356 598	6 367 603	0.4m	8.097	15m NE
Object	355 495	6 368 515	0.4m	9.527	18m NE
Object	**354 796**	**6 369 076**	**0.4m**	**10.424**	**8m NE**
Linear debris	354 552	6 369 283	34m long	10.743	12m NE
Linear debris	354 488	6 369 333	121m long	10.825	11m NE
Linear debris	354 480	6 369 326	37m long	10.826	0m
Linear debris	354 466	6 369 351	120m long	10.853	10m NE
Object	352 800	6 370 681	0.4m	12.985	21m SW

Note: Items in bold occur within 10 m of the route centreline

Particle Size Analysis

The results of the particle size analysis (PSA) determined using wet and dry sieving, are presented in Table 3.3. The PSA results generally supported observations of the recovered sediment samples and seabed imagery and confirmed the dominance of sand across all stations.

Mean particle size ranged from 249 µm at Station ENV14 to 350 µm at Station ENV20; both of which were stations situated along the Eagle to Kittiwake route. Station ENV14 was classified as fine sand according to the Wentworth classification (1922) whilst all remaining stations were classified as medium sand. The median and mode particle size was of a medium sand for all stations. This corresponded with the initial observations from the grab samples and from the SSS data. The sand fraction (≥63µm to <2mm) dominated the sediment composition at all stations and contributed between 93.1% at Station ENV2 along the Eagle to Gadwall route and 100.0% at Station ENV22 along the Eagle to Kittiwake route. This resulted in all stations across the survey area being classified as sand under the modified Folk classification (*Folk,1954*, In: *Gardline, 2019d*). Gravel (≥2mm) was not identified in any of the sediment samples acquired along the proposed routes.

Table 3.3: Particle size analysis from the sediment samples collected during the 2019 survey (Gardline, 2019d)

Station	Designation[1]	Mean Diameter (µm)	Mean Diameter (phi)	Fines %	Sand %	Gravel %	Wentworth Classification	Sorting[2]	Modified Folk Classification
Eagle to Gadwall Route									
ENV1g	186m W of KP3.592	294	1.76	3.1	96.9	0.0	Medium Sand	Moderately well	Sand
ENV2	205m E of KP3.257	277	1.85	6.9	93.1	0.0	Medium Sand	Moderate	Sand
ENV3g	33m W of KP2.151	256	1.96	5.0	95.0	0.0	Medium Sand	Moderately well	Sand
ENV6g	33m E of KP0.708	272	1.88	1.8	98.2	0.0	Medium Sand	Moderately well	Sand
ENV23g	362m W of KP1.942	264	1.92	3.2	96.8	0.0	Medium Sand	Moderately well	Sand
Eagle to Mallard Route									
ENV8g	90m WNW of KP0.968	289	1.79	2.8	97.2	0.0	Medium Sand	Moderately well	Sand
ENV9g	25m ESE of KP2.042	311	1.68	4.1	95.9	0.0	Medium Sand	Moderately well	Sand
ENV11	37m ESE of KP3.085	295	1.76	4.4	95.6	0.0	Medium Sand	Moderately well	Sand
ENV12	118m WNW of KP3.632	320	1.64	5.1	94.9	0.0	Medium Sand	Moderate	Sand
Eagle to Kittiwake Route									
ENV14g	1m SW of KP1.644	249	2.01	6.0	94.0	0.0	Fine Sand	Moderate	Sand
ENV15g	168m SW of KP4.209	272	1.88	3.2	96.8	0.0	Medium Sand	Moderately well	Sand
ENV17g	138m SW of KP7.206	316	1.66	3.5	96.5	0.0	Medium Sand	Moderately well	Sand
ENV19g	136m SW of KP9.433	332	1.59	3.5	96.5	0.0	Medium Sand	Moderately well	Sand
ENV20g	144m NE of KP11.026	350	1.52	2.1	97.9	0.0	Medium Sand	Moderately well	Sand
ENV21g	4m SW of KP11.976	329	1.61	3.9	96.1	0.0	Medium Sand	Moderately well	Sand
ENV22	85m SW of KP14.092	303	1.72	0.0	100.0	0.0	Medium Sand	Moderately well	Sand
Shared Targets									
ENVREF	2735m E of KP1.422EAG-GAD; 1843m ESE of KP2.471 EAG-MAL; 2990m ENE of KP0.000 EAG-KIT	342	1.55	3.9	96.1	0.0	Medium Sand	Moderately well	Sand
This Study	Minimum	249	1.52	0.0	93.1	0.0	Fine to Medium Sand	Moderate to Moderately well	Sand
	Maximum	350	2.01	6.9	100.0	0.0			
	Mean	298	1.75	3.7	96.3	0.0			
	+/- SD	31	0.15	1.6	1.6	0.0			

Notes: Sediments were not treated to remove carbonates prior to particle size analyses.

1. Designation is the distance and direction along the pertinent proposed pipeline route. EAG-GAD, EAG-MAL route coordinates derived from Fugro (2016a) chart alignment sheets and description in SOW (Intertek, 2019c). EAG-KIT route coordinates derived from description in SOW (Intertek, 2019d) and Gardline QPRO 067.

2. Sorting according to Folk and Ward (1957).

Previous Survey Work

The surveys referenced as previous survey work in this section (and in subsequent sections) comprise of the 2016 pipeline route surveys (Eagle to Gadwall, Eagle to Mallard and Kittiwake to Gadwall/ Mallard) conducted by Fugro (*Fugro, 2016a*; *2016b*; *2016c*), and the 2013 and 2014 rig site surveys at the Eagle well location conducted by Fugro (*Fugro, 2014*). The results of the environmental baseline survey are not yet available, therefore, reference is made here to these surveys to provide information on the physico chemical properties and particle size of the sediments in the area.

2016 Pipeline Route Survey

Hydrocarbons

Total hydrocarbon concentrations (THC) measured in the surface sediments during the 2016 pipeline route survey, which sampled 6 stations along a potential pipeline route from the Kittiwake platform to Mallard, ranged from 1.8 μgg^{-1} to 4.4 μgg^{-1} with a mean value of 2.8 μgg^{-1}. The individual station THC levels measured were below the average background concentration (using the same analytical GC technique) calculated from environmental survey data collected between 1975 and 1995 in the CNS area – 9.51 μgg^{-1} (*UKOOA, 2001* in: *Fugro, 2016c*). The North Sea Quality Status Report (*NSTF, 1993* in: *Fugro, 2016c*) suggests that typical THC levels (i.e. 'background') in sediments remote from anthropogenic activities range from 0.2 μgg^{-1} to 5 μgg^{-1}, although in some areas, values may be as high as 15 μgg^{-1} (*Fugro, 2016c*).

The total 2 to 6 ring PAH levels in the Kittiwake to Mallard route sediments ranged from 0.040 μgg^{-1} to 0.196 μgg^{-1} (mean 0.097 μgg^{-1}); lower than the background concentrations previously measured across the central North Sea (mean concentration 0.233 μgg^{-1}: *UKOOA, 2001* in: *Fugro, 2016c*) with individual PAH concentrations well below their respective OSPAR Effects Range-Low (ERL) values (*Fugro, 2016c*).

Heavy and Trace Metals

The distribution of hydrofluoric acid extractable metals from the 6 seabed samples (Table 3.4) indicated low inter-station variations ranging from 3% to 30% relative standard deviation (RSD). The exception was barium (RSD of 92%), with elevated barium levels (1,190 μgg^{-1}) noted at station STN01, which exceeded the mean total barium levels found greater than 5 km from an active platform in the CNS (348 μgg^{-1}). Given the proximity of station STN01 to the Kittiwake platform, the elevated barium level may be indicative of drilling mud deposition (*Fugro, 2016c*).

Comparison of the sediment mean OSPAR Coordinated Environmental Monitoring Programme (CEMP) metals concentrations against their relevant assessment criteria revealed that the mean concentrations of cadmium, lead and mercury were below their assigned ERL and mean background concentration for the CNS. When normalised to 5% aluminium, the mean concentrations of cadmium, lead and mercury were below their respective BC and BAC values.

Although not subject to the same level of monitoring under OSPAR, several other metals analysed have established BC values (arsenic, chromium, copper, nickel and zinc). All mean concentrations and 5% aluminium normalised mean concentrations were below their respective BC values. In addition to BC values, chromium, copper and zinc also had assigned ERLs which the 2016 survey mean concentrations fell below.

Particle Size Analysis

Sediments at stations STN01, STN04, STN05 and STN06 were classified as slightly gravelly sand with station STN03 classified as gravelly sand according to the Folk (1954) classification. The mean particle diameter values ranged from 209 µm to 270 µm (mean 236 µm). Sediments at all stations were dominated by the sand fraction (63 µm to 2 mm diameter) with proportions ranging from 85.0% (station STN03) to 92.3% (station STN05). Station STN03 had a higher percentage of gravel than the other stations (7.4% compared to a mean of 2.2%) and station STN06 had the highest percentage of mud (9.0% compared to a mean of 7.9%) (*Fugro, 2016c*).

Table 3.4: Summary of sediment metal concentrations from the Eagle to Mallard site survey (Fugro 2016c)

Station	Concentrations expressed as µg.g^{-1} dry sediment											
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Ni	Pb	V	Zn
STN01	20,200	4.57	1,190	0.071	15.1	2.63	7,610	0.00242	4.08	11.8	20.1	19.6
STN02	20,100	5.37	253	0.050	14.6	2.30	6,960	0.00188	4.23	8.39	18.1	13.6
STN03	19,000	3.15	250	0.047	12.8	2.25	4,790	0.00233	3.73	8.55	14.6	10.9
STN04	19,500	4.54	289	0.041	17.7	1.92	5,880	0.00302	4.51	9.65	17.7	10.5
STN05	19,400	3.74	269	0.045	14.8	2.05	5,260	0.00214	3.89	8.05	14.7	10.7
Min.	19,000	3.15	250	0.041	12.8	1.92	4,790	0.00188	3.73	8.05	14.6	10.5
Mean	19,600	4.27	450	0.051	15.0	2.23	6,100	0.00236	4.09	9.29	17.0	13.1
Max.	20,200	5.37	1,190	0.071	17.7	2.63	7,610	0.00302	4.51	11.8	20.1	19.6
SD	503	0.85	414	0.012	1.76	0.27	1,170	0.00040	0.30	1.53	2.36	3.87
RSD	3	20	92	24	12	12	19	17	7	16	14	30
Gadwall Comparison Survey (*Fugro EMU, 2014* in: *Fugro, 2016c*)												
Min.	17,600	3.0	258	<0.1	18.2	4.0	6,430	<0.01	4.4	8.1	35.7	10.8
Mean	18,017	3.6	344	-	19.7	5.5	6,845	-	4.8	9.0	37.7	12.4
Max.	18,500	4.1	744	0.1	22.7	6.9	7,360	0.01	5.3	9.3	38.8	15.4
Central North Sea (*UKOOA, 2001* in: *Fugro, 2016c*)												
Mean	-	-	348	0.8	23.9	6.3	7,334	0.17	11.5	12.6	-	21.3
95th %	-	-	720	1	54	18	11,960	0.58	21.7	26.8	-	43.4
Colour key:	< UKOOA Mean background concentration				> UKOOA Mean background concentration				> UKOOA 95th Percentile			

2013 and 2014 Rig Site Survey

Rig site surveys were conducted in 2013 by Centrica and in 2014 by EnQuest. The results of the 2014 survey were reported by Fugro in 2014 with reference also made to the previous surveys conducted in 2013 (*Fugro, 2014a*; *2014b*; *2014c*). Figure 3.4 below shows the location of the environmental grab sampling and drop-down camera work undertaken during these rig surveys. Note that 'revised proposed Eagle well location' represents the location closest to the as-built Eagle discovery well.

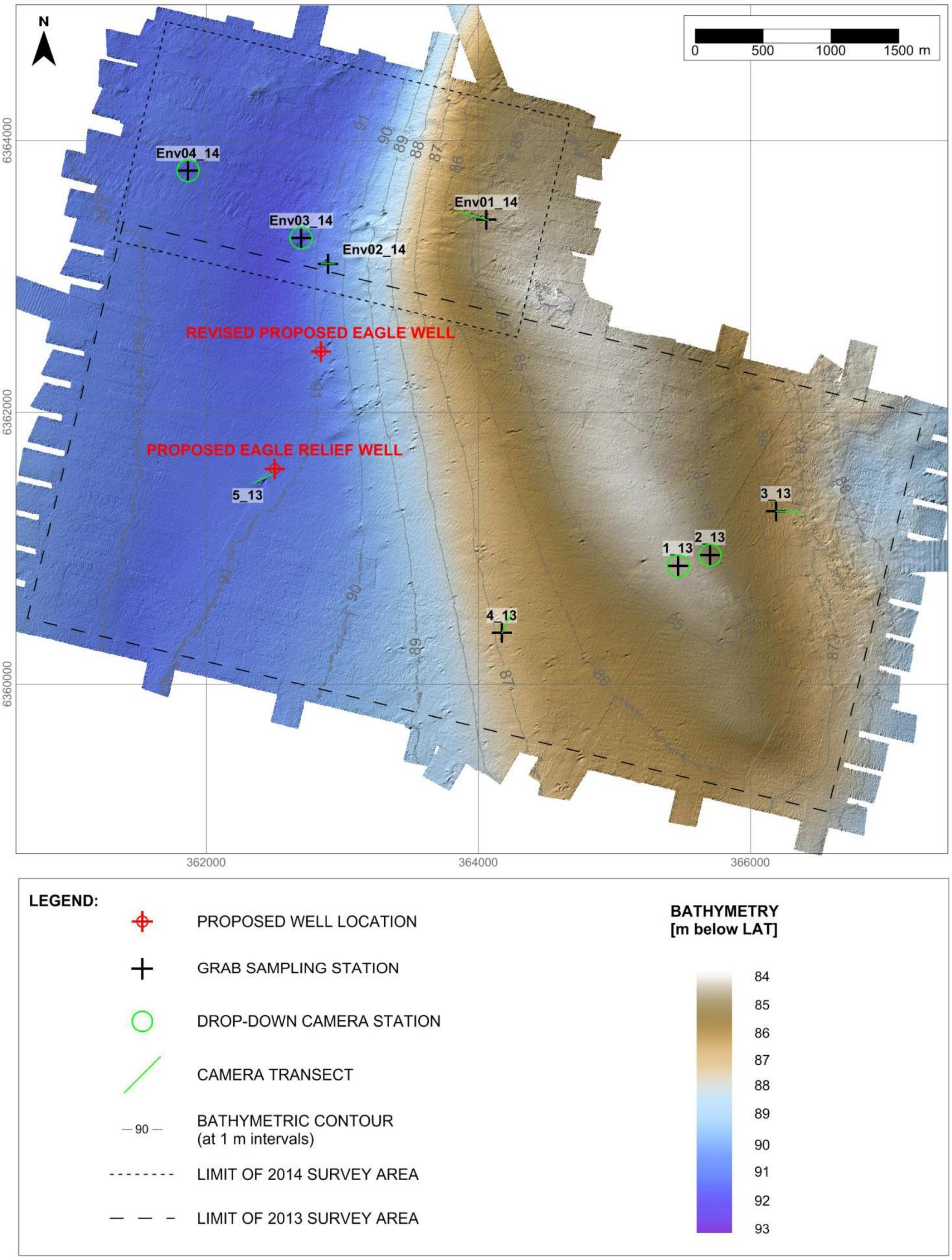

Figure 3.4: General bathymetry and environmental sampling locations acquired during 2014 rig site survey (Fugro, 2014a)

Hydrocarbons

A summary of the hydrocarbon concentrations found across the Eagle rig site survey area in 2013 and 2014, as well as comparison survey datasets, is provided in Table 3.5. Total hydrocarbon (THC) concentrations across the survey area in both years were low compared to the UKOOA mean concentration (9.5 $\mu g.g^{-1}$) for the CNS, with concentrations ranging from 1.0 $\mu g.g^{-1}$ (Stations 1_13 and 2_13) to 1.7 $\mu g.g^{-1}$ (Station 4_13) in 2013 and 1.0 $\mu g.g^{-1}$ (Station ENV01_14) to 2.4 $\mu g.g^{-1}$ (Station ENV04_14) in 2014. Unresolved complex mixture (UCM), a mixture of complex non-linear hydrocarbons (e.g. naphthenic and naphtheno-aromatic compounds) that cannot be resolved by GC-FID analysis, makes up a proportion of the THC. UCM concentrations ranged from 0.7 $\mu g.g^{-1}$ (Stations 1_13 and 2_13) to 1.2 $\mu g.g^{-1}$ (Station 3_13) in 2013 and in 2014, 0.6 $\mu g.g^{-1}$ (Station ENV01_14) to 1.4 $\mu g.g^{-1}$ (Station ENV04_14). This corresponds to 70% (Stations 1_13 and 2_13) to 73% (Station 4_13) of the THC in 2013 and 58% (Station ENV04_14) to 63% (Station ENV03_14) of the THC in 2014. THC and UCM concentrations were observed to correlate with depth ($P<0.05$) (*Fugro, 2014c*).

Mean THC and UCM concentrations (1.3 $\mu g.g^{-1}$ and 0.9 $\mu g.g^{-1}$ in 2013 and 1.7 $\mu g.g^{-1}$ and 1.0 $\mu g.g^{-1}$ in 2014, respectively) were found to be similar to the mean concentrations recorded at the comparison surveys, with Gadwall and Crathes means recorded as 1.7 $\mu g.g^{-1}$ and 1.0 $\mu g.g^{-1}$, and the Goosander and Whitethroat surveys means of 1.6 $\mu g.g^{-1}$ and 1.1 $\mu g.g^{-1}$ (*Fugro, 2014c*).

PAH concentrations were found to be slightly lower in 2013 (mean of 28 $ng.g^{-1}$) than the mean concentrations recorded during either the Goosander and Whitethroat (2010) surveys (mean of 35 $ng.g^{-1}$) or the Crathes (2012) survey (mean of 37 $ng.g^{-1}$). In the 2014 survey, total PAH concentration was on average 46 $ng.g^{-1}$, similar to that of the Gadwall comparison dataset (*Fugro, 2014c*).

Heavy and Trace Metals

Heavy and trace metal data are displayed in Table 3.6, alongside comparison data and the UKOOA (2001) mean concentrations and 95th percentile concentrations for the CNS, as well as NOAA ERL values.

Mean concentrations of the majority of metals were found to be similar to the comparable data and lower than the mean UKOOA background concentrations for the CNS. Concentrations of copper, lead and iron were found to be slightly elevated above the mean UKOOA background concentrations. Concentrations of iron were found to be elevated above the 95th percentile of background concentrations at two 2013 stations and one 2014 station. The higher concentrations of copper, iron and lead were at similar levels to those recorded during comparison surveys, suggesting that these levels may be associated with the local geochemistry or reflect widespread regional scale contamination (*Rees, et al., 2007*, in: *Fugro, 2014c*).

Particle Size Analysis

The mean sediment type was described as 'fine sand' across all the sites with the mean grain size ranging from 0.35 Phi (Station 1_13) to 2.33 Phi (Station 4_13) in 2013, and 2.19 Phi (Station ENV01_14) and 2.77 Phi (Station ENV04_14) in 2014. Sediments at all stations were dominated by sand fractions (63 µm to 2 mm diameter or 4.0 to -1.0 Phi) with proportions ranging from 71.39% (Station 1_13) to 92.57% (Station 3_13) in 2013, and 88.00% (Station ENV03_14) and 90.40% (Station ENV01_14) in 2014. Very low levels of coarse material (>2 mm or > -1.0 Phi) were found at three of the 2013 stations and all of the 2014 stations (ranging from 0.00% to 0.33%) (*Fugro, 2014c*).

Table 3.5: Summary of THC hydrocarbon analysis results from the 2013 and 2014 Eagle rig site surveys, with comparison data from the wider region (Fugro, 2014c)

Station	THC	n-alkanes (nC_{12-36})	UCM	CPI Ratio			Pristane	Phytane
				nC_{12-20}	nC_{21-36}	nC_{12-36}		
2013 Eagle Data								
1_13**	1.0	0.04*	0.7	0.92*	2.59*	1.61*	0.007	<0.001
2_13	1.0	0.03*	0.7	0.98*	3.01*	1.86*	0.005	0.001
3_13	1.7	0.08*	1.2	0.83*	2.84*	1.72*	0.013	0.001
4_13	1.5	0.05*	1.1	0.95*	2.58*	1.69*	0.008	0.001
Min.	1.0	0.03*	0.7	0.83*	2.58*	1.61*	0.005	<0.001
Mean	1.3	0.05*	0.9	0.92*	2.76*	1.72*	0.008	-
Max.	1.7	0.08*	1.2	0.98*	3.01*	1.86*	0.013	0.001
SD	0.4	0.02*	0.3	0.06*	0.21*	0.10*	0.003	-
2014 Eagle Data								
Env01_14	1.0	0.11	0.6	1.58	2.22	2.14	0.006	0.001
Env02_14	1.3	0.13	0.8	1.36	2.42	2.25	0.011	0.001
Env03_14	1.9	0.17	1.2	1.43	2.71	2.47	0.026	0.001
Env04_14	2.4	0.23	1.4	1.47	2.58	2.41	0.015	0.001
Min	1.0	0.11	0.6	1.36	2.22	2.14	0.006	0.001
Mean	1.7	0.16	1.0	1.46	2.48	2.32	0.014	0.001
Max	2.4	0.23	1.4	1.58	2.71	2.47	0.026	0.001
SD	0.6	0.05	0.4	0.09	0.21	0.15	0.009	0.000
Comparison Data – Gadwall (2014)								
Min	1.3	0.13	0.8	1.27	2.21	2.10	0.008	0.001
Mean	1.7	0.16	1.1	1.44	2.30	2.18	0.012	0.001
Max	2.2	0.20	1.5	1.90	2.43	2.29	0.018	0.002
SD	0.3	0.03	0.3	0.24	0.09	0.08	0.004	0.001
Comparison Data – Crathes (2012)								
Min	1.3	0.09	0.8	1.44	3.16	2.91	0.006	0.001
Mean	1.7	0.12	1.1	1.57	3.80	3.40	0.010	0.001
Max	2.1	0.14	1.4	1.77	4.25	3.77	0.013	0.001
SD	0.3	0.01	0.2	0.10	0.38	0.29	0.003	0.000
Comparison Data – Goosander & Whitethroat (2010)								
Min	0.8	0.07	0.6	0.92	1.07	1.06	0.002	0.000
Mean	1.6	0.24	1.0	1.31	2.47	2.24	0.007	0.002
Max	3.8	1.47	1.8	1.83	3.61	3.22	0.015	0.008
SD	0.8	0.38	0.4	0.26	0.78	0.64	0.003	0.002
UKOOA (2001) – Central North Sea								
Mean	9.51	0.40	-	-	-	2.04***	-	-
95th %	40.10	1.18	-	-	-		-	-

Note: * = The Eagle n-alkanes values were recorded in the range of nC_{10-35} rather than nC_{12-36}, therefore, are not directly comparable to the other datasets. ** = Volume of grab sample at Station 1_13 was 25%. : *** = CPI values *below* the UKOOA (2001) may indicate more petrogenic derived hydrocarbons.

Table 3.6: Sediment metal concentrations results from the 2013 and 2014 Eagle rig site surveys, with comparison data from the wider region (Fugro, 2014c)

Station	Concentrations expressed as $\mu g g^{-1}$ dry sediment											
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Ni	Pb	V	Zn
2013 Eagle stations												
1_13*	18500	5.0	290	<0.1	15.7	10.4	12800	<0.01	4.1	10.4	27.8	15.3
2_13	18800	4.7	281	<0.1	13.8	8.6	11300	<0.01	3.8	9.8	26.2	13.4
3_13	20000	4.9	298	<0.1	15.8	8.7	14200	<0.01	4.6	9.9	27.5	16.0
4_13	19100	3.9	303	<0.1	13.7	7.1	9760	<0.01	4.1	9.1	24.8	11.7
Min	18500	3.9	281	<0.1	13.7	7.1	9760	<0.01	3.8	9.1	24.8	11.7
Mean	19100	4.6	293	-	14.8	8.7	12015	<0.01	4.2	9.8	26.6	14.1
Max	20000	5.0	303	0.0	15.8	10.4	14200	<0.01	4.6	10.4	27.8	16.0
SD	648	0.5	10	-	1.2	1.3	1914	0.00	0.3	0.5	1.4	1.9
2014 Eagle stations												
Env01_14	16100	3.2	222	0.1	19.0	7.6	7550	0.01	4.7	15.2	40.0	16.7
Env02_14	17400	3.2	281	0.2	19.0	38.7	6120	<0.01	4.9	11.8	37.5	15.0
Env03_14	17600	2.9	259	0.1	19.8	6.4	26250	0.02	4.9	21.6	36.7	18.1
Env04_14	18000	3.3	262	<0.1	24.0	6.1	6390	0.01	6.0	9.0	37.3	15.8
Min	16100	2.9	222	<0.1	19.0	6.1	6120	<0.01	4.7	9.0	36.7	15.0
Mean	17275	3.2	256	-	20.5	14.7	11578	-	5.1	14.4	37.9	16.4
Max	18000	3.3	281	0.2	24.0	38.7	26250	0.02	6.0	21.6	40.0	18.1
SD	822	0.2	25	-	2.4	16.0	9801	-	0.6	5.4	1.5	1.3
Comparison Data – Gadwall (2014)												
Min	17600	3.0	258	<0.1	18.2	4.0	6430	<0.01	4.4	8.1	35.7	10.8
Mean	18017	3.6	344	-	19.7	5.5	6845	-	4.8	9.0	37.7	12.4
Max	18500	4.1	744	0.1	22.7	6.9	7360	0.01	5.3	9.3	38.8	15.4
SD	337	0.4	196	-	1.7	1.0	369	-	0.4	0.4	1.1	1.7
Comparison Data - Crathes (2012)												
Min	15600	2.4	217	<0.1	13.9	4.1	5400	<0.01	3.5	6.4	23.5	14.1
Mean	16080	3.6	225	-	15.3	7.6	6211	-	4.3	6.8	26.7	15.6
Max	16900	4.2	234	0.1	17.5	13.1	7440	0.02	5.3	7.9	30.5	18.0
SD	361	0.5	5	-	1.1	3.1	601	-	0.7	0.5	1.8	1.3
Comparison Data – Goosander & Whitethroat (2010)												
Min	12700	5.4	194	0.02	8.5	6.3	6670	<0.01	3.2	9.2	17.2	14.5
Mean	14926	15.5	221	0.03	12.6	8.8	9862	-	4.1	12.6	22.9	19.5
Max	18500	45.1	246	0.05	27.9	11.4	15500	0.020	6.7	17.6	35.0	26.7
SD	1593	11.1	17	0.01	5.1	1.7	2256	-	0.9	2.8	5.0	3.4
UKOOA (2001) – Central North Sea												

Station	Concentrations expressed as $\mu g g^{-1}$ dry sediment											
	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Ni	Pb	V	Zn
Mean	-	-	348	0.8	23.9	6.3	7334	0.17	11.5	12.6	-	21.3
95th %	-	-	720	1.0	54.0	18.0	11960	0.58	21.7	26.8	-	43.4
NOAA Effects Range Low - (Buchman, 2008)												
ERL	-	8.2	-	1.2	81.0	34.0	-	0.15	20.9	46.7	-	150.0

Note: * = Volume of grab sample at Station 1_13 was 25%.

3.3 Biological Environment

3.3.1 Plankton

Plankton consists of the plants (phytoplankton) and animals (zooplankton) which live freely in the water column and drift with the water currents. Plankton forms the basis of marine ecosystem food webs and the composition of planktonic communities is variable temporally, depending upon the circulation patterns of water masses, the season and nutrient availability.

The distribution and abundance of plankton is heavily influenced by water depth, tidal mixing and thermal stratification within the water column (*Edwards et al., 2010*). The majority of the plankton occurs in the photic zone, i.e. the upper 20 m or so of the sea in temperate latitudes, which receives enough light for photosynthesis to take place (*Johns & Reid, 2001*). However, zooplankton can extend to greater depths and many species undergo diurnal vertical migrations, rising to feed before returning to depth. Natural seasonality and high small-scale variability, both in species composition and abundance, is an important feature of planktonic communities. Plankton forms a fundamental link in the food chain. They are vulnerable to discharges to the sea and accidental chemical or hydrocarbon spills.

In the CNS, phytoplankton production increases during spring between mid-March and mid-April, reaching a peak or 'bloom' in May, often followed by a smaller peak in autumn. Productivity is determined by a combination of seasonal changes in light penetration and a cycle of nutrient introduction into the water column through mixing and turbulence caused by winds in the autumn and winter, followed by nutrient depletion as phytoplankton blooms (*DECC, 2016*). These blooms are important in sustaining a period of elevated biological productivity throughout marine food chains during the spring months and also to a lesser extent during the autumn.

Plankton species of interest found in the vicinity of the proposed Eagle development are typically temperate shelf sea species and are indicative of the presence of relatively unmixed Atlantic water due to the influence of the North Atlantic Drift (*BODC, 1998*).

Scottish Continental Shelf waters are influenced by the warm waters of the continental shelf current and the currents entering the North Sea from the northeast Atlantic and the Norwegian Sea. The phytoplankton community is dominated by the dinoflagellate genus *Ceratium* (mainly *C. fusus*, *C. furca* and *C. tripos*), with diatoms such as *Thalassiosira* spp. and *Chaetoceros* spp. also abundant. The zooplankton communities of the Scottish continental shelf region are dominated in terms of biomass and productivity by calanoid copepods; particularly *Calanus* spp. (*finmarchicus* and *helgolandicus*), *Paracalanus* spp. and *Pseudocalanus* spp. Meroplanktonic echinoderm larvae and decapod larvae are also abundant (*DTI, 2001*). The planktonic assemblage in the area of the proposed Eagle development is not considered unusual.

Seasonal, inter-annual and decadal natural changes in benthic habitats, community structure and individual species population dynamics may result from physical environmental influences (e.g. episodic storm events; hydroclimatic variability, climate change) and/or ecological influences (e.g. reproductive cycles, larval settlement, predation, parasitism and disease). Long-term changes in benthos composition have been linked to natural (e.g. hydrodynamic factors) and anthropogenic impacts (e.g. fishing, eutrophication), and analysis of North Sea benthos indicates an increase in biomass and opportunistic short-lived species, and a reduction in long-lived sessile organisms (*DECC, 2009*).

Evidence on the effects of hydrocarbon pollution on plankton is limited and conflicting with responses to pollution varying depending on species, season and the type and volume of hydrocarbons spilt. While some studies have found oil to be lethal and decrease photosynthesis in phytoplankton, other sources have found low concentrations of hydrocarbon spills can stimulate phytoplankton growth (*Sloan, 1999*).

3.3.2 Benthos

The benthos describes the organisms that live in and on the seabed. 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 hydrodynamics and degree of organic enrichment (*DECC, 2016*).

Activities that result in physical or chemical disruption of the seabed such as the deposition of discharged drill cuttings can affect the fauna. Surveys of the North Sea show that the benthic fauna is characterised by thermal stability over time, water depth and seabed granulometry *(DTI SEA-2, 2001*).

Existing surveys have shown that benthic faunal diversity within the North Sea tends to increase northwards, mainly associated with changes in water depth and productivity (*DECC, 2009*). The northern North Sea is noted to generally have higher benthic diversities than central or southern North Sea areas (*DECC, 2016*), as the presence of sponges and finer sediment in the area allows for more subsurface species such as molluscs and worms (*DTI SEA-2, 2001*).

2019 Survey Work

The GKA scope of work required investigation of three locations along each of the pipeline route options (Eagle to Gadwall, and Eagle to Mallard) to target potential areas of MDAC structures identified in the previous survey data (*Fugro, 2016a*; *2016b*; *2016c*). Approximately six stations were to be selected along each of the route corridors between Eagle to Gadwall and Eagle to Mallard for sediment sampling with a minimum of three grab samples at each station. Consequently, six stations (ENV1 to ENV6) were situated along the Eagle to Gadwall route, generally targeting potential pockmarks whilst incorporating the three locations identified in the previous 2016 survey data. Station ENV7 targeted an area of potential pockmarks where both the Eagle to Gadwall and Eagle to Mallard routes converged. Five stations (ENV8 to ENV12) were situated along the Eagle to Mallard route to target potential pockmarks and areas of higher reflectivity as detailed in Table 3.7. Figure 3.3 shows the as-sampled environmental stations.

The Eagle to Kittiwake scope of work required approximately ten stations to be selected along the proposed umbilical route with a minimum of three grab samples acquired at each sampling station. Ten stations (ENV13 to ENV22) were selected along the proposed umbilical route targeting features of interest (*Gardline, 2019c*).

There was also a single station required to act as a reference station, which was positioned approximately 1 km outside of the perimeter of the survey coverage of the routes in a direction perpendicular to the prevailing currents. Accordingly, this reference station (ENVREF) was situated away from all planned routes to the north-east of the Eagle well location. Further to the required scopes of work, additional stations (ENV23 and ENV24) were selected by the on-board EnQuest representative to target areas of potential MDAC observed on the geophysical data (*Gardline, 2019c*).

Overall, a total of 25 stations were selected using a drop-down camera to cover a single spot location with additional transects planned at Stations ENV3, ENV4 and ENV7 to investigate more than one feature of interest in a single deployment. The additional transects were predominantly focused on confirming the presence of MDAC, as well as investigating the predominant sediment type surrounding these features. At each of the 17 successful sampling stations, four suitable grab samples were acquired. One sample was acquired for sub-sampling for physico-chemical analyses and the remaining three were obtained for macrofaunal analysis (*Gardline, 2019c*). Across the 17 sampling stations, a total of 68 grab samples were obtained and all were within 10 m of their targets (*Fugro, 2019d*).

Where the station target was associated with a potentially unsamplable feature of interest (i.e. hard substrate, or potential Annex 1 feature), a secondary grab target was specified at an appropriate offset and the station names adjusted with the following suffixes: 'c', 'g' and 'TR'. The suffix 'c' denoted the camera target e.g. ENV1c, whilst the suffix 'g' denoted the grab target e.g. ENV1g. Where the original station target did not require offsetting for the grab sample, no suffix was required. The suffix 'TR' was used for the additional transects at Stations ENV3, ENV4 and ENV7. Details of the targets including their reason for selection, relative location and the anticipated preliminary findings at these stations are presented in Table 3.7. Due to operational constraints and deteriorating weather conditions, not all stations achieved environmental grab sampling. In addition, the Eagle to Gadwall route survey was widened to allow the pipeline to be routed around the observed MDAC features, with the additional stations (stations ENV23 and ENV24) targeting potential MDAC features (*Gardline, 2019c*).

Areas of higher reflectivity were generally due to an increase in shell debris within the sediment. The presence of sea pens (*Pennatulacea*; Figure 3.5) was observed at the majority of stations investigated along the routes.

Along the Kittiwake to Eagle route, the features of interest were predominantly drop boulders (Figure 3.6) or of anthropogenic origin, with a scoured depression round a glacial drop boulder and/or discarded fishing gear giving the feature low resemblance to MDAC filled pockmarks (*Gardline, 2019c*). Further detail on the MDAC encountered during the 2019 survey activities is provided in section 3.4.1.

All sampling stations, including grab samples and drop-down camera transects for the Eagle to Gadwall and Eagle to Kittiwake route surveys can be viewed on the alignment charts provided in Appendix A.

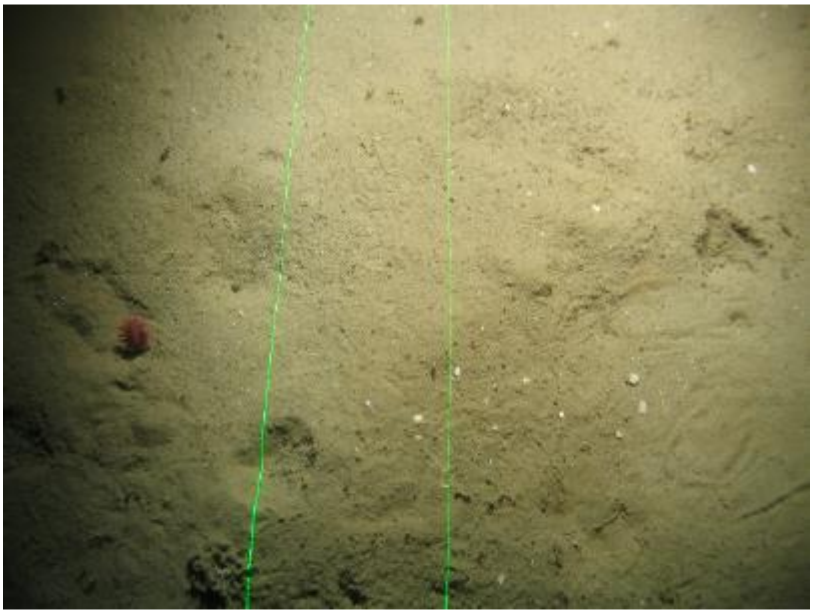

Figure 3.5: Sandy sediment with the sea pen Pennatulacea observed at station ENV3 [Eagle to Gadwall route] (Gardline, 2019c)

Figure 3.6: Boulder with sandy sediment and shell fragments observed at station ENV20 [Eagle to Kittiwake route] (Gardline, 2019c)

Table 3.7: Summary of 2019 survey sampling/ camera stations (note: positions are given in UTM, Zone 31 3°E) (Gardline, 2019c)

	Target ID	Description	Type	Intended sampling	Start Easting	Start Northing	End Easting	End Northing	Sediment and Features Description	Fauna Description	Completed sampling
Infill – Eagle to Gadwall	ENV1c	Isolated depression with contact	Station	Camera	362 709	6 366 072	-	-	Medium sandy sediment with occasional shell fragments, surrounding a boulder.	Arthropoda (Paguroidea), Cnidaria (Pennatulacea, Hydrozoa). Bioturbation.	Camera
	ENV1g			Grabs	362 708	6 366 042	-	-			Grabs
	ENV2	Higher reflectivity area	Station	Camera, grabs	363 094	6 365 701	-	-	Medium sandy sediment with more numerous shell fragments.	Arthropoda (Paguroidea), Chordata (Pleuronectiformes), Cnidaria (*Pennatulacea, Hydrozoa*). Bioturbation	Camera, grabs
	ENV3c	Potential pockmark	Station	Possible camera	362 876	6 364 616	-	-	Medium sandy sediment with occasional shell fragment surrounding depression filled with numerous shells surrounding MDAC outcrop.	Arthropoda (Caridea, Decopoda, Munididae, Paguroidea), Chordata (Actinopterygii, *Pollachius virens*), Cnidaria (Actiniaria, Hydrozoa, Pennatulacea), Porifera. Bacterial mats, Bioturbation.	-
	ENV3g			Grabs	362 840	6 364 599	-	-			Grabs
	ENV3TRa	Potential Pockmarks	Video Transect	Camera	362 813	6 364 644	362 898	6 364 608			Camera
	EMV3TRb	Potential Pockmarks	Video Transect	Camera	362 881	6 364 642	362 852	6 364 550			-
	ENV4TR	Potential Pockmarks	Video Transect	Camera	362 990	6 364 542	363 059	6 364 570	Medium sandy sediment with occasional shell fragment surrounding depression filled with numerous shells surrounding MDAC outcrop.	Arthropoda (Decopoda, Munididae, Paguroidea), Chordata (Actinopterygii, *Pollachius virens*), Cnidaria (Actiniaria, Hydrozoa, Pennatulacea), Porifera. Bacterial mats, Bioturbation.	Camera
	ENV5c	Potential Pockmark	Station	Camera	362 939	6 363 547	-	-	Medium sandy sediment with occasional shell fragment surrounding depression filled with numerous shells surrounding MDAC outcrop.	Arthropoda (Decopoda, Munididae, Paguroidea), Chordata (Actinopterygii, *Pollachius virens*), Cnidaria (Actiniaria, Hydrozoa, Pennatulacea), Porifera. Bacterial mats, Bioturbation.	Camera
	ENV5g			Grabs	362 939	6 363 517	-	-			-
	ENV6c	Potential Pockmark	Station	Camera	362 885	6 363 122	-	-	Medium sandy sediment with occasional shell fragments surrounding depression filled with numerous shells surrounding MDAC outcrop.	Arthropoda (Decopoda, Munididae, Paguroidea), Chordata (Actinopterygii, *Pollachius virens*), Cnidaria (Actiniaria, Hydrozoa, Pennatulacea), Porifera. Bacterial mats, Bioturbation.	Camera
	ENV6g			Grabs	362 884	6 363 155	-	-			Grabs
Infill – Eagle Site	ENV7c	Potential Pockmark	Station	Possible camera	362 922	6 362 304	-	-	Medium sandy sediment with occasional shell fragments surrounding depression filled with numerous shells surrounding MDAC outcrop.	Arthropoda (Caridea, Decopoda, Munididae, Paguroidea), Chordata (Actinopterygii, *Pollachius virens*), Cnidaria (Actinaria, Hydrozoa, Pennatulacea), Porifera. Bacterial mats, Bioturbation.	Camera
	ENV7g			Grabs	362 901	6 362 305	-	-			-
	ENV7TR	Potential Pockmark	Transect	Camera	362 915	6 362 246	362 930	6 362 361			-
In fill	ENV8c	Potential Pockmark	Station	Camera	363 195	6 363 384	-	-	Medium sandy sediment with occasional shell fragments	Arthropoda (Decopoda, Munididae, Paguroidea), Chordata	Camera
	ENV8g			Grabs	363 195	6 363 354	-	-			Grabs

	Target ID	Description	Type	Intended sampling	Start Easting	Start Northing	End Easting	End Northing	Sediment and Features Description	Fauna Description	Completed sampling
									surrounding depression filled with numerous shells surrounding MDAC outcrop.	(Actinopterygii, *Pollachius virens*), Cnidaria (Actiniaria, Hydrozoa, Pennatulacea), Porifera. Bacterial mats, Bioturbation.	
	ENV9c	Potential Pockmark	Station	Camera	363 780	6 364 291	-	-	Medium sandy sediment with occasional shell fragments surrounding depression filled with numerous shells surrounding MDAC outcrop.	Arthropoda (Decopoda, Munididae, Paguroidea), Chordata (Actinopterygii, *Pollachius virens*), Cnidaria (Actinaria, Hydrozoa, Pennatulacea), Porifera. Bacterial mats, Bioturbation.	Camera
	ENV9g			Grabs	363 780	6 364 261	-	-			Grabs
	ENV10c	Potential Pockmark	Station	Camera	363 755	6 364 505	-	-	Medium sandy sediment with occasional shell fragments surrounding depression filled with numerous shells surrounding MDAC outcrop.	Arthropoda (Decopoda, Munididae, Paguroidea), Chordata (Actinopterygii, *Pollachius virens*, Sebastidae), Cnidaria (Actinaria, Hydrozoa, Pennatulacea), Porifera. Bacterial mats, Bioturbation.	Camera
	ENV10g			Grabs	363 752	6 364 531	-	-			-
	ENV11	Higher reflectivity area. Feature of interest, possibly exposure of underlying sediment.	Station	Camera, Grabs	364 259	6 365 188	-	-	Medium sandy sediment with more numerous shell fragments.	Arthropoda (Paguroidea), Chordata (Pleuronectiformes), Cnidaria (Pennatulacea, Hydrozoa). Bacterial mats, Bioturbation.	Camera, Grabs
	ENV12	Higher reflectivity area.	Station	Camera, Grabs	364 366	6 365 747	-	-	Medium sandy sediment with more numerous shell fragments.	Arthropoda (Paguroidea), Chordata (Pleuronectiformes), Cnidaria (Pennatulacea, Hydrozoa). Bioturbation.	Camera, Grab
Eagle to kittiwake	ENV13	Discrete patch of higher reflectivity sediment	Station	Camera, Grabs	359 553	6 365 300	-	-	Medium sandy sediment with occasional shell fragments.	Arthropoda (Paguroidea), Cnidaria (Hydrozoa, Pennatulacea). Bioturbation.	Camera
	ENV14c	Discrete patch of higher reflectivity sediment. Low resemblance to MDAC	Station	Camera	361 764	6 363 303	-	-	Medium sandy sediment with occasional shell fragments.	Arthropoda (Paguroidea), Cnidaria (Hydrozoa, Pennatulacea).	Camera
	ENV14g			Grabs	361 764	6 363 333	-	-			Grabs
	ENV15c		Station	Camera	359 677	6 364 804	-	-			Camera

Target ID	Description	Type	Intended sampling	Start Easting	Start Northing	End Easting	End Northing	Sediment and Features Description	Fauna Description	Completed sampling
ENV15g	Drop boulder		Grabs	359 677	6 364 834	-	-	Medium sandy sediment with occasional shell fragments, surrounding a boulder.	Arthropoda (Paguroidea), Cnidaria (Hydrozoa, Pennatulacea). Bioturbation.	Grabs
ENV16	Disturbed sediment	Station	Camera, Grabs	359 200	6 365 571	-	-	Medium sandy sediment with occasional shell fragments.	Arthropoda (Decopoda, Paguroidea), Cnidaria (Hydrozoa, Pennatulacea). Bioturbation.	Camera
ENV17c	Drop boulder	Station	Camera	357 381	6 366 731	-	-	Medium sandy sediment with occasional shell fragments, surrounding a boulder.	Arthropoda (Decopoda, Munididae, Paguroidea), Chordata (Actinopterygii, *Pollachius virens*), Cnidaria (Actiniaria, Hydrozoa, Pennatulacea), Porifera. Bacterial mats, Bioturbation.	Camera
ENV17g			Grabs	357 381	6 366 761	-	-			Grabs
ENV18c	Drop boulder	Station	Camera	356 695	6 367 647	-	-	Medium sandy sediment with occasional shell fragments, surrounding a boulder.	Arthropoda (Decopoda, Munididae, Paguroidea), Chordata (Actinopterygii, *Pollachius virens*), Cnidaria (Actinaria, Hydrozoa, Pennatulacea), Porifera. Bioturbation.	Camera
ENV18g			Grabs	356 695	6 367 677	-	-			-
ENV19c	Drop boulder	Station	Camera	355 663	6 368 147	-	-	Medium sandy sediment with occasional shell fragments, surrounding a boulder.	Arthropoda (Decopoda, Munididae, Paguroidea), Chordata (Actinopterygii, *Pollachius virens*), Cnidaria (Actinaria, Hydrozoa, Pennatulacea), Porifera. Bioturbation.	Camera
ENV19g			Grabs	355 663	6 368 177	-	-			Grabs
ENV20c	Drop boulder with possible debris	Station	Camera	354 610	6 369 376	-	-	Medium sandy sediment with occasional shell fragments, surrounding a boulder.	Arthropoda (Caridea, Decopoda, Munididae, Paguroidea), Chordata (Actinopterygii, *Pollachius virens*), Cnidaria (Actinaria, Hydrozoa, Pennatulacea), Porifera. Bioturbation.	Camera
ENV20g			Grabs	354 610	6 369 406	-	-			Grabs
ENV21c	Discrete patch of higher reflectivity sediment. Low resemblance to MDAC	Station	Camera	353 782	6 369 865	-	-	Medium sandy sediment with occasional shell fragments surrounding depression filled with numerous shells.	Arthropoda (Paguroidea), Chordata, (Actinopterygii, *Pollachius virens*), Cnidaria (Actiniaria, Hydrozoa, Pennatulacea). Bioturbation.	Camera
ENV21g			Grabs	373 782	6 369 895	-	-			Grabs
ENV22	Discrete patch of higher	Station	Camera, Grabs	352 097	6 371 177	-	-	Medium sandy sediment with occasional shell fragments	Arthropoda (Paguroidea), Chordata (Actinopterygii, *Pollachius virens*), Cnidaria	Camera, Grabs

	Target ID	Description	Type	Intended sampling	Start Easting	Start Northing	End Easting	End Northing	Sediment and Features Description	Fauna Description	Completed sampling
		reflectivity sediment. Low resemblance to MDAC							surrounding depression filled with numerous shells.	(Actiniaria, Hydrozoa, Pennatulacea). Bioturbation.	
Eagle to Gadwall	ENV23c	Potential Pockmark	Station	Camera	362 535	6 364 439	-	-	Medium sandy sediment with occasional shell fragments surrounding depression filled with numerous shells surrounding MDAC outcrop.	Arthropoda (Decopoda, Munididae, Paguroidea), Chordata (Actinopterygii, *Pollachius virens*), Sebasteidae), Cnidaria (Actinaria, Hydrozoa, Pennatulacea), Porifera. Bacterial mats, Bioturbation.	Camera
	ENV23g			Grabs	362 508	6 364 395	-	-			Grabs
	ENV24	Potential Pockmark	Station	Camera	362 477	6 364 345	-	-	Medium sandy sediment with occasional shell fragments surrounding depression filled with numerous shells surrounding MDAC outcrop.	Arthropoda (Decopoda, Munididae, Paguroidea), Chordata (Actinopterygii, *Pollachius virens*), Cnidaria (Actiniaria, Hydrozoa, Pennatulacea), Porifera. Bacterial mats extending out at least 50 m, Bioturbation.	Camera
Reference	ENVREF	Reference Station	Station	Camera, Grabs	365 597	6 363 829	-	-	Medium sandy sediment with more numerous shell fragments.	Arthropoda (Paguroidea), Cnidaria (Hydrozoa, Pennatulacea). Bioturbation.	Camera, Grabs

Notes: Grey cells indicate where sampling was not completed, or where no positional information was required.

Along the Eagle to Gadwall route, visible fauna identified included:

- Annelida (*A. falcata, A. aculeata, B. viridis, H. tubicola, L. conchilega, M. faex,* Pectinariidae, Sabellidae, Serpulidae);
- Arthropoda (*C. pagurus*, Caridea, Galatheoidea, Majoidea, *Munida* sp., *P. prideaux,* Paguroidea, *P. montagui*);
- Bryozoan (*Flustra* sp.);
- Chordata (Actinopterygii, Blenniidae, *C. ascanii*. Gadiformes, *P. gunnellus*, Pleuronectiformes, *Sebastes* sp., *Trisopterus* sp.);
- Cnidaria (Actiniaria, *A. palliata, A. digitatum*, *C. nutans,* Epizoanthidae, *H. echinata,* Hydrozoa*, Nemertesia* sp., *P. phosphorea*, Sertulariidae, *Urticina* sp., *Virgularia sp.*);
- Echinodermata (Asteroidea, *A. rubens*, Echinoidea, *H. oculata*, Ophiuroidea);
- Foraminifera (*Astrorhiza* sp., Xenophyophoroidea);
- Mollusca (*Astarte* sp., Bivalvia, Buccinidae, *Coryphella* sp., Naticidae, Nudibranchia, Polyplacophora, Scaphopoda);
- Porifera (Geodiidae, *H. viscosa,* encrusting, massive);
- Indeterminate Animalia, tubes and turf.

The most frequently observed taxon across the survey area, favouring the predominantly silty sand sediment, was Scaphopoda, present in 50% of photographs. The second most frequently observed taxon was *P. phosphorea* which was observed in 18% of photographs (and 28% of imagery including video frames). In combination with burrows, this can form a 'sea pen and burrowing megafauna communities' habitat which is listed as a threatened and/or declining habitat (*OSPAR, 2008*). Burrows were present in 7% of photographs and 8% of imagery including video frames. MDAC was identified in 21% of photographs in six out of nine stations/transects (ENV3 to ENV7 and ENV23) (*Gardline, 2019d*).

Along the Eagle to Kittiwake proposed umbilical route, visible fauna identified included:

- Annelida (*A. falcata, B. viridis, H. tubicola, L. conchilega,* Pectinariidae, Sabellidae, Serpulidae);
- Arthropoda (*C. pagurus*, Caridea, Galatheoidea, *Macropodia* sp., Majoidea, *Munida* sp., *P. prideaux,* Paguroidea);
- Bryozoan (*Flustra* sp.);
- Chordata (Actinopterygii, *Ammodytes* sp., Blenniidae, Gadiformes, *L. piscatorius*, *P. gunnellus*, *P. platessa*, Pleuronectiformes,);
- Cnidaria (Actiniaria, *A. palliata, A. digitatum*, Epizoanthidae, *H. echinata,* Hydrozoa*, Nemertesia* sp., *P. phosphorea*, Sertulariidae, *Urticina* sp., *Virgularia sp.*);
- Echinodermata (*A. rubens*, Echinoidea, *H. oculata*, Ophiuroidea);
- Foraminifera (Xenophyophoroidea);
- Mollusca (Bivalvia, Naticidae, Nudibranchia, Scaphopoda);
- Porifera (Geodiidae, *H. viscosa,* encrusting, massive, pendunculate);
- Indeterminate Animalia, tubes, turf and egg clusters.

The most frequently observed taxon across the survey area, favouring the predominantly silty sand sediment, was Scaphopoda present in 53% of photographs. The second most frequently observed taxon was *P. phosphorea* which was observed in 21% of photographs and 28% of imagery including video frames). Burrows were present in 7% of photographs and 8% of imagery including video frames (*Gardline, 2019d*).

Imagery observations identified MDAC along Transect ENV7 (near to the Eagle well), which is shared with the other pipeline routes, however there were no other occurrences identified along the Eagle to Kittiwake route. *Ammodytes* sp. (sandeel) were also observed in two photographs at Station ENV14 (*Gardline, 2019d*).

There were several observations of the bivalve mollusc *Arctica islandica* (the ocean quahog), in the form of broken shells at the majority of stations where camera investigations were undertaken. *A. Islandica* is on the list of threatened and/or declining species and habitats (*OSPAR, 2008*) and is widely encountered in the region of the North Sea.

There were observations of individuals belonging to the family Sebastidae, which contains the redfish genus *Sebastes* sp. The genus *Sebastes* includes *Sebastes marinus* (rose fish) which is listed as 'endangered' and *Sebastes mentella* (deepwater redfish), which is listed as 'vulnerable' on the IUCN Red List (*IUCN, 2019*).

The presence of *P. phosphorea* suggests the survey area could present similarity to the '*sea pen and burrowing megafauna communities*' habitat as defined by OSPAR (2010). A 'sea pen and burrowing megafauna communities' habitat is classified as a threatened and/or declining habitat (OSPAR, 2008), however is widespread the central North Sea, around the south and west coasts of Norway and around the north of the British Isles (*OSPAR, 2010*). Therefore, its occurrence within the survey area isn't unexpected (*Gardline, 2019*).

The grab samples obtained during the survey activities were dominated by silty medium sandy sediments with some varying quantities of shell fragments. A slight darkening of sediment below the surface and occasional black, anoxic sediments were observed. Stations ENV19, ENV20, ENV21 and ENVREF presented slightly coarser sediments, whilst Station ENV12 presented the addition of finer shell fragments. Typical species observed within the grab samples included:

- Annelida - Polychata, Hyalinoecia tubicola;
- Arthropoda – Paguroidea (hermit crab);
- Cnidaria - Pennatula phosphorea;
- Echinodermata – Echinoidea (sea urchins) and Ophiuroidea (brittle stars);
- Mollusca – Bivalvia and Scaphopoda (tusk shells).

There were several observations of *A. islandica* in the form of broken shells within the grab samples at station ENV1, ENV2, ENV9, ENV11, ENV12 and ENV19. *A. islandica* is on the list of threatened and/or declining habitats and species (OSPAR, 2008). Additionally, the sea pen *P. phosphorea* was observed within the grab samples at stations ENV1, ENV6, ENV12 and ENV23 which further supports the camera observations that the survey area presents a possible similarity to a '*sea pen and burrowing megafauna communities*' habitat, as defined by OSPAR (2010). *A. islandica* is a key protected feature of the East of Gannet and Montrose Fields Nature Conservation Marine Protected Area (NCMPA) (ocean quahog aggregations, including sands and gravels as their supporting habitat), which lies approximately 11.5 km south-east of the Eagle development. Their presence in close proximity to this protected area is therefore not unexpected or considered to be unusual.

Habitats Classification

Three separate broadscale level 4 EUNIS categorises were identified during the survey activities:

- EUNIS biotope complex A5.27 (deep circalittoral sand) represented areas of sandy sediment with little coarse material. A5.27 generally corresponded with areas or lower or medium Side-scan sonar (SSS) reflectivity and "sand or muddy sand" habitat based on PSA data (for all stations);
- EUNIS biotope complex A5.44 (circalittoral mixed sediments) represented areas of sand with increased aggregations of gravel, cobbles and boulders which corresponded to areas of higher SSS reflectivity. This included areas that were dominated by shell hash;
- EUNIS biotope A5.71 (seeps and vents in sublittoral sediments) represented areas where MDAC and bacterial mats were observed from the imagery data.

The variation in sediment types along the survey routes meant that the majority of the stations/transects could not be classified as a single EUNIS category. The exceptions were Stations ENV2 (Eagle to Gadwall) and ENV14 (Eagle to Kittiwake) where a single EUNIS category (A5.27; deep circalittoral sand) was assigned. Acquired images generally returned a mixture of EUNIS categories A5.27 (deep circalittoral sand) and A5.44 (circalittoral mixed sediments) relating to lower and higher SSS reflectivity, respectively. Six transects/stations along the Eagle to Gadwall route also returned a EUNIS category of A5.71 (seeps and vents in sublittoral sediments). Furthermore, a single station along the Eagle to Kittiwake route and Transect ENV7 (the common shared target), also returned a EUNIS category of A5.71 (seeps and vents in sublittoral sediments) (*Gardline 2019d*).

Previous Survey Work

The results of the environmental baseline survey are not yet available, therefore, reference is made here to previous surveys to provide information on the macrofauna of the wider area.

2016 Pipeline Route Survey

Macrofaunal Results

A total of five stations were sampled in 2016 along the Kittiwake to Mallard route, using a 0.1 m^2 dual van Veen grab (*Fugro, 2016c*). However, no grab sampling or ground truthing was conducted along the Eagle to Gadwall pipeline route in 2016.

A total of 162 species were identified from the Kittiwake to Mallard pipeline route survey area samples. 45.4% of species were annelids, 26.2% arthropods, 18.5% molluscs, 3.1% echinoderms and 6.9% other phyla. The most abundant taxa found at each station are shown in Table 3.8. The echinoderm, *Echinocyamus pusillus* was the dominant species at four of the five stations sampled. This species alone accounted for 98% of the echinoderms identified and 21.6% of the total individuals found. The polychaete *Galathowenia oculata* was dominant at station STN04. Only two species were found in the top ten at all five stations, *E. pusillus* and the polychaete *Scoloplos armiger*. The polychaetes *Paramphinome jeffreysii* and *G. oculata* were found in the top ten at four of the stations. These are common in the central North Sea and share a preference for soft sediments. There was no evidence of anthropogenic modification to the macrofaunal community structure. (*Fugro, 2016c*).

Two adult specimens of *Arctica islandica* (commonly known as the Ocean Quahog) were recorded in the macrofauna data at station STN04 and station STN06. Low numbers of juveniles (10 mm or below in size [*JNCC, pers.comm, 2014* in: *Fugro, 2016c*]) were recorded at all stations except station STN06.

Given the similarities in depth and sediment along the Eagle to Gadwall pipeline route, the macrofaunal communities are expected to be similar to those found along the Eagle to Mallard route. The environmental baseline survey from the 2019 survey will be reported within future environmental submissions.

Table 3.8: Most abundant taxa found at each station along the Kittiwake to Mallard route (Fugro, 2016c)

STN01	No. / 0.2m²	Cum. %	STN03	No. / 0.2m²	Cum. %
Echinocyamus pusillus	40	18.8	*Echinocyamus pusillus*	57	17.1
Paramphinome jeffreysii	20	28.2	*Scoloplos armiger*	26	24.8
Scoloplos armiger	17	36.1	*Phoronis* sp	17	29.9
Harpinia antennaria	12	41.8	*Galathowenia oculata*	16	34.7
Eudorellopsis deformis	10	46.5	*Paramphinome jeffreysii*	15	39.2
Galathowenia oculata	10	51.2	*Tubulanus polymorphus*	14	43.4
Edwardsia claparedii	8	54.9	*Paradoneis lyra*	12	47.0
Goniada maculata	8	58.7	*Harpinia antennaria*	11	50.3
Chaetozone setosa	5	61.0	NEMERTEA spp	11	53.6
Thyasira flexuosa	4	62.9	*Chaetozone setosa*	10	56.6
STN04	**No. / 0.2m²**	**Cum. %**	**STN05**	**No. / 0.2m²**	**Cum. %**
Galathowenia oculata	190	38.0	*Echinocyamus pusillus*	119	46.3
Echinocyamus pusillus	40	46.0	*Paramphinome jeffreysii*	16	52.5
Prionospio fallax	31	52.2	*Scoloplos armiger*	13	57.6
Spiophanes bombyx	26	57.4	*Spiophanes bombyx*	9	61.1
Owenia borealis	24	62.2	*Phoronis* sp	8	64.2
Spiophanes kroyeri	19	66.0	NEMERTEA spp	7	66.9
Tellimya ferruginosa	13	68.6	*Paradoneis lyra*	6	69.3
Scoloplos armiger	11	70.8	*Tubificidae* sp	5	71.2
Kurtiella bidentata	11	73.0	*Lucinoma borealis*	4	72.8
Chaetozone christiei	9	74.8	*Aonides paucibranchiata*	4	74.3
STN06	**No. / 0.2m²**	**Cum. %**			
Echinocyamus pusillus	149	24.1			
Galathowenia oculata	122	43.8			
Owenia borealis	41	50.4			
Myriochele danielsseni	35	56.1			
Phoronis sp	27	60.4			
Paramphinome jeffreysii	21	63.8			
Spiophanes kroyeri	18	66.7			
Spiophanes bombyx	18	69.6			
Prionospio fallax	18	72.5			
Scoloplos armiger	15	75.0			

2013 and 2014 Rig Site Surveys

Macrofaunal Results

Three 0.1 m² macrofaunal grab samples (FA, FB and FC) were acquired at two 2013 stations (Stations 2_13 and 4_13) and four 2014 stations (Stations ENV01_14 to ENV04_14). (*Fugro, 2014c*).

In the 2013 rig survey, a total of 114 discrete macrofaunal taxa were recorded (excluding 26 juvenile, 4 meiofaunal, 2 pelagic and a single damaged taxon). Of the remaining taxa recorded, 57 (50.0%) were annelid, 25 (21.9%) were crustaceans, 21 (18.4%) were molluscs and 5 (4.4%) were echinoderms (Table 3.9). In terms of abundance the Annelida were largely dominant representing three quarters (78.6%) of the 2,224 individuals recorded. Crustaceans and molluscs represented 5.8% and 4.4%, respectively, while echinoderms and members of the 'other' group made up just 2.9% and 8.4% of the total abundance, respectively (*Fugro, 2014c*).

In the 2014 rig survey, a total of 95 discrete macrofaunal taxa were recorded during the course of the survey (excluding 24 juvenile, 4 meiofaunal and 2 damaged taxa). Of the remaining taxa recorded, 45 (47.4%) were annelid, 25 (26.3%) were crustaceans, 15 (15.8%) were molluscs and 5 (5.3%) were echinoderms (Table 3.9). In terms of abundance the Annelida were largely dominant representing almost three quarters (73.3%) of the 1,131 individuals recorded. Crustaceans and molluscs represented 7.5% and 8.5%, respectively, while echinoderms and members of the 'other' group made up just 6.0% and 4.2% of the total abundance, respectively (*Fugro, 2014c*).

Table 3.9: Abundance of major taxonomic groups for 2013 and 2014 Eagle macrofaunal samples (Fugro, 2014c)

Group	Number of Taxa	Total Taxa [%]	Abundance	Total Abundance [%]
2013 Eagle Data				
Annelida	57	50.0	1748	78.6
Crustacea	25	21.9	128	5.8
Mollusca	21	18.4	97	4.4
Echinodermata	5	4.4	64	2.9
Other	6	5.3	187	8.4
Total	**114**	**100.0**	**2224**	**100.0**
Note: Other = Cnidaria, Nemertea, Sipuncula, Chelicerata, Phoronida				
2014 Eagle Data				
Annelida	45	47.4	829	73.3
Crustacea	25	26.3	85	7.5
Mollusca	15	15.8	101	8.9
Echinodermata	5	5.3	68	6.0
Other	5	5.3	48	4.2
Total	**95**	**100.0**	**1131**	**100.0**
Note: Other = Cnidaria, Nemertea, Sipuncula, Phoronida				

The benthic macrofauna was characterised by diverse, but moderately dominated assemblages of common North Sea taxa (*Künitzer, et al., 1992*; *Heip & Craeymeersch, 1995*, in: *Fugro, 2014c*). The most common taxa recorded in the survey area predominantly comprised polychaetes that have all been identified from surveys undertaken in similar North Sea habitats. The most abundant species in both surveys, the amphinomid polychaete *Paramphinome jeffreysii,* was present at moderate to high abundances. It is a widely distributed species, thought to be one of the most abundant infaunal taxa of the central and northern North Sea, where it is associated with muddy and sandy sediments (Fugro Survey Limited, unpublished survey reports; *George & Hartmann-Schroder, 1985*, in: *Fugro, 2014c*). The second most abundant species, the polychaete *Scoloplos armiger*, is prevalent throughout European waters including the North Sea, occurring within soft sediments, from the eulittoral to depths of 2,000 m (*Heip & Craeymeersch, 1995*; *Holtmann, et al., 1996*, in: *Fugro, 2014c*). Other notable species include the spionid polychaete *Spiophanes bombyx* and the echinoderm *Echinocardium flavescens*, which are both associated with a variety of sediment types and are widely distributed in European waters (*Künitzer, et al., 1992*; *Heip & Craeymeersch, 1995*; *DTI, 2004*, in: *Fugro, 2014c*).

The number of taxa found at each station did not vary greatly from that found on comparison surveys; Gadwall (2014), Crathes (2012) and Goosander and Whitethroat (2010) surveys. However, abundance of individuals was found to be greater during the 2013 Eagle survey compared to the 2014 Eagle survey and the comparison surveys (*Fugro, 2014c*).

3.3.3 Fish and Shellfish

Fish and shellfish are important components of marine ecosystems, operating at a number of trophic levels. They utilise a variety of feeding strategies, including filter feeding for plankton suspended in the water column, scavenging for detritus on the seabed, and both pelagic and demersal predation of plankton, small fish, cephalopods, crustaceans and other benthic organisms. Pelagic fish, species which typically inhabit mid-water depths (such as mackerel), primarily feed on planktonic crustaceans, zooplankton, and small fish. Demersal fish, species which inhabit the depths close to the seabed such as gadoids and flatfish, often consume a wide range of benthic invertebrates including crustaceans, polychaetes, molluscs and echinoderms, along with cephalopods and fish. Most benthic crustaceans are scavengers to some extent, feeding on detritus, although many species are also active predators of a variety of benthic organisms. Many bivalve molluscs are filter feeders of material suspended in the water column (*DECC, 2016*).

The proposed Eagle development lies within International Council for the Exploration of the Seas (ICES) rectangle 43F0. Fish and shellfish populations may be vulnerable to impacts from offshore oil and gas activities such as exposure to aqueous effluents and accidental hydrocarbon pollution, especially during the larval and juvenile stages of their lifecycles (*Bakke et al., 2013*). The North Sea is historically important for its fish stocks with commercial fishing occurring throughout the year.

The proposed Eagle field development lies within the spawning and nursery grounds of cod (*Gadus morhua*), mackerel (*Scomber scombrus*), Norway pout (*Trisopterus esmarkii*), *Nephrops* (*Nephrops norvegicus*) and sandeel (*Ammodytidae*) (*Coull et al, 1998*; *Ellis et al., 2012*). ICES rectangle 43F0 is partially within an area of higher egg concentrations for Norway pout and sandeel (*Coull et al., 1998*).

The proposed Eagle development also falls within the nursery grounds for anglerfish (*Lophius Piscatorius*), blue whiting (*Micromesistius poutassou*), European hake (*Merluccius merluccius*), haddock (*Melanogrammus aeglefinus*), herring (*Clupea harengus*), ling (*Molva molva*), plaice (*Pleuronectes platessa*), spurdog (*Squalus acanthias*) and whiting (*Merlangius merlangus*) (*Coull et al, 1998*; *Ellis et al., 2012*).

Seasonal spawning and nursery patterns of these species are shown in Table 3.10 and in Figure 3.7. Out of these species, anglerfish, blue whiting, cod, herring, ling, Norway pout, sandeel and whiting are Considered Priority marine Features PMFs (*SNH, 2014*).

Fisheries sensitivity maps produced by Aires *et al*. (2014) detail aggregations of fish species in the first year of their life. The sensitivity maps found the probability of cod, haddock, whiting, Norway pout, herring, mackerel, horse mackerel (*Trachurus trachurus*), sprat (*Sprattus sprattus*), blue whiting, plaice, sole (*True Soles*), European hake and anglerfish aggregations in area of the proposed Eagle development as being low.

Block 21/19 has a special condition with regards to herring spawning grounds. Block 21/19 also has a period of concern for drilling from August to September, imposed by Marine Scotland (*Oil & Gas Authority, 2018*). However, no evidence of herring spawning activity was found during any of the previous surveys, or the current 2019 survey, conducted in the vicinity of the proposed Eagle development. In addition, the available data indicate that herring spawning areas are located further to the west in ICES Rectangle 43E9 (*Coull et al., 1998*) (Figure 3.7).

In general, areas used for spawning are regarded as more sensitive than nursery areas (*Cefas, 2001*). Spawning areas for most species are not rigidly fixed and fish may spawn earlier or later from year to year in response to seasonal and environmental factors (*Coull et al., 1998*); therefore, mapped areas are indicative at a fairly high level.

Sandeel normally use the seabed directly for spawning and are shown to spawn in ICES Rectangle 43F0 between November and February (*Coull et al., 1998*; *Ellis et al., 2012*). However, the high intensity spawning area is located further to the west of the proposed Eagle development (Figure 3.7). Sandeel species *Ammodytes marinus* and lesser sandeel *A. tobianus* are both mobile species that are marine protected area (MPA) search species as part of the Scottish MPA selection guidelines (*Lancaster et al., 2014*). These two species are abundant in UK waters.

The lesser sandeel (*A. tobianus*) is long and thin with a pointed jaw and a maximum body length of 20 cm. They are most commonly found from mid-tide level over sandy shores to the shallow sublittoral to depths of 30 m and are very widespread throughout the UK and Ireland. *A. tobianus* is the most abundant species of sand eel found in British waters. It is known to spawn in spring and summer (*Dipper, 2001*, in: *MarLIN, 2019a*) or in spring and autumn (*Fishbase, 2014*). Eggs are laid in the sand where they adhere to the sand grains; each female produces 4,000-20,000 eggs which hatch after a few weeks. The diet of *A. tobianus* consists of zooplankton and some large diatoms as well as worms, small crustaceans and small fish. They therefore respond to the North Sea plankton blooms in spring and autumn, which coincides with the time they are most likely to spawn. They swim in schools and are able to dart into the sand immediately on sign of threat or danger (*MarLIN, 2019a*).

Raitt's sandeel (*A. marinus*) is a similar species of sandeel with a thin and elongated body, reaching a maximum length of 25 cm. It is also very widely distributed around the UK and Ireland and commonly inhabits water depths of up to 150 m, and hence are expected to be more abundant than *A. tobianus* in the vicinity of the Eagle development. Their spawning behaviour is very similar to that described above for *A. tobianus*. Traditionally *A. marinus*, like other sand eels, has been little exploited for human consumption but is a major target of industrial fishing for animal feed and fertilizer, particularly in the North Sea. There is evidence to suggest that increasing fishing pressure may be causing problems for some of their natural predators, especially seabirds which prey on them in deeper water (*Muus & Nielsen, 1999*, in: *MarLIN, 2019b*).

Sandeel form an important part of the marine food chain, as they are a staple food source for fish, marine mammals and birds (*Mazik et al., 2015*). Sandeels prefer clean sandy sediments with a low silt/clay content. and when spawning lay their eggs as sticky clumps in the same clean sandy sediment (*DTI, 2004*). In recent years, there is evidence to suggest that sandeel populations are suffering from overfishing pressures; they are a commercially important species, targeted for their fish oil and for fishmeal. Given their preferred habitat is highly specific, any form of disturbance that is likely to disrupt the physical structure of the seabed sediment poses an indirect threat to sandeel populations (*Mazik et al., 2015*).

Nephrops is a small lobster which grows to around 20 cm in length. They are very common throughout the North Sea and are targeting by commercial fisheries. They are found in soft sediment, commonly at depths of between 200 and 800 m, although considerable populations exist at depths of less than 200 m. They live in shallow burrows and are most common on grounds with fine cohesive mud which is stable enough to support their unlined burrows. Their burrows may be up to 10 cm in diameter, over a metre long and penetrate the sediment to a depth of up to 20-30 cm (*Rice & Chapman, 1981,* in: *MarLIN, 2019c*).

Table 3.10: Fish spawning and nursery timings in ICES rectangle 43F0 (Coull et al., 1998; 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/N	S*/N	S*/N	S/N	N	N	N	N	N	N	N	N
European Hake	N	N	N	N	N	N	N	N	N	N	N	N
Haddock	N	N	N	N	N	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	S/N	S/N	S/N	S/N	N	N	N	N
Norway pout	S/N	S*/N	S*/N	S/N	N	N	N	N	N	N	N	N
Nephrops	S/N	S/N	S/N	S*/N	S*/N	S*/N	S/N	S/N	S/N	S/N	S/N	S/N
Plaice	N	N	N	N	N	N	N	N	N	N	N	N
Sandeel	S/N	S/N	N	N	N	N	N	N	N	N	S/N	S/N
Spurdog	N	N	N	N	N	N	N	N	N	N	N	N
Whiting	N	N	N	N	N	N	N	N	N	N	N	N
S = Spawning, N = Nursery, SN = Spawning and Nursery; Species = High intensity spawning, Species = High intensity nursery area; * = peak spawning, Blank = no data												

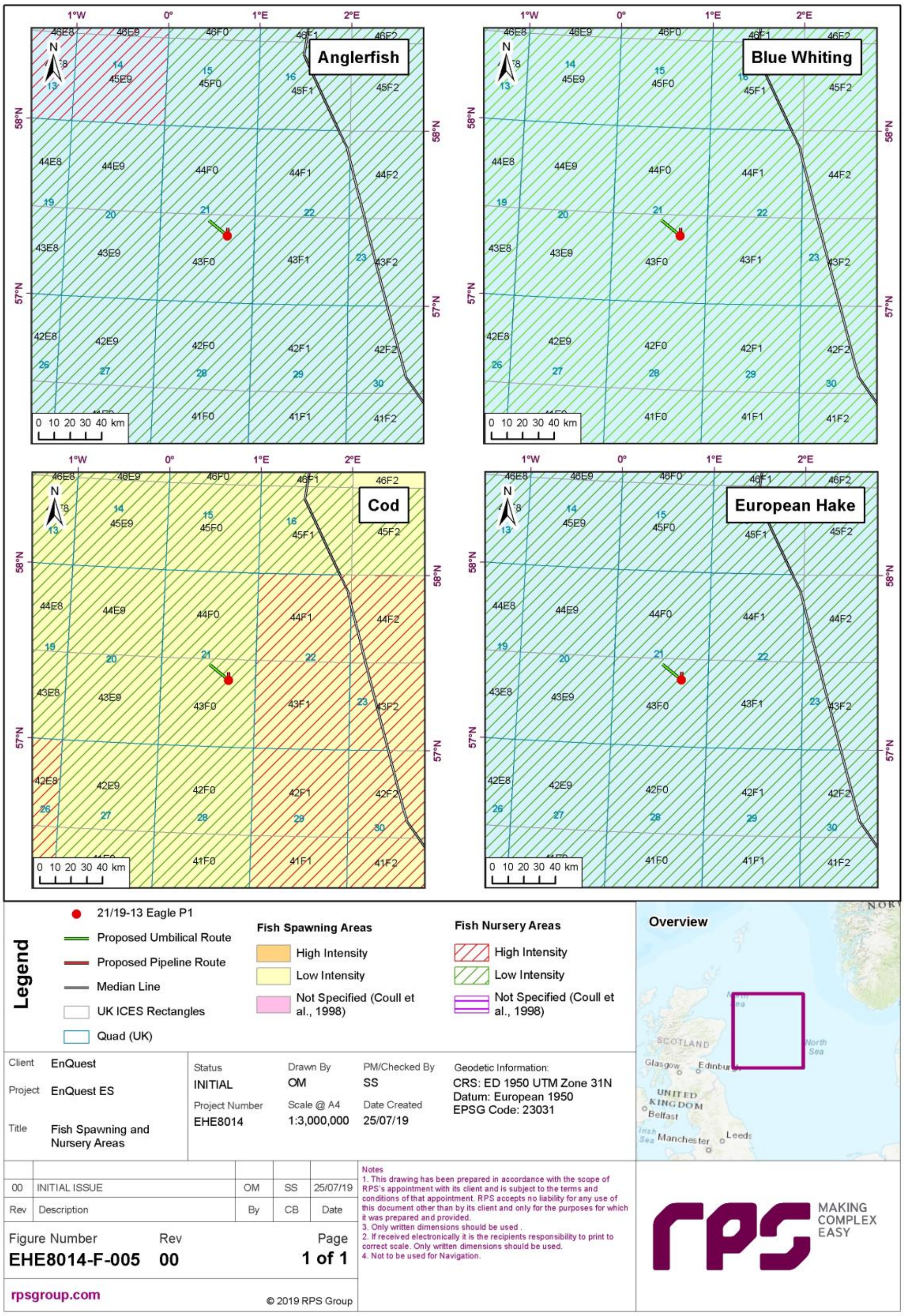

Figure 3.7a: Fish spawning and nursery areas in relation to the proposed Eagle development location (Coull et al., 1998; Ellis et al., 2012)

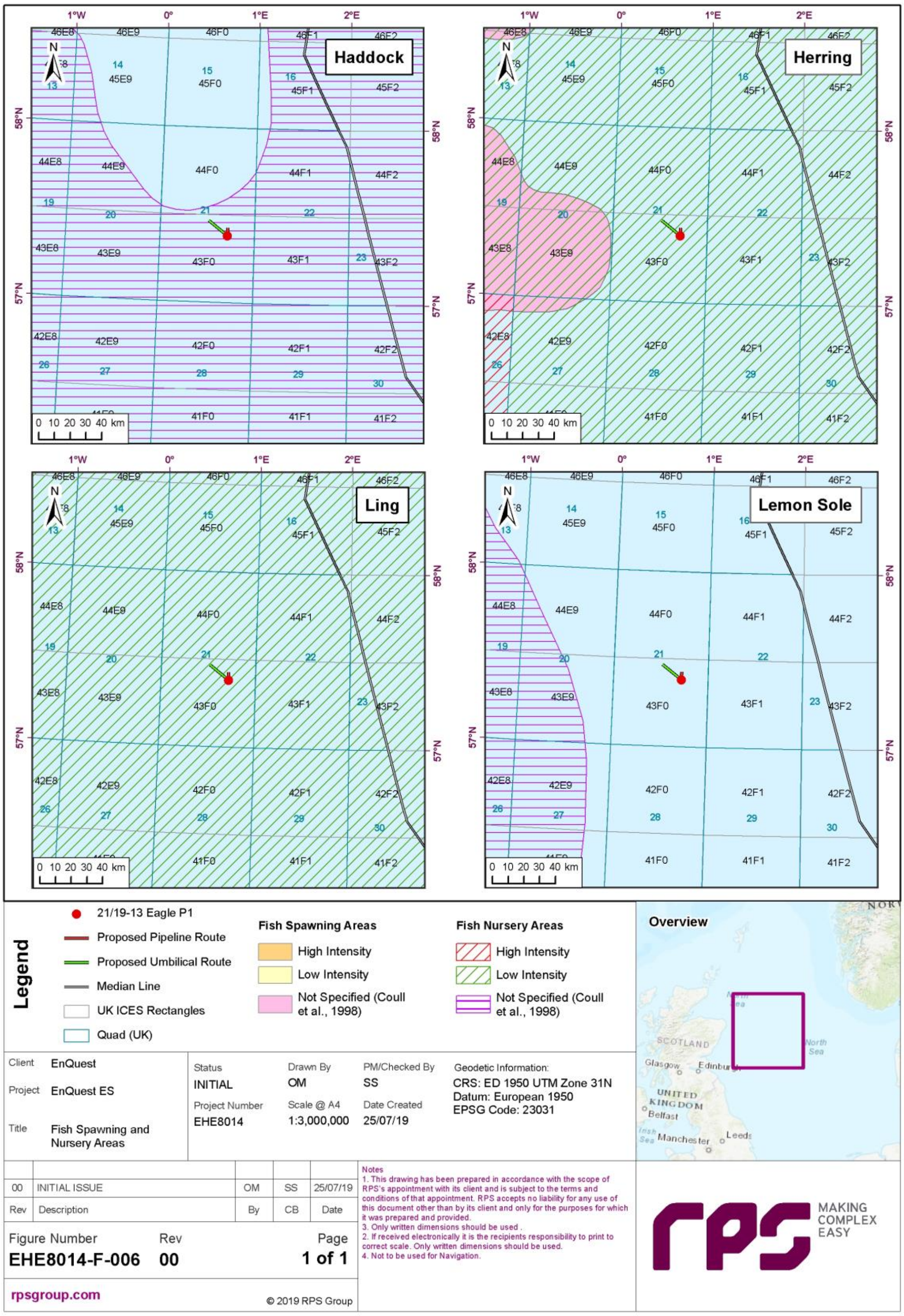

Figure 3.7b: Fish spawning and nursery areas in relation to the proposed Eagle development location (Coull et al., 1998; Ellis et al., 2012)

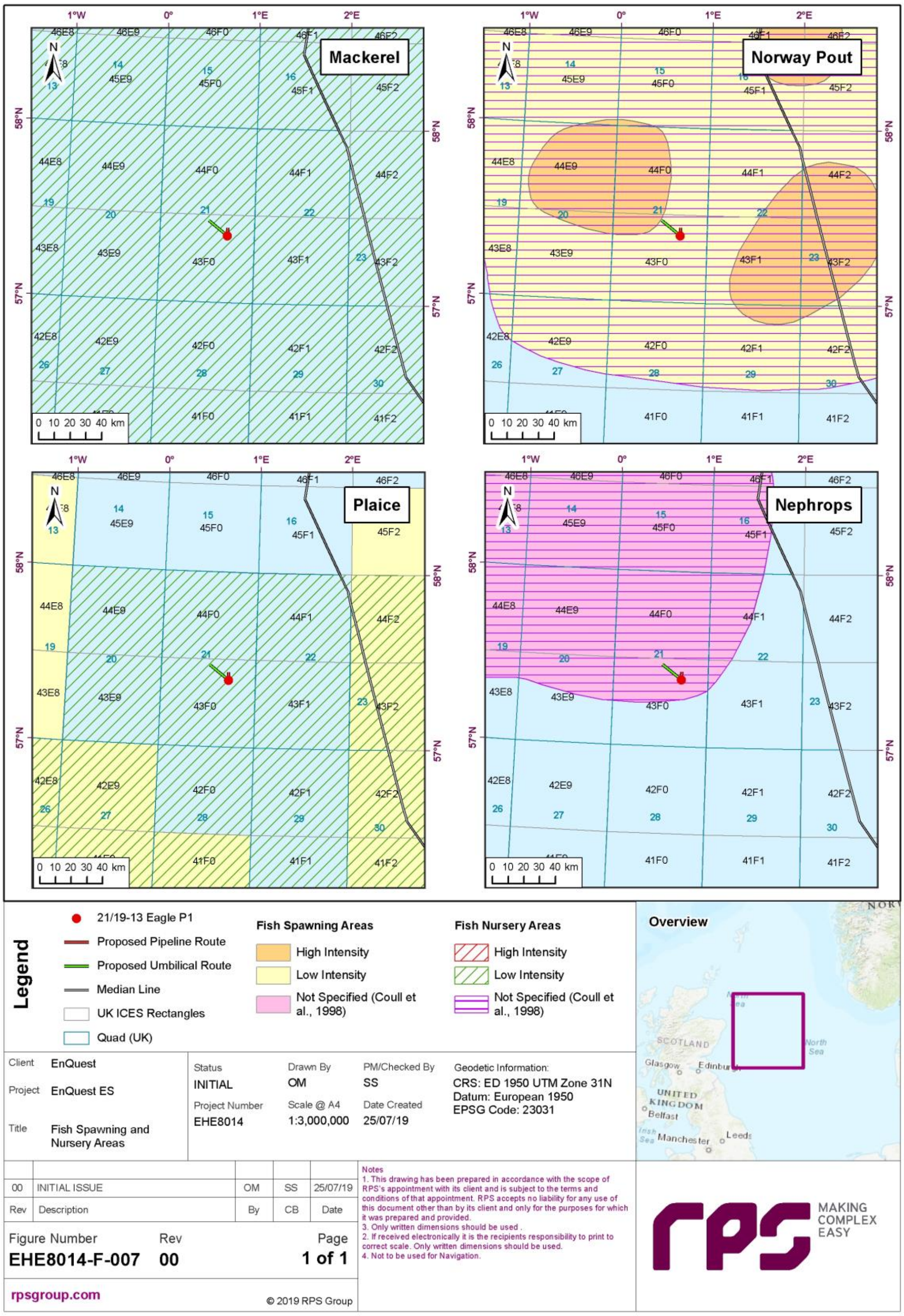

Figure 3.7c: Fish spawning and nursery areas in relation to the proposed Eagle development location (Coull et al., 1998; Ellis et al., 2012)

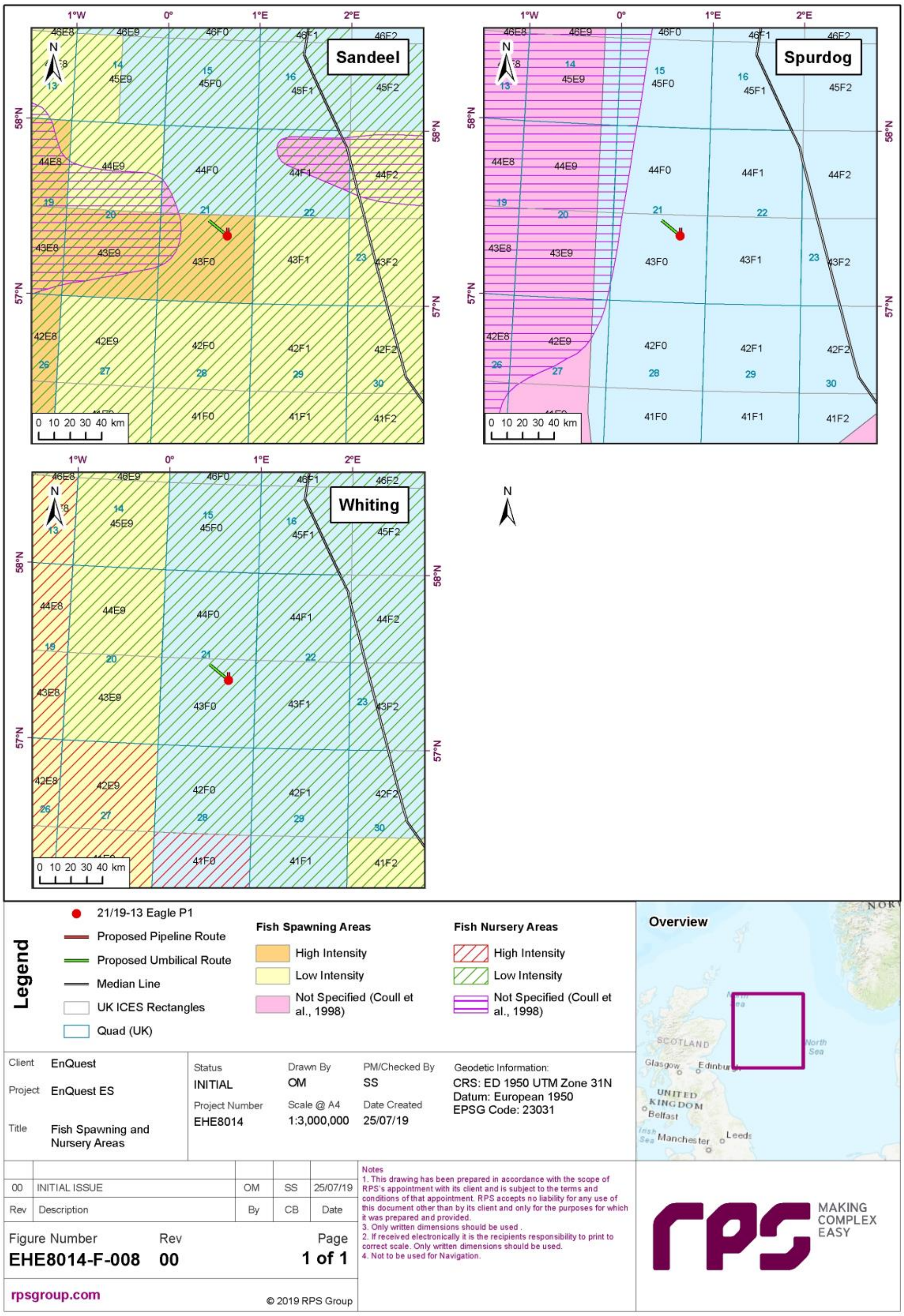

Figure 3.7d: Fish spawning and nursery areas in relation to the proposed Eagle development location (Coull et al., 1998; Ellis et al., 2012)

3.3.4 Seabirds

The northeast coast of Scotland and adjacent offshore waters are internationally important for their seabird populations. Within the vicinity of the Eagle development, seabirds are generally recorded as travelling along seasonal migration routes or on the post-breeding movement away from colonies (*Skov et al., 1995*; *Stone et al., 1995*, in *DTI, 2001*). Seabird species in the vicinity of the Eagle development are likely to include Fulmar (*Fulmarus glacialis*), Kittiwake (*Rissa tridactyla*), Northern Gannet (*Morus bassanus*), Guillemot (*Uria aalge*), Razorbill (*Alca torda*), Black Guillemot (*Cepphus grille*), Herring Gull (*Larus argentatus*), and Atlantic Puffin (*Fratercula arctia*) (*DECC, 2016*).

Gannets and Puffins are present in summer months, whilst Herring Gulls, the Glaucous Gull (*Larus hyperboreus*) and Great Black-Backed Gull (*Larus marinus*) are known to be present in the area in winter (*DECC, 2009*). These seabird species utilise a variety of coastal habitats for breeding, with some species only coming ashore to form colonies during the breeding season (April to August). The proposed Eagle development is located approximately 140 km from the nearest UK coast and is therefore remote from the sensitive seabird breeding areas on the coast.

The offshore distribution and abundance of seabirds varies over the year, being lower during the breeding season when many species return to shore to nest. The offshore distribution outside the breeding season is mostly driven by the availability of food (*DECC, 2009*). The distance birds will travel from their colonies for food varies greatly between species and this influences offshore distribution. Non-breeding birds may be found foraging further offshore than breeding birds. Foraging distances for common North Sea species are reported by Thaxter *et al.* (2012) and are presented in Table 3.11 for those species most likely to be encountered in the vicinity of the proposed Eagle development.

Table 3.11: Representative breeding season foraging ranges of seabird species likely to be present in the vicinity of the proposed Eagle development (Thaxter et al., 2012, in: DECC, 2016)

Species	Maximum foraging range (km)	Confidence of foraging range assessment
Fulmar	580	Moderate
Kittiwake	1,202	Highest
Gannet	590	Highest
Guillemot	135	Highest
Razorbill	95	Moderate
Herring gull	92	Moderate
Puffin	200	Low

Seabird abundance decreases in offshore waters following the winter period (December to February) when large numbers of seabirds start to return to their coastal colonies for the breeding season (April to June). Generally, offshore seabird vulnerability is lowest during the pre-breeding and breeding months. After the breeding season ends in June, large numbers of moulting auks (Guillemot, razorbill and puffin) disperse from their coastal colonies and into the offshore waters from July onwards, resulting in peak numbers of seabirds at sea during the summer. In addition to auks, kittiwake, gannet and fulmar are also present in sizable numbers offshore during the post breeding season. At this time, birds are particularly vulnerable to pollution on the water surface (e.g. accidental chemical or oil spills) as the moulting adults are rendered flightless and juveniles are not yet able to fly. Fulmars, kittiwakes and gannet are highly pelagic and capable of travelling long distances to forage (Table 3.11). These species are also adaptable, opportunistic feeders, and are sometimes found scavenging around fishing vessels (*DECC, 2016*).

In general, seabirds feeding or rafting on the sea surface are those most vulnerable to water-borne pollution. The aerial habits of fulmars and gulls, together with their large populations and widespread distribution, reduce the overall vulnerability of these populations of seabirds to sea surface pollution.

Breeding numbers of some seabird species have shown a long-term decline, most probably as a result of a shortage of key prey species such as sandeel associated with changes in oceanographic conditions (*Baxter et al., 2011*). The Joint Nature Conservation Committee (JNCC) has released data on trends in abundance, productivity, demographic parameters and diet of breeding seabirds, from the Seabird Monitoring Programme (*JNCC, 2016*). The data provides UK population trends as a percentage of change in breeding numbers from complete censuses. From the years 1998-2015, the following population trends for species known to use the Eagle development area have been recorded: Northern Fulmar (-31%), Gannet (+34%), Black Legged Kittiwake (-44%) Guillemot (+5%) and Razorbill (+32).

Oil and Gas UK commissioned a series of seabird surveys to assess the distribution and abundance of both onshore and offshore seabird populations. From these surveys, the 'Seabird Oil Sensitivity Index' (SOSI) has been compiled to assess the vulnerability of seabirds to the threat of oil pollution (*Certain et al., 2015*). This index is based upon four factors:

- The amount of time spent on the water;
- Total biogeographic population;
- Reliance on the marine environment; and
- Potential rates of recovery.

The vulnerability of seabirds to oil pollution in the vicinity of the proposed Eagle development (Blocks 21/18 and 21/19a) is presented in Table 3.12.

Seabird vulnerability to oil pollution within Block 21/18 is rated as 'extremely high' in April and May. At all other times of the year, seabird vulnerability is rated as low in Block 21/18. Seabird vulnerability to oil pollution within Block 21/19 is rated as 'low' throughout the year. However, no data exists for November for neither Block 21/18 nor Block 21/19 (Table 3.12) (*Certain et al., 2015*).

Table 3.12: Seabird sensitivity to oil pollution in Blocks 21/18 and 21/19 and surrounding Blocks (Certain et al., 2015)

Quad / Block	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
21/12	2	2	5	2*	2	5	5	5	5	5*		2*
21/13	2	5	5	5*	5*	5	5	5	5	5*		2*
21/14	5	5	5	5*	5*	5	5	5	5	5*		5*
21/15	5	5	5	5*	5*	5	5	5	5	5*		5*
21/17	5	3	5	2*	2	5	5	5	5	5*		5*
21/18	**5**	**5**	**5**	**1***	**1**	**5**	**5**	**5**	**5**	**5***		**5***
21/19	**5**	**5**	**5**	**5***	**5***	**5**	**5**	**5**	**5**	**5***		**5***
21/20	5	5	5	5*	5*	5	5	5	5	5*		5*
21/22	5	3	5	2*	2	5	5	5	5	5*		5*
21/23	5	4	5	1*	1	5	5	5	5	5*		5*
21/24	5	5*	5	5*	5*	5	5	5	5	5*		5*
21/25	5	5	5	5*	5*	5	5	5	5	5*		5*
Key	1 - Extremely high		2 - Very high		3 - High		4- Medium		5 - Low		No data	

Notes:
* Data not directly covered by the SOSI and taken from either an adjacent month or adjacent Block (as per *JNCC, 2017a*).
Note that the 'median sensitivity' maps in Certain *et al.*, 2015 have been used for this table.

Blocks 21/18 and 21/19 have a period of concern for drilling from September to November, imposed by JNCC (*Oil & Gas Authority, 2018*). However, this period of concern does not match the period of highest seabird sensitivity to oiling (*Certain et al., 2015*), which is from April to May in Block 21/18. The proposed spud date for the Eagle development is July 2020, which does not correspond to a period of concern for drilling or with high seabird vulnerability.

From 2007 to 2009, JNCC commissioned a study for the identification of the most suitable marine areas for the protection of seabirds within the British Fishery Limit (*Kober et al., 2010*). The aim of the study was to identify areas that could qualify as marine SPAs with bird species as a qualifying feature, in accordance with the Birds Directive, using the European Seabirds at Sea (ESAS) data (with input from over a 30-year period) to delineate seabird aggregations that might qualify as offshore SPAs. The data were used to create offshore seabird density maps, utilising various techniques including interpolation of missing or sparse data, and refinement with ICES data to correct for effects such as seabirds following fishing vessels (*Kober et al., 2010*).

Of the 6,013 hotspots identified by the top 5% of spatial association statistical analyses, 127 held qualifying numbers of the species for which they were generated, but only 28 of these hotspots occurred regularly (Figure 3.8).

Four regions were identified as being particularly important, as they had a large number of repeatedly occurring qualifying areas: (1) the outer Firth of Forth including the Wee Bankie and Marr Bank, (2) the inner Firth of Forth, (3) the Moray Firth, and (4) the sea areas to the north and west of the Shetland Islands (*Kober et al., 2010*). No areas over the proposed Eagle development were identified by the study (Figure 3.8), with most aggregations identified by the statistical analysis to be clustered around coastal areas and stretching into offshore areas from the coast. Nevertheless, the study illustrates the importance of the coastal breeding colonies on the overall seabird activity observed in offshore regions.

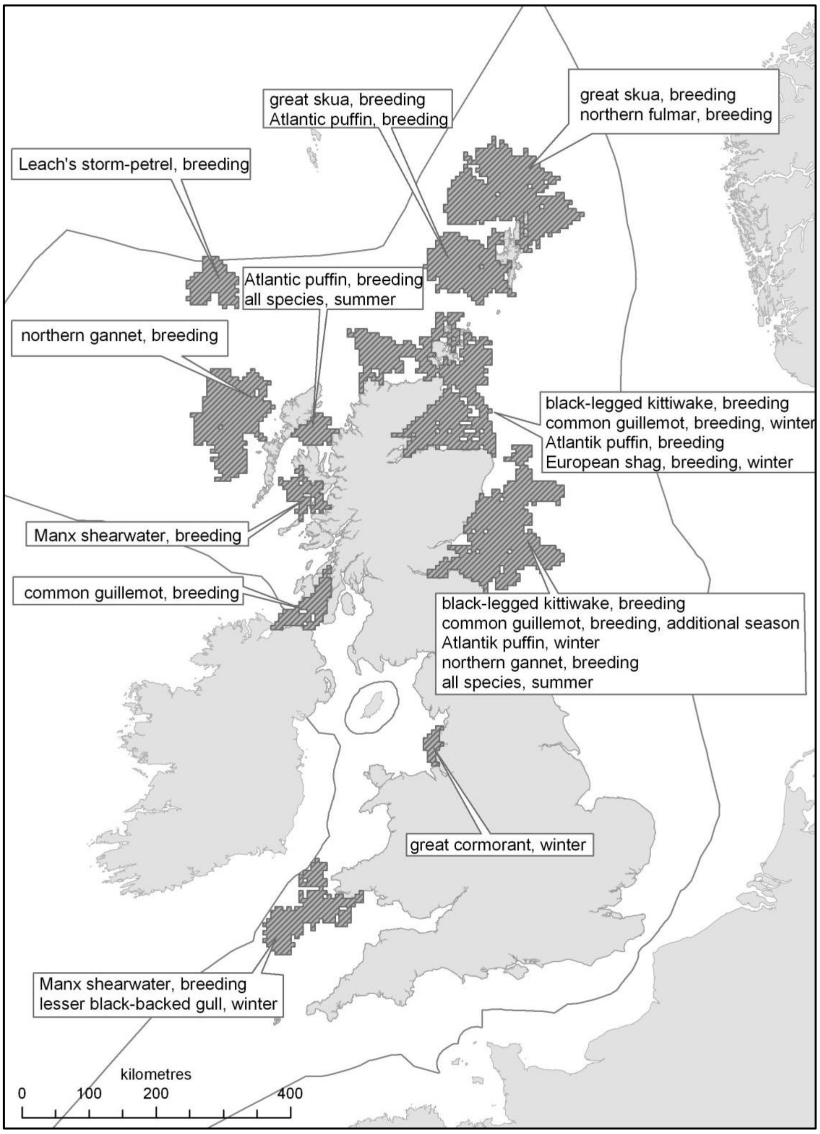

Figure 3.8: All areas qualifying (merged based on a 5% spatial association (Getis-Ord Gi) threshold (Kober et al., 2010)

(Note: Getis-Ord Gi is a statistic used to analyse spatial association)

3.3.5 Marine Mammals

Cetaceans

The CNS generally has a higher density of cetaceans than the southern North Sea. Twenty-eight species of cetacean have been recorded in UK waters based on sightings and strandings data, while seventeen are considered rare or vagrant (*DECC, 2016*). Among the regular species, there are some for which distribution and abundance are reasonably well known: harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), white-beaked dolphin (*Lagenorhyncus albirostris*), minke whale (*Balaenoptera acutorostrata*) and fin whale (*Balaenoptera physalus*). Less data is available for the other six regular species: Atlantic white-sided dolphin (*Lagenorhyncus acutus*), short-beaked common dolphin (*Delphinus delphi*), Risso's dolphin (*Grampus griseus*), killer whale (*Orcinus orca*), long-finned pilot whale (*Globicephala melas*), and sperm whale (*Physeter macrocephalus*) (*DECC, 2016*).

In the vicinity of the proposed Eagle development, Atlantic white-sided dolphin, white-beaked dolphin, minke whale and harbour porpoise have all been sighted (*Reid et al., 2003*) (Table 3.13). However, the limitations of sightings data should be realised and therefore cetacean species have the potential to be present at any time of year within the area. Table 3.14 gives a description of the species sighted in the vicinity of the proposed Eagle development and cetacean density estimates.

Table 3.13: Cetacean sightings records in the vicinity of the proposed Eagle development (Reid et al., 2003)

Species	J	F	M	A	M	J	J	A	S	O	N	D
Atlantic white-sided dolphin							Low					
White-beaked dolphin		Low			Low		Low	Medium	Low			
Minke whale	V. Low		V. Low									
Harbour porpoise					Low		Low	V. Low	Medium			

Key: High (>100); Medium (10-100); Low (1-10); V. Low (0-0.1); No sighting (0)

***Table 3.14**: Cetacean densities in the vicinity of the Eagle development (Reid et al., 2003; Hammond et al., 2002; Hammond et al., 2017)*

Species	Description of occurrence
Atlantic white-sided dolphin	White-sided dolphin show both season and inter-annual variability. They have been sighted in large groups of 10 -100 individuals. They have been sighted in waters ranging from 100 m to very deep waters, but also enter continental shelf waters. They can be sighted in the deep waters around the north of Scotland throughout the year and enter the North Sea in search of food. The Atlantic white-sided dolphin density estimate from the SCANS-III surveys (*Hammond et al., 2017*) is 0.021 animals/km^2 in the vicinity of the Eagle development.
White-beaked dolphin	White-beaked dolphin are usually found in water depths of between 50 and 100 m in groups of around 10 individuals, although large groups of up to 500 animals have been seen. They are present in the UK waters throughout the year, however more sightings have been made between June and October. The white-beaked dolphin density estimate from the SCANS-III surveys (*Hammond et al., 2017*) is 0.037 animals/km^2 in the vicinity of the Eagle development.
Minke whale	Minke whales usually occur in water depths of 200 m or less and occur throughout the northern and central North Sea. They are usually sighted in pairs or singly; however, groups of up to 15 individuals can be sighted feeding. It appears that animals return to the same seasonal feeding grounds. The minke whale density estimate from the SCANS-III surveys (*Hammond et al., 2017*) is 0.032 animals/km^2 in the vicinity of the Eagle development.
Harbour porpoise	Harbour porpoise are frequently found throughout the UK waters. They usually occur in groups of one to three individuals in shallow waters, although they have been sighted in larger groups and in deep water. It is not thought that the species migrate. The harbour porpoise density estimates from the SCANS-III surveys (*Hammond et al., 2017*) is 0.402 animals/km^2 in the vicinity of the Eagle development.

Records from the SCANS-III survey area T (North Sea), as recorded in summer 2016, show the abundance of Atlantic white-sided dolphin is 1,366, corresponding to a density of 0.021 animals per square kilometre, the abundance of white-beaked dolphin is 2,417 animals, corresponding to a density of 0.037 animals per square kilometre, the abundance of minke whale is 2,068 animals, corresponding to a density of 0.032 animals per square kilometre, and the abundance of harbour porpoise is 26,309 animals, corresponding to a density of 0.402 animals per square kilometre (*Hammond et al., 2017*).

Harbour porpoise, minke whale, white beaked dolphin and Atlantic white-sided dolphin are all listed as PMF in Scottish waters (*Tyler-Walters, 2016*). The harbour porpoise is protected under Annex II of the EU Habitats Directive (92/43/EEC, as amended by 97/62/EC).

Based on the available information, Blocks 21/18 and 21/19a have a low to moderate cetacean density.

Pinnipeds

Five species of pinniped have been recorded in the North Sea: grey seal *Halichoerus grypus*, harbour seal *Phoca vitulina*, harp seal *Phoca groenlandica*, hooded seal *Cystophora cristata* and ringed seal *Pusa hispida* (*Jones et al., 2015*). However, only two of these species live and breed in the UK, namely the grey and harbour seal, both of which are protected under Annex II of the EU Habitats Directive and are listed as Scottish PMFs (*SNH, 2014*). The bearded, ringed, harp and hooded seals are Arctic species, and have generally only been sighted on an occasional basis in Scottish waters.

The Sea Mammal Research Unit (SMRU) regularly monitors Scottish seal populations using aerial survey techniques around the Scottish coastline, but these surveys do extend to offshore regions where grey seals in particular have been equipped with satellite relay data loggers in order to study their movements and foraging areas (e.g. *SCOS, 2014*; *SMRU, 2011*). The JNCC Seabirds at Sea Team (SAST) has also been recording seals during surveys in the Atlantic Margin (*Pollock et al., 2000*).

Approximately 38% of the world's grey seals breed in the UK and of these, 88% at colonies in Scotland with the main concentrations in the Outer Hebrides and in Orkney. Approximately 30% of the worlds harbour seals are found in the UK (*SCOS, 2014*). Overall, the UK harbour seal population has increased since the late 2000s, however significant differences in population dynamics exist between regions. Declines have been observed in Orkney (less 78% between 1997-2013), the east coast (down 70% between 1997-2015), the Firth of Tay (down 92% between 2000-2015) and Shetland (down 30% between 2000-2009). Contrarily, the counts in Shetland and on the west coast and the Western Isles have increased in recent years, with a maximum increase of 50% in the Western Isles in 2011 compared to 2007-2009 data (*SCOS, 2014*).

Grey and harbour seals feed both in inshore and offshore waters depending on the distribution of their prey, which changes both seasonally and annually. 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, 2014*). The movements of grey seals can involve larger distances than those of the harbour seal, and trips of several hundred km from one haul-out to another have been recorded (*SMRU, 2011*).

The proposed Eagle development is located approximately 140 km offshore, so although these species may be encountered in the vicinity of the Eagle development from time to time, it is not likely that they use the area with any regularity or in great numbers. This is confirmed by the latest grey and harbour seal density maps published by SMRU, which analysed telemetry data of both grey and harbour seals in the UK spanning 1991 to 2016. The density maps generated from this work predict (on an annual basis) that grey seal density in the vicinity of the Eagle development is between one and five individuals per 25 km^2 and harbour seal density is between zero and one individual per 25 km^2 (*Jones et al., 2017*).

3.4 Conservation

3.4.1 Offshore Conservation

Previous survey work (*Fugro, 2016a; 2016c*) identified that sediments within the survey area were consistent with the '*offshore subtidal sands and gravels*' priority marine feature (PMF), with the biotope '*circalittoral muddy sand*' (A5.26) identified across most of the surveyed area. However, these sandy seabed sediments are widely distributed throughout the central and northern North Sea regions and are therefore not thought to be of conservation significance within the surveyed area (*Fugro, 2016c*).

Smaller discreet areas of '*methane seeps in sublittoral sediments*' (A5.714) were however observed along the Eagle to Gadwall and Kittiwake to Mallard routes (discussed in 'Annex I habitats' below).

The closest offshore protected site to the proposed Eagle development is the East of Gannet and Montrose Fields NCMPA, which lies approximately 11.5 km to the south-east (Figure 3.9). The East of Gannet and Montrose Fields NCMPA is designated for the habitat '*offshore deep-sea muds*'. The site boundaries of this MPA confine the full extent of an area of this habitat and it is one of only a few examples of Atlantic-influenced offshore deep-sea mud habitats on the continental shelf in this region. The deep-sea muds within the site occur in a 2-7 km wide band from the south-east to the north-west, in a water depth of approximately 100 m. There is limited evidence of the composition and diversity of the biological communities present within the habitat, but it is thought to be colonised by animals such as sea spiders, sea cucumbers and sea urchins, which may form diverse communities on the surface of the sediment. The East of Gannet and Montrose Fields MPA is also designated for '*ocean quahog aggregations, including sands and gravels as their supporting habitat*' (*JNCC, 2016a*).

The Norwegian boundary sediment plain NCMPA lies approximately 87 km to the north-east of the proposed Eagle development adjacent to the UK-Norway transboundary line. This site is a sandy plain in relatively shallow waters and is home to a range of animals that live both in and on the sand and gravel habitat. The site is designated for '*ocean quahog aggregations (including sands and gravels as their supporting habitat)*' (*JNCC, 2014*). Further information on the ocean quahog is presented in section 3.4.3.

The proposed Eagle development lies approximately 70 km east of the Turbot Bank NCMPA. The Turbot Bank NCMPA lies within an area of sandy sediment and includes the shelf bank and mound feature known as 'Turbot Bank'. The MPA is designated for the mobile feature sandeels. Sandeel are a commercially important species, particularly Raitt's sandeel (*Ammodytes marinus*). The sandeels present within Turbot Bank are an important component of the larger sandeel population in the CNS and NNS and play an important role in the wider North Sea ecosystem, providing a vital source of food for seabirds, fish and marine mammals (*JNCC, 2017b*).

Annex 1 Habitats

Methane Derived Authigenic Carbonate (MDAC)

The main potential Annex I habitat that may occur within the vicinity of the proposed Eagle development are '*submarine structures made by leaking gases*', which are often found in association with pockmarks. Submarine structures made by leaking gases have a restricted distribution in European waters, due in-part to their relationship to sources of shallow gas. Within UK waters this habitat is mainly (but not exclusively) associated with such large pockmarks commonly found in the Fladen and Witch Grounds in the NNS, as well as part of the Irish Sea (*Jackson & McLeod, 2002*). Localised occurrences of pockmarks in the CNS are not uncommon and may contain this Annex I habitat.

The Annex I habitat '*submarine structures made by leaking gasses*' comprises rocks, pavements and pillars made of carbonate cement. Such cement is mostly made by microbial oxidation of methane and is commonly known as methane derived authigenic carbonate (MDAC). MDAC forms within the sediment at the sulphate-methane transition zone (SMTZ), within a few metres of the seabed (*Judd, 2005*). MDAC concretions in the form of crusts or slabs may then be brought up to the surface by natural movements of surficial sediments. These exposed lumps can have an effect on the local benthos, by providing hard substratum and shelter in an otherwise soft sediment environment.

Methane gas and sulphide escaping through the sediment play host to a number of bacteria. Methane is oxidised both anaerobically within the sediment and aerobically by methanotrophic bacteria, close to the sediment water interface. Anaerobic methane oxidation is closely linked to sulphate reduction; these aggregates of prokaryotes are thought to be responsible for the MDAC, however they have yet to be observed. Sulphur oxidising bacterial mats (probable *Beggiatoa* sp.) observed as white patches on the seabed have been found (*Dando & Hovland, 1992*); these mats are normally described as *Beggiatoa* sp.

The site surveys undertaken over the previous years have identified a number of occurrences of MDAC across the survey area. Of relevance to the proposed Eagle development, possible MDAC was observed along the Eagle to Gadwall pipeline route. 2019 survey activities were tasked to survey the proposed umbilical route from Eagle to the Kittiwake platform and to re-visit areas of possible MDAC along the proposed Eagle to Gadwall pipeline route.

The investigated pockmarks on the Eagle to Gadwall pipeline route were all confirmed to contain MDAC.

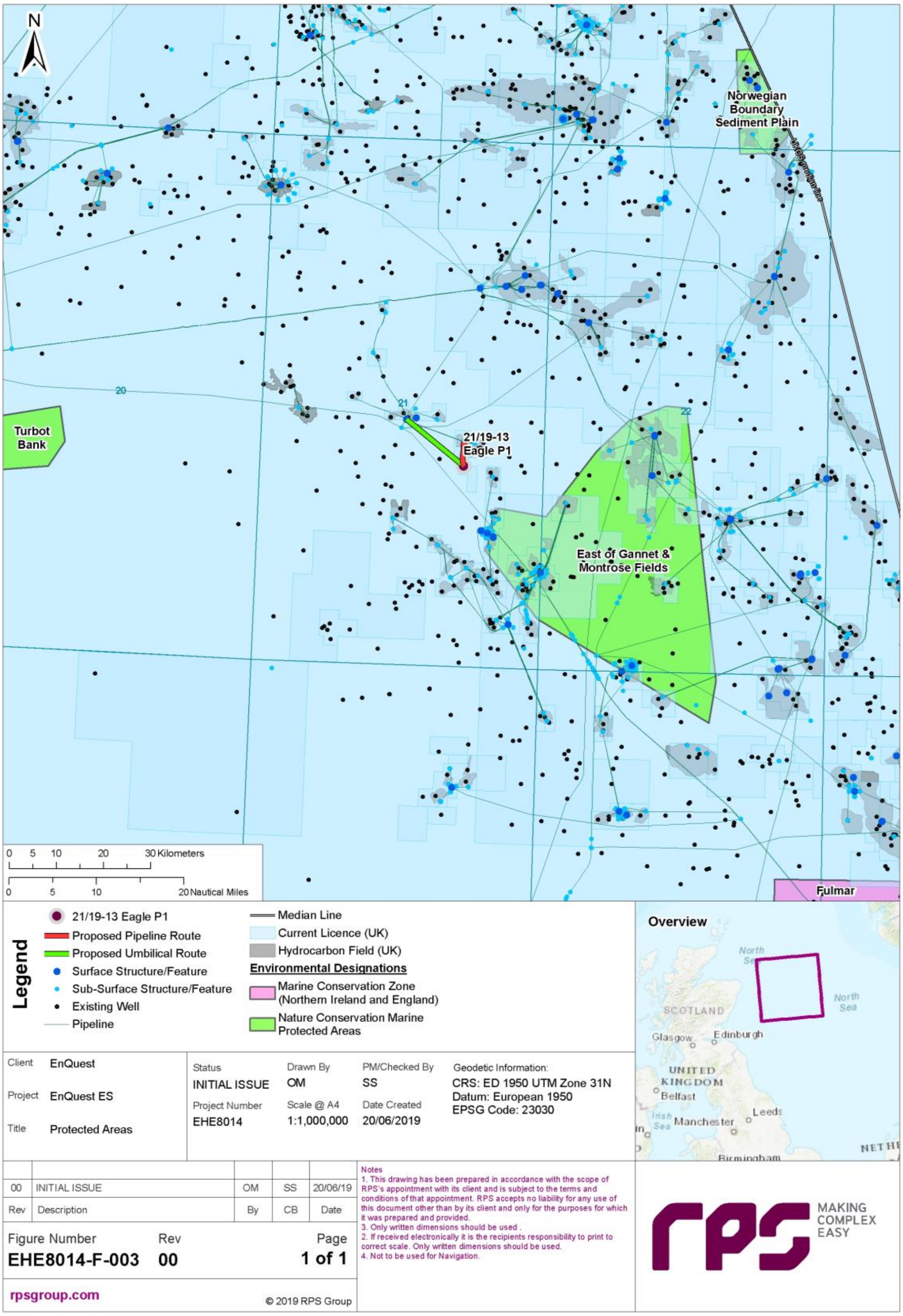

Figure 3.9: Protected sites in the vicinity of the Eagle development

Along the proposed Eagle to Gadwall route, potential MDAC was identified at six stations/transects (ENV3 to ENV7 and ENV23) and accounted for 21% of all photographs acquired along the pipeline route. Bacterial mats were identified in 14% of photographs at the six stations/transects where potential MDAC was noted and 15% of photographs across all stations/transects along the Eagle to Gadwall proposed pipeline route. The presence of bacterial mats further indicated the presence of a chemosynthetic community associated with the MDAC structures. Potential MDAC identified from imagery acquired at transects ENV4 and ENV7 and Stations ENV5 and ENV6 ranged in size from 328 m^2 at transect ENV7 to 1,330m^2 at transect ENV4. Potential MDAC along transect ENV3 was identified from photographs within two separate areas of 452 m^2 and 788 m^2. Furthermore, an area of potential MDAC was identified from photographs at Station ENV23, however this was not distinguishable within the SSS data. The largest two areas of higher reflectivity with the potential to contain MDAC where no imagery data was acquired were 3,936 m^2 situated in the vicinity of KP2.5 and 10,641 m^2 situated between the Eagle to Gadwall and Eagle to Mallard proposed pipeline routes (*Gardline, 2019d*). The identified MDAC along this route is shown in detail in Appendix B.

Along the proposed Eagle to Kittiwake route, potential MDAC was only identified along Transect ENV7 (located in the vicinity of the Eagle well) in 20 of the 49 photographs (41%). The area of potential MDAC coincided with an area of higher reflectivity (328 m^2) and overlapped with an area of higher reflectivity identified during the Fugro (2016) survey (521 m^2). No additional areas of potential MDAC were identified along the umbilical route (*Gardline, 2019d*). The features of interest identified on the geophysical data were observed to be predominantly drop boulders or were anthropogenic in origin, with a scoured depression round a glacial drop boulder and/or discarded fishing gear giving the feature low resemblance to MDAC filled pockmarks on the geophysical data. Table 3.7 shows the location of MDAC features within the proposed Eagle development pipeline route.

Increases in faunal abundance were also observed at all stations containing MDAC. Figures 3.10 to 3.12 provide photo examples of the MDAC and associated faunal features encountered along the survey.

EnQuest proposes to route the pipeline from Eagle to Gadwall, and the umbilical from Eagle to Kittiwake, around the MDAC features by placing exclusion zones around them. Details on how this will be achieved are given in the impact assessment in section 5.1.2.

Figure 3.10: MDAC, shell fragments and anthropogenic debris at station ENV3 (Gardline, 2019c)

Figure 3.11: MDAC and shell fragments at station ENV5 (Gardline, 2019c)

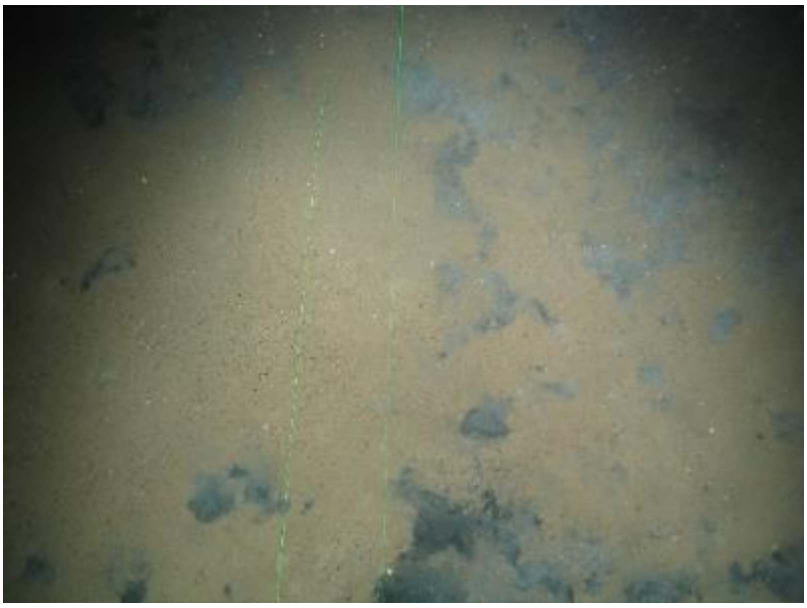

Figure 3.12: Bacterial mat at station ENV5 (Gardline, 2019c)

Sea-pens and Burrowing Megafauna Communities

Sea-pen and burrowing megafauna communities is included as a habitat on the OSPAR list of threatened and/or declining species and habitats. The habitat is characterised by plains of fine mud of depth between 15 and 200 m, which are heavily bioturbed by burrowing megafauna. Burrows and mounds often form part of the seascape in this habitat. Sea-pens are also known to associate with it, including *Virgularia mirabilis* and *Pennatula phosphorea*. The burrowing activity of crustacean megafauna, such as *Nephrops norvegicus* (Norway lobster), *Calocaris macandreae* and *Callianassa subterranea* creates a distinct and complex habitat, providing bioturbation and deep oxygen penetration into sediments. This habitat is known to be widespread in Europe, occurring extensively in sheltered basins of fjords, sea lochs, voes and is also extensive in offshore areas of the North Sea, Irish Sea and the Bay of Biscay (*OSPAR, 2010*).

The definition of the sea-pens and burrowing megafauna communities habitat is the subject of ongoing discussion as the scientific knowledge base improves. The most recent position on the definitions of the sea-pens and burrowing megafauna communities habitat is that the presence of burrowing megafauna is the essential defining characteristic of the feature; the presence or absence of sea-pens does not in itself define the feature. It is the presence of burrows that is the key defining feature (*Pers. Comm.*, *JNCC, 2019*). Furthermore, in recent advice to Defra (concerning data from the *Nephrops* fisheries stock assessments) the threshold considered to demonstrate the presence of a sea-pen and burrowing megafauna communities habitat is a burrow density of greater than 0.2m^2, and/or multiple sightings of burrows and/or mounds attributable to relevant species across a video tow, or present in a sufficient number of still images to identify the burrows and/or burrowing species as at least frequent on the SACFOR scale (*JNCC, 2017c*) (*Pers. Comm.*, *JNCC, 2019*).

During the Eagle rig site survey work undertaken in 2013 and 2014 (Fugro, *2014b*; *2014c*), *Pennatula phosphorea* was recorded sparsely across the survey area. However, the assemblages of sea-pen recorded, and the sediments did not correspond to the OSPAR definition of the ‘sea-pens and burrowing megafauna communities’ habitat due to the lack of burrows observed in the sediments at the sampled stations (*Fugro, 2014b*; *2014c*).

During the pipeline route survey work conducted in 2016, where environmental baseline sampling work was conducted from Kittiwake to Mallard (*Fugro, 2016b*; *2016c*), moderate numbers of faunal burrows were observed across the survey area on the video transects and still images. *Pennatula phosphorea* was observed at station 4. However, the habitat assessment conducted for these survey results did not identify the ‘sea-pens and burrowing megafauna communities’ habitat (*Fugro, 2016b*; *2016c*).

As part of the 2019 survey work, an assessment of the sea-pen and burrowing megafauna community was undertaken, referring to the MNCR SACFOR abundance scale (JNCC, 2013, In: *Gardline, 2019d*). The average burrow and Pennatulacea densities were calculated for each station/transect using the total area covered by the seabed imagery (average swathe width x camera station/ transect length). Along the Eagle to Gadwall route, burrows were observed in 8% of all images and 7% of photographs, with densities <0.5 burrows m^2 and dimensions reaching a maximum of 3 cm. According to the SACFOR scale, burrows were generally ‘rare’ except for Station ENV1 where ‘frequent’ was the upper limit of abundance (*Gardline, 2019d*).

Along the Eagle to Kittiwake route, Burrows were observed in 8% of all images and 6% of photographs, with densities <0.2 burrows m^2 and dimensions reaching a maximum of 2.7 cm. According to the SACFOR scale, burrows were ‘rare’ across all stations/transects along the EAG-KIT proposed umbilical route (*Gardline, 2019d*). Appendix C provides the sea pen and burrows habitat distribution identified across the survey area.

Given the above survey observations, there is limited potential for the sea-pens and burrowing mega fauna community along the Eagle to Gadwall route given that burrows were only classified as ‘frequent’ at one observed station (ENV1). There is less evidence from the initial results that this habitat is present along the Eagle to Kittiwake route. The 2016 survey results from Kittiwake to Gadwall/ Mallard indicated that although some evidence of burrows and sea-pens was seen, the habitat assessment concluded that they did not constitute the habitat.

3.4.2 Coastal Conservation

The closest coastal protected area is the Buchan Ness to Collieston Coast SPA, located approximately 135 km to the west of the Kittiwake platform on the coast of Aberdeenshire, in north-east Scotland. It is a 15 km stretch of south-east facing cliff formed of granite, quartzite and other rocks running to the south of Peterhead, interrupted only by the sandy beach of Cruden Bay. The low, broken cliffs (generally less than 50 m high) show many erosion features such as stacks, arches, caves and blowholes. The varied coastal vegetation on the ledges and cliff tops include maritime heath, grassland and brackish flushes. The site is of importance as a nesting area for several seabird species (gulls and auks). These birds feed outside the SPA in the nearby waters, as well as more distantly (*JNCC, 2001*).

Other coastal protected sites include the Troupp, Pennan and Lions Heads SPA, situated approximately 170 km from the proposed Eagle development. This site is a 9 km stretch of cliffs along the Banff and Buchan coast of Aberdeenshire. The site also includes adjacent areas of grassland and heath, and several small sand or shingle beaches are also present along the otherwise rocky shore. The cliffs rise to over 150 m in places are provide an ideal habitat for nesting seabirds. During the breeding season, the site supports Guillemot (29,902 pairs which represents at least 1/3% of the East Atlantic breeding population). It is also designated as supporting seabird assemblages of international importance, regularly supporting 150,000 individual seabirds including: Razorbill, Kittiwake, Herring Gull, Fulmar and Guillemot (*JNCC, 2005*).

The Fowlsheugh SPA, situated approximately 180 km from the proposed Eagle development, is situated on the north-east coast of Scotland. The Fowlsheugh site consists of cliffs 30-60 m high with a sheer face which provide a breeding area for nesting seabirds. The site supports seabird populations of European importance including Guillemot; 40,140 pairs (count as of 1992) representing at least 1.8% of the breeding east Atlantic population, and Kittiwake; 34,870 pairs (count as of 1992), representing at least 1.2% of the east Atlantic breeding population. The site is also designated for supporting seabird assemblages of international importance, as it regularly supports at least 20,000 seabirds, and during the breeding season, supporting around 170,000 seabird species including, Razorbill, Herring gull, Fulmar, Guillemot and Kittiwake (*JNCC, 2004*).

Among the species listed as protected features of the coastal conservation sites listed above, some are known to travel distances that are greater than the distance between the Eagle development and these protected sites. These include Gannet (590 km), Great skua (219 km), Puffin (200 km), and Fulmar (580 km) (Thaxter *et al*., 2012). These seabird species are therefore likely to forage as far as the Eagle field area.

3.4.3 Species

Marine Mammals

Grey seals, harbour seals, harbour porpoise and bottlenose dolphin are currently protected under Annex II of the EU Habitats Directive. The inner Moray Firth area (over 200 km from the proposed Eagle development) has been designated as a SAC due to the presence of bottlenose dolphin; however, bottlenose dolphins are unlikely to be recorded in the vicinity of the Eagle field, as there are no records of previous sightings of this species in recognised datasets (section 3.3.5).

Harbour and grey seal, which are both listed as Scottish PMFs, have the potential to be present at the Eagle field, but their presence is likely to be in low numbers as discussed in Section 3.3.5. The only Annex II species regularly recorded in the vicinity of the Eagle development area is the harbour porpoise. Harbour porpoise, minke whale, white beaked dolphin and Atlantic white-sided dolphin, are all listed as PMF in Scottish waters (*Tyler-Walters, 2016*). The occurrence of these species in the vicinity of the Eagle development is detailed in section 3.3.5. However, due to their mobile nature marine mammals are likely to move away from areas of disturbance. Noise impacts on marine mammal species from the proposed Eagle development are assessed in section 5.3.

Fish

Some commercially important fish species in the vicinity occupying the Eagle development area are listed as Scottish PMFs: anglerfish, blue whiting, cod, herring, ling, Norway pout, sandeel and whiting (*SNH, 2014*). Section 3.3.3 describes whether these species occupy the area as spawning or nursery grounds.

Sandeels were identified in two photographs at Station ENV14 and observed in grab samples from Station ENV17; both stations were situated along the Eagle to Kittiwake proposed umbilical route. The sediment in the area was assessed to be mostly silty sand from the grab samples, imagery and geophysical analyses and is likely to be suitable for sandeel spawning grounds. The PSA indicated that the sediments at Stations ENV14 and ENV17 were “suitable” for sand eel spawning according to the criteria defined by Latto *et al.*, (2013). A single station had 'prime' sediments, ten stations had ‘sub-prime’ sediments while six were ‘suitable’ for sand eel spawning. No stations were considered ‘unsuitable’ for sand eel spawning according to the assessment (*Gardline, 2019d*). The assessment therefore suggests that the area is suitable for sandeel spawning, although only one station was identified as consisting of ‘prime’ sandeel spawning sediments. The available data suggests that the area of higher sandeel spawning activity is located to the west of the proposed Eagle development (refer to section 3.3.3 and Figure 3.7).

Non-commercially important fish species of conservation value that are found in UK waters include the European sturgeon (*Acipenser sturio*), which is relatively rare and the common whitefish (*Coregonus lavaretus*) both of which qualify for protection under Annex II of the Habitats Directive. Other important species of conservation value include the basking shark (*Cetorhinus maximus*), tope shark (*Galeorhinus galeus*) and porbeagle (*Lamna nasus*). None of these species are recorded in significant densities in the CNS and occur only in small numbers throughout the North Sea during periods of peak zooplankton abundance. Therefore, it is considered unlikely that any of these species will be significantly affected by the proposed Eagle development.

The Ocean Quahog

The infaunal venerid bivalve *Arctica islandica*, commonly known as the Icelandic cyprine or ocean quahog, inhabits sandy and muddy sediments from the low intertidal zone to around 500 m and is notable for its longevity and large size (*Sabatini, et al., 2008*). *A. islandica* is listed on the OSPAR (2008) '*List of threatened and declining habitats and species*' and has subsequently been listed as a species for which Scottish marine protected areas (MPAs) and English/Welsh marine conservation zones (MCZs) may be selected, under UK legislation (The Marine and Coastal Access Act 2009, and the Marine (Scotland) Act). They are also recognised under the Marine Conservation Zone (MCZ) guidance as a Feature of Conservation Importance (FOCI) and a Priority Marine Feature (PMF) (Natural England and Joint Nature Conservation Committee, 2010; Marine Coastal Access Act 2009; Marine Scotland Act 2010).

A. islandica is a species of thick-shelled bivalve mollusc that can live for over 400 years, which makes it one of the longest living creatures on earth. They are filter feeders and can use a shovel-like 'foot' to bury themselves into the sediment. To escape predators, they can burrow even deeper into the sediment and live for long periods without food or oxygen. Ocean quahog are an important food source for several species of fish, including cod.

The nomination of *A. islandica* for inclusion on the OSPAR list of threatened and/or declining species was due to significant recorded changes in the populations of this species during the last century, with particular emphasis placed on OSPAR Region II, the Greater North Sea (*OSPAR, 2009a*). Aggregations are typically found buried in sediment from the shoreline to depths of approximately 400 m and can be found on both sides of the North Atlantic and the Baltic region. The inclusion of the ocean quahog on the OSPAR list is attributed to an observed decline in the population, sensitivities and direct threat from seabed disturbance. Management options proposed by OSPAR include limiting seabed disturbance attributed to human activity in the vicinity of ocean quahog aggregations (*OSPAR, 2009a*).

Evidence of the occurrence of ocean quahog was found during the recent survey work, where individual shells were recovered from grab samples (*Fugro, 2016c*) and broken shells were observed at the majority of camera stations in the spring 2019 survey work undertaken along the Eagle to Gadwall pipeline route and Eagle to Kittiwake umbilical route, although no live individuals were observed (*Gardline, 2019d*). There was no suggestion that the observed evidence of this species constituted aggregations of the species, particularly as no live specimens were observed. Therefore, the seabed habitat in the Eagle development area is not considered of significant conservation importance for this species. Ocean quahog is commonly found within this area of the North Sea (*Oil & Gas UK, 2017*). The current core distribution of this species in the CNS is the Fladen Ground (*OSPAR, 2009a*).

3.5 Socio-Economic Environment

3.5.1 Commercial Fisheries

The North Sea has important fishing grounds and is fished by both UK and international fishing fleets, targeting both demersal and pelagic fish stocks (*Cefas, 2001*). The Eagle development lies within ICES rectangle 43F0. According to Scottish Government 2018 statistics, ICES rectangle 43F0 is mainly targeted for both demersal and pelagic fish, but also comprises shellfish fisheries (*Marine Scotland, 2019a*). Table 3.15 lists the live weight and value of fish and shellfish landings into Scotland from ICES rectangle 43F0 from 2014 to 2018 (*Marine Scotland, 2019a*).

In 2018, pelagic fisheries accounted for 65% of the liveweight and 49% of the value in rectangle 43F0, whilst demersal species accounted for 35% of the liveweight and 50% of the value. In 2017, tonnage for demersal fish recorded in ICES rectangle 43F0 was much higher than pelagic species; 96% and less than 0.1%, respectively (90% and less than 0.1% of the value, respectively).

Between 2014 and 2017, the pelagic fish landed from ICES rectangle 43F0 was virtually non-existent, with only 1 tonne recorded in 2017. The general historic trend indicates that demersal species are primarily targeted in ICES rectangle 43F0, with 2018 marking a departure from this trend, with a vastly increased amount of pelagic landings than any of the previous years. Demersal fish have historically always been caught from ICES 43F0, although in slightly reduced masses than 2014 and 2015 (1,018 and 1,004 tonnes respectively, compared to 392, 572 and 760 tonnes for 2016, 2017 and 2018 respectively). Shellfish species have been caught fairly consistently in ICES 43F0 however 2018 marks the lowest landing of shellfish species out of the five years of historic data. The historic fishing data for

ICES 43F0 indicates that fishing activity in the area is comparable to other areas in the vicinity (*Marine Scotland, 2019a*).

Table 3.15: Live weight and value of fish and shellfish taken from ICES Rectangle 43F0 for 2014-2018 (Marine Scotland, 2019a)

Species type	2018 (provisional data)	
	Liveweight (tonnes)	Value (£)
Demersal	760	538,289
Pelagic	1,403	522,083
Shellfish	6	11,467
Total	**2,169**	**1,071,839**
	2017	
	Liveweight (tonnes)	Value (£)
Demersal	572	765,641
Pelagic	1	1,875
Shellfish	25	86,725
Total	**598**	**854,241**
	2016	
	Liveweight (tonnes)	Value (£)
Demersal	392	438,354
Pelagic	-	-
Shellfish	23	98,387
Total	**415**	**536,741**
	2015	
	Liveweight (tonnes)	Value (£)
Demersal	1,004	1,284,745
Pelagic	0	294
Shellfish	11	41,224
Total	**1,015**	**1,326,263**
	2014	
	Liveweight (tonnes)	Value (£)
Demersal	1,018	1,418,180
Pelagic	0	417
Shellfish	14	48,065
Total	**1,032**	**1,466,662**

The data indicate that haddock and herring are the most valuable fish caught in ICES 43F0, followed by cod, sandeels and *Nephrops*. Hake, whiting and saithe are also important species (*Marine Scotland, 2019a*).

Logbooks submitted by fishermen allow the seasonal pattern of fishing effort to be examined, as shown in Table 3.16. In ICES rectangle 43F0, effort tends to increase in June to December, with the fishing effort often below 5 days from January to May (which is reflected by disclosive data). In 2018, fishing effort from August to October accounted for 57% of the total number of days fished in 2018. Fishing effort in 2018 as a whole is approximately 50% lower than all previous years. In the years preceding 2018, historical fishing effort in ICES 43F0 has been moderate to high (*Marine Scotland, 2019a*).

Table 3.16: Number of days fished per month (all gears) in ICES Rectangles 43F0, 2014 - 2018 (Marine Scotland, 2019a)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
ICES Rectangle 43F0													
2018	8	D	D	D	D	5	D	15	5	6	D	6	45
2017	D	D	D	D	D	7	18	39	21	3	13	D	101
2016	19	D	10	D	6	6	D	11	24	6	40	19	141
2015	13	D	D	D	D	15	17	19	32	48	35	26	205
2014	D	D	D	D	8	D	15	16	D	21	23	31	114

Note: Monthly fishing effort by UK vessels landing into Scotland: green = 0 – 100 days fished, yellow = 101 – 200, orange =201-300, red = ≥301, D = disclosive

Trawls were the main gear type utilised in 2018 in ICES rectangle 43F0 (*Marine Scotland, 2018*). From recent analysis of fishing intensity, demersal fishing intensity in ICES rectangle 43F0 is relatively low in comparison with other areas of the North Sea (*Kafas et al., 2012*).

Recently created aggregated fishing effort datasets, based on ICES data from 2009 to 2016 (*Marine Scotland, 2019b*), show average annual fishing effort in hours for different gear types: bottom trawls, dredges, and bottom trawls targeting *Nephrops* and other crustaceans. Effort in hours was aggregated into total and average for the period 2009-2016 for these three groups of fishing method. The data shows that across the Eagle development, average annual effort for bottom trawls is 5 hours in Block 21/18 and 9 hours in Block 21/19. There is an area in the top-right corner of Block 21/19 that shows bottom trawl effort is significantly higher (58 hours) however this is not located over the development area. The data shows no effort for the other two gear types across the development area and in the wider vicinity (*NMPi, 2019*).

Subsea structures associated with the Eagle development outside of existing 500 metre safety exclusion zones (i.e. outside the Kittiwake platform), namely the Eagle wellhead and subsea termination unit, will be protected by fishing-friendly structures to minimise the risk of snagging fishing gear.

Data that shows fishing intensity associated with oil and gas pipelines and cables, compiled from VMS data of fishing vessels greater than 15 m in length from 2007 to 2015, shows that interaction between fisheries and pipelines in the GKA (Blocks 21/18 and 21/19) is relatively low for demersal trawls, whilst data for *Nephrops* trawls shows very little interaction in the wider area (and no interaction in the vicinity of the proposed Eagle development), and data for dredges shows no interaction (*Scottish Government, 2017*).

Recently, Marine Conservation Orders (MCOs) and fisheries management measures for MPAs and SACs have been considered by the Scottish Government. NCMPAs and SACs are designated under the Marine (Scotland) Act 2010 or the UK Marine and Coastal Access Act 2009 and must be managed in a way that furthers the conservation objectives and prevents deterioration of qualifying features. To this end, there is currently a consultation on potential fisheries management measures; of relevance to the proposed Eagle development is the potential restriction of demersal fishing gear within the nearby East of Gannet and Montrose Fields NCMPA. If successful, this will mean that trawling and dredging within these areas will be completely prohibited (*Marine Scotland, 2018*; *NMPi, 2019*).

3.5.2 Aquaculture

UK aquaculture is dominated by Scottish salmon production; In 2009, 81% of all UK aquaculture by weight (i.e. including freshwater cultivation) was of Scottish salmon (*NEF, 2014* in: *DECC, 2016*). In addition, 99% of marine finfish cultivation takes place in Scottish waters (*Gubbins, et al. 2013*). Aquaculture sites in Scotland are principally located around the west and northern coasts (*DECC, 2016*). The closest location where aquaculture activity is traditionally high to the proposed Eagle development is the Orkney and Shetland Islands, located over 200 km to the north-west. The Shetland and Orkney Islands are well known and highly regarded for salmon and mussel production.

The closest active shellfish site to the proposed Eagle development is Lamb Holm on the Orkney Islands approximately 250 km to the north-west. The closest finfish production site is located in Aberdeen approximately 150 km to the west (*NMPi, 2019*).

3.5.3 Oil and Gas Activities

There is a long history of oil and gas activity in the North Sea, with oil being discovered in the early 1960s and the first well coming online in the early 1970s. Whilst gas production is most common in the southern North Sea, both oil and gas are found in the central and northern North Sea areas. The Eagle field is located in the CNS in an area of extensive existing oil development (*DECC, 2016*). There are a number of topsides installations located within the vicinity of the proposed Eagle development, as shown in Figure 3.13 and Table 3.17. Over 90 wells and over 80 pipelines lie within a 25 km radius of the Eagle well (*UK Oil & Gas Data, 2019*).

The proposed Eagle development lies in the vicinity of the Greater Kittiwake Area (GKA). The GKA comprises five oil fields: Kittiwake, Mallard, Gadwall, Goosander and Grouse (*EnQuest, 2019*). The Gadwall, Mallard and Cook oil fields all lie to the north (4.1 km), north-west (2.3 km) and west (5 km) of the Eagle well respectively. The Kittiwake platform lies 15.7 km to the north-west of the Eagle well (*UK Oil & Gas Data, 2019*).

Table 3.17: Topsides installations located within the vicinity of the Eagle field

Operator	Platform	Block	Approximate position relative to the Eagle field	Status
EnQuest	Kittiwake	21/18	15.5 km NW	Producing
Shell	Anasuria Permanent Wave Buoy	21/25	16.4 km SSE	Active
Shell	Anasuria FPSO	21/25	15.2 km SSE	Producing

3.5.4 Shipping

Shipping traffic within Blocks 21/18 and 21/19 is rated as low (*BEIS, 2016*). UK ports in the area include Sullom Voe, Scalloway and Colgrave Sound (*DECC, 2016*) with vessels mainly supporting the oil & gas and local fishing industries.

3.5.5 Military Activity

Aircraft, surface craft and submarines from many countries use the North Sea as a training ground and for routine operations but the distribution and frequency of these activities is unknown. However, there are no charted military exercise areas in the vicinity of Blocks 21/18 and 21/19 (*Hydrographer of the Navy, 2009*), nor are there any Ministry of Defence (MOD) conditions attached to the Blocks (*Oil & Gas Authority, 2018*).

3.5.6 Wrecks and Archaeology

No wrecks were identified along the proposed pipeline route from Eagle to Gadwall or in the vicinity of the Kittiwake platform during the 2016 site survey (*Fugro, 2016a*). Similarly, no wrecks were identified in the 2019 site survey from Eagle to the Kittiwake platform (*Gardline, 2019a*; *2019b*; *2019c*). There is one charted wreck to the south-west of the Kittiwake platform however this does not lie within the Eagle development project area (*Hydrographer of the Navy, 2009*).

3.5.7 Telecommunication Cables

There are no submarine cables in the vicinity of the proposed Eagle field development, the closest of which is the CNS fibre optic cable that lies over 30 km to the north (*KIS-ORCA, 2019*).

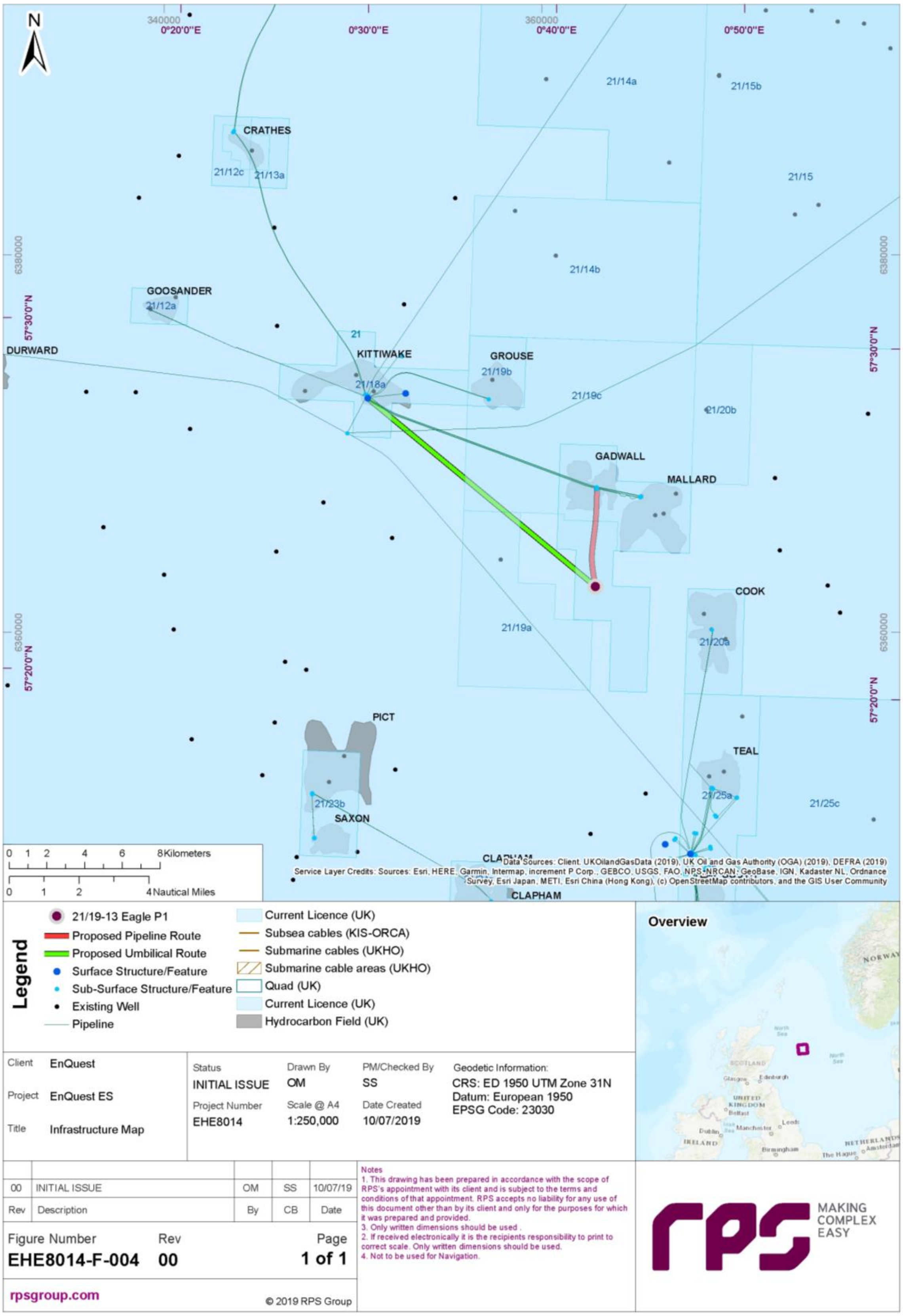

Figure 3.13: Oil and gas activities in the vicinity of the proposed Eagle development

3.5.8 Aggregate Extraction

There is no commercial or capital dredging presently undertaken and no sites are licensed for disposal of dredged material within or in the vicinity of the proposed Eagle development (*The Crown Estate, 2018a*).

3.5.9 Offshore Wind Farms

There are no existing or proposed Round 1, Round 2 or Round 3 offshore wind-farm sites that lie within or around the proposed Eagle development (*The Crown Estate, 2018b*).

3.5.10 Tourism and Leisure

The largely unspoilt north coasts of Scotland, Orkney and the Shetland Islands and the wild natural scenery attract tourists in pursuit of a wide range of activities including walking, bird and cetacean watching, wildfowling, sailing, fishing, diving and the maritime and wartime history of the region (*DECC, 2016*). The tourism industry will not be impacted by normal offshore oil and gas operations, but leisure activities could be threatened in the event of a major accidental oil spill approaching the coast. The proposed development is, however, 140 km from the nearest landfall (to the Kittiwake platform) and the risk of interaction with the tourism industry through routine operational activities is therefore anticipated to be minimal.

4 Environmental Impact Methodology

4.1 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 Development planning, to ensure that best environmental practice (BEP) 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 EnQuest's Health, Safety, Environment and Assurance (HSE&A) policy.

4.2 Identification of Environmental Issues

An EIA is to be focused on the key issues related to the specific activities proposed; the impact assessment write-up should be proportionate to the scale of the development and to the environmental sensitivities of the development area. For the Eagle development, EnQuest undertook an impact identification exercise to:

- Identify key environmental sensitivities;
- discuss sources of potential impact; and
- identify those sources which required further assessment.

The decision on which issues required further assessment was based on the specific proposed activities and environmental sensitivities, a review of industry experience of EIA outcomes and on an assessment of wider stakeholder interest (informed in part by the stakeholder engagement described in Section 4.3). Table 4.1 summarises the identification exercise, providing justification for the inclusion and exclusion of impact sources.

The impact identification process was kept under review throughout the EIA, with mitigation revised as understanding of the Eagle development increased and as consultation continued.

Table 4.1: Summary of the impact identification exercise, with justification for the inclusion and exclusion of impact sources

Source of Potential Impact	Further assessment?	Rationale
Discharges to Sea		
Routine chemical use and discharge to sea during installation (pipeline, spools and jumpers), including pre-commissioning gels and dyes, releases from pipeline and spools during tie-in, barrier checks, dewatering and during operations (subsea valve maintenance) and any incremental use and discharge from Kittiwake.	No	There will be a number of chemical discharges during the operations associated with the Eagle development. These will be fully assessed as part of the environmental permitting process (e.g. through MAT/SAT). Considering the above, discharges to sea during installation and pipeline commissioning are not assessed further herein.

Source of Potential Impact	Further assessment?	Rationale
Routine discharge of ballast water, black water, grey water and food waste (installation and operation phase vessels)	No	Discharges from vessels/drilling units are typically well-controlled activities that are managed on an ongoing basis as per International Maritime Organisation (IMO) standards and Conventions. The duration of the drilling and installation campaign is of relatively short duration (approximately 223 days in total). The Eagle field is not located within a protected area. Considering the above, these discharges are not assessed further herein.
Cuttings and routine chemical use and discharges associated with drilling.	No	The Eagle well will be drilled entirely with LTOBM. The LTOBM mud system will be a closed system with zero discharges of cuttings and associated mud to sea. All cuttings and drilling muds will be sent to shore for processing and recycling/disposal. As there will not be any cuttings or drilling muds discharged to sea, there will be no impact on the water column or seabed from drilling discharges. Considering the above, cuttings discharges are not assessed further herein.
Changes to produced water discharge at Kittiwake as a result of additional production from Eagle well 211/18a-JB	No	The fluids from the 21/19-13 Eagle P1 well do have the potential for produced water in the event that the P10 case is not realised. However, Kittiwake will not be operated outside of its current produced water design envelope. To accommodate fluids from Eagle, both Gadwall and Mallard production will be backed off to free up space in the Kittiwake process systems. Therefore, there will be no increase to the overall water production at Kittiwake as a result of Eagle coming online. Considering the above, produced water discharges are not assessed further herein.
Physical Presence		
Installation of pipeline, umbilical, spools and jumpers, deposited material (concrete mattresses), wellhead, subsea XT and SDU. Physical presence of new infrastructure including deposited material, in relation to other sea users, both in terms of possible exclusion and risk of snagging. Anchoring / spud can placement of drilling unit.	Yes – Section 5.1	Direct damage to benthic habitats and fauna is expected during installation of infrastructure, protection materials and anchoring/spud can placement from the drilling unit. In addition, there is the potential for increased turbidity of the water column due to the installation activities (trenching / jetting) which may lead to wider smothering caused by the resultant sediment plume. MDAC has been identified in the vicinity of the proposed pipeline and umbilical routes. Long term potential obstruction or exclusion from structures laid/fixed on the seabed (e.g. well XT, SDU, pipeline, and umbilical etc) may impede commercial fishing activities and other sea users. Seabed impacts are deemed potentially significant in EIA terms and there is a stakeholder expectation to assess it in this EIA. On this basis, further assessment has been undertaken. No wrecks have been recorded in the vicinity of the proposed Eagle development by any of the site survey work conducted. There is one charted wreck to the south-west of the Kittiwake platform however this does not lie within the Eagle development project area. Considering this, the impact on archaeological features is not assessed further as part of the physical presence assessment.

Source of Potential Impact	Further assessment?	Rationale
Physical presence of vessels and drilling unit	Yes - Section 5.1	The presence of vessels will be relatively short-term in the context of the life of development. The drilling unit will be in an area already exposed to high levels of oil and gas activity. A 500-metre safety exclusion zone will be in place while the drilling unit is on location at the 21/19-13 Eagle P1 well. However, due to the nature of the development, there will be a need to deploy vessels for installation of the pipeline, umbilical and subsea infrastructure. For this reason, the physical presence of the drilling unit and vessels is potentially significant in EIA terms and on this basis, further assessment has been undertaken.
Underwater Noise		
Noise emissions from activities	Yes - Section 5.3	The proposed Eagle development will create underwater noise from various sources, including drilling, use of vessels and potential installation of the SDU by piling. Due to the potential for piling, noise impacts are potentially significant in EIA terms and on this basis, further assessment has been undertaken.
Atmospheric Emissions		
Energy use and emissions to air, including vessel use, and power generation	Yes – Section 5.2	Gas emissions as a result of the Eagle development could result in impacts at a local, regional, trans-boundary and global scale. Local, regional and trans-boundary issues include the potential generation of acid rain from nitrogen and sulphur oxides (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 NOx and volatile organic compounds (VOCs). Atmospheric emissions from the Eagle development will be related largely to fuel consumption by the drilling unit and installation vessels, and from well clean-up / testing. Field life for the Eagle well is estimated at 3 years. Considering the length of field life and the type of activities planned where emissions will be generated over a number of years, further assessment on atmospheric emissions has been undertaken.
Incremental fuel usage and incremental flaring / venting at Kittiwake as a result of the Eagle development coming online.	No	There will be no incremental fuel usage at Kittiwake even though a new development well has been brought online. The Gadwall and Mallard fields will be backed out to accommodate production from Eagle and therefore the Kittiwake platform will not be operated outside of its current design envelope. No venting takes place on board Kittiwake and therefore there will be no venting resulting from the Eagle development coming online. On this basis, atmospheric emissions associated with fuel usage at Kittiwake is not assessed further herein.
Waste		
Waste: Waste including non-hazardous, hazardous, radioactive and marine growth	No	EnQuest has briefly outlined the Waste Management Plan in section 6.3 which describes how the overarching strategy and guiding principles will be applied to manage the Eagle development. Regarding capacity, part of the waste tenderer's bid will need to include demonstration of capacity to handle expected volumes. If a yard outside the UK is selected, EnQuest will ensure commitments regarding trans-frontier shipments (Basel Convention) are met. Waste will be managed as per EnQuest standards and existing legislation and guidance.

Source of Potential Impact	Further assessment?	Rationale
		On this basis, assessment of waste has not been made further herein however, Section 6.3 describes the EnQuest Waste Management Plan.
Accidental Events		
Dropped objects	No	The Industry has effective management controls in place to reduce the potential for dropping objects. There is the potential for the loss of objects during the Eagle development. Depending on size and type of dropped object, these may present a hazard to other sea users. EnQuest will follow industry standard dropped objects procedures to ensure safety to other sea users is met at all times. Accidental events associated with dropped objects are not assessed further herein.
Accidental events, including accidental discharge/spill of medium/ large volumes of hydrocarbons/ chemicals to sea	Yes – Section 5.4	The potential impact of any accidental hydrocarbon or chemical release will be determined by the characteristics of the release of hydrocarbons or chemicals, the products' weathering properties, the direction of travel and whether environmental sensitivities lie in its path. The worst-case scenario associated with the Eagle development where a large spill could occur, is a well blowout. EnQuest will have an Oil Pollution Emergency Plan (OPEP) in place to cover the activities at the Eagle development. Catastrophic accidental events are deemed potentially significant in EIA terms. There is also a stakeholder expectation to assess this in the EIA. On this basis, further assessment has been undertaken.
Accidental events including small scale discharges/ spills of hydrocarbons/ chemicals from vessels/ drilling unit/ Kittiwake platform	No	Smaller spills may cause localised, short term contamination of seawater and limited damage to the aquatic ecosystem. EnQuest will have an approved OPEP in place during Eagle development activities (including production) which EnQuest will follow when dealing with any small-scale spills. On this basis, accidental events associated with small scale discharges/spills is not assessed further herein.

4.3 Stakeholder Engagement

In the early stages of the project, a number of key stakeholders were consulted in order to gauge their initial views on the project. A project information document (PID) was prepared containing key information on the project, which was sent with the consultation letters. A consultation meeting was also held in the early stages of the project with attendees from both OPRED and the JNCC. During this meeting, the preliminary survey results were presented, summarising the results and the MDAC features found, and the proposed mitigation of routing the pipeline around these features using an 80 metre pipeline installation corridor.

Overall, the consultees were satisfied with the proposed approach to the EIA, the key environmental issues and potential impacts identified for assessment, and the supporting studies proposed to facilitate assessment. The issues raised through this process have been considered and addressed during the course of the EIA to date and are summarised in Table 4.2.

Table 4.2: Summary of Issues Raised during Consultation Responses, and Details of how these have been Addressed by the Project

Issues Raised	Comments on issues raised and ES section in which addressed
Offshore Petroleum Regulator for Environment and Decommissioning (OPRED)	
Consideration should be given to the impacts of drilling, pipe/umbilical lay and production activities.	All of these activities have been given due consideration throughout the EIA process, as reported in the ES.
The design of the pipeline with regard to decommissioning potential should be included.	No decisions relating to the subsea equipment or option selection for the development have knowingly been taken that will preclude the ultimate aims of a decommissioning programme in line with BEIS (2018) guidance. Decommissioning is discussed throughout section 2 and also forms part of the impact assessment process in section 5.
Clearly explain what aspects have been considered and where they are not discussed further within the ES please clarify why.	Table 4.1 in this section clearly explains the rationale for aspects of the development that have been either excluded from further assessment or taken forward for further assessment.
Where the final approach has not yet been decided e.g. method of pipeline protection, then the ES must describe all potential options and assess the impact of the worst environmental case option. It should be noted that it is the Department's expectation that the introduction of rock into a mainly sedimentary environment is minimised as far as possible while allowing for adequate protection of subsea infrastructure.	The uncertainties associated with the Eagle development have been described within section 1.5 of the ES. Where uncertainties in the project arise, the potential worst-case options have been assumed. The use of protection structures and rock dump is discussed throughout section 2 (and specifically section 2.4.8). The impacts to the seabed from installation, including protection structures, are presented in section 5.1.
It is acceptable to submit the ES without the results of the full environmental baseline survey, however these must be submitted as soon as practicable after submission of the ES and the ES should contain an indicative date for such.	EnQuest will submit the full environmental baseline survey report from the spring 2019 site survey activities to all interested parties, as soon as this report becomes available.
Based upon the information presented at the meeting on 23 July 2019 with respect to the proximity of MDAC to the proposed pipeline route I would confirm that EnQuest are expected to maximise the separation distance between the various occurrences of MDAC and the pipeline with associated disturbance. The method(s) for avoiding or minimising the impact upon MDAC should be fully described in the ES e.g. slowing of pipe lay in vicinity of MDAC and the increased accuracy this allows. In support of the impact assessment I would advise that EnQuest include the results of the sediment deposition modelling that was submitted in support of PLA/607 (Scolty Crathes) including the confidence level of the modelling, which given the relative proximity to Eagle may still be considered relevant.	EnQuest is highly confident that it can employ pipeline installation methodology to avoid the occurrences of MDAC confirmed by the spring 2019 survey, having executed similar installation methodology around areas of MDAC identified in another field development project in the wider GKA area (namely Scolty-Crathes). The methodology is described in section 5.1.2 of the ES. Reference to previous suspended sediment modelling conducted for the installation of the Scolty-Crathes pipeline infrastructure has also been made.
Following completion of activities, it is assumed that EnQuest will undertake a re-survey of any MDAC potentially affected by the activities and make the relevant survey report(s) available to the Department and JNCC. The ES should state EnQuest's intentions in this regard, preferably as a commitment.	As part of post installation as-built surveys, EnQuest will revisit the areas of identified MDAC that are located closest to the pipeline route during the post-installation as-built surveys to confirm the status of these features following installation. The results of such survey activities will be made available to all interested parties.
It is understood that the type of MODU has not yet been determined. Where a semi-submersible MODU may be utilised it is the Department's expectation that the areas of existing MODU anchor scars are re-used where possible and the ES should reflect this, including any aspects that may preclude this. Inclusion of this as a commitment is advised.	EnQuest confirms that it will endeavour to re-use the previous anchor pattern used at the 2/19-13 discovery well to avoid further disturbance to the seabed and to avoid the identified MDAC features. Details of this are provided in section 5.1.2.

Issues Raised	Comments on issues raised and ES section in which addressed
The reason for the proposed direct routing of the umbilical from Kittiwake to Eagle should be justified. Where other options are being considered, such as the replacement of the Kittiwake to Gadwall control lines which could incorporate the Eagle umbilical this should be described within the ES.	During the design selection stage, control umbilicals of existing sub-sea infrastructure were considered not suitable for inclusion of Eagle due to uncertainties related to age and integrity which posed an unacceptable risk to the project. Therefore, the option selection base-case was that a new control umbilical would be installed direct from Eagle to the preferred tieback location. The uncertainties associated with the Eagle development have been described within section 1.5 of the ES, and the development option selection process summarised in section 2.1.
It is accepted that any future developments beyond the proposed single well are out-with the scope of this ES, however it is advised that potential options are briefly discussed.	At this stage, there is very little information on any potential future expansion to the development available. This is due to the inherent uncertainty associated with the Eagle field itself. This is discussed in section 2.1.6.
Marine Scotland (MS-ML)	
It is advised that a brief overview of the existing infrastructure and expected field life is included in the ES to provide some context for the proposed development. As existing facilities are being utilised it is useful to show how the anticipated field life of the Kittiwake development is aligned with the proposal.	An overview of the existing infrastructure in the GKA and the expected field life for Eagle is presented throughout section 2.
It is advised that the UK Offshore Energy Strategic Environmental Assessment 3 is reviewed and incorporated into the ES.	Information from OESEA3 (*DECC, 2016*) has been included where relevant in section 3.
The ES should discuss how the proposed works comply with Scotland's National Marine Plan, which was published in March 2015, in accordance with the Marine (Scotland) Act 2010.	Alignment with the policies of the NMP are discussed in section 7 of the ES.
The introduction would benefit from the key facts of the development being highlighted, including but not limited to; grid reference, quadrant/ block numbers, field name, ICES rectangles, nature of hydrocarbons expected, expected field life.	This is provided in section 1, 'Environmental Statement Details'.
Marine Scotland would ask that an option selection and alternatives section is included in the ES which should discuss how the proposed development (including pipeline routes, installation options and use of protective materials) represent Best Environmental Practice (BEP) using Best Available Technology (BAT). The option selection process should take account of the lifecycle of the project and future decommissioning.	The option selection process for the Eagle development is provided in section 2.1.
Alignment of the project with the Scottish Fishermen's Federation (SFF) Offshore Oil and Gas Decommissioning Policy and Key Principles documents would benefit from being discussed.	The SFF decommissioning philosophy is discussed in section 5.1.5. EnQuest would consider all such relevant issues and integrate them into the EA process at the time of decommissioning planning.
It would be useful to provide an overview of how other adjacent pipelines have been installed, in support of the chosen pipeline installation method.	With regards to other pipelines in the vicinity, these have been either trenched and buried or buried (refer to Table 3.1 in section 3). The installation method of the pipeline is discussed in section 2.4.3 and is assessed in section 5.1.
A detailed schedule of works should be provided with any contingency periods clearly stated.	The outline of the works programme known at the current time is provided in section 2.2.
The detailed assessment of chemical usage will correctly be deferred to the chemical permitting stage, however, an upfront overview of any potential concerns from a chemical discharge perspective is advised.	A description of chemical use and discharges is provided in section 2 where relevant.

Issues Raised	Comments on issues raised and ES section in which addressed
Produced water management and worst-case discharge profiles are not detailed in the project information document but it is assumed these will be provided in line with Section 3.2.6. of The Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended) – A Guide, produced by BEIS Offshore Petroleum Regulator for Environment and Decommissioning).	The production profiles given in section 2.5 are in alignment with the guidance. However, as the P05 case does not provide the worst-case in terms of produced water, the P90 profile for produced water has been included.
Marine Scotland welcome that a site-specific environmental survey has been conducted in 2019 and welcome that detail from this is to be included in the ES. It is advised that an upfront description of the environmental surveys used in support of the application is provided. This should include detail of the methods used and justification for the location of sampling stations. The location of all sampling stations should be shown on a map.	Details of surveys carried out in the area have been provided in section 3. The environmental baseline survey results were not available at the time of drafting the ES. The environmental baseline survey report will be provided to all interested parties as soon as it becomes available and will be reported in future submissions (i.e. MAT/SAT).
The physical characteristics of the environment at the location should be fully described and include, for example, information on currents, wind speed, wave height / power, temperature and salinity.	The baseline environment has been fully described in section 3.
Marine Scotland has recently added new spatial layers to the NMPi, which show predicted seabed habitats (European Nature Information System (EUNIS) biotope classifications) and sediment types which the author may find useful. Presenting these visually in the ES would give useful wider scale context. It is advised that biotope classifications are defined for the area in accordance with the EUNIS / JNCC indices.	Previous survey work conducted in the area included habitats assessment; this is discussed in section 3. The EUNIS broad scale predictive habitat dataset describes the biotope across Blocks 21/18 and 21/19 as A5.27: 'Offshore ciralittoral sand' (*NMPi, 2019*).
A summary of any particle size analysis and contaminant analysis of sediments should be provided.	Data from previous site surveys has been provided throughout section 3 where relevant.
Reference to the following report is advised, which provides a modelled spatial representation of the probability of presence of 0 age group fish (fish in the first year of their life) and the probability of aggregations of 0 age group fish. It is recommended these data are presented visually in conjunction with the Coull *et al.* (1998) and Ellis *et al.* (2012) nursery maps, as there are certain limitations with the data. A basic assessment of the spawning habits and preferred habitats of the main species identified, as compared to the conditions experienced locally, may highlight additional mitigation opportunities.	Fish spawning and nursery periods are discussed in section 3.3.3, including reference to the probability of presence of 0 group fish. The data have also been plotted in a visual format to enable interpretation of the data in relation to the proposed development.
Scottish Natural Heritage, The Joint Nature Conservation Committee and Marine Scotland have developed a priority list of marine habitats and species in Scotland's seas, known as Priority Marine Features (PMF's), which should be referred to in the ES.	PMFs have been referred to throughout the ES where relevant.
New maps showing the distribution of grey and harbour seals around the UK are now available and provide an update of the previous seal usage maps described in Jones et al. (2015).	This information has been included in section 3.3.5.

Issues Raised	Comments on issues raised and ES section in which addressed
Marine Scotland have published the following report on fishing effort, which assesses Vessel Monitoring Systems (VMS) data for all UK-registered commercial fishing vessels (≥15m length) for the period 2009 - 2013. This VMS data, obtained for ICES areas VIa, VIb, IVa, IVb, IVc, IIa, VIId, and VIIa , is combined with landings information to develop GIS layers describing the spatial patterns of landings of the Scottish offshore fleet from within the Scottish zone of the UK Fishing limits (200nm).	This data has been referenced where appropriate in section 3.5.1. A shipping density study was commissioned in support of the EIA, which included analysis of fishing vessels, in the vicinity of the Eagle development. The results are described in section 5.1.1.
Provisional fisheries statistics for 2018 were published in May 2019. A basic comparison of landings, values and effort to previous years (e.g. last five years) is useful, in order to add strength to the assessment and identify any trends in the activity. It is advised that context is provided by comparing landings and effort figures for the ICES rectangles in question to the wider UK. An assessment of 'within-year' seasonality is recommended for fishing effort as this may highlight additional mitigation opportunities.	Information on the levels of fishing activity, including the 2018 provisional data, have been provided in section 3.5.1.
Marine Scotland has recently added new spatial layers to the NMPi showing the intensity of mobile fishing associated with oil and gas pipelines and cables in the UK for 2007 - 2015.	Information from this dataset has been provided in section 3.5.1.
It is advised that the ES discusses the proposed fisheries management measures within Marine Protected Areas (MPAs). It is anticipated that that implementation of the measures by the EC, through a delegated Act will be made and further developments will be published on the Marine Scotland website as information becomes available.	Potential management measures of relevance to the Eagle field development have been presented in section 3.5.1. The potential impact of displacement of demersal fishing activities from the East of Gannet and Montrose Fields NCMPA is considered within section 5.1.3.
The location of existing oil and gas infrastructure and previously drilled wells would benefit from being shown in a visual format.	The location of the proposed Eagle development in relation to existing infrastructure is shown in section 3.5.3.
The detailed impact assessment methodology to be used is not detailed in the project information document, but it is advised that a systematic impact assessment methodology is applied to allow impacts to be ranked. An overview of the method used is advised and an indication of the criteria used to determine whether an impact is ‘likely’ and whether it is ‘significant’. The magnitude of the impacts should be predicted in terms of the deviation from the established baseline conditions, for each phase or element of the proposals	A full description of the EIA methodology is provided in section 4 (this section).
It is advised that the potential for in-combination, cumulative and transboundary impacts are discussed in the ES.	The potential for in-combination, cumulative and trans-boundary impact assessment has been discussed where relevant throughout section 5.
It is advised that the worst-case volumes and locations of protective materials are included in the ES. Marine Scotland recommend that the extent of any 500 m safety zone is shown on a figure in relation to the proposed infrastructure and location of any protective materials. Early engagement with fishing representative organisations such as the Scottish Fisherman’s Federation (SFF) is advised, particularly with regards to how the formation of another safety zone in this area will impact fishing behaviour.	At the time of writing the ES, detailed information on proposed protection structures for use in the Eagle development are not known, therefore worst-case assumptions have been made for the protection structure requirements. SFF were consulted as part of the preliminary consultation and their response is recorded below.

Issues Raised	Comments on issues raised and ES section in which addressed
It is advised that the potential impacts on fish spawning and nursery areas are specifically considered. This area is regarded as a high intensity sandeel spawning area and as this species lay eggs on the seabed and are particularly vulnerable to smothering, it is advised that timing of specific phases of the development such as pipeline installation should be carefully considered. The following reports contain useful information on sandeel spawning: (*Lancaster et al., 2014*; *Mazik et al., 2015*).	Section 3.3.3 describes the spawning activity in the vicinity of the proposed Eagle development with reference to the mentioned studies. Further analysis of the available data indicates that the high intensity spawning area for sandeel is located further to the west. The high intensity area for Norway pout is also located away from the proposed development to the west, although the Kittiwake platform lies immediately adjacent to it. Significant impacts on the high intensity spawning areas of these species are therefore not anticipated. Block 21/19 has a special condition with regards to herring spawning grounds, however, the available evidence indicates that herring spawning areas are located much further to the west in ICES Rectangle 43E9.
Details of whether any proposed infrastructure will be fitted with fishing friendly/ over-trawlable structures should be provided.	Details of the particular subsea equipment that will be installed with fishing friendly protection structures are provided in section 2 and discussed in section 5 where relevant.
It is highlighted that the Feature Activity Sensitivity Tool (FEAST) contains useful information regarding pressures on selected features of conservation concern and may be a useful source of information. In addition, the sensitivity reviews (particularly relating to *Nephrops*) from the Marine Life Information Network (MARLIN) would be a useful source of information.	The impact assessment on physical disturbance to the seabed (section 5.1.1) includes reference to FEAST in the assessment of potential impacts on sensitive seabed features, particularly MDAC. Reference to MARLIN has also been made for assessment of potential effects on species.
It is advised that potential impacts arising from the re-suspension of contaminated sediments is discussed. Will existing oil-based cuttings piles be disturbed at the Kittiwake platform, for example.	The potential impact of the disturbance of legacy cuttings piles has been discussed in section 5.1.1: Disturbance of Seabed Habitats (Indirect Impacts).
Marine Scotland would advise that the worst case potential release of hydrocarbons is modelled and included in the ES. Confirmation that an approved Oil Pollution Emergency Plan (OPEP) or similar will be in place is also advised	Worst-case blow-out scenario oil spill modelling has been conducted and the results presented in the ES. Other modelling studies (e.g. diesel inventory modelling/ pipeline inventory modelling) will be used to support future submissions associated with the Eagle development (e.g. MAT/SAT), including the Oil Pollution Emergency Plan (OPEP) developed for the Eagle development project.
Where modelling demonstrates the possibility of surface oiling on the Scottish coastline, if an accidental event were to occur, it is advised that impacts on aquaculture and Shellfish Water Protected areas are considered.	The oil spill modelling results, which include an assessment of the effects of coastline oiling, including impact on aquaculture and shellfish water protected areas, are presented in section 5.4.
It is advised that section 3.2.10.1 is reviewed of The Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended) – A Guide, produced by BEIS Offshore Petroleum Regulator for Environment and Decommissioning, regarding major accidents and the potential for, and environmental consequences of, a Major Environmental Incident (MEI) resulting in significant or serious damage to the environment.	An assessment of an MEI is included with the oil spill modelling results presented in section 5.4.

Issues Raised	Comments on issues raised and ES section in which addressed
The predicted effectiveness of the stated mitigation measures should be made clear, and the ES should demonstrate a firm commitment to implementing the proposed measures, where appropriate, indicating how and when the measures will be implemented and confirming lines of responsibility for ensuring implementation. Any commitments relating to matters addressed in the ES should be drawn together into one section or table and be clearly identifiable. It should also be indicated how these commitments are to be monitored to ensure compliance.	Appendix D summarises the environmental commitments for integration within the project, which will be implemented and monitored.
It is recommended that the ES considers decommissioning upfront and details how all installed infrastructure / protective material would be removed should this be the policy in place at that time.	Decommissioning is addressed throughout section 2 and in particular, section 2.9. It is also assessed throughout section 5 where relevant.
Please ensure the ES contains a comprehensive conclusion summarising the main environmental sensitivities and how these are to be mitigated or why they are not considered to be significantly affected.	The conclusion of the ES is presented in section 7.
Scottish Fishermen's Federation (SFF)	
SFF would like post lay survey data to verify berm height of the trenched pipeline and umbilical. Remedial action may be required if fishing vessels experience difficulties in the area post lay.	EnQuest will forward as built survey data on the pipeline and umbilical to SFF. Should fishing vessels encounter difficulties in the area following installation, EnQuest would seek to assist with any problems encountered due to installation through the standard industry communication channels in place.
Joint Nature Conservation Committee (JNCC)	
JNCC considers it best practice to consider the full worst-case scenario to enable a meaningful assessment of the full environmental impacts of a project.	The project presented in section 2 of the ES is the worst-case scenario for the first phase of the Eagle development. There is the possibility that there may be further extension to the development, depending on the performance of the Eagle field. However, it is not possible to include further development options in the ES due to the large uncertainties faced at this stage (refer to section 2.1.6). Therefore, any further possible extensions to the Eagle field will be the subject of a future ES or ES Addendum.
We understand that at this stage the type of Mobile Offshore Drilling Unit (MODU) to be used for drilling the development well is likely to be a semi-submersible or a jack-up MODU and is yet to be confirmed. Hence, there is a possibility an anchored rig will be used for the operation. Therefore, to allow consideration of the worst-case scenario, we suggest that the placement of drilling rig anchors and lines on the seabed is scoped in to the upcoming ES. Because the presence of the Annex 1 habitat, MDAC, has been established in the operational area, we recommend that the potential impact of such rig anchors and lines on MDAC should also be included in the ES. It is also important to provide information (volume and location) should hard substrate depositions (e.g. rock dumps) be necessary for the operations along with the total area expected to be impacted.	At this stage, the drilling rig to be used for the drilling of the 21/19-13 Eagle P1 well is not confirmed; either a jack-up or semi-submersible unit could be used. The ES will consider the use of both types of drilling unit, with the use of a semi-submersible unit assessed as the worst-case in terms of the potential impact on the seabed due to the use of anchors. This is assessed in section 5.1.

Issues Raised	Comments on issues raised and ES section in which addressed
We recommend that the ES contains maps showing the following information in relation to the operational area: • The nearest Marine Protected Area (in this case East of Gannet and Montrose Fields NCMPA); • Positions of protected features, in this case MDAC and *Arctica islandica* (ocean quahog) in the operational area; and • Positions of sampling stations of environmental surveys conducted in 2016 (Fugro) and 2019 (Gardline).	This information has been provided throughout section 3 of the ES and referenced where relevant to seabed alignment sheets from site surveys provided in the Appendices.
We note that environmental surveys have identified the presence of the protected features MDAC and *Arctica islandica* in the operational area. We commend EnQuest for proposing to place exclusion zones around areas confirmed as MDAC and recommend such zones have a radius of at least 500m.	EnQuest is confident that it can route the pipeline accordingly around the identified MDAC features using an 80-metre-wide installation corridor to avoid disturbance to these features. Details of the proposed routing and how this will be achieved are provided in section 5.1.2.
We continue to have very limited knowledge on the extent of MDAC Annex I habitat in UK seas, and as such, we strongly suggest that any developer who may have MDAC within their area of proposed operations: • Provide video / still footage and side-scan data to JNCC for determination as to whether it represents Annex I habitat, • If needed, undertake carbon isotope tests of the submarine structure using an ROV to minimise damage, and • Propose mitigation to minimise damage to the habitat. Preferably, this would include rerouting pipelines around, or moving infrastructure away from, the MDAC site.	The full site survey reports and video footage can be forwarded to JNCC as soon as these reports and files are finalised and become available for release. EnQuest is confident that it can mitigate any potential impacts on MDAC features in the operational area by routing the pipeline accordingly using an 80-metre-wide pipeline installation corridor. Details of the proposed routing and how this will be achieved are provided in section 5.1.2.
We recommend that where possible, the operator avoids *A. islandica* as much as practically possible during proposed operations.	Previous site surveys (*Fugro, 2014c*; *Fugro 2016c*) and the current spring 2019 survey (*Gardline, 2019c*) did identify evidence of *A. islandica* in the area. However, there was no suggestion that the observed evidence constituted aggregations of the species, particularly as no live specimens were found. Therefore, the seabed habitat in the Eagle development area is not considered of significant conservation importance for this species. As no clear aggregations of this species were found, or any live specimens, it is not possible to suggest a strategy for avoidance of this species along the proposed pipeline and umbilical routes. Installation of the pipeline and umbilical and the potential impact to the seabed and associated species, is discussed in section 5.1.1.
We note that the Seabird Oil Sensitivity Index (SOSI) has in some cases been recorded incorrectly.	The SOSI presented in section 3.3.4 has been re-drafted using the median sensitivity data.
We commend EnQuest for considering periods of concern for drilling in Block 21/18 and 21/19. However, due to the extremely high or very high SOSI recorded within Block 21/18 during the months of April and May, we ask EnQuest to consider these months also as period of concern for drilling.	Periods of concern have been identified and described in throughout section 3 where relevant. EnQuest will, as far as possible, avoid any periods of concern for drilling during detailed planning of the project activities.
We also recommend consideration of other data sources when describing the baseline biological environment in the EIA, e.g. Kober *et al.*, 2010.	Information from this study has been included in section 3.3.4.

Issues Raised	Comments on issues raised and ES section in which addressed
There is a requirement for assessing the cumulative effects of a project under the EIA Directive. JNCC suggests that the proposed operations are assessed in the upcoming ES alongside approved developments under construction, approved developments that have not yet commenced construction, developments submitted for approval but not yet approved, as well as any other significant appropriate development for which some realistic figures are available.	Potential cumulative impacts are discussed throughout section 5 in each of the impact assessment topic areas.
Ministry of Defence (MOD)	
The MOD indicated that they had no safeguarding concerns in the area of the Eagle development.	
General Lighthouse Authority	
No response was received.	
Royal Society for the Protection of Birds (RSPB)	
Commented that further oil and gas extraction, especially new operations, represent activities that are contrary to, and will frustrate achievement of, the UK's net-zero greenhouse gas emissions targets by 2050.	The project proposal is in line with the policies presented within Scotland's National Marine Plan (NMP).
Sea Mammal Research Unit (SMRU)	
No response was received.	

4.4 Environmental Significance

4.4.1 Overview

The decision process related to defining whether or not a Development is likely to have significant impacts on the environment is the core principle of the EIA process; 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 Charted Institute of Ecology and Environmental Management (CIEEM) guidelines for Ecological Impact Assessment (terrestrial, freshwater, coastal and marine) (*CIEEM, 2018*), the Marine Life Information Network (MarLIN) species and ecosystem sensitivities guidelines (*Tyler-Walters et al., 2001*) and guidance provided by Scottish Natural Heritage (SNH) in their handbook on EIA (*SNH, 2013*) and by The Institute of Environmental Management and Assessment (IEMA) in their "Guidelines for EIA" (*IEMA, 2016*).

The EIA provides an assessment of the environmental effects that may result from a development'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 development 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.

4.4.2 Baseline Characterisation and Receptor Identification

In order to make an assessment of potential impacts on the environment, it was necessary to firstly characterise the different aspects of the environment that could potentially be affected (the baseline environment). The baseline environment has been described in section 3 and is based on regional studies combined with site-specific surveys.

Where data gaps and uncertainties remained (e.g. where there are no suitable options for filling data gaps), as part of the EIA process these have been documented and taken into consideration as appropriate as part of the assessment of impact significance (section 4.4.3).

The EIA process requires identification of the potential receptors that could be affected by the Eagle development (e.g. marine mammals, seabed species and habitats). Receptors are identified within the impact assessments (section 5).

4.4.3 Impact Definition

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, i.e. the geographical area;
- Duration over which the impact is likely to occur i.e. 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 Table 4.3 to Table 4.6 to provide consistent definitions across all EA topics. In each impact assessment, these terms are used in the assessment summary table to summarise the impact and are expanded upon as necessary in any supporting text. With respect to the nature of the impact (Table 4.3), it should be noted that all impacts discussed in this ES are adverse unless explicitly stated.

Table 4.3: 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 4.4: Type of Impact

Type of impact	Definition
Direct	Impacts that result from a direct interaction between the development and the receptor. Impacts that are actually caused by the introduction of development activities into the receiving environment. For example, the direct loss of benthic habitat.
Indirect	Reasonably foreseeable impacts that are caused by the interactions of the development but which occur later in time than the original, or at a further distance from the proposed development location. Indirect impacts include impacts that may be referred to as 'secondary', 'related' or 'induced'. For example, 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 development. Definition encompasses "in-combination" impacts.

Table 4.5: Duration of Impact

Duration	Definition
Short term	Impacts that are predicted to last for a short duration (e.g. less than one year).
Temporary	Impacts that are predicted to last a limited period (e.g. a few years). For example, impacts that occur during the proposed activities and which do not extend beyond the main activity period for the works or which, due to the timescale for mitigation, reinstatement or natural recovery, continue for only a limited time beyond completion of the anticipated activity.
Prolonged	Impacts that may, although not necessarily, commence during the main phase of the proposed activities and which continue through the monitoring and maintenance, but which will eventually cease.
Permanent	Impacts that are predicted to cause a permanent, irreversible change.

Table 4.6: Frequency of Impact

Frequency	Definition
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 development. This definition also covers such impacts that occur on a planned or unplanned basis and those that may be described as 'periodic' impacts.

Table 4.7: Geographical Extent of Impact

Geographical extent	Definition
Local	Impacts that are limited to the area surrounding the proposed development footprint and associated working areas. Alternatively, where appropriate, impacts that are restricted to a single habitat or biotope or community.
Regional	Impacts that are experienced beyond the local area to the wider region, as determined by habitat/ ecosystem extent.
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.
Trans-boundary	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).

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 4.8. The resulting effect on the receptor is considered under vulnerability and is an evaluation based on scientific judgement.

Table 4.8: 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 prolonged 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 informed judgement is used to determine the most appropriate magnitude ranking and this is explained through the narrative of the assessment.	

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 (Table 4.9). This captures the probability that the impact will occur and also the probability that the receptor will be present and is generally based on knowledge of the receptor and experienced professional judgement. Consideration of likelihood is described in the impact characterisation text and used to provide context to the specific impact being assessed in topic specific sections as required.

Table 4.9: Probability of Accidental Events Occurring

Likelihood category	Accidental event probability
5	Likely More than once per year Event likely to occur more than once on the facility
4	Possible One in 10 years Could occur within the life time of the Project
3	Unlikely One in 100 years Event could occur within life time of 10 similar facilities. Has occurred at similar facilities.
2	Remote One in 1,000 years Similar event has occurred somewhere in industry or similar industry but not likely to occur with current practices and procedures.
1	Extremely remote One in 10,000 years Has never occurred within industry or similar industry but theoretically possible.

4.4.4 Receptor Definition

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 an 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.

Receptor Sensitivity

Example definitions for assessing the sensitivity of a receptor are provided in Table 4.10.

Table 4.10: 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.

Receptor Vulnerability

Information on both receptor sensitivity and impact magnitude is required to be able to determine receptor vulnerability as per Table 4.11.

Table 4.11: Vulnerability of Receptor

Receptor vulnerability	Definition
Very high	The impact will have a permanent effect on the behaviour or condition on 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 on 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 short-term effect on the behaviour or condition on 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 development 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 or 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 in section 5.

Receptor Value

The value or importance of a receptor is based on a pre-defined judgement based on legislative requirements, guidance or policy. Where these may be absent, it is necessary to make an informed judgement on receptor value based on perceived views of key stakeholders and specialists. Examples of receptor value definitions are provided in Table 4.12.

Table 4.12: Receptor Value

Value of receptor	Definition
Very high	Receptor of international importance (e.g. United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage Site (WHS)). Receptor of very high importance or rarity, such as those designated under international legislation (e.g. EU Habitats Directive) or those that are internationally recognised as globally threatened (e.g. IUCN red list). Receptor has little flexibility or capability to utilise alternative area. Best known or only example and/or significant potential to contribute to knowledge and understanding and/or outreach.
High	Receptor of national importance (e.g. NCMPA, MCZ). Receptor of high importance or rarity, such as those which are designated under national legislation, and/or ecological receptors such as UK Biodiversity Action Plan (UKBAP) priority species with nationally important populations in the study area, and species that are near-threatened or vulnerable on the IUCN red list. Receptor provides the majority of income from the development area. Above average example and/ or high potential to contribute to knowledge and understanding and/ or outreach.
Medium	Receptor of regional importance. Receptor of moderate value or regional importance, and/ or ecological receptors listed as of least concern on the IUCN red list but which form qualifying interests on internationally designated sites, or which are present in internationally important numbers. Any receptor which is active in the development area and utilises it for up to half of its annual income/ activities. Average example and/ or moderate potential to contribute to knowledge and understanding and/ or outreach.
Low	Receptor of local importance. Receptor of low local importance and/ or ecological receptors such as species which contribute to a national site, are present in regionally. Any receptor which is active in the development area and reliant upon it for some income/activities. Below average example and/ or low potential to contribute to knowledge and understanding and/or outreach.
Negligible	Receptor of very low importance, no specific value or concern. Receptor of very low importance, such as those which are generally abundant around the UK with no specific value or conservation concern. Receptor of very low importance and activity generally abundant in other areas/ not typically present in the project area. Poor example and/ or little or no potential to contribute to knowledge and understanding and/ or outreach.

4.4.5 Consequence and Significance of Potential Impact

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 based on assessment consequence;
- Mitigation; and
- Residual impacts.

Assessment of Consequence and Impact Significance

The sensitivity, vulnerability and value of receptor are combined with magnitude (and likelihood, where appropriate) of impact using informed judgement to arrive at a consequence for each impact, as shown in Table 4.13. The significance of impact is derived directly from the assigned consequence ranking.

Table 4.13: Assessment of Consequence

Assessment consequence	Description (consideration of receptor sensitivity and value and impact magnitude)	Impact significance
Major	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	Impacts are likely to be noticeable and result in prolonged 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	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

Mitigation

Where potentially significant impacts (i.e. those ranked as being of moderate impact level or higher in Table 4.13) 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. For impacts that are deemed not significant (i.e. low, negligible or positive in Table 4.13), there is no requirement to adopt specific mitigation. However, mitigation can be adopted in such cases to ensure impacts that are predicted to be not significant remain so. Section 6 provides detail on how any mitigation measures identified during the impact assessment will be managed.

4.4.6 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.

4.5 Cumulative and In-combination Impact Assessment

The European Commission has defined cumulative impact 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 development;
- 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 impact perspective.

To assist the assessment of cumulative and in-combination impacts, a review of existing developments (including oil and gas, cables and renewables) that could have the potential to interact with the development was undertaken; the output of this review is reported in the environmental description (section 3). The impact assessment has considered these projects when defining the potential for cumulative and in-combination impact (section 5). This includes, where appropriate, reference to existing fields producing through Kittiwake.

4.6 Transboundary Impact Assessment

The impact assessment presented in section 5 contains sections which identify the potential for, and where appropriate, assessment of trans-boundary impacts. For the Eagle development, the UK/ Norway median lies approximately 80 km away.

4.7 Habitats Regulation 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 where relevant 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 Eagle development.

For offshore areas (12 – 200 nm) the requirements of the Habitats Directive are transposed through the Offshore Marine Conservation Natural Habitats Regulations (2007) as amended. 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 NCMPAs and MCZs (respectively) being achieved to be assessed.

5 Impact Assessment

This section presents an assessment of those potential environmental interactions identified in Section 4 for which the potential for significant effects were identified for particular receptors (Table 4.1).

5.1 Physical Presence

This section discusses the potential environmental impacts associated with physical presence of the proposed Eagle development. It looks at the seabed interaction as a result of the installation of the Eagle development. It also considers the potential impact on other sea users during the installation of the development as well as throughout its life.

The Eagle development activities have the potential to impact the seabed as per the following:

- Temporary placement of anchors or spud-cans on the seabed from the drilling unit;
- Installation of the pipeline and umbilical;
- Installation of associated subsea equipment, including spools, jumpers and SDU;
- Installation of subsea XT and protection structure; and
- Installation of concrete mattresses for the protection of subsea infrastructure.

The above activities will cause disturbance to the seabed, causing re-suspension of and re-settling of sediments.

The Eagle development also has the potential to impact other users of the sea through the presence of the drilling unit and vessels used for installation of the subsea infrastructure.

5.1.1 Description and Quantification of Impact

Section 2 provides a detailed description of the proposed Eagle development and the key assumptions made for the purposes of EIA. The information below provides an overview of the elements which are predicted to have an impact as a result of physical presence on the seabed.

Drilling of the 21/19-13 Eagle P1 well is likely to be carried out using either a semi-submersible or a jack-up drilling unit. At this time, the exact drilling unit to be used is uncertain. If a semi-submersible unit is used, the drilling unit will be moored on station to the seabed using eight anchors. The exact drilling unit that may be used is still being confirmed, but an example semi-submersible type could be the *Stena Spey* or equivalent (*Stena Drilling, 2018*). The maximum anchor spread radius will be 1,500 m (*Intermoor, 2015*). The anchors will be connected to the drilling unit by 80 mm anchor chains, of which approximately 500 m of each chain is estimated to lie on the seabed during drilling operations. The anchors used will be of Bruce FFTS MkIV design or equivalent. A small area of seabed where each anchor is placed will be compressed as the anchors sink into the seabed. The area directly affecting the seabed due to the anchor size is estimated to be 28 m^2 (assuming the 9-tonne model is used). The outer 500 m of the anchor lines will lie on the seabed, possibly with some lateral movement of up to 5 m due to tides and currents; this movement of the anchor lines as they move back and forth over the seabed will affect the benthos for as long as the anchor chains remain in position.

If a jack-up drilling unit is used, the unit will be fixed on station using 3 extending legs, which are lowered through the water to rest on the seabed. At the bottom of each leg is a base plate structure, called a spud-can, which is the part of the leg that contacts the seabed. The exact drilling unit that may be used is still being confirmed, but an example jack-up type could be the *Maersk Resilient* or equivalent. The area of each spud can is estimated to be 350 m^2. The spud-can centres are spaced equidistant at a radius of approximately 35 m (*Maersk Drilling, 2019*). Spud-can depressions are made in the seabed during the jack-up process.

Physical disturbance to the seabed will also be caused by the subsea infrastructure installation activities, as well as where protection structures are laid (i.e. concrete mattresses, grout bags and rock dump). These activities and structures have the potential to cause mortality or displacement of benthic species in the direct footprint of installation. The significance of direct habitat loss or mortality of sessile seabed organisms depends on the footprint of the area of disturbance.

In consultation with its contractors, EnQuest has defined an installation corridor of 80 m total width (i.e. 40 m either side of the route lay centerline) for both the export pipeline and the control umbilical. There will also be loss/ disturbance of seabed habitat due to the installation of the XT, SDU structure and tie-in spools. There is the possibility that the SDU will be piled into the seabed, however piles driven into the structure will lie within the footprint of the SDU. There is also the possibility that the export pipeline will be laid onto the seabed and rock-dumped along its entire length, rather than trenched and backfilled. This scenario is unlikely however and is viewed as a contingency; however, if rock dump were to occur, the rock dump used would fall within the assessed installation corridor, as the rock-dump berm width would be 8 m. The installation of the pipeline by trenching and backfilling is viewed as worst-case in terms of seabed disturbance (particularly through potential indirect impacts through mobilisation of sediment into the water column), therefore trenching and backfilling has been focused on in the impact assessment.

There is also the possibility that 1 tonne sandbags may be needed as turning bollards. These will be deployed onto the seabed. The sandbags are punctured on recovery, leaving the sand on the seabed. It is assumed as a worst-case that up to 100 sandbags may be used for turning bollards.

Table 5.1 quantifies the area of seabed that may be directly impacted by the Eagle development. This has been based on the known dimensions of individual items of equipment, and also accounts for the fact that certain items may cover other items.

The potential direct effects of seabed disturbance include mortality as a result of physical trauma, smothering by displaced and re-suspended sediment, and habitat modification due to changed physico-chemical characteristics (e.g. sediment porosity and oxygenation).

The significance of direct habitat loss or mortality of sessile seabed organisms depends on the footprint of the area of disturbance, the level of tolerance of the affected habitat and species to direct disturbance, the conservation value of the affected habitat or species and the uniqueness of the affected habitats or species assemblages to the area.

Table 5.1: Quantified areas of seabed impact associated with the Eagle development

Infrastructure/Project element	Dimensions	Seabed impact (km²)
Short-term disturbance of the seabed		
Semi-submersible drilling unit option		
Drilling rig anchors	28 m² Quantity: 8 anchors at 1 well location	0.000224
Drilling rig anchor chains	Anchor max. radius: 1,500 m (presumed 500 m of each anchor chain resting on the seabed, with possible lateral movement of 5 m) at 1 well location.	0.04
	Total:	0.040
Jack-up drilling unit option		
Drilling rig spud-cans	350 m² Quantity: 3 spud-cans at 1 well location	0.00105
	Total:	0.00105
Turning Bollards		
1 Tonne sandbags as turning bollards	Area: 0.9 m x 0.9 m Quantity 100	0.000081
	Total:	0.000081
	Total short-term (worst-case semi-sub option):	**0.040**
Long-term presence of infrastructure on the seabed		
Well (21/19-13 Eagle P1)	Diameter: 0.9144 m Quantity: 1 well	0.00000066 (note: lies within subsea tree footprint)
Subsea tree and wellhead protection structure	Area: 9.6 m x 9.6 m Quantity: 1 well	0.00009216
SDU adjacent to Eagle XT	Area: 5 m x 10 m Quantity: 1	0.000050
Export pipeline from Eagle to Gadwall	Length: 5,500 m Installation corridor: 80 m	0.44
Control umbilical from Eagle to Kittiwake	Length: 16,000 m Installation corridor: 80 m	1.28
Well (21/19-13 Eagle P1) spool	Area: 35 m x 0.2032 m Quantity: 1	0.0000071
Tie-in manifold adjacent to existing Gadwall manifold	Area: 5 m x 3 m Quantity: 1	0.000015

Infrastructure/Project element	Dimensions	Seabed impact (km²)
Pipeline tie-in spool	Area: 100 m x 0.2032 m Quantity: 1	0.00002032
Replacement spools at the tie-n to the Gadwall/ Mallard system	Area: 100 m x 0.2032 m Quantity: 2	0.00004064
Well (21/19-13 Eagle P1) HFLs, EFLs	Electrical: 100 m x 0.2032 m Chemical/Hydraulic: 100 x 0.2032 Quantity of each: 1	0.00004064
Concrete mattresses	120 off 6 m x 3 m	0.00216 (note: lies within installation corridor)
Grout bags	15 off 0.9 x 0.9 m	0.0000215 (note: lies within installation corridor)
Contingency Rock-dump of Export Pipeline		
Rock dump	8 m berm width x 5.5 km	0.044 (note: lies within installation corridor)
	Total long-term footprint:	**1.7202659**

Benthic Disturbance and Habitat Loss (Direct Impacts)

The Eagle development will result in the introduction of approximately 1.72 km^2 of new infrastructure on the seabed for the long-term and will temporarily disturb an area of 0.040 km^2 due to the placement of the drilling unit and use of sand bags as turning bollards (Table 5.1).

Infrastructure Installation

Where infrastructure is placed on the seabed, including the trenching and burial of the export pipeline and jetting of the umbilical, there will be direct disturbance to, and displacement of, species present at the location of installation. At the source of disturbance, fauna may either be crushed, injured or killed by the installation and placement of subsea infrastructure and protection structures. Mobile epifauna may move away from the impacted area; sessile epifauna and infauna are therefore more likely to be impacted. If sedimentary habitat is covered by impenetrable material for the long-term, or is disturbed during installation activities, that area of habitat is lost for use by the indigenous marine fauna.

Site survey work in the area has confirmed the presence of MDAC features on the seabed along the proposed pipeline route. Table 3.7 in section 3.3.2 provides the locations of the confirmed MDAC features. MDAC is often associated with pockmark features, which are also formed by gas escaping from the seabed, hence the common association with pockmarks and MDAC. The investigated pockmarks on the Eagle to Gadwall pipeline route were all confirmed to contain MDAC. However, as pockmarks are only formed in certain sediment types, MDAC can also occur in pockmark-free areas (*Judd, 2001*).

The Marine Scotland Feature Activity Sensitivity Tool (FEAST) indicates that pockmarks are sensitive to pressures including physical removal (rated by FEAST as high), sub-surface abrasion/penetration (rated as medium) and local water flow (tidal current) changes (rated as medium). Surface abrasion pressures and wave exposure changes are both rated by FEAST as low. FEAST rates pockmarks as not sensitive to the following pressures: physical change (to another seabed type), high siltation changes, and water clarity changes (*Marine Scotland, 2013*). FEAST does not specifically include MDAC as a feature, however due to their common association with pockmarks, can be considered to be just as sensitive to the above pressures, if not more so on a precautionary basis, due to the presence of epifauna commonly associated with MDAC, which were observed on the drop-down seabed imagery at the MDAC features (*Gardline, 2019c*).

Of particular interest were bacterial mats, which were observed in the vicinity of MDAC features at 12 of the environmental stations during the 2019 survey activities (refer to Table 3.14). The hydrogen sulphide produced from the seabed in the vicinity of MDAC features can be utilized by the sulphur oxidizing bacterium *Beggiatoa*, which occurs as bacterial mats on the seabed. The presence of bacterial mats is a relatively good indicator that gas seepage from MDAC features in the vicinity is on-going (*Judd, 2001*). These features are not presented specifically within FEAST, but can be considered to be just as sensitive, if not more so on a precautionary basis, to the pressures discussed above for MDAC.

It is now generally accepted that the OSPAR listed 'sea-pens and burrowing megafauna' community key defining feature is the presence of burrows in the seabed sediment, and that sea-pens alone do not define or indicate the habitat (*Pers. Comm., JNCC, 2019*). FEAST presents 'burrowed mud' as a feature within the tool's database. It rates the feature sensitivity as 'medium' for the pressure of physical removal and sub-surface abrasion/penetration. The pressure high siltation changes is rated as 'medium', and the pressure water clarity changes is rated as 'low' (*Marine Scotland, 2013*). The various site survey results conducted over and in the vicinity of the Eagle development over recent years, including the most recent environmental survey work in 2019, has indicated that there is limited potential for the sea-pens and burrowing mega fauna community to be present along the Eagle to Gadwall route, given that burrows in the sediment were only classified as 'frequent' at one observed station (ENV1). There is less evidence from the initial results that this habitat is present along the Eagle to Kittiwake route, as burrows along this route were not observed in any abundance. The 2016 survey results from Kittiwake to Gadwall/ Mallard indicated that although some evidence of burrows and sea-pens was seen on the seabed imagery, the habitat assessment concluded that they did not constitute the sea-pens and burrowing megafauna habitat. Therefore, there is only limited potential for disturbance of this habitat; station ENV1 (in the 2019 survey results) is located 100 metres to the west of the proposed pipeline route (refer to alignment sheets in Appendix C) and represents the most likely potential location of this habitat.

The limited/ low mobility species 'ocean quahog (aggregations)' is listed as a feature within FEAST. FEAST presents that ocean quahog sensitivity as 'high' for the pressures physical removal (extraction of sub-stratum), sub-surface abrasion/ penetration and high siltation changes (*Marine Scotland, 2013*). During the previous survey work conducted over the development over recent years, evidence of the occurrence of ocean quahog was found in the form of broken shells recovered from grab samples (*Fugro, 2016c*), and broken shells were observed at the majority of camera stations in the spring 2019 survey work undertaken along the Eagle to Gadwall pipeline route and Eagle to Kittiwake umbilical route, although no live individuals were observed (*Gardline, 2019c*). There was no suggestion that the observed evidence of the species constituted aggregations of this species, particularly as no live specimens were observed. Therefore, there is only limited potential that disturbance of aggregations of ocean quahog species could occur as a result of the installation activities. If a population of ocean quahog experienced significant mortality through direct impacts, recovery is estimated to take in excess of 10 years and possibly in excess of 25 years (*Tyler-Walters & Sabatini, 2017*).

With regard to other potential benthic changes, new structures protruding from the seabed may provide additional habitat for epifauna that require a hard attachment point, leading to a potential localised change in both the habitats and species present in the area. Hard-surfaced items protruding above or laying on the seabed, including subsea structures (XT, SDU, tie-in manifold and spools) and protection structures (concrete mattresses, grout bags) are likely to become colonised through larval settlement from the water column and will eventually support a fauna distinct from that found in the surrounding sediments. However, the resultant epifauna is likely to be similar to that observed on hard substrata such as boulders present in the area naturally. The introduction of new infrastructure on the seabed is not predicted to change the character of the species typically present in the area as a whole.

The duration of potential effects on benthic community structure are related to individual species biology and to successional development. The majority of seabed species recorded on the European continental shelf are known, or believed, to have short lifespans (a few years or less) and relatively high reproductive rates, indicating the potential for rapid population recovery, typically between one to five years (*Jennings & Kaiser, 1998*). In general, macrofaunal population levels are limited by post-settlement factors, rather than larval availability. It is therefore considered probable, that both the physical habitat consequences and benthic community effects of physical disturbance of the seabed from the installation activities, will fully recover within a five- to ten-year period. However similar rapid recovery of MDAC features that may be directly disturbed by installation activities will not occur, as the formation of pockmarks and MDAC itself, and the unique faunal communities that these features support, takes place over thousands of years (potentially over the last 8,000 years) (*Judd, 2001*).

Tillin and Tyler-Walters (2015) assess the permanent change of one marine habitat type to another marine habitat type, through the change in substratum, including introduced 'artificial' substrates (e.g. concrete mattresses). They concluded that the permanent loss of one marine habitat type will result in the equal creation of a different marine habitat type. The predicted seabed type in the vicinity of the Eagle field development, according to EUNIS is A5.27 '*offshore circalittoral sand*' (*NMPi, 2019*), but was classified by survey activities as A5.26 '*circalittoral muddy sand*'.

Tillin *et al* (2010) consider continental shelf coarse sediments to have a medium sensitivity to physical change (to another seabed type) but with no supporting evidence provided. The provision of hard substrata in areas dominated by soft sediments attracts a new suite of species (*Crowe & Frid, 2015*). Often hard substrata occur in areas normally dominated by sediments, creating not only a novel habitat, but adding a new type of habitat (hard substrata) into areas that have naturally soft sediments (*Crowe & Frid, 2015*). Species may be attracted to the area by the provision of hard substrata.

Due to the disturbance of seabed during the installation phase of the Eagle project, there is the potential to affect fish species and activity, particularly spawning. Fish species known to spawn in the vicinity of the Eagle development include cod, mackerel, Norway pout, *Nephrops* and sandeel (*Coull et al, 1998*; *Ellis et al., 2012*). Block 21/19 has a special condition with regards to herring spawning grounds (*Oil & Gas Authority, 2018*). However, the available evidence indicates that herring spawning areas are located much further to the west in ICES Rectangle 43E9 (*Coull et al., 1998*) (Figure 3.14). In addition, no evidence of herring spawning activity was found during any of the site surveys.

The data for ICES rectangle 43F0 as a whole suggests that there are high intensity spawning areas for sandeel and Norway pout over the Eagle development. However, the high intensity spawning area for sandeel is located further to the west (Figure 3.14). The high intensity area for Norway pout is also located away from the proposed development to the west, although the Kittiwake platform lies immediately adjacent to it (Figure 3.14). Significant impacts on the high intensity spawning areas of these species are therefore not anticipated. Of the above species, there are three demersal species (cod, Norway pout and sandeel) that are also able to spawn in the water column over large areas, and so their eggs and juveniles are unlikely to be significantly impacted by the Eagle development.

Nephrops, however, live in burrows on the seabed, which they rarely venture far from, and are therefore vulnerable to sediment disturbance (*MarLIN, 2019c*). Burrows were observed in 7% of photographs during the 2019 survey activities (*Gardline, 2019d*), as well as within video footage but were “rare” at all transects except for one (Station ENV1), where burrows were described as ‘frequent’. Five of the environmental stations did have some similarity to a ‘sea pen and burrowing megafauna community’ habitat, although burrows were not present in high enough numbers to definitively classify the area as consisting of this habitat. Disturbance of this species is possible through direct disturbance of the sediment in the immediate vicinity of anchor placement and pipeline/ umbilical installation. However, the sea pens and burrowing megafauna habitat was not identified, and therefore the area of the Eagle development is not considered of conservation significance for this species.

Although there is fish spawning and nursery activity in the vicinity of the proposed Eagle development at certain times of the year, the spawning and nursery areas are part of very large offshore areas. The temporary disturbance of seabed during the installation of the field development represents a very small area compared to available sea room in the wider region. Disturbance to the seabed will be temporary during installation activities; once the operations are complete the seabed will again become available to fish species. Fish are highly mobile and are therefore likely to avoid areas of disturbance during the operations, however significant displacement of sensitive species is not expected, as neither herring spawning areas nor high intensity spawning areas for sandeel and Norway pout are located over the development.

In conclusion, there will be direct long-term impacts to the benthic community in the direct footprint of installation, resulting in exclusion and/or disturbance to the dominant sedimentary infauna, amounting to a worst-case area of 1.72 km^2. Effects on the benthic community will also be felt by the introduction of anthropogenic hard substrata protruding from or resting on the seabed. In terms of the circalittoral muddy sand habitat present in the region of the development, this area is negligible when compared to the available similar habitat in the surrounding area and is very unlikely to cause significant change to populations or to the biogeography of features present, such as burrowing megafauna or ocean quahog. Similarly, as outlined above with regard to the introduction of hard substrata, the area involved is small and not likely to result in significant change to the character of the species or habitats present in the region.

Budd (2006) suggests that the threat from infrastructure installation offshore is low. Although substratum loss was deemed to cause decline of species in the area of direct footprint, species that inhabit this type of benthic habitat were deemed to be highly recoverable. However, there is the possibility of significant impacts on the sensitive MDAC features present along the proposed pipeline route without appropriate mitigation.

Placement of Drilling Unit

There is potential for the anchoring of a semi-submersible drilling unit to cause direct disturbance to the seabed and benthic communities, due to scarring and/or anchor mounds being created as the anchors are placed and subsequently removed from the seabed, and the anchor chains moving and being dragged along the seabed causing scarring. With regards to use of a jack-up drilling unit, the placement of the spud cans will cause disturbance to the sediments underneath them. The total area directly affected by either semi-submersible rig anchoring or jack-up placement amounts to 0.040 km^2 and 0.001 km^2 respectively (refer to Table 5.1).

Physical disturbance as a result of anchor placement can cause mortality or displacement of benthic species in the impacted zone. Direct loss of habitat and direct mortality of sessile seabed organisms that cannot move away from the contact area are potentially expected at the anchor locations and anchor chain/seabed contact points.

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

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

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

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

There is not anticipated to be a significant long-term impact on the seabed and seabed communities from anchoring, especially given the small footprint (0.040 km^2 for semi-submersible anchoring and 0.001 km^2 for jack-up placement). This is however, assuming that the MDAC features encountered at the well location are actively avoided; placement of anchors or spud-cans over these features would likely cause significant long-term damage to them. There is therefore the potential for significant effects on these seabed features without proper mitigation.

Disturbance of Seabed Habitats (Indirect Impacts)

The temporary placement of anchors and the installation of the subsea infrastructure for the development will cause direct impacts to the seabed during the installation phase, but recovery of the seabed and associated fauna is expected in the long-term. In addition to these direct impacts, installation activities including installation of subsea infrastructure and concrete mattresses will lead to the raising of sediment plumes and their settlement over the wider area. This raising of sediment plumes and their consequent settling, could cause an indirect impact on the surrounding area as the disturbed sediments settle back to the seabed.

Redistribution and suspension of sediments has the potential to impact on species present in the vicinity. Filter feeding organisms that rely on suspended particles for food may be more vulnerable to potential smothering impacts than deposit-feeding organisms. Filter feeding species may become temporarily clogged with increased suspended solids in the water column just above the seabed and therefore the feeding pattern of these species could be temporarily limited. MDAC features, sea-pens and ocean quahog present in the area may be vulnerable to this type of impact.

MDAC features have been confirmed in the vicinity of the propose pipeline route. The MDAC features may themselves be resilient to smothering, as suggested by the FEAST assessment for pockmarks, which rates pockmarks as not sensitive to the activity pressures high siltation changes, and water clarity changes (*Marine Scotland, 2013*). However, as discussed above, the epifaunal features that they support (such as bacterial mats) may be sensitive to such changes given their close relationship to the MDAC features. During the site surveys, the observed faunal density at stations with MDAC notably increased with encrusting fauna, including cnidaria – actiniaria (sea anemones), hydrozoans, and nemertesia, including *Pennatula phosphorea* (phosphorescent sea pen) and porifera (sponges) (*Gardline, 2019c*). Although sponges are not listed as a specific feature within FEAST, they are listed as a component of the feature 'northern sea-fan and sponge communities'. For this feature, FEAST presents that the activity pressure low and high siltation changes is rated as 'high', and the activity pressure water clarity changes is rated as 'low'. Anemones are also specified as a feature within the burrowed mud feature within FEAST; the pressure high siltation changes is rated as 'medium', and the pressure water clarity changes is rated as 'low' (*Marine Scotland, 2013*). There is therefore the potential for effects on some epifaunal species due to sediment deposition.

There was evidence of ocean quahog presence in the site survey results (mainly observed broken shells) even though no live specimens were found. As stated above no evidence of aggregations of the species was present. FEAST presents that ocean quahog sensitivity is 'high' for the activity pressure of high siltation changes (*Marine Scotland, 2013*). If a population of ocean quahog experienced significant mortality through direct impacts, recovery is estimated to take in excess of 10 years and possibly in excess of 25 years. However, if only a small proportion of the population in the area were to suffer mortality through smothering, resilience could be considered medium and recovery may occur from low levels of continuous recruitment. Recruitment and recovery will depend on numerous factors including the size of the local population, variations in sea temperature, the local hydrography, regional oceanic currents and local reproductive isolation from other populations (*Tyler-Walters & Sabatini, 2017*). However, the expected potential impact to ocean quahog due to smothering from sediment settlement is considered to be limited due to the fact that no live specimens or evidence of aggregations of the species was found.

Fish species in general show high tolerance to water column suspended sediment changes and move away from high turbidity areas if they are disturbed. *Nephrops*, which are less mobile and remain largely in the vicinity of their burrows, also show tolerance to smothering effects and suspended sediment changes (*MarLIN, 2019c*). Other low-mobility species common to the area, and the North Sea in general, includes the common starfish (*Asterias rubens*). This species is considered to have a high recoverability to impacts due to the high fecundity of the species (> 1.5 million eggs per female), annual reproduction, long lived pelagic larva (> 80 days) that have a high dispersal potential and larvae which are able to settle upon a variety of benthic substrata (*Clark & Downey, 1992*). Significant impacts to such species are therefore not anticipated.

Brittle stars, such as *Amphiura filiformis*, have larvae which can disperse over a considerable distance due to the long pelagic stage associated with the larval life stage. However, adults although mobile are not highly active (*Hill & Wilson, 2008*). Rosenberg *et al*. (1997) showed after a pollution incident, where there were no individuals left, that juveniles were seen a year after the incident and a density of 100 adults per square metre were found after two years at several stations. However, it can take approximately five to six years for *Amphiura filiformis* to grow to maturity, so population structure may not return to original levels for at least this length of time in the event the species are impacted. In addition, it is likely that if a population is significantly depleted, a recovery will be determined by the presence of suitable hydrodynamic forces providing new larvae. Once settled, the population may take longer than five years to return to maturity (*Hill & Wilson, 2008*). After deposition, particulate material on the seabed will be subject to re-distribution through the action of seabed currents.

The disturbance of seabed sediments has the potential to cause mobilisation of any contaminants within them, however this is not likely to occur over the Eagle development; TOC and metal concentration data in sediments from previous site surveys shows that the area falls below UKOOA mean background concentrations. (*Fugro, 2016c*; *Fugro 2014c*). The only exception to this was sampling station STN01 which lies to the south-east of the Kittiwake platform (refer to Table 3.4) (*Fugro, 2016a*). This shows an elevated barium concentration, indicative of potential deposition of drilling cuttings/ muds given the proximity to the Kittiwake platform. The same sample did not however show an increased THC concentration, suggesting that the sediment is possibly associated with a water-based drilling cuttings discharge.

There is the potential that installation of the umbilical may encroach into this area, and therefore for mobilisation of this sediment during the installation of the umbilical by jetting. However, barite in drilling mud is essentially insoluble, and is not in a form readily absorbed by marine organisms; several metal bioaccumulation studies using water-based drilling fluid cuttings have found that metal concentrations in the tissue of exposed animals were very similar to those in the tissues of unexposed animals (*IOGP, 2016*). Furthermore, studies were undertaken by OSPAR (2009b) into older legacy cuttings piles associated with oil phase fluid (OPF) discharges. A study undertaken in the UK using trawling operations to disturb a cuttings pile concluded that although contamination was spread, it was not in amounts or at rates likely to pose serious wider contamination or toxicological threats to the marine environment. The study found that the act of spreading will encourage, albeit at a slow rate, increased aeration of deposited material which will enable further degradation by natural processes (*OSPAR, 2009b*). Therefore, significant effects on benthic marine organisms are not expected in the event any legacy cuttings piles are disturbed.

The environmental baseline survey report from the 2019 survey activities was not available at the time of drafting the ES, however the results will be made available once the analysis and reporting is completed. Given the similarity in depths and sediments, and the fact that previous surveys have covered a fair amount of seabed, the results with regard to THC and metals analysis are expected to be similar.

During the environmental planning process for another project in the wider GKA area (namely, Scolty Crathes), EnQuest commissioned a study into the potential effects of sediment dispersion from the use of a backfill trenching plough for pipeline installation. This study is relevant to the Eagle development as the Scolty and Crathes wells are tied back to Kittiwake; the study assessed the potential effect of the installation of a new pipeline alongside the originally installed pipelines on the locations of confirmed MDAC on the seabed within the proposed pipeline route. Sediment dispersion modelling was done as part of the study to asses the indirect effects of any temporary additional sedimentation from material thrown into suspension by trenching and backfilling activities (*Xodus, 2018*).

A total of 26 mapped fluid seep features of diameters between 40 to 90 metres were identified as occurring within 200 metres of the proposed replacement Scolty Crathes pipeline centreline, including three MDAC occurrences and 23 pockmarks. Four dispersion models were run, simulating the continuous release of sediment disturbed by backfill trenching operations (using 2% and 10% of fine sediment [silt and clay]). The models were run for a section of the pipeline closest to MDAC records over 1-hour and 5-hour periods along the route centreline, as a series of batch releases at approximately 7 metre intervals along the proposed pipeline route. The modelling using the 10% fine sediment (considered worst case for fines, where 2% is more likely) showed that fine sediment particles were carried in the direction of the prevailing currents, eastwards from the release location a minimum of 1 km before the deposition of fine particles on the seabed began. The mass of deposited sediment over the entire area following settling was predicted to be much less than 0.5 µg per square metre. Assuming a density of 2.65 g/cm^3, a spherical sand particle with a diameter of 63 µm would have a mass of approximately 0.05 µg and a spherical sand particle with a diameter of 2 mm would have a mass of approximately 1,580 µg; thus, the maximum deposition predicted was equivalent to between 1 and 10 grains of sand per m^2. This represents a very limited deposition that is not likely to affect any physical or biological feature (*Xodus, 2018*).

Given the similarity in seabed sediments between the referenced modelling study and the Eagle field development area (predominantly fine sand), the sediment modelling results are considered to be directly relevant to the proposed Eagle development; it is considered that backfill ploughing operations at Eagle will have limited to no effects on the benthos through the deposition of suspended sediment disturbed by backfill ploughing operations.

The control umbilical between Eagle and Kittiwake will be installed using a jetting plough. Jetting is a technique that uses high-pressure water to fluidise the seabed, enabling simultaneous trenching and burial of subsea cables and umbilicals. It is particularly suited to umbilical installation as control umbilicals are more flexible than pipelines and have a narrow gauge. As soon as the cable is sunk into the seabed by the jetting plough whilst the seabed sediments are fluidised, the seabed sediments immediately settle back down around the umbilical, simultaneously achieving the required depth and backfill of seabed material. Jetting is preferable to traditional backfill ploughing for umbilicals as it offers a rapid installation and a high level of accuracy can be achieved both in terms of burial depth and position.

Although jetting does disturb the seabed, the disturbance is much more localised than the use of a backfill trenching plough, as all the disturbance is focused within the depth of the 'swords', which are slightly longer than the required burial depth. A combination of the pressure and the design of the swords fluidises the seabed directly under the umbilical, allowing the umbilical to fall under its own weight into the 'slot' created. Some machines are also fitted with a depressor arm which is a mechanical device to ensure that the umbilical is pushed to the bottom of the trench before it fills itself in.

This type of burial operation does give rise to sediments being suspended in the water immediately adjacent to the burial operation. However, a sediment dispersion study for cable installation techniques at the Nysted offshore wind farm in Denmark (*BERR, 2008*), indicated that jetting operations were found to result in significantly less water turbidity than pre-trenching and backfilling operations. Table 5.2 shows water sediment concentration measurements undertaken at 200 metres distance from each of the cable installation methods (*Seacon, 2005*, in: *BERR, 2008*).

Table 5.2: Mean and maximum values of sediment concentration at 200 metres from three cable laying operation methodologies (Seacon, 2005 in BERR, 2008)

Method	Mean	Maximum
Trenching	14 mg/l	75 mg/l
Backfilling	5 mg/l	35 mg/l
Jetting	2 mg/l	18 mg/l

In areas that do receive a thin covering of additional material, either from direct settling or re-suspension, it is expected that deposited material will be worked into the existing seabed sediments by reworking of the sediment (burrowing, ingestion and defecation of sediment grains) by the benthic species present. This process will gradually return the seabed to a condition similar to its unimpacted state. Defra (2010) states that impacts arising from sediment re-suspension are short-term (generally over a period of a few days to a few weeks). In addition, infaunal communities are naturally habituated to sediment transport processes and are therefore less susceptible to increased sedimentation rates. To serve as an example, previous research and metocean data collected for the Hornsea 1 offshore wind farm indicate that background suspended sediment concentration levels are typically between 0 to 30 mg/l in the offshore area, although under storm conditions values can increase to up to 250 mg/l offshore (*HR Wallingford et al., 2002*, in: *SMartWind, 2013*). The predicted modelled suspended sediment concentrations in the studies referenced above are within this natural range.

Overall, any sediment resettlement sufficient to cause smothering is only expected to occur in the immediate vicinity of installation activities. Most of the plume resettlement will be relatively light, as shown by previous sediment dispersion modelling conducted for similar EnQuest installation operations. Available evidence indicates a good recovery potential for any of the predominantly sedimentary infauna affected. In addition to the small area affected, recovery will also be aided by the long, narrow shape of the project pipeline and umbilical footprints and the fact that it will be mediated heavily through inward migration from adjacent undisturbed areas (rather than through the potentially long process of larval settlement and recruitment). Following completion of the Eagle development, the natural physical processes of sediment transportation and natural backfilling, together with faunal migration over short distances, are expected to result in recovery of the seabed habitat around the installed infrastructure within the order of one to five years.

Other Sea Users

During the Eagle development, the potential for disturbance to other sea users exists through potential disruption of commercial shipping traffic and fishing vessel activity. During the drilling programme, a 500 m safety exclusion zone will be in place around the drilling unit to prevent third-party vessels from travelling in unsafe close proximity to the drilling unit. The safety exclusion zone will result in a total sea area of 0.8 km^2 being unavailable to other sea users for a period of approximately 46 days. In addition, the anchor chains and anchors are likely to extend out-with the safety exclusion zone, spreading up to 1.5 km from the drilling unit. There will also be potential disruption to other sea users through the use of the various vessels needed to install the subsea infrastructure. Whilst these vessels are on site engaged in the operations, they will have restricted maneuverability and other sea users will be required to give these vessels due wide berth. This temporary restriction of access to the sea has the potential to disrupt fishing and commercial shipping activities.

The available evidence within the environmental description suggests that the area is not a busy commercial shipping location (refer to section 3.5.4) and that fishing activity in the vicinity is low compared to other areas of the North Sea (refer to section 3.5.1).

In order to assess the impact on other sea users, EnQuest commissioned a vessel traffic study, centred on the Eagle well location (*Risktec, 2019*). The study was based on historical shipping traffic information using transmissions from the Automatic Identification System (AIS) operated by most vessels. AIS is a system designed to provide information about the ship to other ships and to coastal authorities automatically. It is required to be fitted aboard all ships of 300 gross tonnage (GT) and upwards engaged on international voyages, cargo ships of 500 GT and upwards not engaged on international voyages, and all passenger ships irrespective of size. The study provided general analysis of the AIS transmissions observed within 10 nautical miles (nm) of the Eagle well location.

The data set consisted of AIS signals over a period covering January 2014 to June 2019, with a time resolution of 5 minutes. The AIS data within 10 nm of the Eagle well site is shown in Figure 5.1. The upper image in Figure 5.1 shows all AIS signals from the dataset, while the lower image has filtered areas with only single AIS signals, to allow the density plot to be superimposed on the existing subsea infrastructure. It can be seen that the historical traffic is centred on several localised areas: the Eagle well site and nearby areas to the north and to the east, plus more distant activity at the Kittiwake platform and the Anasuria FPSO (*Risktec, 2019*).

The AIS data set was analysed to identify passenger vessel activity in the region. A very low representation of passenger vessels was observed in the data, with only 90 individual AIS signals identified from 10 distinct journeys by 6 different vessels. Table 5.3 provides the 6 passenger vessels that were identified within 10 nm of the Eagle well site during the period 2014-2019. No passing lanes were identified in this area which would be indicative of high frequency commercial shipping routes (*Risktec, 2019*).

Table 5.3: Passenger vessels within 10nm of the Eagle well site (2014-2019) (Risktec, 2019)

IMO Number	Name	Call Sign	First Observed	Last Observed
8217881	MAGELLAN	C6BR5	11/05/2018	18/05/2018
8201480	ARTANIA	ZCDM7	09/09/2015	09/09/2015
8101276	THALASSA	PHYD	10/05/2016	10/05/2016
8027298	THOMSON CELEBRATION	9HUI9	05/06/2017	05/06/2017
8024014	THOMSON SPIRIT	9HA2336	06/07/2014	26/07/2014
7218395	BOUDICCA	C6VA3	03/08/2015	03/08/2015

Figure 5.4: Vessel activity within 10 nm of the Eagle well site from 2014-2019

The AIS dataset was also analysed to identify fishing activity in the region. It should be noted that while the IMO does not require fishing vessels be equipped with AIS if <500 GT, as of 31st May 2014 all EU fishing vessels of 15 m and over must be equipped with AIS. The AIS data here may therefore omit any non-EU vessels which are not required to comply with this legislation, but the analysis is considered overall to provide a broadly accurate view of fishing activity (*Risktec, 2019*).

A total of 976 AIS signals were identified from fishing vessels, encompassing 82 separate journeys from 46 vessels. The low quantity of fishing data observed suggests that this is not an active fishing area. This is further supported by the average speeds of the vessels: of the 82 journeys by fishing vessels, 70 had an average speed above 7 knots, indicating they were likely in transit rather than actively fishing.

Table 5.4 provides the 46 fishing vessels that were identified within 10 nm of the Eagle well site during the period 2014-2019 (*Risktec, 2019*).

Table 5.4: Fishing vessels within 10nm of the Eagle well site (2014-2019) (Risktec, 2019)

IMO Number	Name	Call Sign	First Observed	Last Observed
9162655	SCH81 CAROLIEN	PDHC	12/08/2016	03/07/2018
8817746	ESVAGT BETA	OUJM2	01/10/2015	28/06/2018
9674830	GITTE HENNING	OUXD	26/08/2014	10/09/2015
8012085	FV SANDETTIE	FKHI	30/05/2014	06/10/2016
8508307	HM379 LINGBANK	OYNB	02/09/2014	18/09/2017
8707446	JAN MARIA	DFDJ	11/07/2014	06/07/2016
9249556	PH1100 WIRON 5	2HGD8	11/06/2014	17/11/2018
9116058	ROCKALL	OXNN	09/09/2015	06/06/2016
9816775	CLIPPERTON	SBCR	20/05/2018	23/05/2018
9182801	FMS MAARTJE THEADORA	DEAN2	08/09/2015	09/09/2015
7922233	ACC MOSBY	LJIT	28/06/2018	28/06/2018
9175834	SCH24 AFRIKA	PEAT	06/10/2016	13/07/2018
9251107	CEFAS ENDEAVOUR	VQHF3	03/09/2014	18/08/2016
9350628	CETON	OYEC	06/06/2016	06/06/2016
8224406	FV PRINS BERNHARD	FKHH	06/06/2018	24/06/2018
8714334	F/V CAP NORD	FNLM	01/10/2015	01/10/2015
8716928	GERDA MARIA	DFLM	20/04/2014	16/05/2019
9182801	MAARTJE THEADORA	DEAN2	30/06/2018	30/06/2018
8901913	SCH123 ZEELAND	PIWT	19/07/2017	19/07/2017
9187306	WILLEM VAN DER ZWAN	PCII	10/06/2014	11/06/2014
9782778	CUXHAVEN	DFQH	07/04/2019	07/04/2019
9249568	PH2200 WIRON 6	2HGE2	16/06/2014	17/11/2018
9806847	ROCKALL	OUHA	08/06/2018	08/06/2018
8616908	G/V.ARDENT.INS 127	MZNA6	05/05/2017	05/05/2017
8506830	GERDA MARIE	LAUP	24/08/2016	25/08/2016
7032179	ZVEZDA MURMANA	UEDV	13/05/2019	13/05/2019
9204556	KW174 ANNELIES ILENA	PHKE	06/07/2016	02/08/2016
8224418	SCH6 ALIDA	PCLU	28/07/2018	13/08/2018
9746097	BEINUR	OWAR	27/08/2016	27/08/2016
9809265	GITTE HENNING	OWLR	05/09/2018	05/11/2018
9126364	HELEN MARY	DQLI	13/07/2014	13/07/2014
8965440	STARLIGHT RAYS	LGDF	05/01/2015	05/01/2015
8505434	NORAFJELL	JXAY	29/10/2015	29/10/2015

IMO Number	Name	Call Sign	First Observed	Last Observed
8506828	SJOBRIS	JWSG	29/10/2015	29/10/2015
9217852	TOR-ON	SMIT	08/09/2015	08/09/2015
8028412	ANNIE HILLINA	DEDT2	21/07/2017	21/07/2017
9117519	F/V LABEL NORMANDY	FJXN	07/07/2018	07/07/2018
9194323	VIKINGBANK	LLAS	01/07/2014	01/07/2014
9074951	FRANK BONEFAAS	PEDV	27/07/2014	27/07/2014
9168685	GINNETON	SJTN	17/06/2014	17/06/2014
9414682	OCEAN HARVEST PD198	2BAK6	01/06/2017	01/06/2017
9227431	POLAR	SKGQ	04/09/2018	04/09/2018
9350616	ISAFOLD	OYEB	21/05/2018	21/05/2018
7234636	KIEL	DEOF	05/04/2014	05/04/2014
8516225	STELLA NOVA	OXHK	20/05/2018	20/05/2018
9806859	THEMIS	OXNP	02/09/2018	02/09/2018

Two other areas of activity are noted in Figure 5.4 close to the well site: one to the north and one to the east. In the area to the north, a total of 7,569 AIS signals were observed originating from the area. Most of the AIS signals relate to historical activity in this region during 2014 and 2015; further analysis showed the majority of vessels to be tug/supply ships and standby vessels (*Risktec, 2019*).

In the area to the east of the well site, a total of 3,907 AIS signals were observed; most of these AIS signals related to recent activity during 2019 and were predominantly platform and tug/supply ships. Further analysis of the AIS data shows the *Deepsea Bergen* (a jack-up drilling unit) was located here between 6-Apr-2019 and 22-May-2019, also transmitting AIS. Of the AIS signals not originating from *Deepsea Bergen*, 71% were from vessels which indicated *Deepsea Bergen* as a destination in their AIS transmissions. As indicated in Figure 5, outside of the 2019 operation involving *Deepsea Bergen*, there has been minimal historical activity in this region (*Risktec, 2019*).

The study indicates that the area in the vicinity of the proposed Eagle development is not an especially important area for fishing, with very limited evidence of fishing activity over the last five years. Nor is there evidence of significant commercial shipping, with no shipping lanes apparent and very limited passenger vessel activity. Given these findings, the potential impact on other users of the sea is considered to be negligible.

In respect of potential future fishing activity in the area, there is the possibility that demersal trawlers may snag fishing gear on the installed subsea infrastructure. However, this risk is considered to be very low due to the fact that the subsea XT, double-isolation valve, SDU and tie-in manifold will incorporate fishing-friendly protection structures, together with very limited evidence of active fishing in the region over the past 5 years.

5.1.2 Mitigation

Several mitigation measures will be adopted by EnQuest to reduce, where possible, the potential impacts of the Eagle development on benthic habitats and species:

- In the event a semi-submersible drilling unit is used, EnQuest will undertake a rig mooring study, which will examine the MDAC features identified and provide an anchor plan to avoid these features. Where possible, the previous anchor layout (as used for the Eagle discovery well) will be used, which will occupy the same anchor bedding locations and chain marks to limit any new disturbance to the seabed.
- In the event a jack-up drilling unit is used, EnQuest will undertake a rig positioning study, which will examine the MDAC features identified and provide a jack-up placement plan to avoid these features. The study will also take into account any potential spud-can rock dump requirements

to ensure that if rock dump is required for spud-can placement, this contingency will also not affect the MDAC features.

- Should the drilling unit need to leave the site during the operations, for unexpected weather for example, on its return the same anchor pattern/ placement will be used.
- EnQuest will ensure that the subsea XT, double-isolation valve, SDU and tie-in manifold incorporate fishing-friendly protection structures and will limit the use of protection structures placed on the seabed (concrete mattresses, grout bags and potential rock dump) to restrict the seabed impact and to keep the risk of fishing gear snagging to a minimum.
- Consultation with the Scottish Fishermen's Federation (SFF) will continue to take place. SFF will be notified, in writing, a minimum of 30 calendar days before the start of any operations, so that fishing vessels can plot the drilling location and/or the location of installation vessels on marine charts and plan their sea passage to/from favoured fishing grounds and their fishing activities accordingly. EnQuest will also forward as-built survey data on the pipeline and umbilical to SFF.
- EnQuest will route the export pipeline around the MDAC features identified during the 2016 and 2019 site survey operations using an 80-metre-wide installation corridor (further details on how this will be achieved are provided below).
- EnQuest will ensure that no sandbags for use as turning bollards will be deployed in the vicinity of MDAC features.
- EnQuest will re-visit the MDAC features during the post-installation as-built surveys, to investigate the condition of the MDAC features following the installation works.

Avoidance of MDAC During Pipeline Laying and Trenching/ Backfilling

EnQuest will route the export pipeline around the MDAC features identified and confirmed during the 2016 and 2019 survey operations. EnQuest has worked closely with its installation contractors to ensure that this can be achieved and this will be built into the specifications of the installation contracts. The locations of the identified MDAC features were shared with installation design engineers in order that an appropriate route and installation corridor could be designed to actively avoid these features. The proposed export pipeline route is shown on the Eagle to Gadwall site survey alignment sheets in Appendix C.

The base case is that the export pipeline will be simultaneously laid, trenched and backfilled. Figure 5.5 shows a detailed view of the trenching and backfill plough proposed for use; it has a span of 21.02 m. The Figure also shows an MDAC feature as an example at an absolute worst-case closest point of approach (CPA). During ploughing, the spoil heap from this plough in the type of sediment at the Eagle development will extend 12.25 metres to either side of the pipeline route centreline (*Xodus, 2018*).

The pipeline contractor, Technip, also advised that if the pipelay speed is slowed, a lay accuracy of +/-1.5 metres is achievable (*TechnipFMC, 2018*). A lay tolerance of ±1.5 m would mean that the direct seabed disturbance of trenching/ backfilling along the Eagle to Gadwall pipeline route would have a CPA of 70 metres from the closest confirmed MDAC record, located at station ENV3TR at KP2.8 (*Gardline, 2019c*) (refer to alignment charts in Appendix C). There is also an area of high reflectivity (that has not been sampled) located adjacent (approximately 5 metres) to the installation corridor at the same location. However, given the achievable lay tolerance and the wide pipeline installation corridor proposed, successful installation of the Eagle export pipeline will be undertaken without disturbing either confirmed or probable (areas of high reflectivity) MDAC features. This is further enhanced by EnQuest previous experience of avoiding MDAC features on pipeline installation operations on the Scolty Crathes project.

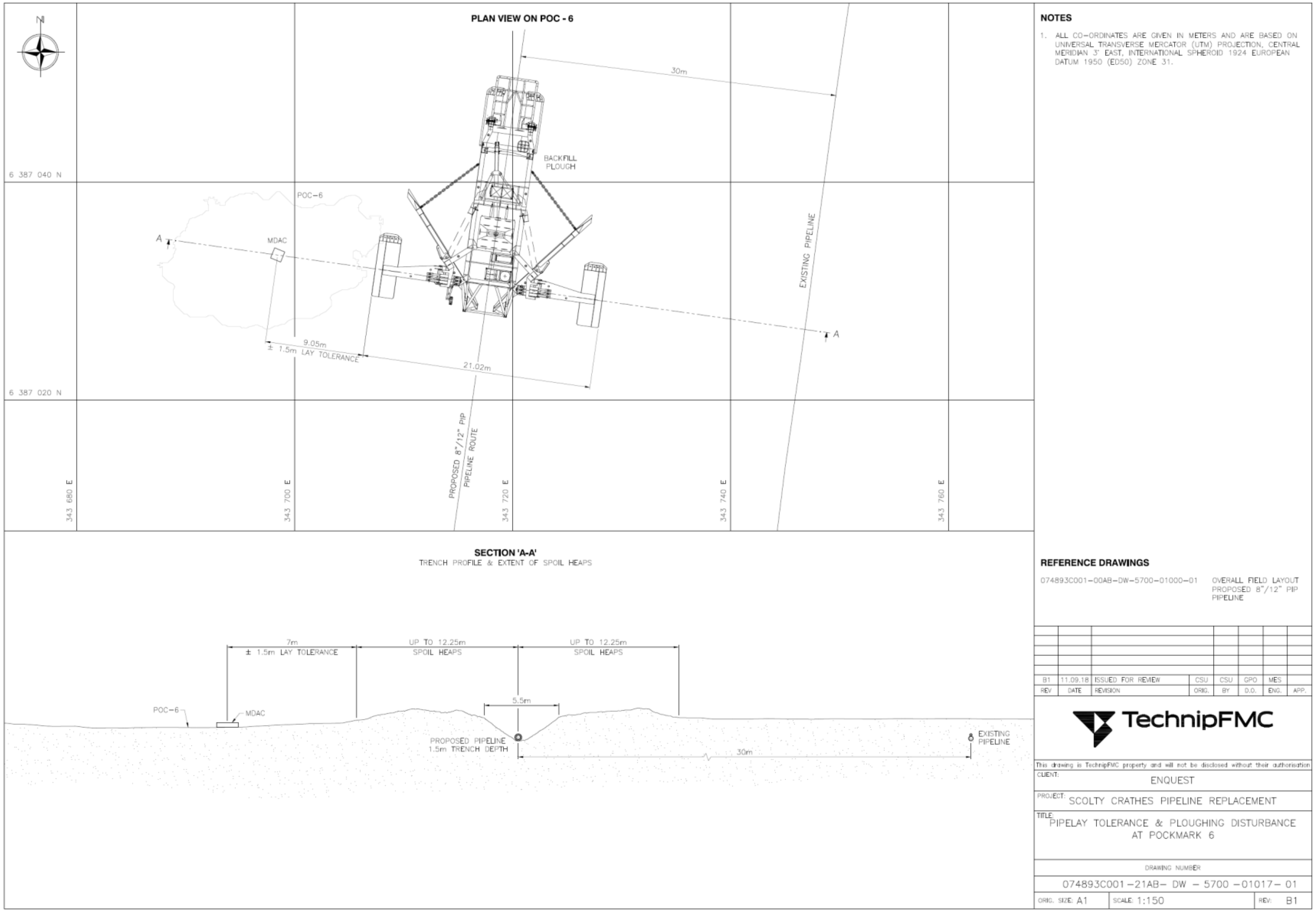

Figure 5.5: Trenching plough and example CPA to an MDAC feature (Technip FMC, 2018)

5.1.3 Cumulative Impact

DECC (2016) identifies that the sources of cumulative physical disturbance to the seabed associated with oil and gas activities include drilling rigs, wellhead placement and recovery, umbilical and pipeline installation and trenching and decommissioning of infrastructure. Of these, pipelay is considered to account for the largest spatial extent. The Eagle development is predicted to cause direct disturbance of 1.72 km^2 of seabed. The majority of this area is likely to be affected only in the short term, and the area affected is extremely small compared to available similar habitat in the vicinity of the development.

As illustrated in Figure 3.13 (section 3.5.3), there are a number of established oil and gas fields in proximity to the proposed Eagle development, but the ongoing seabed impacts caused by these projects is likely to be very small (i.e. installation has been completed and ongoing operational impacts on the seabed are minimal). There are no other industry projects (e.g. offshore renewables, aggregate extraction) in the wider vicinity. Therefore, the cumulative impact of the Eagle development on the seabed is considered to be negligible.

The most widespread and damaging activity taking place in the area is almost certainly the use of bottom-fishing gear by fishing vessels. This is highlighted by the OSPAR background documents for ocean quahog (*OSPAR, 2009*) and sea-pen and burrowing megafauna communities (*OSPAR, 2010*), both of which identify beam trawling / bottom trawling as the main threat to the species / habitat assessed. In contrast, OSPAR (2010) identifies habitat loss through infrastructure development, including offshore oil and gas, as a low scale threat. In comparison with the seabed disturbance caused by this activity, impacts from the Eagle development will be negligible, and make an insignificant contribution to any cumulative impact.

The shipping density study (*Risktec, 2019*) suggests that the area is not an active fishing area. However, the potential future fisheries management measures for the East of Gannet and Montrose Field NCMPA, whereby trawling and dredging within this NCMPA may be completely prohibited (*Marine Scotland, 2018*; *NMPi, 2019*) will displace fishing activities from the NCMPA into adjacent areas. The available data indicate that demersal trawling activity is limited over most of the NCMPA, however dredging activity has historically taken place in the very southern region (*NMPi, 2019*). However, a displacement of fishing activity from such a large area could therefore increase potential future fishing activity in the vicinity of the Eagle development. This could potentially be of concern due to the MDAC features present and the risk for them to be damaged by trawling.

5.1.4 Transboundary Impact

The Offshore Energy SEA for UKCS waters (*DECC, 2016*) states that seabed impacts are unlikely to result in transboundary effects and even if they were to occur, the scale and consequences of the environmental effects in the adjacent state territories would be less than those in UK waters and would be considered unlikely to be significant. The Eagle development is located approximately 80 km from UK/Norway median line; direct and indirect seabed impacts will not occur this far from the development and therefore transboundary impacts will not occur.

5.1.5 Decommissioning

Any potential impacts as a result of decommissioning operations (e.g. removal of the Eagle development infrastructure) will occur in the area that experienced seabed disturbance during the installation operations. The decision on whether to leave infrastructure in place or to remove it will depend on the regulatory philosophy prevailing at the time. Any proposed decommissioning operations would be the subject of comparative assessment and EA.

It is possible that there may be some re-suspension of sediment during the removal of seabed infrastructure, but recovery and re-colonisation would be expected to occur rapidly. The potential impacts from decommissioning operations are likely to be similar in magnitude to those experienced during installation and thus not considered significant.

During the decommissioning EA process, the SFF Offshore Oil and Gas Decommissioning Policy would be taken into account (*SFF, 2018*). A return to clean seabed is the SFF's overarching principle in relation to oil and gas decommissioning on the UKCS, taking into account current legislation, related guidelines and the UK Fisheries Offshore Oil and Gas Legacy Trust Fund Limited (FLTC) Memorandum of Understanding. The SFF preference is of total removal to shore for all surface and subsea installations, pipelines and flowlines (*SFF, 2018*). Such preferences would need to be considered against the potential environmental impacts of the various decommissioning options in the comparative assessment stage, as well as the prevailing environmental and planning guidance at the time. SFF also indicate that there is an expectation for oil and gas operators to provide a legacy and liability management plan for all issues including survey, sampling, monitoring and mitigation. EnQuest would consider all such relevant issues and integrate them into the EA process at the time of decommissioning planning.

5.1.6 Protected Sites

The conclusions on the impacts presented in this chapter have taken account of protected sites as relevant. The Eagle development does not occur within an SAC, SPA, NCMPA or MCZ and therefore no impacts to protected sites are expected to occur as a result of the physical presence of the development and its associated impacts on the seabed. As such, there is considered to be no likely significant effect (LSE) on SACs, SPAs and NCMPAs; hence no impact on any conservation objectives or site integrity.

The closest NCMPA to the Eagle development is the East of Gannet and Montrose Fields NCMPA. *A. islandica* aggregations is a key protected feature of this NCMPA, including the sands and gravels as their supporting habitat, which lies approximately 11.5 km south-east of the Eagle development. Evidence of their presence (observed broken shell fragments on the site survey imagery [*Gardline, 2019c*]) in close proximity to this protected area is therefore not unexpected or considered to be unusual. No live specimens were observed during the site survey and there was no evidence of aggregations of the species.

5.1.7 Residual Impact

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Benthos	Low	Low	Very High	Minor
Rationale				

The information in the environment description (Section 3) has been used to assign the sensitivity, vulnerability and value of the receptor as follows.

The sensitivity of seabed habitats and species to direct long-term disturbance and indirect temporary disturbance due to sedimentation is low. Direct impacted area (1.72 km^2) and potential indirect impacted area due to the Eagle development is small relative to the available habitat and associated species present in the CNS. The habitats in the vicinity are considered to have some tolerance to the potential impacts of the development. It is considered that species present will be able to accommodate a particular effect or where a long-term impact is predicted such as long-term exclusion from a habitat as a result of new infrastructure, species will be able to adapt by finding new habitat in the large amount of available undisturbed habitat in the immediate vicinity.

The vulnerability is considered to be low, as any impacts are not likely to affect the long-term function of the benthic community present with the avoidance mitigation proposed. Most impacts are expected to be short-term, with prolonged impacts occurring over a very limited area.

The value of the receptor is considered to be very high due to the presence of MDAC identified. Other benthic features found across the area are considered highly representative of the wider environment and no species are considered to be solely dependent on the development area for suitable habitat. Some evidence of the possible presence of the habitat 'sea pens and burrowing megafauna' was seen based on burrows observed on seabed imagery (*Gardline ,2019c*), however, burrows were not present in high enough numbers to definitively classify the area as consisting of this habitat. Evidence of *Arctica islandica* was recorded at several stations (observed broken shell fragments), although no live specimens were observed and there was no evidence of aggregations of the species. This species and habitat (not including the MDAC) are commonly found within this area of the North Sea (*OSPAR, 2009*; *2010*) and given the evidence from the survey results, this area is not considered of conservation importance for these species and habitats.

The impact magnitude is considered to be minor due to the short length of time any impacts will occur and the estimated recoverability of the species present, together with the MDAC avoidance mitigation proposed.

The Eagle development activities are expected to be negligible in terms of cumulative and in-combination impacts, and mitigation measures will be used to reduce the potential impact to an acceptable level.

The overall consequence is therefore considered to be low and the impact is not considered to be significant.

Consequence	Impact significance
Low	Not significant.

5.2 Atmospheric Emissions

5.2.1 Introduction

Gas emissions as a result of the construction of the Eagle development could result in impacts at a local, regional, transboundary and global scale. Local, regional and transboundary issues include the potential generation of acid rain from nitrogen and sulphur oxides (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 NOx 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 fourth assessment report (*IPCC, 2007*) stated that '*Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas (GHG) concentrations*'. Climate change projections included in the IPCC report for Europe and Africa forecast a temperature increase of between 2.3°C and 5.3°C in the period from 2080 to 2099.

GHGs include water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxides (N_2O), O_3 and chlorofluorocarbons (CFCs). The most abundant GHG is water vapour, followed by CO_2. IPCC (2013) reports a 35% increase in CO_2 concentrations compared to pre-industrial concentrations and states that the combustion of fossil fuels is the primary contributor.

5.2.2 Description and Quantification of Impact

The demands placed on the existing generators and compressor drives on the Kittiwake platform will not increase relative to the existing operation, as other producing fields (namely Gadwall and Mallard) will be backed out (flow reduced) accordingly to make space for Eagle in the existing production systems. Therefore, there will be minimal (if any) increase in emissions from power generation on Kittiwake due to combustion relative to the current Kittiwake operation. For this reason, this section utilises the figures from the current Kittiwake PPC permit, as it is anticipated that Kittiwake will not be operated outside of its current permitted envelope as a result of Eagle coming online.

Atmospheric emissions from the Eagle development will be related largely to fuel consumption by the drilling unit, during well clean-up/ testing (if performed) and from the associated vessels, including installation / pipelay vessels. There will also be emissions during the production phase through the use of a proportion of gas produced from Eagle as fuel gas. A summary of predicted atmospheric emissions from the construction of the Eagle development is provided in Table 5.5.

Prior to production, the 21/19-13 Eagle P1 well will be cleaned up to remove any waste and debris to prevent damage to the subsea infrastructure or topsides production facilities. A well test may also be conducted. During well clean up and testing, up to 2,000 tonnes of oil may be produced from the well. Oil and gas produced during well testing will be flared over a maximum period of 96 hours. Flared gas is not expected to exceed 200 tonnes. Flaring emissions from well clean-up and testing are also detailed in Table 5.5.

Table 5.5: Atmospheric emissions from the Eagle development [fuel use and emission factors derived from Environmental and Emissions Monitoring System (EEMS) (Oil & Gas UK / DECC, 2008) and IPCC (2013)]

Source	Emission factor (tonnes)							
	CO_2	CO	NO_x	N_2O	SO2	CH4	VOC	CO_2eq (*IPCC, 2013*)
Drilling								
Drilling rig (30T / day)	4,416.00	21.67	81.97	0.30	5.52	0.25	2.76	7,855.00
Anchor handling vessel (6T / day)	76.80	0.38	1.43	0.01	0.10	0.00	0.05	137.96
Debris survey vessel (10T / day)	64.00	0.31	1.19	0.00	0.08	0.00	0.04	112.66
Standby vessel 3T / day)	441.60	2.17	8.20	0.03	0.55	0.02	0.28	785.53
Supply vessel (5T / day)	400.00	1.96	7.43	0.03	0.50	0.02	0.25	712.38
Helicopters (refer to Table 5.6)	46.27	0.08	0.18	0.00	0.06	0.00	0.01	53.74
Well Testing and Flaring								
2,000T oil, 200 tonnes gas	6,960.00	37.34	7.64	0.18	0.03	59.00	51.00	9,600.98
Installation of subsea infrastructure								
DSV trip #1 (15T / day)	672.00	3.30	12.47	0.05	0.84	0.04	0.42	1,196.39
Pipelay (20T / day)	448.00	2.20	8.32	0.03	0.56	0.03	0.28	797.07
Pipeline trench and backfill (20T / day)	896.00	4.40	16.63	0.06	1.12	0.05	0.56	1,593.46
Pipelay support / survey / pre-commissioning (10T / day)	896.00	4.40	16.63	0.06	1.12	0.05	0.56	1,593.46
Umbilical installation vessel (20T / day)	896.00	4.40	16.63	0.06	1.12	0.05	0.56	1,593.46
Jet trenching vessel (20T / day)	896.00	4.40	16.63	0.06	1.12	0.05	0.56	1,593.46
DSV trip #2 (20T / day)	1,344.00	6.59	24.95	0.09	1.68	0.08	0.84	2,390.51
Kittiwake Topsides Modifications								
Pull-in of control umbilical, installation of TUTU (15T / day)	96.00	0.47	1.78	0.01	0.12	0.01	0.06	171.73
Totals	**18,548.67**	**94.07**	**222.08**	**0.97**	**14.52**	**59.65**	**58.23**	**30,187.79**
Kittiwake Operation (estimated yearly totals)								
Kittiwake fuel gas use	40,000.00	110.00	170.00	3.00	16.00	15.00	15.00	48,400.00
Kittiwake LP flare	4,088.00	9.78	1.75	0.12	0.02	26.28	2.92	4,977.32
Totals:	**44,088.00**	**119.78**	**171.75**	**3.12**	**16.02**	**41.28**	**17.92**	**53,377.32**

Note: Durations are provided in Table 2.6.

Table 5.6: Flights fuel consumption estimate for the drilling programme

	Estimated consumption per rotation (litres)	Estimated consumption per rotation (tonnes)	Estimated number of rotations	Total estimated fuel consumption (tonnes)
Helicopter: ABZ-Eagle-ABZ	1,333[1]	1.033[2]	14	14.46

1: Based on a fuel consumption of 0.27 km per litre for a S-92 helicopter and a round trip distance of 360 km.

2: Density assumed as Jet A1 fuel: 775.0 $kg.m^{-3}$

Note: Durations are provided in Table 2.6.

5.2.3 Mitigation

EnQuest will take appropriate steps to ensure the following:

- All vessels will comply with the *Merchant Shipping (Prevention of Air Pollution from Ships) (Amendment) Regulations 2014*;
- Operations will be carefully planned to reduce vessel numbers and the duration of operations;
- All vessels will have the appropriate UK Air Pollution Prevention or International Air Pollution Prevention certificates in place as required;
- The duration of any clean-up and well testing, if applicable, will be limited as far as is practicable, to reduce the requirement to flare. The well-test package used on board the drilling unit will incorporate the latest 'green burner' technology;
- Various processes (i.e. maintenance procedures, ongoing monitoring, competent personnel, internal/external auditing) are also available to optimise energy efficiency and thereby minimise emissions; and
- EnQuest will ensure that all combustion equipment will be subject to regular monitoring and inspections to ensure an effective maintenance regime is in place, ensuring all combustion equipment runs as efficiently as possible. Operational fuel use and flaring will be managed by the existing permits in place at the Kittiwake Alpha platform and in line with existing monitoring and maintenance procedures in place on board the facility.

5.2.4 Cumulative Impact

Local Air Quality

Throughout the drilling, installation, commissioning and operation of the Eagle development there will be atmospheric emissions, which may or may not have local or regional (including transboundary) effects. Any releases from installation vessels will be transitory, whilst emissions from operational activities will be intermittent throughout the life of the field.

The development is located in an area that is already occupied by a high level of oil and gas activity. There are a number of surface and subsea installations located within the vicinity, as shown in Figure 3.19 and Table 3.5. Not including the Eagle field or EnQuest GKA assets, the nearest oil and gas infrastructure to the development is the Anasuria FPSO located approximately 15 km south-south-east of the Eagle well. Whilst air quality is not monitored routinely at offshore sites, regular air quality monitoring is carried out by local authorities in coastal areas. The development will be located at approximately 140 km from the Scottish coastline. This is not expected to result in any impact on local air quality in the coastal area as it will disperse long before reaching the coastline.

The activities associated with the Eagle development are located approximately 80 km from the UK / Norway median line. Due to the distance from the activities, there will be no significant transboundary air quality impacts.

Global Climate Change

To understand the potential impact from the atmospheric emissions associated with the development, it is useful to set the emissions in the context of wider UK emissions. Whilst an exact figure for offshore emissions in UK waters does not exist, the contribution of emissions from shipping activities can be summed with oil and gas industry emissions to provide a benchmark against which the Eagle development can be considered. The latest available total annual CO_2 equivalent (CO_2eq) emissions estimate from oil and gas exploration and production is 15,700,000 tonnes for 2017 (*Oil & Gas UK, 2018*) and the latest total annual CO_2eq emissions estimate for UK shipping is approximately 7,800,000 tonnes for 2017 (*BEIS, 2017*), giving a total of 23,500,000 tonnes of CO_2eq from both industries.

The total CO_2eq emissions from installation of the Eagle development are estimated to be approximately 30,188 tonnes, which by comparison is 0.13% of the CO_2eq atmospheric emissions associated with UK offshore shipping and oil and gas activities in 2017. Whilst this represents a small percentage of UK offshore emissions, the UK Government has set a target of reducing the UK's overall greenhouse gas (GHG) emissions by at least 100% of 1990 levels by 2050 as part of the Climate Change Act 2008 (as amended). A series of phased budgets have been implemented (Table 5.7), with the 5th carbon budget setting a 57% reduction by 2030. As such, it is likely that the total annual emissions from the UK will decline over the life of the Eagle development and it is important therefore to examine how the development will sit within the context of declining UK emissions. Table 5.8 presents the predicted installation emissions and the Kittiwake platform yearly CO_2eq emissions against the first UK carbon budget period, assuming a production start date of September 2021. Only comparison to the first budget is possible as there are no production emissions estimates available beyond 2022.

Table 5.7: UK carbon budget

Budget	Annual carbon budget ($MTCO_2$eq)	% reduction below base year (1990)
1st carbon budget (2008 to 2012)	3,018	23%
2nd carbon budget (2013 to 2017)	2,782	29%
3rd carbon budget (2018 to 2022)	2,544	35% by 2020
4th carbon budget (2023 to 2027)	1,950	50% by 2025
5th carbon budget (2028 to 2032)	1,765	57% by 2030

Table 5.8: Eagle development CO_2eq emissions against UK carbon budget

Emission item	Carbon accounting period
	2018 to 2022
UK carbon budget for period (tonnes CO_2eq)	2,544,000,000
Estimated Eagle development emissions for period (tonnes CO_2eq)	101,358*
Eagle development CO_2eq emissions as % of UK budget	0.004%

* Assumes drilling and installation in 2021, and production from September 2021 and throughout 2022.

For the comparison carbon budget period, the UK's total carbon budget is 2,544 MT CO_2eq. The total estimated Kittiwake installation and production emissions during this carbon budget period is equal to 101,358 tonnes; 0.004 % of the whole UK budget, a very small component of the overall emissions in the UK.

Overall, this comparison shows that the potential emissions from the Eagle development will likely have a limited cumulative effect in the context of the release of GHGs into the environment and their contribution to global climate change (i.e. the development in isolation will not lead to a significant cumulative or transboundary impact).

5.2.5 Transboundary Impact

The Eagle development is located approximately 80 km from the UK/Norway median line. Due to the distance involved, no significant transboundary impacts will occur as a result of changes in air quality regarding the Eagle development. With the application of mitigation measures described in section 5.2.3, significant impacts will not occur.

Additionally, the impact assessment presented above for cumulative impact demonstrates that the development activities will make no significant cumulative contribution to UK emissions. As such, there will be no significant transboundary impacts.

5.2.6 Decommissioning

At the end of field life, the Eagle development will be decommissioned. The decommissioning process will generate atmospheric emissions both directly from cessation operations and associated vessel traffic, and indirectly through the re-use and recycling of materials (e.g. steel). It is not possible at this stage to fully quantify the likely atmospheric emissions from decommissioning activities, and exact emissions will depend on the removal technologies available at that time, as well as the regulatory requirements.

5.2.7 Protected Sites and Features

Atmospheric emissions associated with the Eagle development will not occur within any SAC, SPA, NCMPA or MCZ. Although Annex I features have been identified on the seabed in the vicinity of the Eagle development, there will be no impacts on the sea floor from atmospheric emissions, and hence no impact on these protected features. The emissions from the Eagle development are expected to represent a very small percentage of UK emissions and there is considered to be no cumulative impact from the development with regards to the potential impact on protected sites. As such there is considered to be no likely significant effect (LSE) on SACs and SPAs and hence no impact on conservation objectives or site integrity. This assessment also considers there to be no potential for atmospheric emissions to interact with protected features of an NCMPA or MCZ and there is therefore no significant risk to the conservation objectives of any NCMPA or MCZ.

5.2.8 Residual Impact

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Atmosphere: Air quality and climate change	Low	Negligible	Low	Minor
Rationale				
The information in the environment description (section 3) has been used to assign the sensitivity, vulnerability and value of the receptor as follows. The sensitivity of the receptor is considered to be low as the Eagle development is located remotely from potentially sensitive receptors, and there are no impacts from atmospheric emissions on the seabed. The vulnerability is considered to be negligible as any changes to the baseline conditions are expected to be virtually imperceptible. The value of the receptor is considered to be low as there are no concerns over the status of local air quality. The magnitude of the impact is considered to be minor as although Eagle activities (life of field) will occur over a relatively long period of time (three years) the actual changes to air quality are predicted to be very small. In terms of global climate change (i.e. cumulative and transboundary impacts), the Eagle development will add a relatively small increment to the overall offshore emissions of the UK and the release of GHG into the environment and their contribution to global warming will be negligible or minor in relation to those from the wider offshore industry and outputs at a national or international level. Any cumulative impact is therefore considered to have a very limited contribution to climate change. Considering all of the above, including that there will be no impact on protected features, protected sites or on species from protected sites, the residual consequence of atmospheric emissions is ranked as low and therefore not significant.				
Consequence		**Impact significance**		
Low		Not significant.		

5.3 Underwater Noise

5.3.1 Introduction

The development has the potential to cause underwater noise disturbance, mainly due to potential piling operations during installation of subsea infrastructure. Underwater noise can cause disturbance to marine mammal species in particular. For this reason, an underwater noise study has been undertaken.

5.3.2 Description and Quantification of Impact

Acoustic Assessment Criteria

It is important to understand how an animal's hearing varies over the entire frequency range in order to assess the effects of sound on marine life. Consequently, use can be made of frequency weighting scales to determine the level of the sound in comparison with the auditory response of the animal concerned. A comparison between the typical hearing response curves for fish, humans and marine mammals is shown in Figure 5.6.

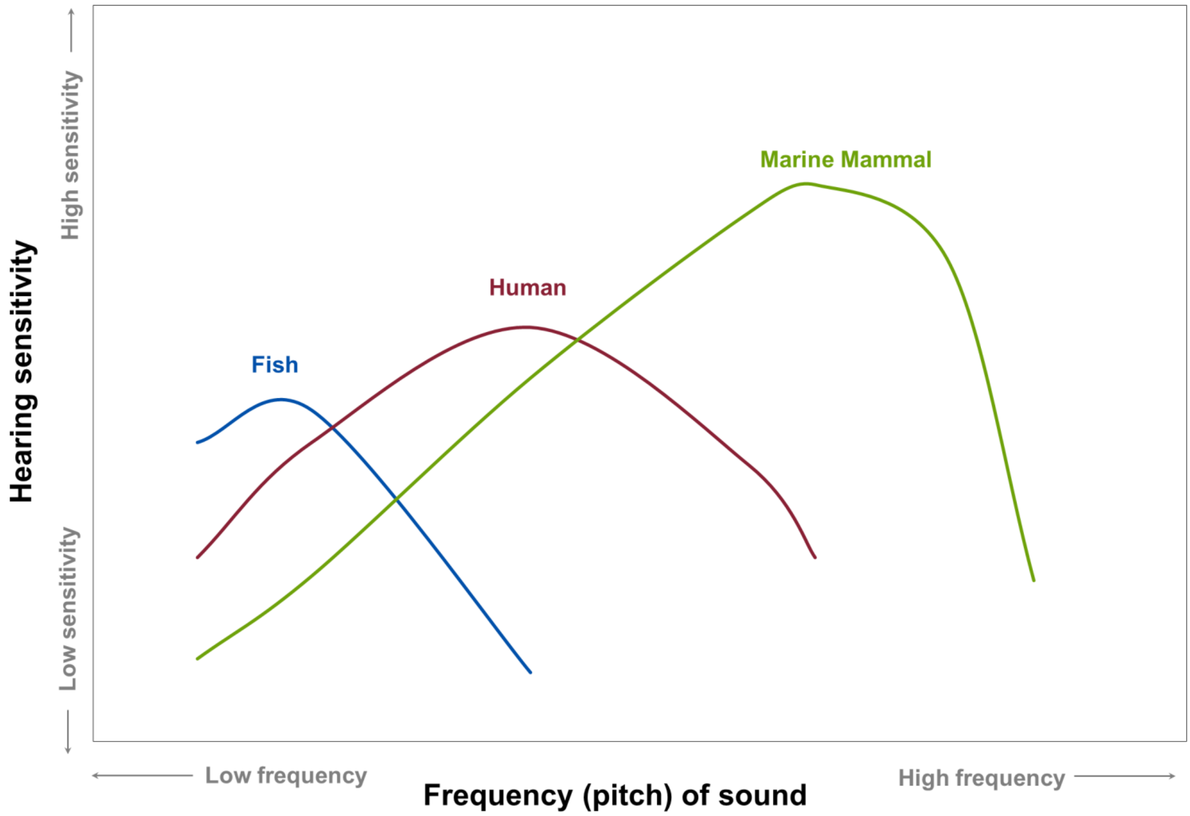

Figure 5.6: Schematic comparison between the hearing thresholds of different animals

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

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

For this study, it is the zones of injury and disturbance (i.e. responsiveness) that are of concern. The zone of injury is classified as the distance over which a marine mammal can suffer a Permanent Threshold Shift (PTS) leading to non-reversible auditory injury. Injury thresholds are based on a dual criteria approach using both linear (i.e. un-weighted) peak sound pressure level (SPL) and marine mammal hearing-weighted sound exposure levels (SELs). The hearing weighting function is designed to represent the bandwidth for each group within which acoustic exposures can have auditory effects. The categories include:

- **Low-frequency (LF) cetaceans** (i.e. marine mammal species such as baleen whales with an estimated functional hearing range between 7 Hz and 35 kHz);
- **Mid-frequency (MF) cetaceans** (i.e. marine mammal species such as dolphins, toothed whales, beaked whales and bottlenose whales with an estimated functional hearing range between 150 Hz and 160 kHz);
- **High-frequency (HF) cetaceans** (i.e. marine mammal species such as true porpoises, Kogia, river dolphins and cephalorhynchid with an estimated functional hearing range between 275 Hz and 160 kHz);
- **Phocid pinnipeds (PW)** (i.e. true seals with an estimated functional hearing range between 50 Hz and 86 kHz); and
- **Otariid pinnipeds (OW)** (i.e. sea lions and fur seals with an estimated functional hearing range between 60 Hz and 39 kHz).

These weightings have therefore been used in this study and are shown in Figure 5.7.

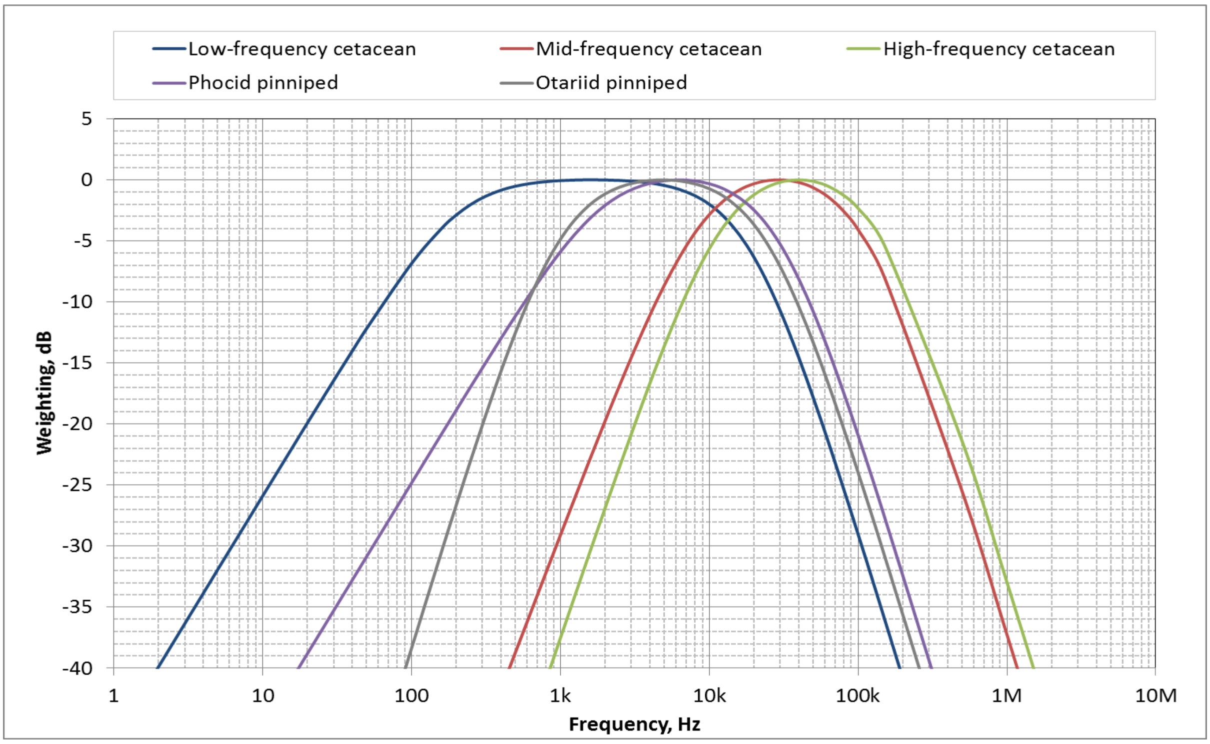

Figure 5.7: Hearing weighting functions for pinnipeds and cetaceans (NMFS, 2018)

Injury criteria are proposed in NOAA (*NMFS, 2018*) for two different types of sound as follows:

- **Impulsive sounds** which are typically transient, brief (less than 1 second), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay (*ANSI, 1986*; *NIOSH, 1998*; *ANSI, 2005*). This category includes sound sources such as seismic surveys, impact piling and underwater explosions; and
- **Non-impulsive sounds** which can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent and typically do not have a high peak sound pressure with rapid

rise/decay time as impulsive sounds do (*ANSI, 1995*; *NIOSH, 1998*). This category includes sound sources such as continuous running machinery, sonar and vessels.

The relevant criteria proposed by NOAA are as summarised in Table 5.9 for impulsive sound (e.g. impact piling) and non-impulsive sound (e.g. drilling and vessels). The SEL criteria are marine mammal hearing weighted whereas the peak criteria are unweighted. Table 5.9 also gives an indication of the presence of these animals in the vicinity of the Eagle development according to the environmental description information in section 3.

Table 5.9: Summary of PTS onset acoustic thresholds (NMFS, 2018)

Hearing Group	Parameter	Impulsive	Non-impulsive	Presence in the vicinity of Eagle
Low-frequency (LF) cetaceans	Peak, dB re 1 µPa (unweighted)	219	-	Minke whale have been sighted in January and March in low numbers (*Reid, et al., 2003*).
	SEL, dB re 1 µPa^{2}s (LF weighted)	183	199	
Mid-frequency (MF) cetaceans	Peak, dB re 1 µPa (unweighted)	230	-	Atlantic white sided dolphin have been sighted in June in low numbers, and white beaked dolphin in February, May and from July to September (*Reid, et al., 2003*).
	SEL, dB re 1 µPa^{2}s (MF weighted)	185	198	
High-frequency (HF) cetaceans	Peak, dB re 1 µPa (unweighted)	202	-	Harbour porpoise have been sighted in May and from July to September in low to moderate number (*Reid et al., 2003*).
	SEL, dB re 1 µPa^{2}s (HF weighted)	155	173	
Phocid pinnipeds (PW)	Peak, dB re 1 µPa (unweighted)	218	-	Grey seal and harbour seal presence is possible but unlikely/ low numbers due to the distance from shore.
	SEL, dB re 1 µPa^{2}s (PW weighted)	185	201	
Otariid pinnipeds (OW)	Peak, dB re 1 µPa (unweighted)	232	-	Not known to occur in the North Sea.
	SEL, dB re 1 µPa^{2}s (OW weighted)	203	219	

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

To consider the possibility of significant disturbance resulting from the project, it is therefore necessary to consider the likelihood that the sound could cause non-trivial disturbance, the likelihood that the sensitive receptors will be exposed to that sound and whether the number of animals exposed are likely to be significant at the population level.

Southall *et al*. (2007) recommended that the only currently feasible way to assess whether a specific sound could cause disturbance is to compare the circumstances of the situation with empirical studies. JNCC guidance on European Protected Species (EPS) (*JNCC, 2010*) indicates that a score of 5 or more on the Southall *et al*. (2007) behavioural response severity scale could be significant. The more severe the response on the scale, the lower the amount of time that the animals will tolerate it before there could be significant negative effects on life functions, which would constitute a disturbance under the relevant regulations.

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

For non-pulsed sound (e.g. vessels etc.), the lowest sound pressure level at which a score of 5 or more occurs for low frequency cetaceans is 90 - 100 dB re 1 µPa (rms). However, this relates to a study involving migrating grey whales. A study for minke whales showed a response score of 3 at a received level of 100 – 110 dB re 1 µPa (rms), with no higher severity score encountered for this species. For mid frequency cetaceans, a response score of 8 was encountered at a received level of 90 - 100 dB re 1 µPa (rms), but this was for one mammal (a sperm whale) and is therefore perhaps not directly applicable for the species likely to be encountered near the Eagle development. For Atlantic white-beaked dolphin, a response score of 3 was encountered for received levels of 110 – 120 dB re 1 μPa (rms), with no higher severity score encountered. For high frequency cetaceans, a number of individual responses with a response score of 6 are noted ranging from 80 dB re 1 μPa (rms) and upwards. There is a significant increase in the number of mammals responding at a response score of 6 once the received sound pressure level is greater than 140 dB re 1 μPa (rms).

The NMFS guidance (2005) sets the marine mammal level B harassment threshold for continuous noise at 120 dB re 1 μPa (rms). This value sits approximately mid-way between the range of values identified in Southall *et al*. (2007) for continuous sound but is lower than the value at which the majority of mammals responded at a response score of 6 (i.e. once the received rms sound pressure level is greater than 140 dB re 1 μPa). Taking into account the paucity and high-level variation of data relating to onset of behavioural effects due to continuous sound, it is recommended that any ranges predicted using this number are viewed as probabilistic and potentially over-precautionary.

Southall et al. (2007) presents a summary of observed behavioural responses due to multiple pulsed sound, although the data are primarily based on responses to seismic exploration activities. Although these datasets contain much relevant data for low-frequency cetaceans, there are no strong data for mid-frequency or high-frequency cetaceans. Low frequency cetaceans, other than bow-head whales, were typically observed to respond significantly at a received level of 140 – 160 dB re 1 μPa (rms). Behavioural changes at these levels during multiple pulses may have included visible startle response, extended cessation or modification of vocal behaviour, brief cessation of reproductive behaviour or brief/ minor separation of females and dependent offspring. The data available for mid-frequency cetaceans indicate that some significant response was observed at a sound pressure level of 120 – 130 dB re 1μPa (rms), although the majority of cetaceans in this category did not display behaviours of this severity until exposed to a level of 170 – 180 dB re 1μPa (rms). Furthermore, other mid-frequency cetaceans within the same study were observed to have no behavioural response even when exposed to a level of 170 – 180 dB re 1μPa (rms).

A more recent study is described in *Graham et al*. (2017). Empirical evidence from piling at the Beatrice offshore wind farm was used to derive a dose-response curve for harbour porpoise. The unweighted single pulse SEL contours were plotted in 5 dB increments and applied the dose-response curve to estimate the number of animals that would be disturbed by piling within each stepped contour. The study shows a 100% probability of disturbance at an SEL of 180 dB re $1μPa^2s$, 50% at 155 dB re $1μPa^2s$ and dropping to approximately 0% at an SEL of 120 dB re $1μPa^2s$.

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

Southall *et al*. (2007) also notes that, due to the uncertainty over whether high-frequency cetaceans may perceive certain sounds and due to paucity of data, it was not possible to present any data on responses of high frequency-cetaceans. However, Lucke *et al*. (2008) showed a single harbour porpoise consistently showed aversive behavioural reactions to pulsed sound at received sound pressure levels above 174 dB re 1 μPa (peak-to-peak) or a SEL of 145 dB re $1μPa^2s$, equivalent to an estimated rms sound pressure level of 166 dB re 1 μPa.

Clearly, there is much intra-category and perhaps intra-species variability in behavioural response. As such, a conservative approach should be taken to ensure that the most sensitive cetaceans remain protected.

The High Energy Seismic Survey workshop on the effects of seismic (i.e. pulsed) sound on marine mammals (*HESS, 1997*) concluded that mild behavioural disturbance would most likely occur at rms sound levels greater than 140 dB re 1 μPa (rms). This workshop drew on studies by Richardson (1995) but recognised that there was some degree of variability in reactions between different studies and mammal groups. Consequently, for the purposes of this study, a precautionary level of 140 dB re 1 μPa (rms) is used to indicate the onset of low-level marine mammal disturbance effects for all mammal groups for impulsive sound.

This assessment adopts a conservative approach and uses the US National Marine Fisheries Service (*NMFS, 2005b*) Level B harassment threshold of 160 dB re 1 μPa (rms) for impulsive sound. Level B Harassment is defined as having the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild. This is similar to the JNCC (2010) description of non-trivial disturbance and has therefore been used as the basis for onset of behavioural change in this assessment.

It is important to understand that exposure to sound levels in excess of the behavioural change threshold stated above does not necessarily imply that the sound will result in significant disturbance. As noted previously, it is also necessary to assess the likelihood that the sensitive receptors will be exposed to that sound and whether the numbers exposed are likely to be significant at the population level.

Source Noise Data

The noise emissions from the vessels and piling that may be used in the project are quantified in Table 5.10, based on a review of publicly available data. SELs have been estimated for each source based on 24 hours continuous operation. Source noise levels for vessels depend on the vessel size and speed as well as propeller design and other factors. There can be considerable variation in noise magnitude and character between vessels even within the same class. Therefore, source data has been based largely on worst-case assumptions (i.e. using noise data toward the higher end of the scale for the relevant class of ship as a proxy). The source sound pressure levels and associated impact zones can therefore be viewed as indicative precautionary ranges.

It is important to note that it is highly unlikely that any marine mammal or fish would stay at a stationary location or within a fixed radius of a vessel (or any other noise source) for 24 hours. Consequently, any resulting injury zones should be treated as a very pessimistic, worst case scenario. To put this into context, if an animal spent one hour instead of 24 hours being exposed to sound, this would result in a SEL 13 dB lower than predicted in this study which, in very ballpark terms, equates a potential injury radius of approximately a quarter of the size (and a reduction in the potential area over which injury might occur by one sixteenth). Taking into account the various precautionary assumptions made in derivation of injury criteria as well as the potential overestimate in sound exposure due to use of 24-hour SEL values, any estimated injury zones in this report should be treated as being precautionary over-estimates.

There are no known publicly available data for subsea jet or plough trenching units but it is considered likely that noise from such operations are insignificant in comparison to vessels and other noise sources during installation.

Table 5.10: Source noise data

Item / activity	Description / assumptions	Data source	Source sound pressure level at 1 m	
			Rms, dB re 1 μPa	SEL(24h), dB re 1 μPa²s
Installation vessels	DP drilling rig used as proxy	McCauley (1998)	183	232
Semi-sub or jack-up drill rig	Assumed anchored in position (no DP)	Nedwell and Edwards (2004)	162	211
Supply, standby and support vessels	Tug used as proxy	Richardson (1995)	172	221
Ploughing vessel / pipe laying vessel	Pipe laying vessel used as proxy	Hannay (2004)	179	229
Piling of SDU and tie-in manifold	8 x 610 mm diameter piles	Nehls *et al*. (2007)	200	190 (per strike)

Sound Propagation Model

Sound propagation modelling for this assessment was therefore based on an established, peer reviewed, range dependent sound propagation model which utilises the semi-empirical model developed by Rogers (1981). The model provides a robust balance between complexity and technical rigour over a wide range of frequencies, has been validated by numerous field studies and has been benchmarked against a range of other models. The following inputs are required for the model:

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

The level of detail presented in terms of noise modelling needs to be considered in relation to the level of uncertainty for animal injury and disturbance thresholds. Uncertainty in the sound level predictions will be higher over larger propagation distances (i.e. in relation to disturbance thresholds) and much lower over shorter ones (i.e. in relation to injury thresholds). Nevertheless, it is considered that the uncertainty in animal injury and disturbance thresholds is likely to be higher than uncertainty in sound predictions. This is further compounded by differences in individual animal response, sensitivity and behaviour. It would therefore be wholly misleading to present any injury or disturbance ranges as a hard and fast line beyond which no effect can occur, and it would be equally misleading to present any noise modelling results in such a way.

It should be borne in mind that noise levels (and associated range of effects) will vary depending on actual conditions at the time (day-to-day and season-to-season) and that the model predicts a typical worst-case scenario. Taking into account factors such as animal behaviour and habituation, any injury and disturbance ranges should be viewed as indicative and probabilistic ranges to assist in understanding potential impacts on marine life rather than lines either side of which an impact definitely will or will not occur.

The development area seabed primarily consists of loose to medium dense, silty fine to medium sand with occasional shells and shell fragments. The following geo-acoustic parameters for the bottom have been utilised in the noise model (*Hamilton 1970*, *1980*; *Jensen 1994*):

- sediment sound speed cs = 1,522 m/s
- density of sediment ρs = 2 kg/m^3
- sediment attenuation coefficient Ks = 0.21 dB/m/kHz

Water depths in the area are generally around 85 m to 92 m. The estimated injury ranges in this report are therefore based on the typical water depth in the area of 90 m. It is considered that this is a reasonable balance between technical robustness, uncertainty and variability taking into account the stated probabilistic nature of the ranges due to potentially very large variations and uncertainty in animal response and the thresholds, along with the relatively flat bathymetry in the survey area. Injury and disturbance ranges should be viewed as indicative and probabilistic ranges to assist in understanding potential impacts on marine life rather than lines either side of which an impact definitely will or will not occur. It has been assumed that the same sound speed profile and bottom conditions apply over the entire area modelled.

As well as calculating the un-weighted rms and peak sound pressure levels at various distances from the source, it is also necessary to calculate the SEL for a mammal using the relevant hearing weightings described above taking into account the number of pulses to which it is exposed.

Exposure modelling was based on the assumption of a mammal swimming at a constant speed in a perpendicular direction away from a stationary source.

The above case was modelled for a range of start distances (initial or closest distance between the animal and source) in order to calculate cumulative exposure for a range of scenarios. In each case, the pulses to which the mammal is exposed in closest proximity to the source dominate the sound exposure. This is due to the logarithmic nature of sound energy summation.

In order to carry out the swimming mammal calculation, it has been assumed that a mammal will swim away from the piling noise source at an average speed of 1.5 ms^{-1}. The calculation considers each pulse to be established separately resulting in a series of discrete SEL values of decreasing magnitude (refer to Figure 5.8).

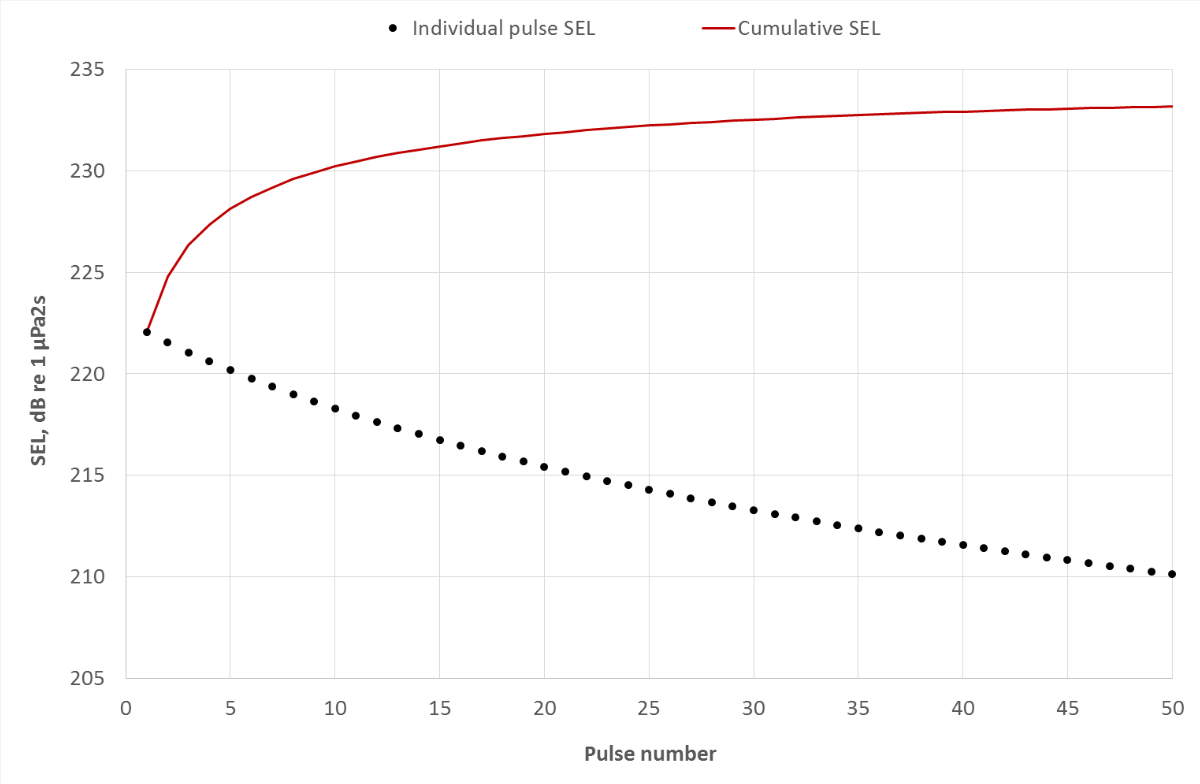

Figure 5.8: Discrete pulse SEL and cumulative SEL

As a mammal swims away from the source, the noise will become progressively quieter; the cumulative SEL is worked out by logarithmically adding the SEL to which the mammal is exposed as it travels away from the source. This calculation was used to estimate the approximate minimum start distance for a marine mammal in order for it to be exposed to sufficient sound energy to result in the onset of potential injury. It should be noted that the sound exposure calculations are based on the simplistic assumption that the animal will continue to swim away at a fairly constant relative speed.

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

It should be noted that the multiple pulse sound criteria described in the NOAA guidelines assume that the animal does not recover hearing between each pulse or series of pulses. It is likely that both the intervals between pulses and any breaks in operations could allow some recovery from temporary hearing threshold shifts for animals exposed to the sound and, therefore, the assessment of sound exposure level is considered to be conservative. This over-estimate is, however, considered to be small because the majority of sound energy to which an animal is exposed occurs when it is at the closest distance to the source, with subsequent exposure at greater ranges making an insignificant contribution to the overall exposure.

Model Results

The radius of the potential marine mammal injury and disturbance zones for piling are presented in Table 5.11 based on a comparison of the calculated sound level at various ranges against the criteria. The radius of the potential fish injury and disturbance zones for piling are presented in Table 5.12.

Table 5.11: Summary of potential injury and disturbance zones for marine mammals for piling activity

Situation	Radius of Effect, m				
	LF Cetacean	MF Cetacean	HF Cetacean	Phocid Pinniped	Otariid Pinniped
Peak pressure (SPL) physiological damage	N/E	N/E	6 m	N/E	N/E
SEL of mammal swimming away from source	N/E	N/E	10 m	N/E	N/E
RMS behavioural change (Strong)	145 m				
RMS behavioural change (Mild)	1.4 km				
N/E = not exceeded					

Note: N/E = Not exceeded

Table 5.12: Summary of potential injury and disturbance zones for fish for piling

Class:	Radius of Effect, m
Mortality No swim bladder (particle motion detection)	N/E
Impairment No swim bladder (particle motion detection)	N/E
Mortality Swim bladder not involved in hearing (particle motion detection)	3 m
Impairment Swim bladder not involved in hearing (particle motion detection)	3 m
Mortality Swim bladder involved in hearing (primarily pressure detection)	3 m
Impairment Swim bladder involved in hearing (primarily pressure detection)	3 m
Mortality Fish eggs and larvae	3 m
Behaviour - strong avoidance	443 m

Note: N/E = Not exceeded

The potential ranges presented for injury and disturbance are not a hard and fast ‘line’ where an impact will occur on one side and not on the other. Potential impact is more probabilistic; dose dependency in PTS onset, individual variations and uncertainties regarding behavioural response and swim speed/direction all mean that in reality it is much more complex than drawing a contour around a location. These ranges are designed to provide an understandable way in which a wider audience can understand the potential spatial extent of the impact.

The radius of potential effect on marine mammals for continuous sources is summarised in Table 5.13. As noted previously, the potential radii for injury are based on exposure levels over a 24-hour period. Thus, for example, a low frequency cetacean would need to stay within 58 m of the ploughing vessel for a period of 24 hours to experience any injury. This is considered to be an unrealistically pessimistic scenario and therefore it is not thought likely that any marine mammals will be injured as a result of installation activities. If, for example, the animal was to only spend 1 hour near the vessel then the injury range would decrease to 5 m.

The table also presents the potential radius of disturbance for marine mammals based on the conservative 120 dB re 1 μPa (rms) criterion. It is important to bear in mind when viewing these potential disturbance radii that the 120 dB re 1 μPa (rms) criterion is very precautionary and that ambient noise levels could well exceed this value.

The radius of potential effect on fish for continuous sources is summarised in Table 5.14.

Table 5.13: Summary of potential injury and disturbance zones for marine mammals for vessels and drilling

Activity / vessel	Radius of potential injury zone (assuming continuous exposure within that radius over 24 hour period)					Radius of potential disturbance – all marine mammals
	LF Cetacean	MF Cetacean	HF Cetacean	Phocid Pinniped	Otariid Pinniped	
Installation vessels	58 m	0 m	2 m	5 m	0 m	8.3 km
Semi-sub or jack-up drill rig	3 m	1 m	31 m	2 m	0 m	358 m
Supply, standby and support vessels	13 m	2 m	31 m	5 m	0 m	1.4 km
Ploughing vessel / pipe laying vessel	33 m	0 m	1 m	3 m	0 m	4.8 km

Table 5.14: Summary of potential injury and disturbance zones for fish for vessels and drilling

Activity / vessel	Recoverable injury	Disturbance
	Fish: swim bladder involved in hearing	All fish
Installation vessels	4 m	88 m
Semi-sub or jack-up drill rig	0 m	4 m
Supply, standby and support vessels	1 m	15 m
Ploughing vessel / pipe laying vessel	2 m	50 m

Conclusion

Based on the propagation and sound exposure modelling carried out for this assessment, it is concluded that:

- There is potential for mild disturbance to marine mammals within up to 1.4 km of piling operations, although strong disturbance is only likely within approximately 145 m of the sound source. This equates to an area of approximately 6 km^2 for mild disturbance and 0.1 km^2 for strong disturbance.
- Assuming a swimming animal, it is likely that potential injury zones for high frequency cetaceans during piling could be up to 10 m from the sound source. Injury is unlikely for other hearing groups of marine mammal.
- Assuming that an animal stays within that radius continuously for 24 hours, it is possible that injury could occur to some marine mammals within 58 m of some installation activities. However, this is considered a highly unlikely scenario as it is unlikely that an animal would stay within this radius continuously over a 24-hour period.
- Disturbance to marine mammals could occur within 8.3 km of some vessels. However, this is also considered as highly unlikely, as it is unlikely that an animal would stay within this radius continuously over a 24-hour period (for example, if the animal was to only spend 1 hour near the vessel then the injury range would decrease to 5 m).

It is therefore concluded that it is unlikely that marine mammals will be injured as a result of the proposed activities associated with the Eagle development.

5.3.3 Mitigation

During the piling activities (if conducted), EnQuest will adhere to JNCC guidelines for reducing the potential for injury and disturbance to marine mammals (*JNCC, 2017*), which include:

- A suitably trained marine mammal observer (MMO) will conduct a pre-shooting search over a 30-minute period prior to the commencement of piling. This will involve a visual assessment to determine if any marine mammals are within a 500 m monitoring zone (measured from the location of the pile). Should operations cease for ten minutes or more, a search will be undertaken before the re-commencement of activities.

- Should any marine mammals be detected within 500 m of the piling operations, these operations will be delayed until marine mammals have moved outside the mitigation zone. In this case, there will be a 20-minute delay from the time of the last marine mammal sighting to the commencement of activities.
- The piling hammer power will be ramped up slowly over 20 minutes in order to give marine mammals time to leave the area. Build-up of power will occur in uniform stages to provide a constant 'ramp-up' in amplitude. These soft start procedures will also be undertaken if the operations are stopped for at least 10 minutes, to allow for checking of the visual observation zone to determine if any marine mammals have entered the area whilst the piling activities were suspended. If marine mammals have re-entered the observation zone, restart of the operations will be delayed until 20 minutes after the last sighting of the marine mammal.
- If piling is required to commence in sub-optimal conditions for visual monitoring, consideration will be given to using passive acoustic monitoring (PAM) in addition to MMOs. Use of PAM in conditions that are sub-optimal for visual monitoring enhances the probability of detecting marine mammals (when vocalising), reducing the likelihood of potential negative impacts.

5.3.4 Cumulative Impact

It is possible that the various noise sources associated with the Eagle development activities (i.e. multiple vessels operating at the same time, or piling occurring at the same time as vessels being used) could result in an impact to marine mammals and fish species. However, as shown by the modelling study, potential disturbance zones are likely to be small and, for the most part, highly limited in temporal extent. For fish, the potential for injury or disturbance to result in any detectable changes at the population level is very low. Cumulative impact from sources within the Eagle development are therefore not expected.

In the context of the number of vessels that use the North Sea for fishing, shipping, passenger transport, oil and gas activity, recreation and others, which will all emit noise (the 'noise map' created by Cefas indicates that shipping background noise in the vicinity of the Eagle development is in the region of 100 dB re 1 μPa [*BBC, 2019*]), the scale of the additional in-field time required for vessels associated with the Eagle development is clearly limited.

In theory, any project that regularly emits underwater noise has the potential to act cumulatively with the proposed activities; this includes the ongoing operation of the Kittiwake platform and the Anasuria FPSO, located 15.2 km to the south-south-east. Cetacean and fish populations are free-ranging and long-distance movement is likely to be frequent. Any animal experiencing a noise from the Eagle development is likely to belong to a much wider ranging population and there is the potential for that same animal to subsequently come into contact with noise from activities related to other unrelated projects. However, potential injury and disturbance impacts resulting from any individual element of the Eagle development are not expected to be significant (e.g. animals will not be excluded from the area), and significant cumulative impact from animals encountering noise emissions from multiple activities within a short period of time is therefore considered highly unlikely.

5.3.5 Transboundary Impact

The Eagle development is located approximately 80 km from the UK/Norway median line. Given the expected noise sources involved in the project and the noise modelling conducted, direct transboundary impact from noise emissions will not occur. However, marine mammals and fish are free-ranging animals and any impact that occurs in UK waters is likely to occur on animals that belong to a much wider ranging population, with the potential to cross median lines. Such a potential impact could qualify as a transboundary impact, however, since injury and disturbance from the operations associated with the Eagle development are not expected to result in significant impact to any population (as concluded by the noise modelling), potential indirect transboundary impacts are therefore considered not significant.

5.3.6 Decommissioning

During decommissioning of the Eagle field development, it is likely that the disturbance/ potential for injury predicted by the noise modelling study will be very similar for any vessels used for decommissioning operations. The noise modelling has predicted the zones of disturbance and potential injury, which are small, and has concluded that it is unlikely that marine mammals will be injured as a result of the proposed activities.

Decommissioning activities will be subject to the prevailing regulatory regime at the time. Any decommissioning planning process will involve an EA, which will consider the potential for noise disturbance for the various options available during the comparative assessment process.

5.3.7 Protected Sites

Species listed on Annex II of the Habitats Directive that have the potential to occur across the Eagle development include harbour porpoise, grey seals and harbour seals. Harbour porpoise have been sighted in the vicinity previously (Reid et al., 2003). Grey and harbour seal do have the potential for presence but only in limited numbers due to the distance from shore, as they tend to stay within coastal areas for most of their time. However, the noise modelling has concluded that it is unlikely that marine mammals will be injured as a result of the proposed activities associated with the Eagle development. No injury and no effect of disturbance at the population level is expected taking into account the mitigation proposed.

It is possible that vessel transits nearshore associated with the development could overlap with bottlenose dolphin (also on Annex II of the directive) and grey and harbour seal use of an area, but the presence of vessels in such areas would be highly limited in temporal extent and there would be no significant effect on any nearby protected sites.

This assessment also considers there to be no potential for underwater noise emissions to interact with protected features of an NCMPA or MCZ, primarily as there are no sites designated for features that may be affected by noise emissions close to the Eagle development. The closest NCMPA to the Eagle development is located approximately 11.5 km to the south-east; the East of Gannet and Montrose Fields NCMPA. Given the distance and the noise modelling results, impacts from underwater noise on the NCMPA is not expected.

Sensitive species in the vicinity of the proposed Eagle development include *A islandica*. However, the FEAST indicates that *A. islandica* are not sensitive to noise disturbance (*Marine Scotland, 2013*).

5.3.8 Residual Impact

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Marine Mammals	Low	Low	Low	Minor
Fish	Low	Low	Negligible	Minor
Rationale				
The information in the environment description (section 3) has been used to assign the sensitivity, vulnerability and value of the receptors as follows. Both receptor groups have some tolerance to accommodate the limited effects that vessel use and piling activity could give rise to. The noise modelling study has shown that predicted the zones of disturbance and potential injury are small, and has concluded that it is unlikely that marine mammals will be injured as a result of the proposed activities. As there is expected to be no change at the population level for either receptor group, the impact is not likely to affect long term function or status of any population; the vulnerability can also be considered ‘low’. In terms of value, marine mammals found at the site are considered for protection under European legislation but as they do not belong to protected sites around the project area they can be classed as ‘low’ value. For fish, species found at the site are generally abundant on the UKCS and are not afforded specific conservation protection. As such, they can be classed as ‘negligible’ value. For magnitude, based on the noise modelling results any possible impact on either receptor group is expected to be highly localised in scale and of a temporary nature. On this basis, a magnitude of minor is assigned. Considering all of the above, the residual consequence of underwater noise is ranked as low and therefore not significant.				
Consequence		**Impact significance**		
Low		Not significant.		

5.4 Accidental Events

5.4.1 Introduction

The potential impact of any accidental hydrocarbon and chemical release will be determined by the characteristics of the release of hydrocarbons or chemicals, its weathering properties, the direction of travel and whether environmental sensitivities lie in its path. Any environmental sensitivities will have spatial and temporal variations. Therefore, the likelihood of any accidental release having a potential impact on the environment must consider the likelihood of the release occurring against the probability of that hydrocarbon or chemical reaching a sensitive area and the environmental sensitivities present in that area at the time.

5.4.2 Description and Quantification of Potential Impact

Sources and Likelihood of Occurrence

Dropped Objects

There exists the possibility that during drilling, installation and operational activities associated with the Eagle development, dropped objects to sea may occur. Any objects dropped during development activities will be removed from the seabed where appropriate. Dropped object procedures are industry standard and there is only a very remote probability of any interaction with any live infrastructure.

Considering the above, accidental events associated with dropped objects are not assessed further herein.

Natural Disasters

Major disasters are incidents resulting from natural events such as earthquakes, tsunamis and hurricanes. Seismic activity in the North Sea is concentrated between the Fladen Ground and the waters offshore of Norway, and within the Dogger Bank area, both of which are approximately 100 km and 300 km from the location of the Eagle development respectively (*DECC, 2016*). Furthermore, most seismic activity occurs on the western side of the UK. This suggests the likelihood of a major accident due to an earthquake or associated tsunami is extremely remote. In addition, it is recognised that climate change is likely to cause changes in global weather patterns over the Eagle development lifecycle and may lead to more frequent and stronger extreme weather events at the development location. In the event of a sufficiently extreme weather event being forecast mobile assets such as drilling rigs, installation or support vessels would move to safe refuge locations close to shore, reducing the possibility of a major hydrocarbon release from vessels. As such, the possibility of a major disaster is considered extremely remote and potential impacts are not discussed further, although the worst-case would be similar to the uncontrolled well blow-out described for the worst-case major accident scenario.

Spills from Offshore Installations

Potential accidental releases of hydrocarbons from installations on the UKCS may be caused by mechanical failure, operational failure or human error. Potential sources include diesel, drilling mud, small accidental oil or chemical releases and hydraulic fluids.

Table 5.10 shows the number of oil releases on the UKCS greater than 100 tonnes that occurred from 1975 to 2005 (*UKOOA, 2006*). Table 5.11 shows hydrocarbon release data from 1991 to 2019 from PON1 spill reporting data (*BEIS, 2019*). These data suggest that the number of larger hydrocarbon release incidents has decreased in recent years, whilst the number of smaller release incidents involving quantities of less than 1 tonne has remained relatively high.

Table 5.10: Hydrocarbon releases greater than 100 tonnes in size from 1975-2005 (UKOOA, 2006)

Date of spill	Product spilled	Size of spill (tonnes)	Stated source and cause of pollution
7th Jan 1977	Crude oil	528	Loading buoy - cleaned by spraying, some discrepancy of amount.
5th Sep 1977	Crude oil	396	Flange parted during loading. Slick moved slowly, breaking in 20ft waves.
28th Jun 1978	Crude oil	112	Malfunction in separator level control and level alarm.

Date of spill	Product spilled	Size of spill (tonnes)	Stated source and cause of pollution
6th Apr 1980	Crude oil	980	Lost in pipeline rupture. Degraded and dispersed naturally.
25th Nov 1986	Oil based mud	208	Rig losing stability, OBM dumped overboard.
26th Nov 1986	Crude oil	3,000	Spillage from pipeline.
2nd July 1988	Crude oil	112	Accidental discharge from platform, diverter valve failure to open.
9th Sep 1988	Crude oil	750	General oil releases following Piper Alpha incident.
24th Dec 1988	Crude oil	1,504	Floating Storage Unit, break away from subsea.
7th Jul 1989	Oil based mud	240	Oil based mud used in wrong section of well.
13th Aug 1989	Crude oil	1,800	Arising from planned de-oiling operation – flaring of recovered oil.
1st Dec 1989	Methanol	120	Loss of methanol during transfer operations.
18th Jun 1990	Crude oil	112	Possible open valve.

Table 5.11: Hydrocarbon releases greater than 100 tonnes in size from 1991-2016 (BEIS, 2019)

Tear	Total amount of oil spilled (tonnes)	Number of spills >1 tonnes	Number of spills <1 tonnes	Remarks
1991	192	-	-	
1992	225	-	-	
1993	224	-	-	
1994	174	-	-	
1995	84	-	-	
1996	127	-	-	
1997	866	26	323	Includes large spills of 685 tonnes, 29 tonnes and 36 tonnes.
1998	137	14	378	
1999	120	21	-	
2000	524	18	405	Hutton tension leg platform oil release.
2001	94	17	419	
2002	96	18	463	
2003	113	10	365	
2004	75	13	425	
2005	75	10	256	
2006	27	4	271	
2007	63	10	271	
2008	37	8	264	

Tear	Total amount of oil spilled (tonnes)	Number of spills >1 tonnes	Number of spills <1 tonnes	Remarks
2009	51	8	285	
2010	154	6	265	
2011	42	9	275	
2012	40	8	240	
2013	85	8	272	
2014	30.3	2	268	
2015	23.8	3	560	
2016	9.2	1	610	
2017	31.64	6	245	
2018	10.98	1	276	

Figure 5.10 graphically illustrates recent trends in hydrocarbon release history on the UKCS. It clearly shows that since 2000, the total amount of oil released has decreased. It also illustrates that the number of installations reporting hydrocarbon releases has increased due to the increased awareness and enforcement of PON1 oil spill reporting requirements.

The historical spill data from recent years on the UKCS shows that spill sizes have shifted toward smaller volumes, with the most common hydrocarbon release size being less than 1 tonne. It is reasonable to conclude from this data that releases of smaller volumes are more likely to occur.

Unintentional releases can potentially occur through the day-to-day handling and transfer of fluid products used during the drilling project, including diesel, chemicals, hydraulic oil and lubricants.

The recent trends in hydrocarbon release history reported above suggest that accidental releases of small volumes of fluids represent the most likely source of accidental releases. Examples include the loss of small volumes of diesel or lubricants during handling, use, or storage.

Various equipment and machinery in use on board vessels also represent a possible source of leaks or unintentional releases, mainly of diesel, hydraulic oil, bulk drilling chemicals and drilling muds. In addition, the well test also has the potential to release some hydrocarbons to the sea surface in the event that the test flare drops out; although every effort is made to ensure that this does not happen during well test flow.

The significance of the resulting potential impacts on environmental receptors (e.g. water quality, plankton, birds, fish and marine mammal species) will depend on the size, location and nature of the spill and the receptors. Unintentional releases of fuel or other fluids are generally small in volume, and compared to other types of spills, small releases are the more frequent type of release (as suggested by the above UKCS data). The blow-out scenario discussed below is the worst-case scenario in terms of potential impact, which has been taken forward for further assessment.

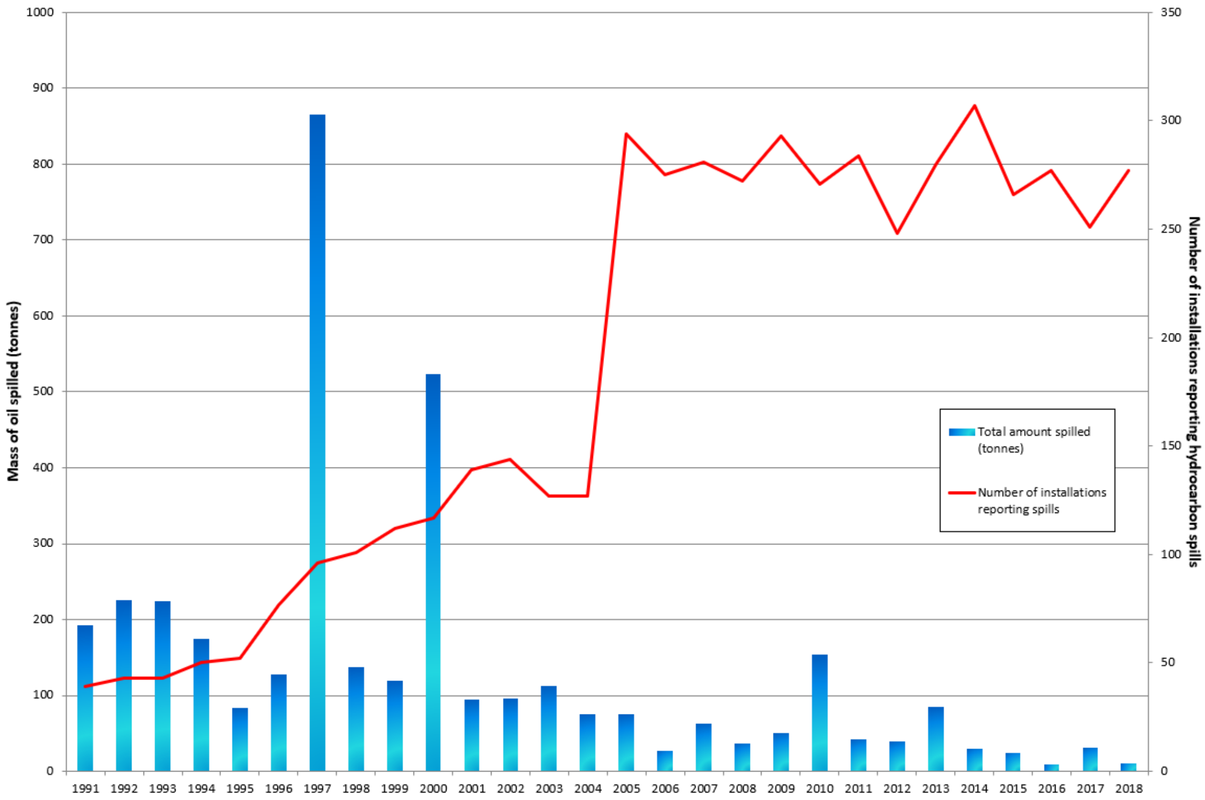

Figure 5.10: Amount of hydrocarbons released on the UKCS against total number of installations reporting spills (BEIS, 2019a)

Subsea Tie-backs

Accidental releases from subsea facilities are potentially associated with structural failures of equipment including pipelines, control and valves at the manifold or wellhead. Of all accidental releases reported from subsea tie-back facilities (1975–2007), over 70% involved less than 1 tonne of oil (*TINA Consultants, 2013*).

Spool and pipeline leaks are caused by corrosion and impact damage. Impact damage may be caused by fishing gear and anchoring impacts or impacts from dropped objects. The potential likelihood of fishing gear / anchoring impacts is remote to extremely remote, due to the fact that pipelines and infrastructure are marled on navigational charts, are commonly trenched and buried under the seabed, and are protected by rock dump or other structures (e.g. concrete mattresses) at vulnerable locations such as crossings.

Dive Support Vessel and Other Support Vessels

Potential sources of accidental releases from installation vessels include:

- Upsets in bilge treatment systems;
- Storage tank failure of lube oils, fuel oil (diesel), oil-based mud, base oil and chemicals;
- Accidental release during maintenance activities, including equipment removal and lubrication; and
- Damage sustained during a collision, grounding or fire.

The vessels involved with the Eagle development activities will all make use of DP and will not need anchors. The probability of a collision or grounding of a vessel with another vessel is extremely remote.

The most frequently reported accidental releases from vessels are associated with upsets in bilge treatment systems and are usually small (<1 tonne). The Advisory Committee on Protection of the Sea (ACOPS) report on discharges to sea states that in 2014, approximately 85% of accidental chemical releases involved PLONOR chemicals, which are considered to 'pose little or no risk' to the environment (*ACOPS, 2017*). No chemicals included in the OSPAR list of chemicals for priority action (i.e. those which are considered to pose the greatest potential impact) were released, and none of the releases were recorded as having a significant environmental impact (*ACOPS, 2017*).

The likelihood of a major accidental release from a vessel is remote. Historical data suggests that most likely vessel accidental releases are small (<1 tonne) and are most likely to occur during bulk transfer or bunkering operations.

The total diesel inventory of a DSV involved with installation activities comprises a much smaller volume of hydrocarbons than that associated with a well blow-out. Diesel is more volatile than the crude oil expected from the development, and in the event of a diesel inventory spill, the majority of the diesel would be expected to evaporate within a few days, before reaching any sensitive coastlines. Diesel has a lower specific gravity than crude oil and will float on the sea surface; the hydrocarbons would be constantly exposed to weathering and evaporation. No interactions are expected with seabed habitats. The only potential impact of a diesel release is likely be on seabirds potentially located in the immediate vicinity of the Eagle development.

Drilling Rigs

Potential accidental releases of inventory from drilling rigs (i.e. diesel, drilling muds, oil, chemicals, hydraulic fluids) may be caused by mechanical failure, operational failure or human error.

No accidental releases greater than 100 tonnes were recorded on the UKCS (from drilling rigs) between 2001 and 2007 (Table 5.12). The majority of accidental releases recorded were of less than 1 tonne. The most common types of accidental releases from drilling rigs were found to be associated with drilling operations (42%); of these, 94% were less than 1 tonne. The second most common type of accidental release was associated with maintenance/ operational activities (27%); of these, 97% were less than 1 tonne (*TINA Consultants, 2013*).

Table 5.12: Volume and cause of accidental releases from drilling rigs (UKCS) (TINA Consultants, 2013)

Accidental release cause	10 to <100 te	1 to <10 te	0.1 to <1 te	10 to <100 te	10 to <100 kg	1 to <10 kg	Number of accidental releases
Maintenance/operational activities	***	1	5	4	14	10	35
Bunkering	***	***	9	2	9	2	22
Subsea releases	1	2	1	3	3	1	12
Drilling	1	2	15	15	6	12	54
ROV associated	***	***	***	1	3	1	5
Other production	***	***	1	***	***	***	1
All accidental releases	2	8	42	40	42	35	179
*Includes accidental releases of unknown size **Did not occur within the report period ***Includes accidental releases of unknown cause and accidental releases that could not be categorised							

The scenarios from drilling rigs (other than blow-outs) which have the potential to result in the greatest impact are from incidents such as vessel grounding, collision or explosion that could lead to a total loss of hydrocarbon inventory (most likely to be marine diesel or base oil), although this is unlikely as diesel/ hydrocarbon stock is stored in multiple locations in separate tanks and containers).

Blow-outs

During drilling, primary well control is achieved by maintaining an overbalance of hydrostatic pressure in the wellbore that is greater than the formation pressure being drilled (but less than the formation fracture pressure to avoid lost circulation and formation damage). This overbalance prevents influx of reservoir fluids into the wellbore. If the formation pressure is greater than the hydrostatic pressure of the drilling fluid column, the well will flow and hydrocarbons will enter the wellbore.

If primary well control is lost, secondary well control is achieved by activating the Blow-out Preventer (BOP). The BOP seals the wellbore at (or just above) the wellhead. This makes the well safe and enables a plan of action to be developed and executed by the drilling crew to regain primary well control. If both primary and secondary well control is lost, a blow-out may occur. A blow-out is defined as an influx of hydrocarbons into a well that results in uncontrolled well flow reaching the drilling unit at the surface.

Blow-outs have the potential to cause considerable danger to the drilling unit and crew, and to cause considerable pollution. The most notable blow-out on the UKCS from a MODU was in 1988 when an explosion led to a fire on a semi-submersible rig whilst drilling a high-pressure high temperature (HPHT) field in the central North Sea. Table 5.13 provides historical blow-out frequency data for the UKCS (*OGUK, 2009*).

Table 5-13: Blow-out frequency per unit per year on the UKCS (OGUK, 2009)

Type of facility	Period					
	1990 to 1999		2000 to 2007		1990 to 2007	
	Number	Frequency per year	Number	Frequency per year	Number	Frequency per year
MODU	13	0.020	3	0.0066	16	0.014

Blowouts are extremely rare events in modern drilling (*DTI SEA-2, 2001*). Table 5-14 shows the occurrences of blowouts during the different operational phases of hydrocarbon production between 1980 and 2008. There were only 17 recorded blowouts from exploration drilling in the UK and Norwegian Sectors of the North Sea during this period (*IOGP, 2010*). To put this into context, over 3,970 exploration and appraisal wells have been drilled on the UKCS alone since 1965 (*UKOOA, 2010*). However, the most recent serious UK blowout was in 2012 when an underground gas blowout led to evacuation of a platform and surrounding platforms in the central North Sea (*Total, 2013*).

Table 5-14: Well blowouts during different operational phases 1980 - 2008 (IOGP, 2010)

Drilling			Completion	Workover	Production causes		Wireline	Total
Development	Exploration	Other			External	Internal		
34	17	2	9	20	7	1	4	94
36.17%	18.08%	2.16%	9.57%	21.27%	7.44%	1.06%	4.25%	100%

Table 5.15 uses these historical records, as analysed by IOGP (2010), to inform the assessment of the potential frequency of blowout and well release incidents from the proposed Eagle development. The analysis of the SINTEF Offshore Blowout Database in relation to the proposed drilling assumes the drilling of one development well. The numbers provided in Table 5.14 do not provide a probability of the blowout or well release but places the Eagle development in the context of historical data.

Table 5.15: Projected frequency of blowout and well release incidents for the proposed drilling project

Scenario	Blowout			Well release		
	Historical frequency (IOGP, 2010) (individual units per given operation)	Values for the proposed project		Historical frequency (IOGP, 2010) (individual units per given operation)	Values for the proposed project	
		Estimated frequency per year[1]	Estimated return period (years)		Estimated frequency per year[1]	Estimated return period (years)
Development drilling (deep), normally pressured	6.0×10^{-5}	6.0×10^{-5}	16,666	4.9×10^{-4}	4.9×10^{-4}	2,040

1: Based on approach from Scandpower (1999) (in: *IOGP, 2010*), which uses the historical frequency to estimate the event return period, or average recurrence interval of an event.

Based on the estimated potential frequencies in Table 5.15, the likelihood of a blow-out or well release is considered to be extremely low. However, due to the nature of the drilling process, the potential for a blow-out does remain. This is also the worst-case in terms of potential hydrocarbon releases from the Eagle development and therefore has been taken forward for further assessment utilising oil spill modelling.

Behaviour of Hydrocarbons at Sea

Oil spill modelling was conducted to assess the fate of a worst-case blow-out release from the Eagle development well, using the SIMAP oil spill modelling software. SIMAP is designed to simulate the fate and effects of spilled hydrocarbons for both the surface and subsurface releases.

Seasonal stochastic modelling using SIMAP was undertaken in line with the latest OPEP guidance (*BEIS, 2019b*) for a well blow-out, the results of which are discussed in this section. The accidental release scenario modelled is detailed in Table 5.16. A declining flow rate was modelled, based on the blow-out calculations conducted for the Eagle development well (Figure 5.11).

Note that, in the event of an accidental release from the pipeline or production spools, the well would be shut in and production stopped. The exact rig to be used for drilling of the Eagle development well has not yet been defined, however it is likely that the total diesel inventory of the drilling rig which would be on site will be in the region of 3,000 m^3. As the production spools and drilling rig inventory volumes are significantly lower than the well blow-out scenario volume calculated for the Eagle development well, the loss of the production pipeline inventory and drilling rig diesel inventory have not been modelled or further assessed in this ES.

Table 5.16: Reservoir blow-out stochastic spill scenarios at the Eagle development well location; spill modelling input parameters

<table>
<tr><th colspan="9">Well Loss Parameters</th></tr>
<tr><td>Loss from:</td><td colspan="3">Eagle development well</td><td colspan="3">Instantaneous loss?</td><td colspan="2">No</td></tr>
<tr><td>Worst case volume</td><td colspan="3">1,420,560 m^3</td><td colspan="3" rowspan="2">Will the well self-kill?
If yes, when?</td><td colspan="2" rowspan="2">No</td></tr>
<tr><td>Flow rate</td><td colspan="3">Variable: 22,170 stb/day on day 1 to 17,507 on day 73</td></tr>
<tr><td>Justification for predicted worst case volume</td><td colspan="8">Expected Eagle oil rate has been modelled. The blowout calculations conducted as part of the reservoir modelling indicated a declining flow rate in the blow-out case (Figure 5.11).</td></tr>
<tr><th colspan="9">Location</th></tr>
<tr><td>Spill source point:</td><td>Lat:</td><td colspan="2">57° 22' 58.219” N</td><td colspan="2">Long:</td><td colspan="3">0° 43' 6.792” E</td></tr>
<tr><td>Installation/facility name:</td><td colspan="3">Eagle development well</td><td colspan="2">Quad/Block</td><td colspan="3">21/19a</td></tr>
<tr><th colspan="9">Hydrocarbon Properties</th></tr>
<tr><td>Hydrocarbon name</td><td colspan="3">Crude – Eagle</td><td colspan="2">Gas / oil ratio:</td><td colspan="3">355 scf/stb</td></tr>
<tr><td>Assay Available:</td><td>No</td><td colspan="4">Was an analogue used for spill modelling?</td><td colspan="3">Yes</td></tr>
<tr><td></td><td>Name</td><td>ITOPF Category</td><td>Specific Gravity</td><td>API</td><td>Pour point (°C)</td><td>Wax content (%)</td><td>Asphaltene content (%)</td><td>Viscosity (Cp and °C)</td></tr>
<tr><td rowspan="2">Hydrocarbon</td><td>Eagle</td><td>Group 2</td><td>0.833</td><td>38.4</td><td>-6</td><td>7.8%</td><td>1.90%</td><td>0.364 @ 15°C</td></tr>
<tr><td>Analogue</td><td>Group 1</td><td>0.792</td><td>47.1</td><td>-42</td><td>7.2%</td><td>0.54%</td><td>1.56 @ 20°C</td></tr>
</table>

<table>
<tr><th colspan="6">Metocean parameters</th></tr>
<tr><td>Model Name</td><td>Season</td><td>Air Temperature</td><td>Sea Surface Temperature</td><td>Wind data</td><td>Current data</td></tr>
<tr><td>Summer</td><td>Jun-Aug</td><td>17°C</td><td>14.1 °C</td><td rowspan="4">5 years (2011-2015) NCEP CFSR dataset.</td><td rowspan="4">5 years (2011-2015) 3D HYCOM 3-hourly current dataset, aggregated with 1 km resolution tidal currents.</td></tr>
<tr><td>Autumn</td><td>Sep-Nov</td><td>12°C</td><td>11.2 °C</td></tr>
<tr><td>Winter</td><td>Dec-Feb</td><td>4°C</td><td>8.0 °C</td></tr>
<tr><td>Spring</td><td>Mar-May</td><td>10°C</td><td>7.5 °C</td></tr>
</table>

<table>
<tr><th colspan="4">Modelled release parameters</th></tr>
<tr><td>Surface or Subsurface:</td><td>Subsurface</td><td>Release depth:</td><td>93 m</td></tr>
<tr><td>Release duration:</td><td>73 days</td><td>Instantaneous?</td><td>No</td></tr>
<tr><td>Persistence duration:</td><td>30 days</td><td>Release rate:</td><td>Refer to Figure 5.11</td></tr>
<tr><td>Total simulation time:</td><td>103 days</td><td>Total release:</td><td>1,420,560 m^3</td></tr>
<tr><th colspan="4">Spill Modelling Software</th></tr>
<tr><td>Name of software:</td><td>SIMAP</td><td>Version:</td><td>7.0.0.20</td></tr>
</table>

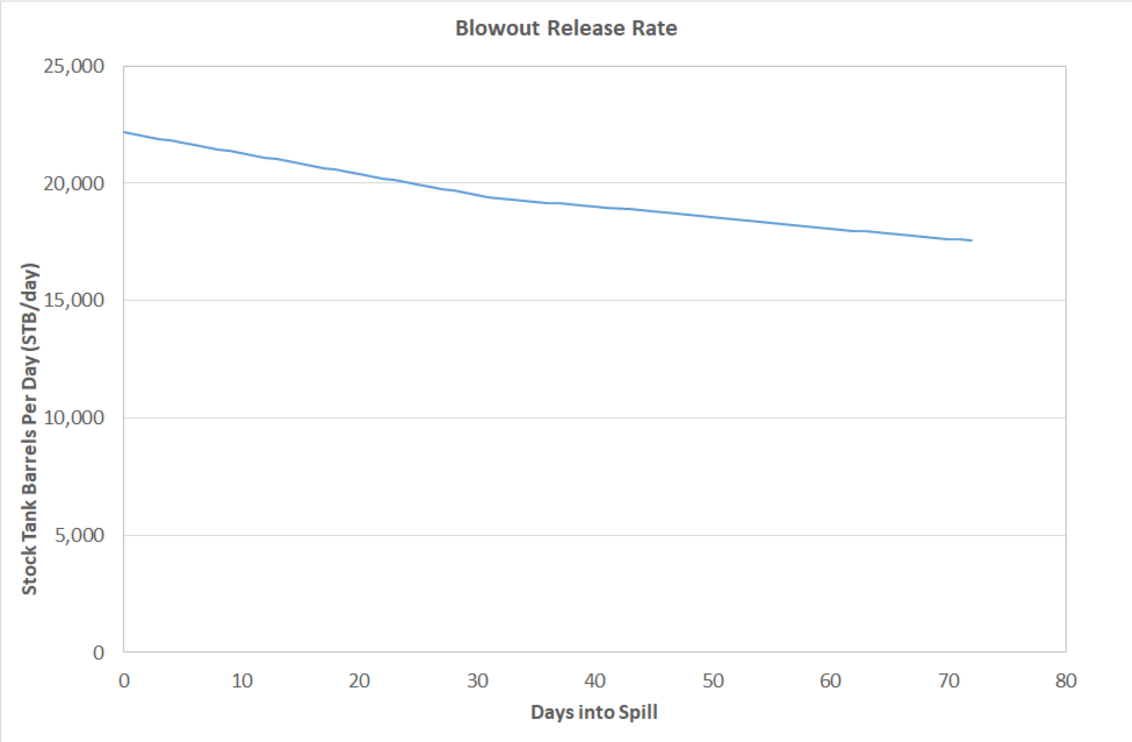

Figure 5.11: Eagle development well blow-out case declining flow rate

The surface probability of oil spill contamination is presented in Figure 5.13. The minimum crossing times to all relevant median lines are shown in Table 5.12. Modelling indicated that there was a worst-case probability of 100% crossing the UK/Norway median line within 3 days of release start during the autumn and winter scenarios. The modelling predicted that the release would reach as far as German and Faroese waters (Table 5.12).

The shoreline probability of oil spill contamination is presented in Table 5.13. The probability of shoreline oiling is highest in the autumn and winter scenarios, where Norway has 100% and 99% predicted probability of beaching in 21 days and 17 days, respectively. For the UK, the probability of shoreline oiling is highest in the winter and spring scenarios, with the Shetland and Orkney Islands predicted to be impacted, as well as areas along the Scottish and English coastlines. The maximum predicted potential shoreline loading is shown in Figure 5.14.

Table 5.12: Shortest time and probability of oiling on the sea surface after 73 days

Eagle Well Blow-out				
Shortest time and probability of sea surface oiling above a threshold of 0.3µm (0.3g/m²) after 73 days				
North Sea Coastal States	**Jun – Aug**	**Sep – Nov**	**Dec – Feb**	**Mar – May**
Denmark EEZ	26 days	14 days	15 days	33 days
	87%	99%	93%	71%
Netherlands EEZ	51 days	55 days	54 days	100 days
	17%	2%	10%	11%
Germany EEZ	48 days	46 days	20 days	68 days
	19%	49%	45%	25%
Norway EEZ	6 days	3 days	3 days	7 days
	100%	100%	100%	93%
Sweden EEZ	33 days	19 days	25 days	41 days

	73%	77%	80%	20%
UK EEZ	*0 days*	*0 days*	*0 days*	*0 days*
	100%	*100%*	*100%*	*100%*
Faroe EEZ	-	74 days	24 days	-
	-	7%	5%	-

Table 5.13: Predicted shoreline oiling data after 73 days

North Sea Coastal States	Probability of shoreline contact (%)	Minimum time to shoreline contact (days)	Peak volume on shoreline (m³)	Mean length of shoreline contacted* (km)
Summer (Jun-Aug)				
Denmark	37%	38 days	3,844 m^3	156 km
Norway	79%	47 days	24,594 m^3	690 km
Sweden	56%	36 days	13.496 m^3	140 km
Autumn (Sep-Nov)				
Denmark	66%	21 days	5,169 m^3	247 km
Germany	13%	59 days	473 m^3	67 km
Norway	100%	21 days	30,808 m^3	1,011 km
Sweden	67%	21 days	18,003 m^3	273 km
UK:				
Orkney Islands	7%	71 days	1,977 m^3	27 km
Shetland Islands	23%	47 days	5,131 m^3	81 km
Winter (Dec-Feb)				
Denmark	82%	24 days	5,819 m^3	234 km
Germany	24%	65 days	99 m^3	80 km
Norway	99%	17 days	18,069 m^3	736 km
Sweden	80%	26 days	13,143 m^3	227 km
UK:				
Aberdeenshire	5%	72 days	9 m^3	9 km
Highland	13%	37 days	6,586 m^3	122 km
Northumberland	3%	88 days	453 m^3	42 km
Scottish Borders	1%	101 days	7 m^3	11 km
Shetland Islands	9%	16 days	5,879 m^3	216 km
Orkney Islands	18%	20 days	2,244 m^3	28 km
Spring (Mar-May)				
Denmark	27%	39 days	2,197 m^3	117 km
Norway	27%	36 days	13,102 m^3	360 km
Sweden	18%	44 days	3,019 m^3	163 km
UK:				
Aberdeen	13%	51 days	1 m^3	2 km
Aberdeenshire	20%	36 days	120 m^3	24 km

North Sea Coastal States	Probability of shoreline contact (%)	Minimum time to shoreline contact (days)	Peak volume on shoreline (m^3)	Mean length of shoreline contacted* (km)
Angus	18%	63 days	9 m^3	1 km
Durham	4%	95 days	1 m^3	2 km
East Lothian	9%	61 days	418 m^3	60 km
Edinburgh	5%	73 days	1 m^3	3 km
Fife	9%	59 days	110 m^3	30 km
Hartlepool	2%	96 days	0 m^3	1 km
Highland	2%	30 days	2,824 m^3	94 km
North Yorkshire	2%	103 days	0 m^3	1 km
Northumberland	11%	54 days	1,833 m^3	107 km
Orkney Islands	2%	40 days	78 m^3	22 km
Scottish Borders	9%	60 days	583 m^3	35 km
Tyne and Wear	9%	77 days	39 m^3	9 km

* Note: The shoreline contact length parameter defines the total length of contacted shoreline by oil at any stage during the weathering process. This means that not all oil calculated as contacting the shore will be visible to the human eye.

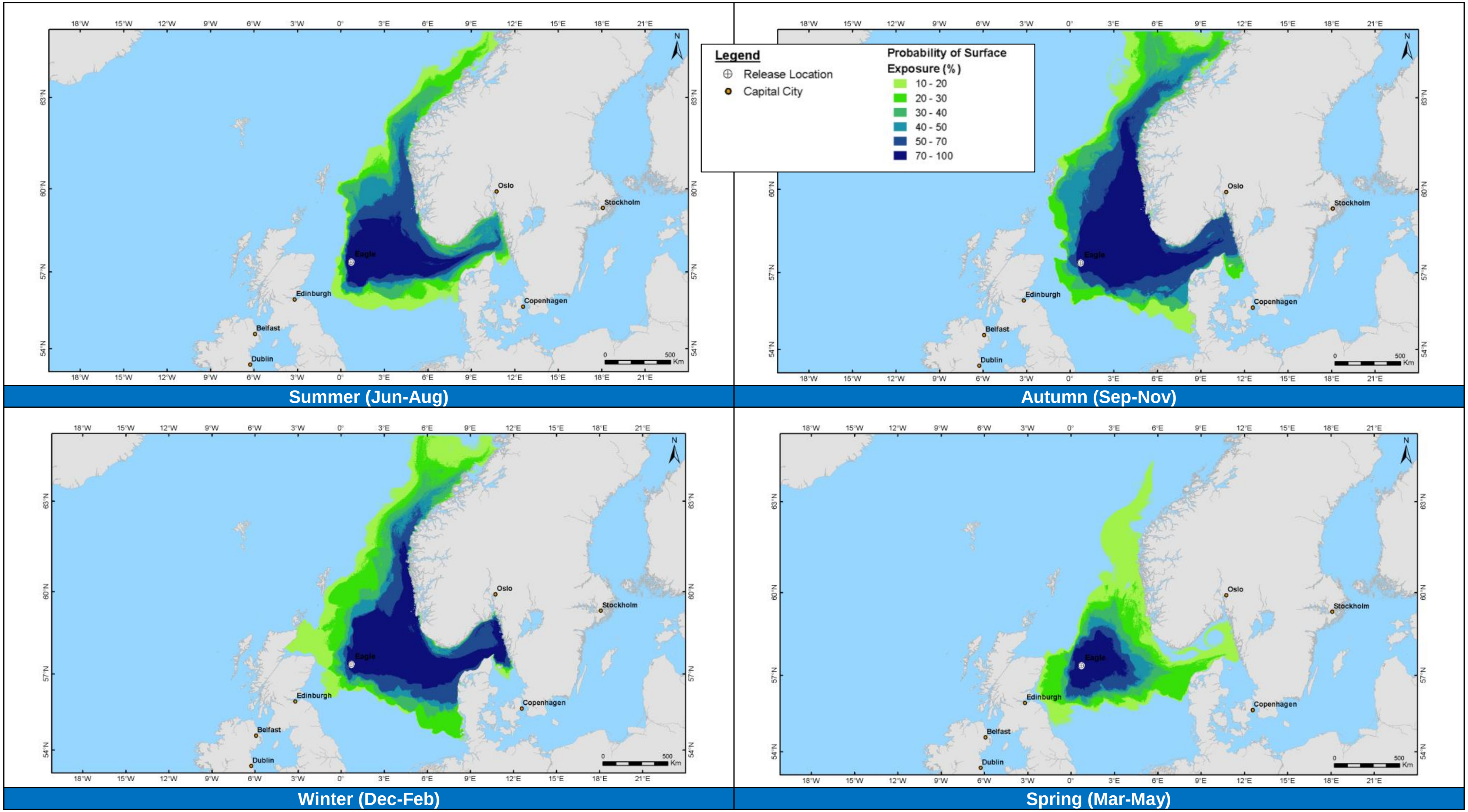

Figure 5.13: Probability of oil exposure on the sea surface above low exposure (≥0.3 g/m²) from a 73-day loss of well control from all seasons

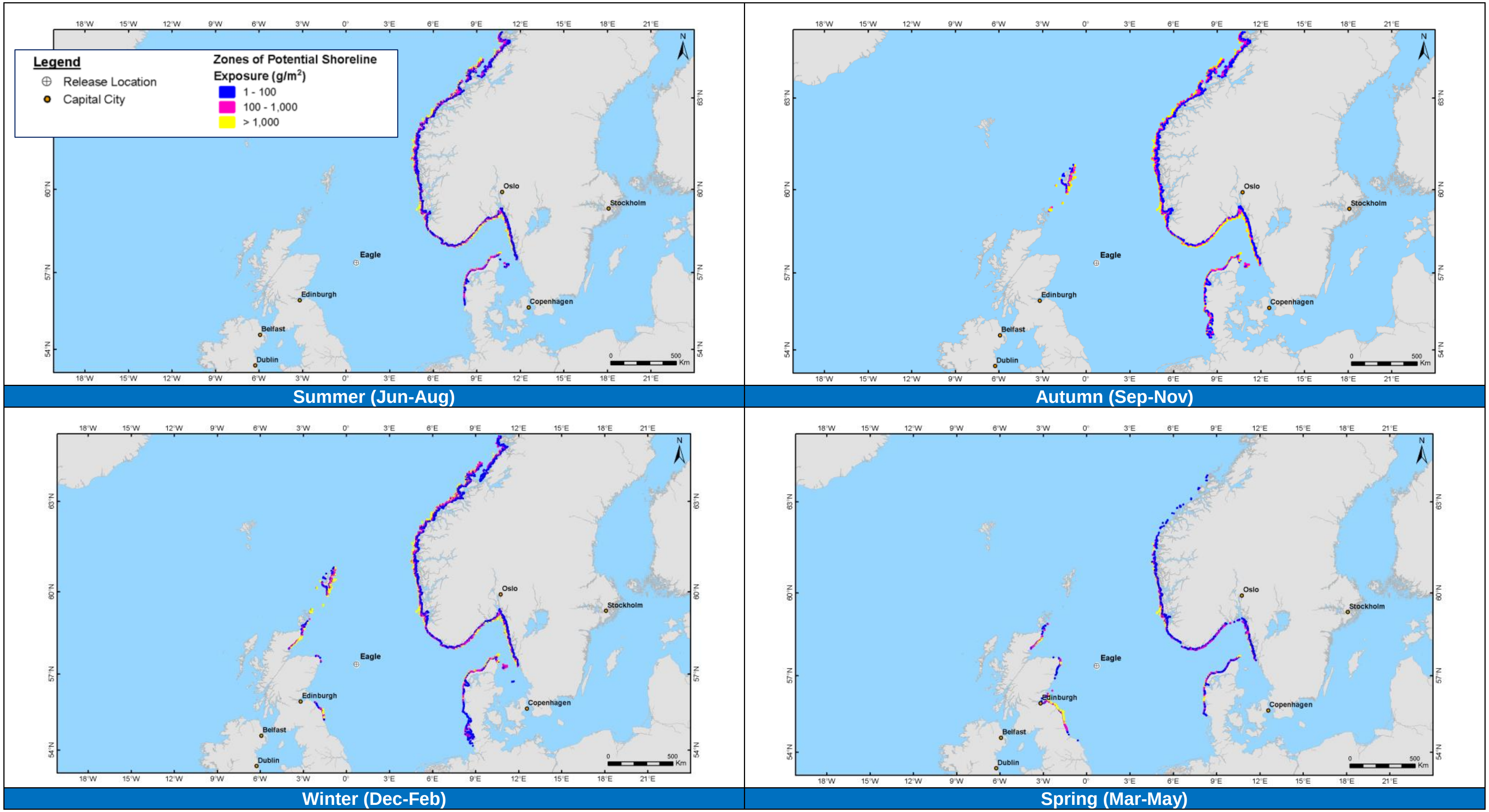

Figure 5.14: Maximum potential shoreline loading (g/m²) from a 73-day loss of well control from all seasons

Environmental Vulnerability to Spills

Environmental vulnerability to spills is a function of both the likelihood of impact from a spill (as considered in previous sections) and the sensitivity of the environment. Offshore and coastal vulnerabilities need to be considered separately as different parameters will apply.

There can be impacts on plankton in the immediate area of the release due to the dissolution of aromatic fractions into the water column. Such effects will be greater during a period of plankton bloom and during fish spawning periods. In addition, juvenile fish and eggs are potentially the most sensitive life-stage to hydrocarbon releases. As outlined in Section 3.3.3, a number of commercially important pelagic and demersal fish species are found in the vicinity of the Eagle development. Contamination of marine prey including plankton and small fish species may then lead to aromatic hydrocarbons accumulating in the food chain. These could have long-term chronic effects such as reduced fecundity and breeding failure, on fish, bird and cetacean populations. This may affect fish stocks of commercially fished species. A major release could also have a localised effect on the fishing industry, should certain areas be temporarily closed to fishing due to concerns over a possible 'taint' effect.

The JNCC has stated that the greatest risks to nature conservation, of oil on the offshore sea surface, are to seabirds (*JNCC, 2011*). The seasonal vulnerability of seabirds to surface pollutants in the vicinity of the development suggests an overall low vulnerability to surface pollution, with the exception of April and May in Block 21/18 which are rated as extremely high (Section 3.3.4). The magnitude of any impact will depend on the number of birds present, the percentage of the population present, their vulnerability to spilled hydrocarbons and their recovery rates from oil pollution. The physical impact of a spill is one of plumage damage, leading to loss of insulation and waterproofing and ingestion of oil during preening, causing potential liver and kidney damage (*Furness & Monaghan, 1987*).

Marine mammals are also present in the vicinity of the development (refer to Section 3.3.5). In the event of a spill, the potential impact will depend on the species present and their feeding habits, the overall health of individuals before exposure, and the characteristics of the hydrocarbons. It is thought unlikely that a population of cetaceans in the open sea would be affected by a spill in the long-term (*Aubin, 1990*). Cetaceans are pelagic (move freely in the oceans) and migrate. Their strong attraction to specific areas for breeding or feeding may override any tendency cetaceans have to avoid hydrocarbon contaminated areas. In contrast to seabirds, there is relatively little evidence of direct mortality associated with oil spills (*Geraci & St. Aubin, 1990*; *Hammond et al. 2002*), although the aggregated distribution of some species (especially dolphins) may expose large numbers of individuals to localised oiling.

The likelihood of a hydrocarbon spill impacting the coastal environment is a function of the likelihood of a hydrocarbon spill occurring and the probability of the released hydrocarbons beaching. The level of impact is also directly related to the volume of hydrocarbon beaching, the composition of the beached hydrocarbons, and the type of beach. The hydrocarbon associated with the Eagle development that may beach in the event of a spill is a light crude oil.

Coastal environmental sensitivities to spills include nearshore breeding seabird populations, shore birds, over wintering diver and duck species, marine mammals, aquaculture operations and sub-littoral and coastal habitats including SACs and SPAs. An assessment of the potential effects on protected sites is made in section 5.4.8.

Intertidal areas of the coast show varying degrees of sensitivity to spills. This variability is a function of both actual effects on specific organisms and the physical fate of the released substances within the habitat concerned. For example, high energy rock, boulder or cliff coastlines tend to have lower sensitivity to hydrocarbon pollution because oil is rapidly broken up and dispersed by wave action, and beached oil remains on the surface of rocks and is exposed to weathering. In contrast, sheltered, low energy shorelines tend to have moderate to high sensitivity because oil is not broken up by wave action and it can be mixed into the sediment where it is not exposed to weathering and therefore persists for longer.

5.4.3 Mitigation

Spills from production facilities and support vessels are largely preventable through provision of appropriate equipment, maintenance and training. The ACOPS review (*Dixon, 2014*) noted that a combination of technical, operational and regulatory measures effectively contributed to a decrease of oil and chemical spills in UKCS waters originating from industries such as oil and gas and shipping.

The mitigation measures below reduce either the probability of an accidental release, or the consequences in the event of a release:

- EnQuest will implement a well examination scheme, operated by independent well examiners, to ensure there is an independent check on well design, construction, maintenance and operations;
- The development well and associated subsea infrastructure will be designed as per Oil and Gas UK best practice;
- The drilling rig will have a minimum 10,000 pound per square inch BOP stack (standard for drilling rigs);
- EnQuest has a verification scheme for Safety and Environmentally Critical Elements (SECEs) and will identify SECEs in future design stages;
- A simultaneous operations (SIMOPs) report will detail the precautions and controls to be implemented during the installation of the pipeline, umbilical and subsea infrastructure;
- EnQuest will ensure the development of, and conformance to, appropriate equipment containment maintenance procedures;
- All relevant installation and vessel personnel will be given full training in chemical release prevention and actions to be taken in the event of an accidental hydrocarbon/ chemical release;
- Shipboard Oil Pollution Emergency Plans (SOPEPs) will be in place for all relevant vessels involved in the operations;
- An Oil Pollution Emergency Plan (OPEP) will be in place prior to the start of both drilling and production operations;
- The drilling rig will be subject to an environmental containment audit prior to drilling operations commencing, which will cover oil spill response, procedural controls, bunkering and chemical storage arrangements.

5.4.4 Cumulative Impact Assessment

Existing hydrocarbon spill risks in the North Sea are associated primarily with oil and gas industry activities as well as other marine industries such as merchant shipping and fishing. A major well blowout can result in significant release to sea of oil; however, the probability of such events occurring, and thus influencing cumulative risk, is extremely low. Although the acute effects of oil spills can be severe at a local scale, the cumulative effects of oil spills from shipping and oil and gas developments do not appear to have resulted in wide-scale or chronic ecological effects (*DECC, 2011*).

5.4.5 Transboundary Impact Assessment

Worst-case well blow-out hydrocarbon release modelling undertaken for the Eagle development (which assumed no response measures were implemented) indicates the likelihood of transboundary impact. Modelling showed the potential for impact in the waters and shorelines of neighbouring states (Tables 5.12 and 5.13). 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 as a result of the Eagle 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 managing pollution incidents that cross into the waters of states bordering the UK, which include the NORBRIT Agreement and the Bonn Agreement. The oil spill modelling predicted that Norwegian waters are the most likely to be impacted in the event of a major well blow-out release. In the event that a release drifts into Norwegian waters, the NORBRIT agreement will be activated, which details how a spill crossing the transboundary lines of the two states are to be managed. Notification to other states is done via the MCA.

5.4.6 Socio-economic Vulnerability to Spills

In the event of a major release, there would probably be an exclusion of commercial fishing from the area until it could be determined that hydrocarbon levels had diminished and the absence of taint had been confirmed. There also exists the possibility that a release could impact on coastal fisheries, including sites of aquaculture interest. The coastlines of Shetland and Orkney in the UK, and the coastline of Norway are known for their high aquaculture activity; the Shetland and Orkney Islands both have protected shellfish fishery areas on their coastlines. The oil spill modelling has shown that in the event of a worst-case well blow-out release, there is the potential for impacts to these areas (Section 5.4.2).

The Eagle development area lies within ICES rectangle 43F0, an area of low fishing effort (refer to Section 3.5.1). The vessel traffic survey provided further insight into the local fishing movements (refer to section 5.1.1) and suggests that the Eagle development area is not an active fishing area due to the low quantity of fishing data observed. In the wider area of the CNS, vessels will generally be trawling in the region to target demersal and pelagic species, as well as shellfish.

Accidental hydrocarbon releases may also have a direct impact on the amenity value of the coastline, due to the physical and visual impact of oiling. The effect is generally short-term as a large proportion of beached oil is broken down by natural means or mechanical removal. Perception of damage may be longer lived, particularly by potential tourists. The tourism industry of coastal populations represents a significant proportion of the local economy value, with walking, ornithology, sailing, fishing, archaeology and diving being the most important. Mirroring the issues associated with public perceptions of fisheries produce, experience following the MV *Braer* incident in Shetland showed that marketing efforts were necessary to reassure tourists.

An accidental hydrocarbon release large enough to cause impact upon the UK coastline and coastal waters (i.e. a well blow-out) is remote and it is therefore concluded that the Eagle development is very unlikely to have a significant impact upon UK coastal industries.

5.4.7 Decommissioning

Cessation of production will remove one of the main sources of potential accidental hydrocarbon release since there will no longer be a hydrocarbon flow from the Eagle well or through the pipeline system to the Kittiwake platform.

Additional vessels will be required to execute decommissioning activities, with potential impacts related to accidental hydrocarbon and chemical release from those vessels likely to occur at a similar magnitude to those associated with installation activities. Any such spill risk from future decommissioning activities will be addressed within an EA as part of the decommissioning permitting process.

5.4.8 Protected sites

As part of the oil spill modelling study, protected sites potentially impacted by a worst-case release were identified. The protected sites identified as being at risk of oiling, based on the oil spill modelling outputs from all four seasons, are listed in Tables 5.14 to 5.16. It should be noted that the distances given are to the Eagle development at its closest point, and not to the extent of the spill modelling.

Offshore Sites

Surface occurrence of released hydrocarbon within an offshore site is taken as an indication that the site has the potential to be impacted. Table 5.14 shows the key offshore sites affected by surface and dissolved hydrocarbon oiling. The likelihood of an effect from an accidental hydrocarbon release will be determined by the direction of travel of the release, the amount of oil released, prevailing weather and sea conditions and water depth. The Eagle development will produce a crude oil which has a specific gravity of approximately 0.83 and therefore will float on water. Once the lighter fractions of the hydrocarbon have evaporated, the remaining fraction is expected to form a stable water-in-oil emulsion.

The closest offshore conservation site is the East of Gannet and Montrose fields NCMPA and is located approximately 11.5 km from the Eagle development. The East of Gannet and Montrose Fields NCMPA is designated for the habitat '*offshore deep-sea muds*', and for '*ocean quahog aggregations, including sands and gravels as their supporting habitat*' (*JNCC, 2016a*). The oil spill modelling predicts a maximum instantaneous dissolved hydrocarbon exposure at a depth of between 40-60 metres of 14ppb for this site. The Norwegian Boundary Sediment Plain NCMPA which lies approximately 87 km to the north-east of the development is also designated for ocean quahog aggregations, and the oil spill modelling predicts a maximum instantaneous dissolved hydrocarbon exposure at a depth of between 40-60 metres of 27ppb over this site. French MacKay (2018) indicates dissolved hydrocarbon concentrations of 1ppb for sublethal effects (or Predicted No Effect Concentration), 10ppb for lethal effects for sensitive species and/or early life stages, and 300ppb for lethal effects for less sensitive species and/or older life stages (*French McKay, 2018*). The Marine Scotland FEAST indicates that ocean quahog aggregations are sensitive to Non-synthetic compound contamination (including heavy metals, hydrocarbons, produced water) (*Marine Scotland, 2013*). However, the water depths across the East of Gannet and Montrose Fields NCMPA and the Norwegian Boundary Sediment Plain NCMPA are in the region of 80-100 metres and from 80 to 120 metres (respectively), and the model predicts a sharp decline in dissolved hydrocarbon concentration with depth. Given this trend and the depths across the NCMPAs, which are at least 20 metres more than the depths for which the model calculated dissolved hydrocarbon concentrations, impacts on seabed features from dissolved hydrocarbon fractions are not anticipated from a worst-case blow-out release.

Due to distance from the release, other sites listed in table 5.14 have very low (or no) predicted dissolved hydrocarbon concentrations at 40-60 metres depth.

Given the remote probability of a release occurring and the very low water column concentrations predicted in the deeper waters, significant impacts upon the features of the sites are highly unlikely to occur, and there will therefore be no effect on the integrity of the sites or on the ability to meet the conservation objectives of these sites.

Table 5.14: Key offshore protected sites predicted to be impacted by surface oiling from a worst-case blow-out release

Site	Maximum probability of oil exposure on the sea surface (%)	Minimum time before oil exposure on the sea surface (days)	Maximum instantaneous dissolved hydrocarbon exposure (ppb) at 40-60 m water depth	Protected features
Fulmar MCZ	84% (spring)	6 days (winter)	0 (all seasons)	Broad-scale habitats: Subtidal sand, subtidal mud, subtidal mixed sediments, Species Feature of Conservation Importance: Ocean quahog.
Swallow Sand MCZ	60% (spring)	36 days (autumn)	0 (all seasons)	Broad-scale habitats: Subtidal sand, subtidal coarse sediments. Geological/ Geomorphological features: North Sea glacial tunnel valley.
East of Gannet and Montrose Fields NCMPA	100% (all seasons)	0 days (winter)	14ppb (spring)	Broad-scale habitats: Offshore deep-sea muds. Species Feature of Conservation Importance: Ocean quahog aggregations.
Turbot Bank NCMPA	27% (spring)	15 days (spring)	1ppb (spring and winter)	Mobile species: sandeels.
Braemar Pockmarks SAC	90% (winter)	9 days (winter)	0 (all seasons)	Annex I Habitat: Submarine structures made by leaking gases.
Scanner Pockmark SAC	90% (autumn)	4 days (winter)	4ppb (winter)	Annex I Habitat: Submarine structures made by leaking gases.
Norwegian Boundary Sediment Plain	100% (summer and autumn)	4 days (winter)	27ppb (winter)	Low or limited mobility species: Ocean quahog aggregations.

Coastal Sites

Table 5.15 shows the key coastal sites predicted to be affected by oiling in the event of a worst-case blow-out release.

Table 5.15: Key coastal protected sites predicted to be impacted by surface oiling from a worst-case blow-out release

Site	Maximum probability of oil exposure on the sea surface (%)	Minimum time before oil exposure on the sea surface (days)	Maximum instantaneous dissolved hydrocarbon exposure (ppb) at 40-60 m water depth	Protected features
Papa Stour SAC	84% (spring)	6 days (winter)	0 (all seasons)	Annex I habitats: Reefs; submergerd or partially submerged sea caves.
Yell Sound SAC	3% (winter)	17 (winter)	0 (all seasons)	Annex II species: Otter (*Luttra luttra*), harbour seal
Mousa SAC	14% (autumn)	17 (winter)	0 (all seasons)	Annex I habitats: Reefs; submergerd or partially submerged sea caves. Annex II species: Harbour seal
Sanday SAC	7% (autumn)	20 (winter)	0 (all seasons)	Annex I habitats: Reefs, Annex II species: Harbour seal.

Habitats most likely to be negatively affected by hydrocarbon contamination are exposed reefs and species that forage in the contaminated areas. Various seal haul-out locations are present in the Shetland and Orkney areas. The animals most at risk from oil coming ashore on seal haul-out sites and breeding colonies are neonatal pups. These animals are born without any blubber and rely on their prenatal fur (the white lanugo in grey seals) and metabolic activity for thermal balance. They are therefore more susceptible than adults to external oil contamination (*Ekker et al., 1992*). The pups remain on the breeding colonies until they are weaned and unlike adults or juveniles, would be unable to leave the contaminated areas. The oil spill modelling results show that the highest probability of contamination is predicted in spring. Harbour seals breed during the summer months and grey seals breed from late autumn into winter.

Due to the fact that most of the oil will weather offshore, and the nature of the qualifying features of the SPA sites, long-term environmental impacts are not anticipated in the event of a worst-case hydrocarbon release. Potential effects on the integrity of the sites or on the ability to meet the conservation objectives of the sites are therefore not anticipated.

Special Protection Areas, SPAs

The qualifying features in the SPAs identified as having the potential to be impacted as a result of oiling, are seabirds (Table 5.16). The SPA with the highest probability (20%) of oiling is Buchan Ness to Collieston Cast SPA, located 135 km to the west of the Kittiwake platform on the coast of Aberdeenshire, in north-east Scotland.

Table 5.16: Key SPAs predicted to be impacted by surface oiling from a worst-case blow-out release

Site	Maximum probability of oil exposure on the sea surface (%)	Minimum time before oil exposure on the sea surface (days)	Protected features
Buchan Ness to Collieston Coast SPA	20% (winter)	35 (spring)	A seabird assemblage of international importance: 95,000 seabirds during the breeding season: Guillemot, Kittiwake, Herring Gull, Shag, Fulmar.
East Caithness Cliffs SPA	13% (winter)	30 (spring)	0.5% of the breeding population of Peregrine Falcon (*Falco prergrinus*) in Great Britain. Populations of European importance of migratory species: Guillemot, Herring Gull, Kittiwake, Razrbill. Seabird assemblage of international importance: 300,000 seabirds including: Puffin, Great Black-backed Gull, Cormorant, Fulmar, Razorbill, Guillemot, Kittiwake, Herring Gull, Shag.
East Sanday Coast SPA	7% (autumn)	20 (winter)	Annex I species (over winter): Bar-tailed Godwit (*Limosa lapponica*), Purple Sandpiper (*Calidris maritima*).
Fair Isle SPA	8% (winter)	18 (winter)	Populations of European importance: Artic tern, Fair Isle Wren (*Troglodytes troglodytes*), Guillemot. Seabird assemblage of international importance: 20,000 seabirds Puffin, Razorbill, Kittiwake, Great Skua, Arctic Skua, Shag, Gannet, Fulmar, Guillemot, Arctic Tern.
Fetlar SPA	8% (winter)	17 (winter)	Populations of European importance: Artic tern, Red-necked Phalarope (*Phalaropus lobatus*), Dunlin (*Calidris alpina schinzii*), Great skua, Whimbrel (*Numenius phaeopus*). Seabird assemblage of international importance: 20,000 seabirds including: Arctic skua, Fulmar, Great skua, Arctic Tern, Red-necked Phalarope.
Fowlsheugh SPA	11% (spring)	51 (spring)	Populations of European importance: Guillemot, Kittiwake. Seabird assemblage of international importance: 20,000 seabirds including: Razorbill, Herring gull, Fulmar, Guillemot, Kittiwake.

For many seabirds, once breeding is complete, individuals are no longer restricted to foraging within certain distances (i.e. foraging ranges) from their breeding colony as there is no longer any requirement to return to eggs or chicks. For a number of key species, there is strong evidence that once birds leave the breeding colony, they become widely dispersed over large distances, often inter-mingling with birds from other breeding colonies (typically of the same species) and in some cases birds that have migrated from overseas breeding colonies (*Furness, 2014*). Consequently, given that individuals from an SPA population become so widely dispersed, the potential for an impact to any of these birds at these coastal locations becomes significantly diluted. Potential impacts on birds during the non-breeding season (i.e. when they are offshore) are expected to be much less than during times of breeding.

Given the highly remote probability of a release occurring, significant impacts upon the features of the protected sites is highly unlikely to occur. It is therefore highly unlikely that there will be an effect on the integrity of the sites or on the ability to meet the conservation objectives of these sites.

5.4.9 Residual impact

Accidental Hydrocarbon Release

Although the probability of a catastrophic release from the Eagle development is remote, and comprehensive prevention and mitigation measures will be in place, the residual risk of an accidental release, and thus impact on the marine environment, remains. This is recognised to be true for the offshore oil and gas industry in general and the formulation of detailed and fully tested contingency response plans is thus an integral part of such projects. As such, EnQuest will have in place a range of response/ mitigation measures to address these risks (refer to section 5.4.3). All applicable offshore activities associated with the Eagle development will be covered by approved OPEPs and Ship-board Oil Pollution Emergency Plans (SOPEPs) which will set out the responses required and the available resources for managing and responding to spills of all sizes. The planning, design and support of all activities for the Eagle development will aim to eliminate or minimise potential environmental risks. EnQuest's management processes will ensure that these mitigation commitments are implemented and monitored.

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Protected sites and socio-economic features	Major	High	High	Moderate
Rationale				
The information in the Environment Description (Section 3) has been used to assign the sensitivity, vulnerability and value of the receptor as follows. Given the possibility of interaction between a range of potential receptors following a release of hydrocarbons from a well blow-out, sensitivity has been assigned as Major. Similarly, it is anticipated that some features could exhibit high vulnerability and value (e.g. sites of conservation importance) and rankings have been assigned as such. Should a hydrocarbon release make landfall, it is expected that there could be potential impacts on local habitats and species and therefore magnitude has been ranked as Moderate. It is recognised that a hydrocarbon release from a well blow-out could result in demonstrable change in some receptors. However, for this type of accidental event, it is especially important to assess the likelihood of the impact occurring. Review of UKCS historical data relating to well blow-out events confirm that the likelihood of a blowout is remote. Based solely on the residual risk of the expected impact should a well blow-out occur, the magnitude would be considered moderate. However, given the mitigation measures detailed in Section 5.4.3 (aligned with improved industry standards for well design) and the remote likelihood of a well blow-out occurring, the impact is significance is considered not significant.				
Consequence		**Impact significance**		
Low		Not significant		

Accidental Chemical Release

In addition to the hydrocarbon spill risk, there is also the risk of a chemical spill. Chemical spills may occur during chemical transfer, chemical handling, or through mechanical failure. The fate of any chemical entering the water column is dependent upon how physico-chemical properties influence its partitioning between seawater and its susceptibility to degradation (*DTI, 2001*). Given the high energy marine environment of the wider area, chemical spills are expected to disperse in the offshore marine environment with a possible negligible to minor localised and transient impact on plankton or fish eggs/larvae, depending on the season.

EnQuest has in place a range of response / mitigation measures to address these risks (as detailed in Section 5.4.3). EnQuest will work with its chemical suppliers to ensure that chemical use is minimised without compromising technical performance. Furthermore, EnQuest recognises that substitution is an important part of the OSPAR Harmonised Mandatory Control Scheme (HMCS) and is committed to the use of non-substitution chemicals and to the investigation of alternatives where this is not possible. Information on specific chemical use and associated environmental impact assessment will be provided in the relevant environmental chemical permit prior to the commencement of activity.

EnQuest will endeavour to use chemicals with a good environmental profile (PLONOR, OCNS group E or Gold banded chemicals) where possible, to reduce potential impacts from these chemicals on the marine environment.

Major Accident Hazards (MAHs) and Major Environmental Incidents (MEIs)

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

For the Eagle development, one worst-case hydrocarbon release scenario was defined and modelled based on the Major Accident Hazard (MAH) scenario (loss of well control) during drilling: Uncontrolled flow of oil from the well due to a loss of well control which has the potential to reach the coastline.

This scenario is identified as potential MEI due to the potential for environmental impacts caused by the release. The spill modelling has played a key part in the MEI identification process. Reservoir hydrocarbons modelling has been conducted with four seasonal periods modelled. The key results of this modelling are fully described above in section 5.4.2.

Specific environmental impacts from hydrocarbon spills are very difficult to predict and quantify. In terms of beaching, it is reasonable to assume that potential impacts on receptors are greatest where the largest volumes have beached. The modelling performed shows that there is potential for the oil to beach in various states (Table 5.13), with Norway having the greatest potential for beaching. Predicted peak beaching volumes also vary, with the largest peak volume predicted to beach on the coast of Norway (30,808 m^3) in autumn, with a corresponding mean shoreline contact length of 1,011 km (Table 5.13).

It is difficult to specify exact quantities of hydrocarbons that will give rise to any specific environmental impact. Model outputs can be used to predict hydrocarbon concentrations, which can then be compared to known trigger concentrations for particular species. However, such application of modelling results does not take into account all aspects of a potential environmental impact, many of which are not easily quantifiable or measurable, for example potential impacts on conservation value or tourism interests. Spill models only take a few of these variables (e.g. wind, water currents, air temperature, etc.) as the basis for a simulation and for this reason the results of spill modelling are indicative only.

However, it is reasonable to assume that a greater volume of beaching may give rise to potentially greater environmental impacts on shoreline receptors, and therefore, it is also reasonable to assume that such impacts could potentially be considered to constitute a MEI. As it is impossible to say what the exact metocean conditions will be on any particular day or time in the future, it is reasonable to state that the potential for a MEI from uncontrolled flow of oil from the well exists for shoreline impacts, however, the likelihood of occurrence is low. The volume of beaching and extent of the impact on beaching sites is difficult to predict, as discussed above.

The qualifying features and conservation objectives of key coastal designated sites are described in Tables 5.15 and 5.16, including the potential for interaction with the hydrocarbon releases. Considering the conservation objectives for each of these above designated sites, it is reasonable to state that an impact on any one of these objectives due to significant beaching cannot be ruled out.

In summary, the spill modelling results demonstrate that uncontrolled well flow has the potential to cause a MEI, although the likelihood of this scenario occurring is extremely remote.

6 Environmental Management

6.1 Environmental Management System

EnQuest manage their environmental activities via their integrated Safety and Environmental Management System (SEMS). The SEMS is accessed via the Business Management System (BMS). The environmental management system (EMS) of EnQuest's SEMS has been established and implemented to ensure company activities are conducted in such a way that minimises risks to the environment throughout company operations. It provides a framework for the achievement of objectives in order for EnQuest to manage risk in accordance with the requirement of company policies, applicable legislation, national/international standards and contractual or partnership commitments.

EnQuest's EMS is structured in line with the requirements of the international standard for environmental management and has been externally verified to meet the requirements of OSPAR Recommendation 2003/5.

EnQuest has established a Health, Safety, Environment and Assurance (HSE&A) policy (Figure 6.1), which is a statement of intent from the Chief Executive Officer (CEO) and is intended to communicate to personnel and stakeholders (including contractors, clients and shareholders) EnQuest's aims and expectations regarding environmental management. The Corporate Major Accident Prevention Policy (CMAPP) complements the HSE&A policy and outlines the approach for managing major accident hazards.

HSE&A is EnQuest's top priority and it is deeply embedded in EnQuest's culture and values. It is integral to how EnQuest manage their business with regards to people, installations and the environment in which EnQuest operate. The HSE&A policy underpins how EnQuest's environmental goals are progressed throughout EnQuest business operations. EnQuest are fully committed to operating responsibly so that environmental risks are minimised.

Consideration of the potential for impact on the environment does not end at ES submission but continues throughout the lifecycle of the Eagle development. As such, an important element of EnQuest's ongoing environmental commitments will be ensuring that the mitigation measures developed as part of the EIA are suitably managed as part of the ongoing development of Eagle. The commitments made within this ES are summarised in Appendix D.

Commitments, objectives and targets set for the Eagle development will be communicated to EnQuest's key contractors and service providers pre-contract award and for the lifecycle of the contract. Environmental performance measures will feature within the agreed Contract KPIs. During the operational phase, an EnQuest representative will be onboard the drilling rig and associated installation vessels to ensure that environmental commitments made herein are communicated, implemented accordingly, and met.

Monitoring of environmental performance (including alignment with the commitments made in this ES) will be ongoing through the life of the Eagle development. Specific monitoring strategies will be developed for a number of activities, but are likely to be required for key purposes such as:

- Monitoring data for compliance with environmental consents and regulatory requirements;
- Environmental data required for submission to the Environmental and Emissions Monitoring System (EEMS); and
- To track performance against corporate objectives and targets, including improvement programmes.

Specific measurements that will be conducted for the Eagle development include:

- Chemical use and discharge;
- Oil-in-water levels;
- Hydrocarbon and chemical releases;
- Fuel use; and
- Atmospheric emissions.

6.2 Environmental Management and Commitments

A commitments register is presented in Appendix A which summarises mitigation and management measures above and beyond regulatory requirements identified during the EIA process that will be implemented as part of the Eagle development. Each commitment will be reviewed regularly to ensure that it is being met. Objectives and targets are also used for setting goals for continuous improvement in performance as part of EnQuest's HSE&A Continual Improvement Plan (CIP). In this way, environmental management is an ongoing process and will continue beyond implementation of mitigation measures identified during this EIA in order to strive for continuous improvement.

6.3 Waste

As a producer of waste, EnQuest has a duty of care to ensure that all waste is transferred and disposed of in accordance with the relevant legislation. EnQuest operations consume natural resources and other material which generates a range of wastes. EnQuest ensure that the segregation, transportation and eventual disposal of waste are managed in accordance with legislative requirements. EnQuest works closely with its onshore waste management contractors to identify recycling routes for as much of its waste as possible and conducts regular audits to evaluate waste management practices.

EnQuest has the following waste management standard requirements:

- All sites shall develop a site-specific Waste Management Plan (WMP). The WMP will detail how the asset will comply with the waste standards, include a segregation guide, waste station map and information on how to correctly consign the waste;
- In line with legislation, no waste shall be disposed of to sea, other than macerated food waste from the galley, sewage, and macerated sand/scale discharges providing it meets permit conditions; and
- Waste shall be disposed of in accordance with the Scottish Environment Protection Agency (SEPA), 2014 waste hierarchy.

Upon both drilling rig contract award and pipeline installation contract award, the drilling rig contractor and installation contractor shall work with EnQuest to undertake a gap analysis to highlight differences in waste management practices. Where the contractor is performing below the EnQuest standard, the recommended improvements will be recorded in an interface document.

HSE&A Policy

Health, Safety, Environment & Assurance

enQuest

EnQuest is one of the largest UK independent oil producers in the UK North Sea. We are committed to operating responsibly and will not compromise our health, safety or environmental standards to meet our business objectives.

Through respect for our people, our contractors, our customers, our stakeholders and the environment, we will operate to achieve our principal aim: ***safe results, with no harm to people and respect for the environment.***

To achieve this we will manage our business such that we:

- Demonstrate strong leadership and visible commitment to HSE&A
- Comply with all applicable legislation and industry standards
- Maintain high-quality systems and processes
- Assess and manage risks
- Maintain safe and healthy workplaces
- Manage and mitigate our impact on the environment
- Provide trained and competent resources
- Encourage open and honest communication
- Ensure our contractors and suppliers comply with our policies and procedures
- Maintain the integrity of our assets over their life cycles
- Assess and manage change
- Plan and be prepared for potential emergencies
- Investigate and learn from incidents
- Strive for continual improvement in our performance

Should operational results and safety ever come into conflict, we all have a responsibility to choose safety over operational results. This includes the responsibility to stop a job whenever activities may conflict with this policy.

Amjad Bseisu
Chief Executive Officer
EnQuest PLC, January 2018

Bob Davenport
Managing Director - North Sea
EnQuest PLC, January 2018

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Figure 6.1: EnQuest HSE&A policy

7 Conclusions

The EIA presented in this ES has been undertaken in support of the Eagle development. The EIA has assessed the proposed drilling, installation, commissioning, operation and eventual decommissioning of infrastructure at the Eagle field in the context of the environmental sensitivities of the area and has described the control measures that will be in place during the project execution. The key findings of the EIA are summarised in the following sections, together with how the Eagle development is being developed in line with the Scottish NMP.

7.1 Key Findings

The topic areas taken forward for further assessment in the EIA included physical presence, atmospheric emissions, underwater noise and accidental events.

The EIA has found that there will be no significant impacts on the seabed as a result of the Eagle development, given the control measures in place, which include routing the export pipeline around the Annex I MDAC features found on the seabed during the site survey activities. The EIA has also found that there will be no significant impact on other sea users, namely commercial shipping and fishing; detailed analysis of historical vessel activity in the area strongly suggests that the area is not located within busy commercial shipping lanes and is not fished extensively.

There will be some atmospheric emissions released due to the Eagle development during its installation and across its lifetime. The assessment has placed the atmospheric emissions in the context of UK emissions from offshore (installations and shipping activities) and highlighted that the Eagle development will add a relatively small increment to the overall offshore emissions of the UK and the release of GHG into the environment and their contribution to global warming will be negligible or minor, in relation to those from the wider offshore industry and outputs at a national or international level. The Eagle development will be subject to the relevant emissions permitting at the host installation throughout its lifetime.

The EIA found that there is some potential for impacts from underwater noise, however the underwater noise modelling study predicts that potential areas of injury to marine mammals and fish are limited to within very short distances from the noise sources. Potential effects on marine mammals during any piling activities can be mitigated appropriately using recognised industry mitigation measures. The potential impacts from underwater noise due to the Eagle development are therefore not considered to be significant.

To assess the potential impact of a worst-case hydrocarbon release from the Eagle development, a worst-case blowout scenario was modelled. The impact assessment has highlighted in the event of such a release, there is the potential for significant effects on coastal protected sites due to the potential for beaching, and therefore such a worst-case hydrocarbon release could give rise to an MEI. However, it should be noted that blow-outs are extremely rare events. Given the control measures that EnQuest will have in place for hydrocarbon releases, the risk of hydrocarbon spills occurring is reduced to acceptable levels.

7.2 Scottish National Marine Plan

The Eagle development has considered the objectives and marine planning policies of the Scottish NMP across the range of policy topics including natural heritage, air quality, cumulative impacts and oil and gas. EnQuest considers that the Eagle development is in broad alignment with such objectives and policies; the extent to which the Development is aligned with the oil and gas objectives and policies is summarised in Table 7.1.

Table 7.1: Alignment between Eagle development and the Scottish National Marine Plan (oil and gas objectives and policies)

Objective/policy	Eagle development 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 employment 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.	Appropriate mitigation measures and response strategies developed for identified risks.

Objective/policy	Eagle development details
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 during option selection and design.
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 development will draw on experienced engineers, environmental specialists and other groups that are not necessarily limited to oil and gas sector throughout the development life time.
The Scottish Government will work with BEIS, the Oil and Gas Authority (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 development design. The potentially significant environmental impacts from drilling, installation, well testing/flaring activities, accidental release and habitat change 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.	EnQuest will review decommissioning best practice closer to the point at which the development will be decommissioned as part of a comparative assessment and Environmental Appraisal (EA). Full consideration will be given to available decommissioning options, including re-use and removal.
Supporting marine and coastal infrastructure for oil and gas developments, including for storage, should utilise the minimum space needed for activity and should take into account environmental and socio-economic constraints.	The Eagle development will make use of existing infrastructure, including the Gadwall/ Mallard export flowline and Kittiwake platform, reducing the requirement for further offshore infrastructure.
All oil and gas platforms will be subject to 9 nautical mile (nm) consultation zones in line with Civil Aviation Authority guidance.	EnQuest will engage as necessary with any relevant future developments that may be proposed within 9 nm of the Eagle 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 Eagle development has been designed 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 relative to existing assets. The selection of the proposed option for the Eagle development gives due consideration to how best to develop the field in the context of existing and future developments in the region.
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 EnQuest response strategy to accidental hydrocarbon release will be developed with due reference to the MCA NCP.

7.3 Protected Sites

The majority of species protected under Annex I of the Birds Directive that are present within the North Sea are generally found much closer to shore. These species may only encounter the Eagle development with any regularity during the limited period of the installation activity when the drilling rig and installation vessels are present on the sea surface. Outside of this time, the potential interaction with the development will be no more than that already possible through interaction with the existing Kittiwake platform.

The site survey results have shown that there are sensitive MDAC features present within the vicinity of the proposed export pipeline location. However, EnQuest has proposed a pipeline routing to avoid these MDAC features with a suitable installation corridor and route design. EnQuest is confident that the export pipeline can be installed without disturbing these features, having executed similar operations during other pipeline installation works in the GKA. Therefore, there will be no significant impact on any Annex I habitat or species highlighted in the Habitats Directive from the Eagle development.

The presence of species within the Eagle development area protected under Annex II of the Habitats Directive is limited to marine mammals. Based on the available data, marine mammal species that may be present in the area occur in relatively moderate to low densities, or occur only occasionally, or as casual visitors. This assessment concluded that there is a very limited area of potential injury (such as temporary or permanent hearing loss) or disturbance as a result of the activities associated with the Eagle development. The risks during piling operations (which pose the greatest potential impact in terms of impulsive underwater noise) can be mitigated to acceptable levels using the appropriate industry recognised JNCC Guidelines (*JNCC, 2017*). Therefore, potential impacts from underwater noise due to the Eagle development are not considered to be significant and unlikely to result in any population level impacts.

There are a number of offshore and coastal conservation areas on the Scottish mainland that have been designated under the Habitats Directive as SACs, under the EU Birds Directive as SPAs and under the Marine Scotland Act 2010 and Marine and Coastal Access Act 2009 as NCMPAs. The potential for significant impacts on any such site has been considered within each impact assessment, with particular focus given to the potential for an accidental hydrocarbon release to interact with such sites. Given the remote location of the Eagle development, the relatively short-term duration of drilling and installation activities and the mitigation and management measures in place (including for a worst-case accidental hydrocarbon release), the development is considered unlikely to affect the conservation objectives or site integrity of any SAC and SPA and neither is there a significant risk to the conservation objectives of an NCMPA being achieved.

Considering all of the above, no significant impacts are expected upon protected species and habitats from the Eagle development.

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Appendix A – 2019 Pipeline Route Site Survey: Alignment Charts

Site survey alignment charts from the 2019 pipeline route site survey (*Gardline, 2019a*; *2019b*).

Eagle to Gadwall Pipeline Route: Charts 1-2:

Alignment Sheet 1 of 2: KP 0.000 to KP 3.780

Alignment Sheet 2 of 2: KP 2.242 to KP 4.398

Eagle to Kittiwake Umbilical Route: Charts 1-4:

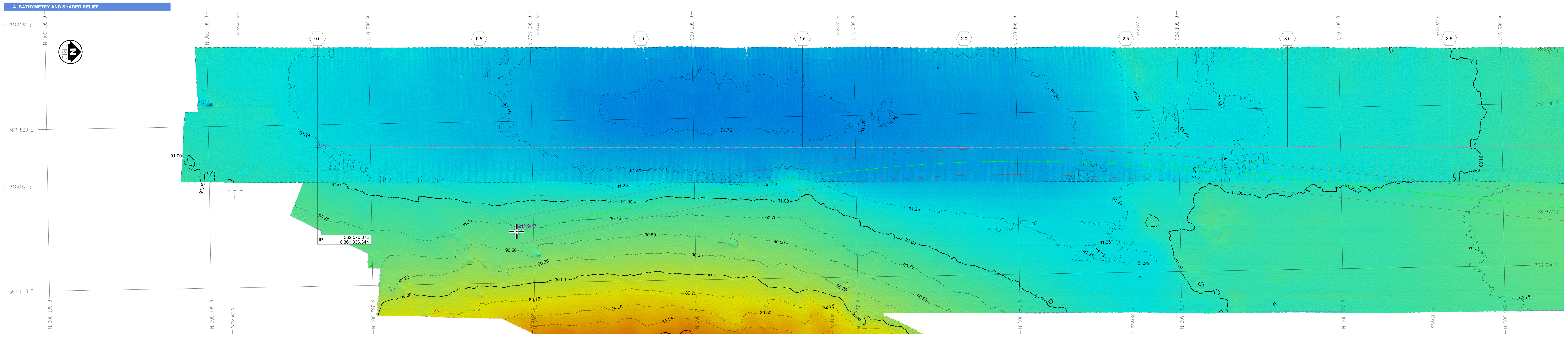
Alignment Sheet 1 of 4: KP 0.000 to KP 3.280

Alignment Sheet 2 of 4: (KP 2.953 to KP 7.628

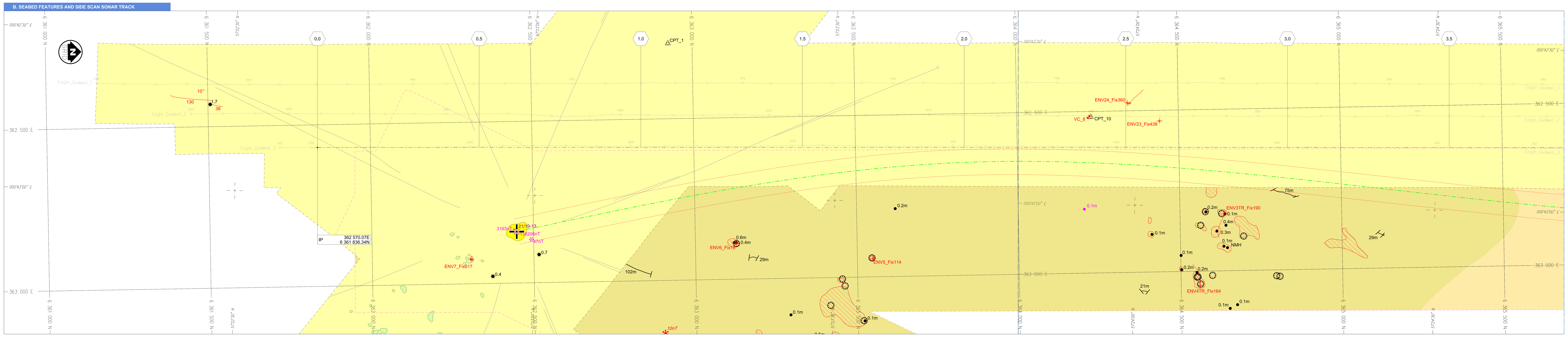
Alignment Sheet 3 of 4: KP7.253 to KP11.928

Alignment Sheet 4 of 4: KP11.561 to KP15.633

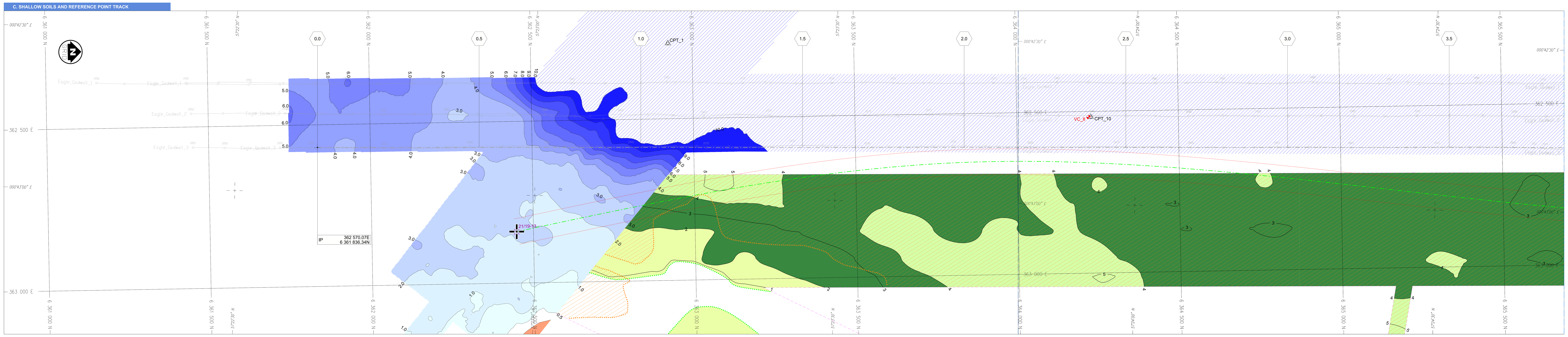
A. BATHYMETRY AND SHADED RELIEF



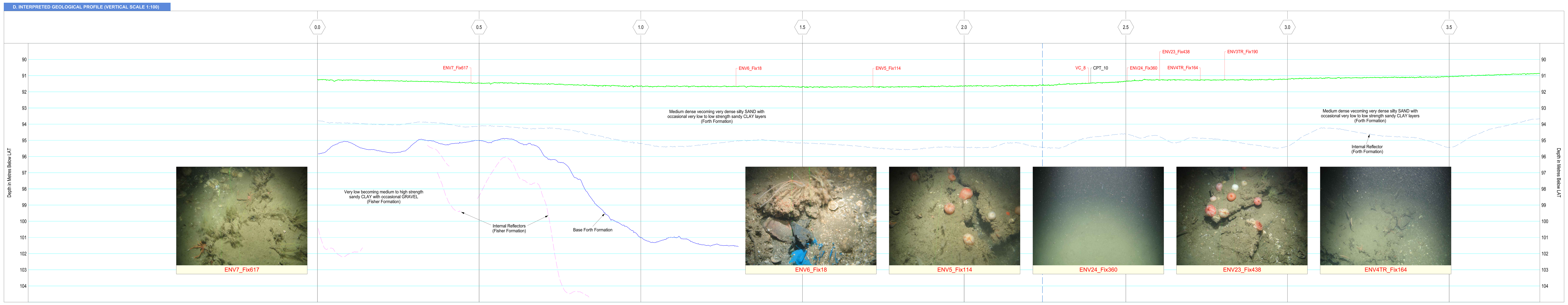
B. SEABED FEATURES AND SIDE SCAN SONAR TRACK



C. SHALLOW SOILS AND REFERENCE POINT TRACK



D. INTERPRETED GEOLOGICAL PROFILE (VERTICAL SCALE 1:100)



LEGEND

PROPOSED PIPELINE ROUTE (GREEN) WITH 80 METRE WIDE LAY CORRIDOR (RED)	
ORIGINAL PROPOSED PIPELINE ROUTE WITH KILOMETRE POSTS	
EAGLE WELL LOCATION (362 841 E, 6 362 448 N)	
GADWALL LOCATION (350 782.82 E, 6 372 396.23 N)	
INFRASTRUCTURE (POSITION FROM ENQUEST HEATHER)	
WELL (POSITION FROM UKOILANDGASDATA)	
PIPELINE (POSITION FROM UKOILANDGASDATA)	
BLOCK BOUNDARY	

FEATURE SYMBOLOGY FUGRO SURVEY LTD 2016

- OIL PIPELINE (POSITION AS SUPPLIED BY ENQUEST HEATHER LIMITED)
- UMBILICAL (POSITION AS SUPPLIED BY ENQUEST HEATHER LIMITED)

A: BATHYMETRY AND SHADED RELIEF

- 91.00 BATHYMETRIC CONTOURS (1 METRE INTERVALS LAT)
- 90.75 BATHYMETRIC CONTOURS (0.25 METRE INTERVALS LAT)
- LIMIT OF MBES COVERAGE

DEPTH IN METRES BELOW LAT: 92.5, 92.0, 91.5, 91.0, 90.5, 90.0, 89.5, 89.0, 88.5

A: BATHYMETRY (FUGRO SURVEY LTD 2016)

- LIMIT OF MBES COVERAGE

B: SEABED FEATURES AND SIDE SCAN SONAR TRACK

- SIDE SCAN SONAR TRACK
- SILTY SAND
- AREA OF POSSIBLE MDAC
- MOUND
- OBJECT WITH HEIGHT IN METRES
- LINEAR DEBRIS WITH LENGTH IN METRES
- MAGNETOMETER ANOMALY (FIELD STRENGTH IN nT)
- ANCHOR SCAR
- CPT LOCATION
- VIBROCORE LOCATION
- ENVIRONMENTAL CAMERA LOCATION
- ENVIRONMENTAL VIDEO TRANSECT
- LIMIT OF SONAR COVERAGE

B: SEABED FEATURES (FUGRO SURVEY LTD 2016)

- LOOSE TO MEDIUM DENSE SILTY FINE TO MEDIUM SAND WITH OCCASIONAL SHELLS AND SHELL FRAGMENTS
- AREA OF HIGH REFLECTIVITY (HIGH SHELL CONCENTRATIONS & PROBABLE MDAC WHERE SAMPLED)
- 0.2m OBJECT (HEIGHT IN M) NMH = NO MEASURABLE HEIGHT
- 0.1m POSSIBLE DEBRIS WITH HEIGHT IN METRES NMH = NO MEASURABLE HEIGHT
- PIPELINE/UMBILICAL (POSITION AS FOUND)
- TRAWL/ANCHOR SCAR WITH PIT
- 23m LINEAR DEBRIS WITH LENGTH IN METRES
- 10nT MAGNETIC ANOMALY (AMPLITUDE IN NANOTESLA)
- DEPRESSION
- GRAB SAMPLE LOCATION (FROM PREVIOUS SURVEYS)
- CPT LOCATION (FROM PREVIOUS SURVEYS)
- VIBROCORE LOCATION (FROM PREVIOUS SURVEYS)
- WELL LOCATION (POSITION AS SUPPLIED BY ENQUEST HEATHER LIMITED)
- 1.0m DEPTH OF PIPELINE BURIAL
- LIMIT OF SONAR COVERAGE

C: SHALLOW SOILS AND REFERENCE POINT TRACK

- REFERENCE POINT TRACK
- 2 DEPTH IN METRES BELOW SEABED TO BASE FORTH FM, CONTOURED AT 0.5 METRE & 1 METRE INTERVAL
- BASE FORTH FORMATION >10 METRES BELOW SEABED
- FORTH FORMATION ABSENT (FISHER FM. PRESENT)
- CPT LOCATION
- VIBROCORE LOCATION

DEPTH IN METRES BELOW SEABED TO BASE FORTH FORMATION: 10, 9, 8, 7, 6, 5, 4, 3, 3, 2, 1, 0.5

C: SHALLOW SOILS (FUGRO SURVEY LTD 2016)

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- LIMIT OF FORTH FORMATION, WHITETHORN MEMBER
- <2m 2-4m >4m
- APPROXIMATE LIMIT OF FORTH FM, FITZROY MEMBER
- SOFT TO FIRM SANDY CLAY WITH THIN SAND LAYERS (FORTH FORMATION, FITZROY MEMBER)
- LIMIT OF SHALLOW SOILS INTERPRETATION

D: INTERPRETED GEOLOGICAL PROFILE (VERTICAL SCALE 1:100)

- SEABED
- BASE FORTH FORMATION
- INTERNAL FORTH FORMATION REFLECTOR
- INTERNAL FISHER FORMATION REFLECTOR

NOTES

BATHYMETRY AND SHADED RELIEF

OBSERVED SOUNDINGS HAVE BEEN REDUCED TO LAT TIDAL DATUM USING GNSS HEIGHT DATA PROCESSED USING PPP (PRECISE POINT POSITIONING) TECHNIQUES AND THE UKHO VORF MODEL.

LAT TO MSL IS 1.00m

DATA GRIDDED AT 1 x 1m

SHADED RELIEF IMAGE - AZIMUTH=45°, ELEVATION=55°ASSUMED SEISMIC VELOCITY = 1600m/s.

SEABED FEATURES

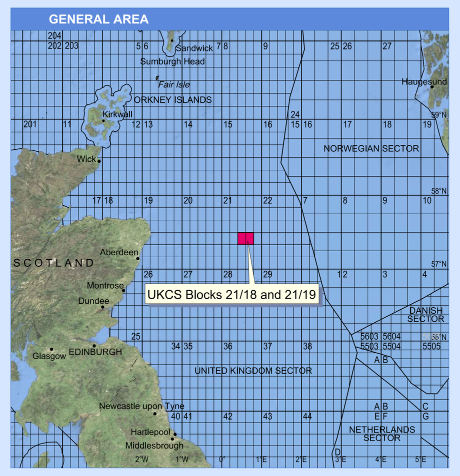
ALTHOUGH MDAC WAS OBSERVED ON CAMERA FOOTAGE AT ENV23, NO SIGNIFICANT FEATURES WERE OBSERVED ON BATHYMETRY OR SONAR DATA, ONLY A SMALL AREA OF HIGH REFLECTIVITY

SHALLOW SOILS

THE INTERNAL FORTH FORMATION HORIZON (WHITEHORN MEMBER) MAPPED BY FURGO SURVEY LIMITED (2016) HAS BEEN SHOWN BY GEOTECHNICAL SAMPLING TO NOT REPRESENT A CHANGE IN LITHOLOGY. THEREFORE, THE BASE FORTH FORMATION HAS BEEN MAPPED (TO A DEPTH OF 10 METRES BELOW SEABED) FROM THE 2019 DATASET AND PRESENTED ON PANEL C

ASSUMED SEISMIC VELOCITY = 1700m/s

GENERAL AREA



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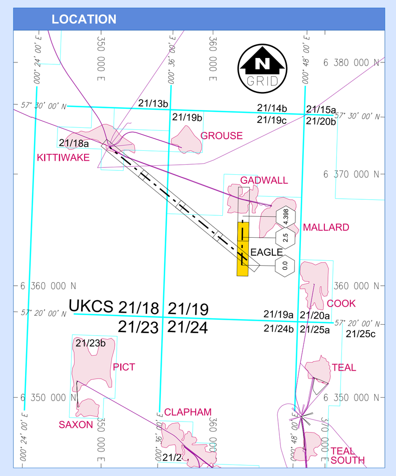


GEODETIC REFERENCE SYSTEM

GEODETIC DATUM:	EUROPEAN DATUM 1950
ELLIPSOID:	INTERNATIONAL 1924
PROJECTION:	UTM ZONE 31 N (CENTRAL MERIDIAN 3° E)
COORDINATE TRANSFORMATION:	FROM WGS84 (GPS SATELLITE DATUM) TO ED50 EPSG TRANSFORMATION CODE 1311

SURVEY INFORMATION

SURVEY VESSEL:	M.V. OCEAN ENDEAVOUR
SURVEY DATE:	24-MAY-2019 TO 03-JUN-2019
POSITIONING SYSTEM:	FUGRO STARFIX DGNSS SONARDYNE RANGER USBL
NAVIGATION SYSTEM:	VOYAGER 5
ECHO SOUNDER (MULTI-BEAM SYSTEM):	SIMRAD EM2040
ECHO SOUNDER (SINGLE-BEAM SYSTEM):	SIMRAD EA400
SIDE SCAN SONAR:	EDGETECH 4200FS
SUB-BOTTOM PROFILER:	INNOMAR
MAGNETOMETER:	GEOMETRICS G882
VIBROCORER:	AIMERS MCLEAN
CONE PENETROMETER:	GTec-1
ENVIRONMENTAL CAMERA:	KONGSBERG OE14-208
ENVIRONMENTAL GRAB:	DAY GRAB

SCALE (A0 ORIGINAL)

1 : 5 000 (Horizontal)

50 0 250 500

METRES

TITLE

SURVEY CONTRACTOR

GARDLINE LIMITED
ENDEAVOUR HOUSE, ADMIRALTY ROAD, GREAT YARMOUTH, NORFOLK NR30 3NG. ENGLAND
TELEPHONE +44 (0) 1493 845600 FAX +44 (0) 1493 852106 WEBSITE WWW.GARDLINE.COM

CLIENT

PROJECT TITLE

UKCS BLOCK 21/18 AND 21/19
EAGLE TO GADWALL PIPELINE ROUTE SURVEY

DRAWING TITLE

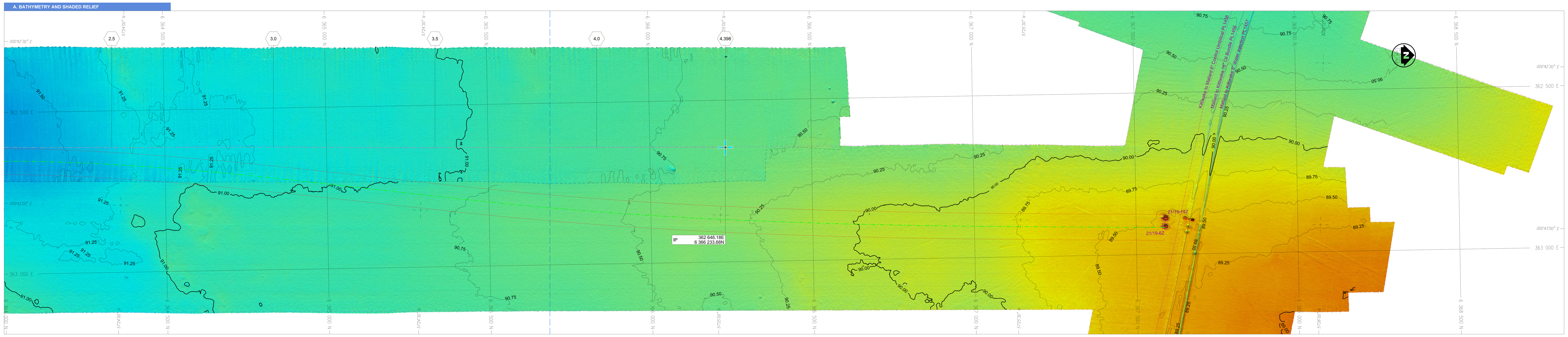
ALIGNMENT SHEET 1 OF 2
(KP 0.000 TO KP 3.780)

REVISION

NO.	DATE	DESCRIPTION	AUTHOR	DRAWN	CHECKED	APP'D
0	02-JUL-2019	DRAFT	LOB/KD	MCB	ES	DIG

REVISION REFERENCE 0/02-JUL-2019/DRAFT REPORT REFERENCE 11373.2 DRAWING NO 11373.201

A. BATHYMETRY AND SHADED RELIEF



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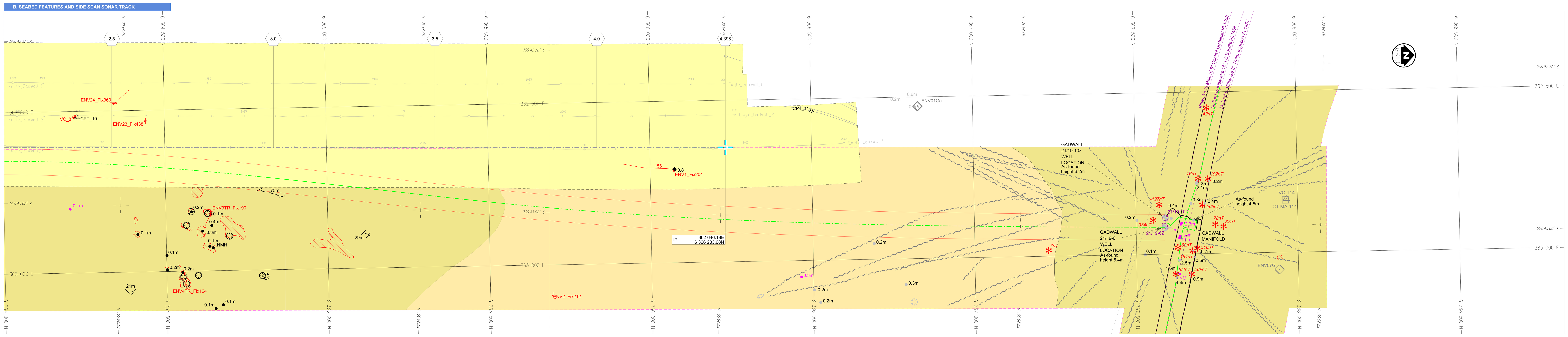

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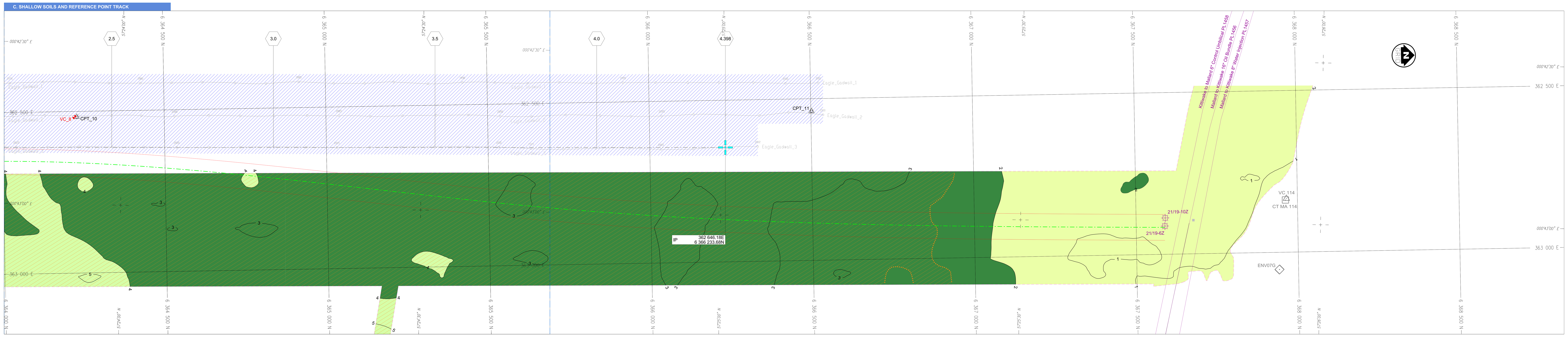
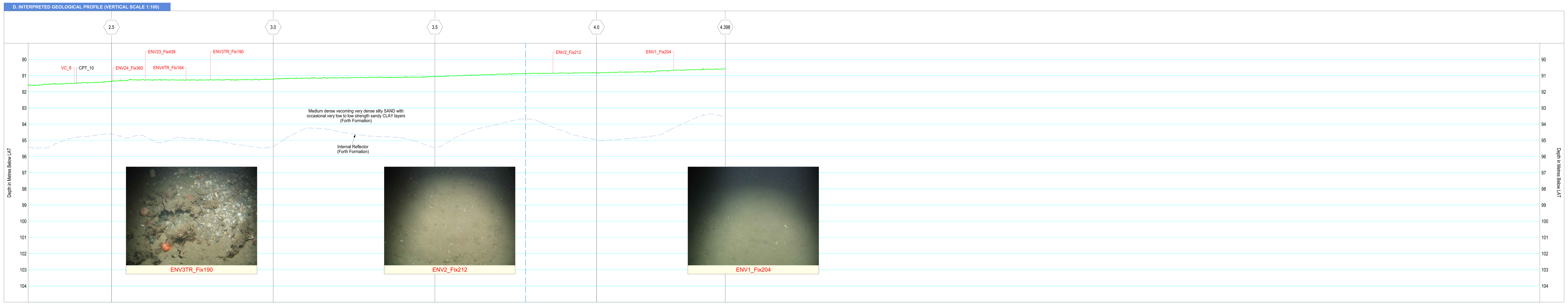


D. INTERPRETED GEOLOGICAL PROFILE (VERTICAL SCALE 1:100)



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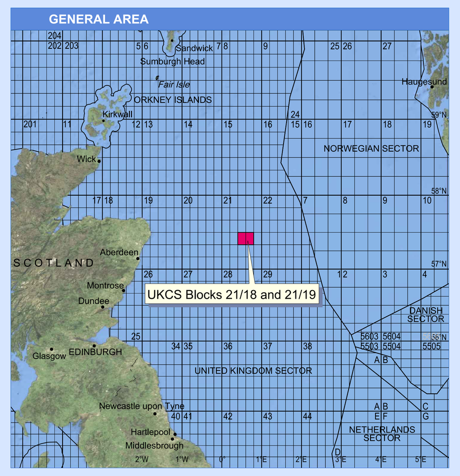
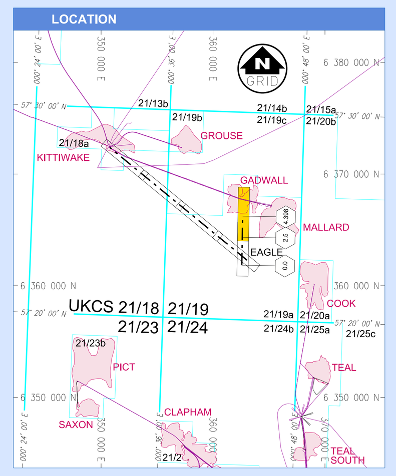
GENERAL AREA



LOCATION



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MAGNETOMETER:	GEOMETRICS G882
VIBROCORER:	AIMERS MCLEAN
CONE PENETROMETER:	GTec-1
ENVIRONMENTAL CAMERA:	KONGSBERG OE14-208
ENVIRONMENTAL GRAB:	DAY GRAB

SCALE (A0 ORIGINAL)

1 : 5 000 (Horizontal)

50 0 250 500

METRES

TITLE

SURVEY CONTRACTOR

Gardline

GARDLINE LIMITED
ENDEAVOUR HOUSE, ADMIRALTY ROAD, GREAT YARMOUTH, NORFOLK NR30 3NG. ENGLAND
TELEPHONE +44 (0) 1493 845600 FAX +44 (0) 1493 852106 WEBSITE WWW.GARDLINE.COM

CLIENT

EnQuest

PROJECT TITLE

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EAGLE TO GADWALL PIPELINE ROUTE SURVEY

DRAWING TITLE

ALIGNMENT SHEET 2 OF 2
(KP 2.242 TO KP 4.398)

REVISION

NO.	DATE	DESCRIPTION	AUTHOR	DRAWN	CHECKED	APP'D
0	02-JUL-2019	DRAFT	LOB/KD	MCB	ES	DIG

REVISION REFERENCE 0/02-JUL-2019/DRAFT | REPORT REFERENCE 11373.2 | DRAWING NO 11373.202

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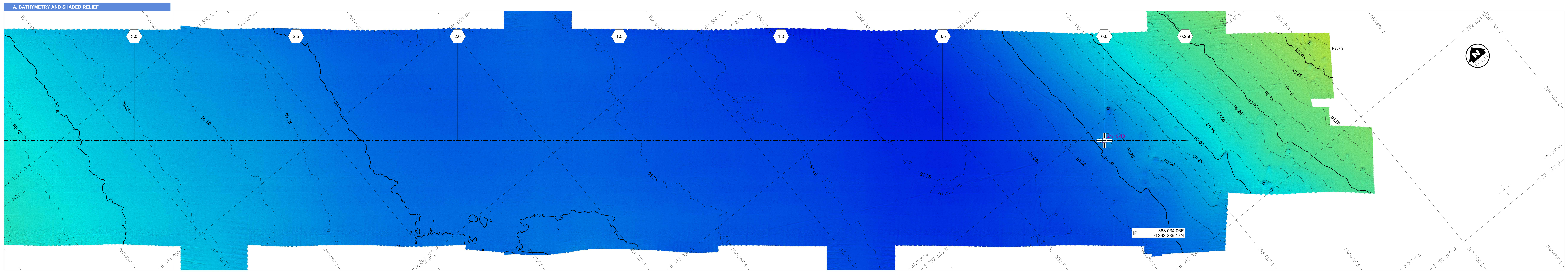

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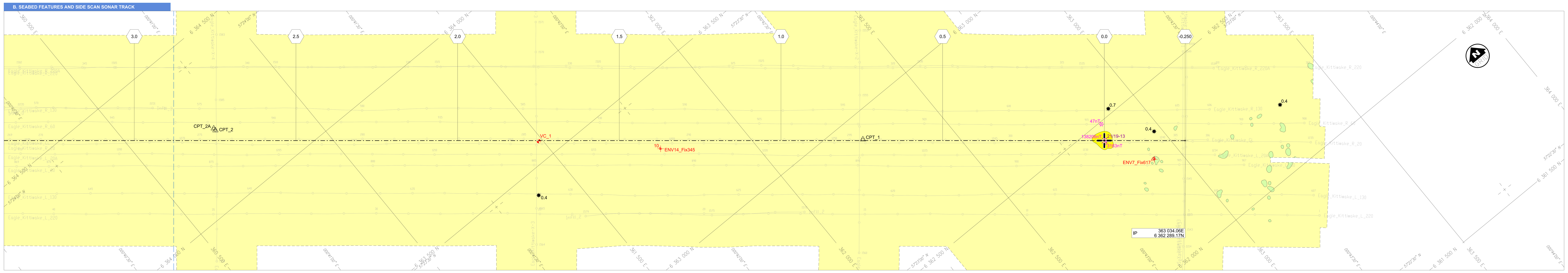

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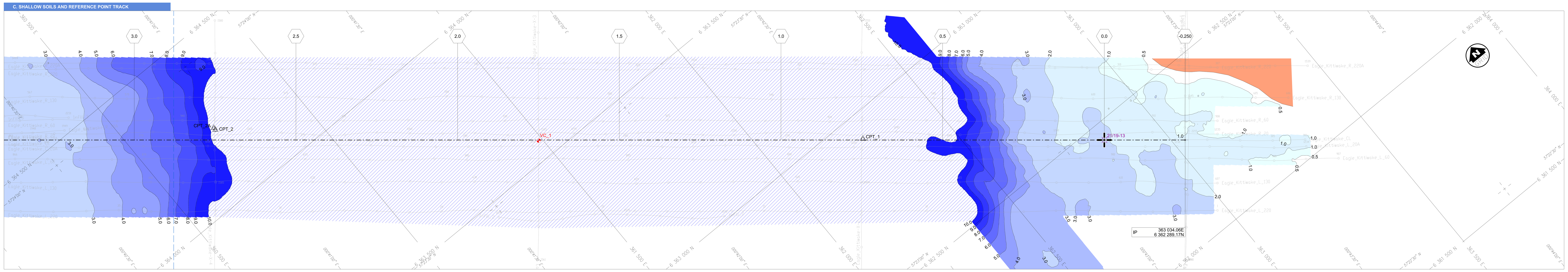

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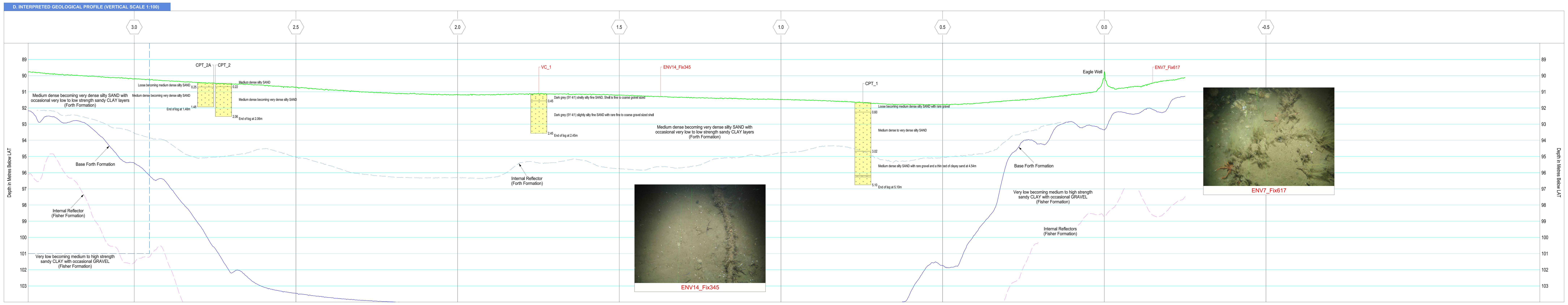

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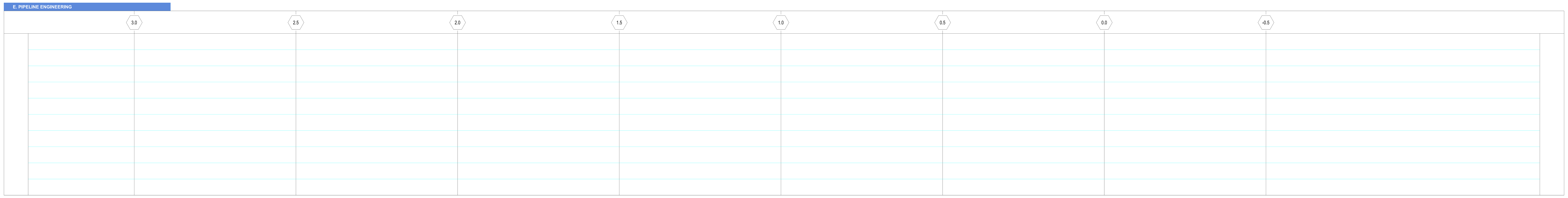


LEGEND

- PROPOSED PIPELINE ROUTE WITH KILOMETRE POSTS
- EAGLE WELL LOCATION (362 841 E, 6 362 448 N)
- KITTIWAKE PLATFORM CENTRE (350 782.82 E, 6 372 396.23 N)
- INFRASTRUCTURE (POSITION FROM ENQUEST HEATHER)
- WELL (POSITION FROM UKOILANDGASDATA)
- PIPELINE (POSITION FROM UKOILANDGASDATA)
- BLOCK BOUNDARY

A: BATHYMETRY AND SHADED RELIEF

- 90.00 — BATHYMETRIC CONTOURS SHOWN AT 1 METRE INTERVALS LAT
- 89.75 — BATHYMETRIC CONTOURS SHOWN AT 1 METRE INTERVALS LAT

DEPTH IN METRES BELOW LAT: -92.0 m, -91.0 m, -90.0 m, -89.0 m, -88.0 m, -87.0 m, -86.0 m, -85.0 m

B: SEABED FEATURES AND SIDE SCAN SONAR TRACK

- SIDE SCAN SONAR TRACK
- SILTY SAND
- AREA OF POSSIBLE MDAC
- TRENCH
- MOUND
- OBJECT WITH HEIGHT IN METRES
- LINEAR DEBRIS WITH LENGTH IN METRES
- MAGNETOMETER ANOMALY WITH FIELD STRENGTH IN nT
- ANCHOR SCAR
- CPT LOCATION
- VIBROCORE LOCATION
- ENVIRONMENTAL CAMERA LOCATION
- ENVIRONMENTAL VIDEO TRANSECT
- LIMIT OF SONAR COVERAGE

C: SHALLOW SOILS AND REFERENCE POINT TRACK

- REFERENCE POINT TRACK
- 6 — DEPTH IN METRES BELOW SEABED TO BASE FORTH FORMATION, CONTOURED AT 0.5 METRE & 1 METRE INTERVAL
- BASE FORTH FORMATION GREATER THAN 10 METRES BELOW SEABED
- FORTH FORMATION ABSENT (FISHER FORMATION PRESENT)
- CPT LOCATION
- VIBROCORE LOCATION

DEPTH IN METRES BELOW SEABED TO BASE FORTH FORMATION: 10, 9, 8, 7, 6, 5, 4, 3, 3, 2, 1, 0.5

D: INTERPRETED GEOLOGICAL PROFILE (VERTICAL SCALE 1:100)

- SEABED
- BASE FORTH FORMATION
- INTERNAL FORTH FORMATION REFLECTOR
- INTERNAL FISHER FORMATION REFLECTOR

NOTES

BATHYMETRY AND SHADED RELIEF

OBSERVED SOUNDINGS HAVE BEEN REDUCED TO LAT TIDAL DATUM USING GNSS HEIGHT DATA PROCESSED USING PPP (PRECISE POINT POSITIONING) TECHNIQUES AND THE UKHO VORF MODEL.

LAT TO MSL IS 1.00m

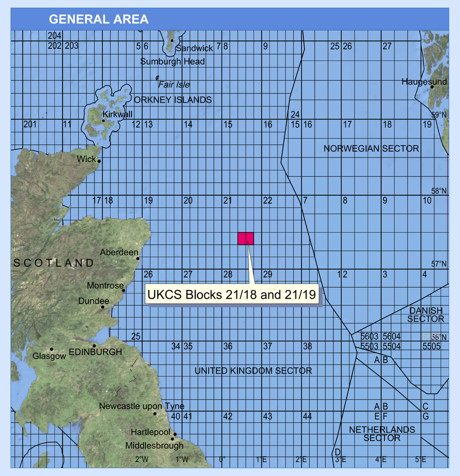
DATA GRIDDED AT 1 x 1m

SHADED RELIEF IMAGE - AZIMUTH=45°, ELEVATION=55°ASSUMED SEISMIC VELOCITY = 1600m/s.

SHALLOW SOILS

ASSUMED SEISMIC VELOCITY = 1700m/s

GENERAL AREA



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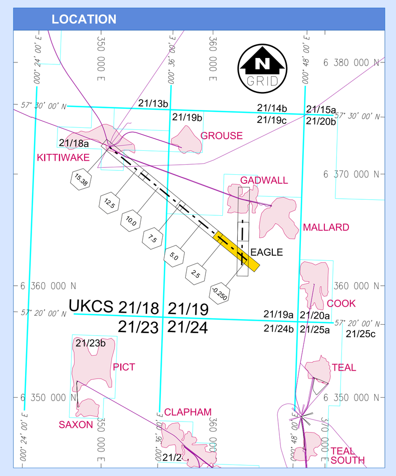


GEODETIC REFERENCE SYSTEM

GEODETIC DATUM:	EUROPEAN DATUM 1950
ELLIPSOID:	INTERNATIONAL 1924
PROJECTION:	UTM ZONE 31 N (CENTRAL MERIDIAN 3° E)
COORDINATE TRANSFORMATION:	FROM WGS84 (GPS SATELLITE DATUM) TO ED50 EPSG TRANSFORMATION CODE 1311

SURVEY INFORMATION

SURVEY VESSEL:	M.V. OCEAN ENDEAVOUR
SURVEY DATE:	24-MAY-2019 TO 03-JUN-2019
POSITIONING SYSTEM:	FUGRO STARFIX DGNSS SONARDYNE RANGER USBL
NAVIGATION SYSTEM:	VOYAGER 5
ECHO SOUNDER (MULTI-BEAM SYSTEM):	SIMRAD EM2040
ECHO SOUNDER (SINGLE-BEAM SYSTEM):	SIMRAD EA400
SIDE SCAN SONAR:	EDGETECH 4200FS
SUB-BOTTOM PROFILER:	INNOMAR
MAGNETOMETER:	GEOMETRICS G882
VIBROCORER:	AIMERS MCLEAN
CONE PENETROMETER:	GTec-1
ENVIRONMENTAL CAMERA:	KONGSBERG OE14-208
ENVIRONMENTAL GRAB:	DAY GRAB

SCALE (A0 ORIGINAL)

1 : 5 000 (Horizontal)

50 0 250 500

METRES

TITLE

SURVEY CONTRACTOR

Gardline

GARDLINE LIMITED
ENDEAVOUR HOUSE, ADMIRALTY ROAD, GREAT YARMOUTH, NORFOLK NR30 3NG. ENGLAND
TELEPHONE +44 (0) 1493 845600 FAX +44 (0) 1493 852106 WEBSITE WWW.GARDLINE.COM

CLIENT

EnQuest

PROJECT TITLE

UKCS BLOCKS 21/18 AND 21/19
EAGLE TO KITTIWAKE UMBILICAL ROUTE SURVEY

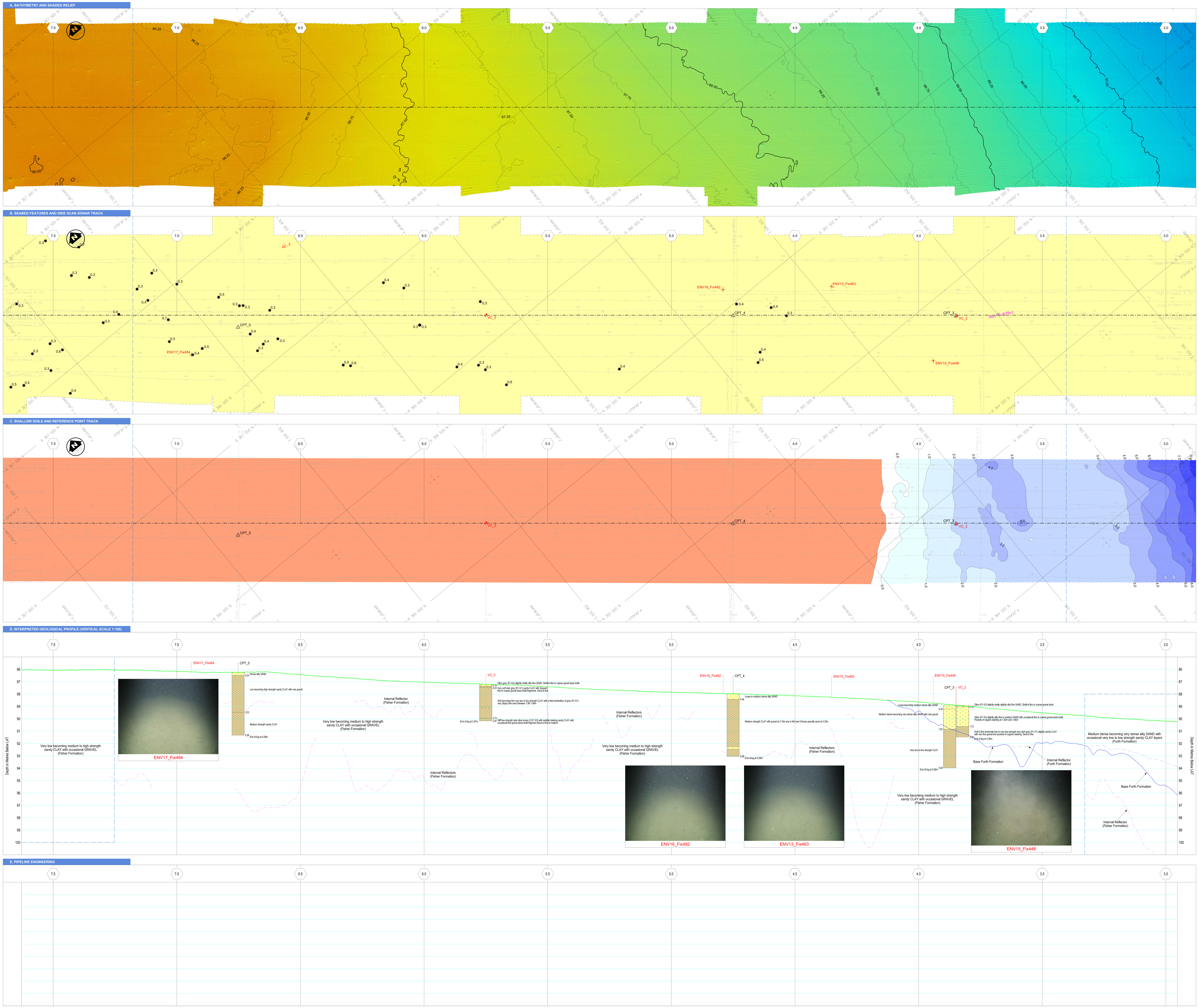
DRAWING TITLE

ALIGNMENT SHEET 1 OF 4
(KP 0.000 TO KP 3.328)

REVISION

NO.	DATE	DESCRIPTION	AUTHOR	DRAWN	CHECKED	APP'D
0	02-JUL-2019	DRAFT	LOB/KD	MCB	ES	DIG
1	16-JUL-2019	FINAL			ES	DIG

REVISION REFERENCE 1/16-JUL-2019/FINAL | REPORT REFERENCE 11373.1 | DRAWING NO 11373.101



LEGEND

PROPOSED PIPELINE ROUTE WITH KILOMETRE POSTS
EAGLE WELL LOCATION (362 841 E, 6 362 448 N)
KITTIWAKE PLATFORM CENTRE (350 782.82 E, 6 372 396.23 N)
INFRASTRUCTURE (POSITION FROM ENQUEST HEATHER)
WELL (POSITION FROM UKOILANDGASDATA)
PIPELINE (POSITION FROM UKOILANDGASDATA)
BLOCK BOUNDARY

A: BATHYMETRY AND SHADED RELIEF

90.00 BATHYMETRIC CONTOURS SHOWN AT 1 METRE INTERVALS LAT
89.75 BATHYMETRIC CONTOURS SHOWN AT 1 METRE INTERVALS LAT

DEPTH IN METRES BELOW LAT: -92.0 m, -91.0 m, -90.0 m, -89.0 m, -88.0 m, -87.0 m, -86.0 m, -85.0 m

B: SEABED FEATURES AND SIDE SCAN SONAR TRACK

SIDE SCAN SONAR TRACK
SILTY SAND
AREA OF POSSIBLE MDAC
TRENCH
MOUND
OBJECT WITH HEIGHT IN METRES
LINEAR DEBRIS WITH LENGTH IN METRES
MAGNETOMETER ANOMALY WITH FIELD STRENGTH IN nT
ANCHOR SCAR
CPT LOCATION
VIBROCORE LOCATION
ENVIRONMENTAL CAMERA LOCATION
ENVIRONMENTAL VIDEO TRANSECT
LIMIT OF SONAR COVERAGE

C: SHALLOW SOILS AND REFERENCE POINT TRACK

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BASE FORTH FORMATION GREATER THAN 10 METRES BELOW SEABED
FORTH FORMATION ABSENT (FISHER FORMATION PRESENT)
CPT LOCATION
VIBROCORE LOCATION

DEPTH IN METRES BELOW SEABED TO BASE FORTH FORMATION: 10, 9, 8, 7, 6, 5, 4, 3, 3, 2, 1, 0.5

D: INTERPRETED GEOLOGICAL PROFILE (VERTICAL SCALE 1:100)

SEABED
BASE FORTH FORMATION
INTERNAL FORTH FORMATION REFLECTOR
INTERNAL FISHER FORMATION REFLECTOR

NOTES

BATHYMETRY AND SHADED RELIEF

OBSERVED SOUNDINGS HAVE BEEN REDUCED TO LAT TIDAL DATUM USING GNSS HEIGHT DATA PROCESSED USING PPP (PRECISE POINT POSITIONING) TECHNIQUES AND THE UKHO VORF MODEL.

LAT TO MSL IS 1.00m

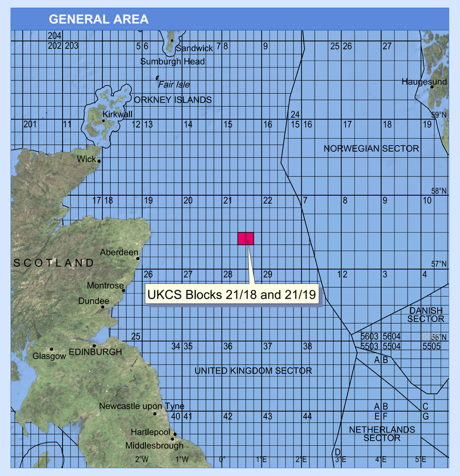
DATA GRIDDED AT 1 x 1m

SHADED RELIEF IMAGE - AZIMUTH=45°, ELEVATION=55°ASSUMED SEISMIC VELOCITY = 1600m/s.

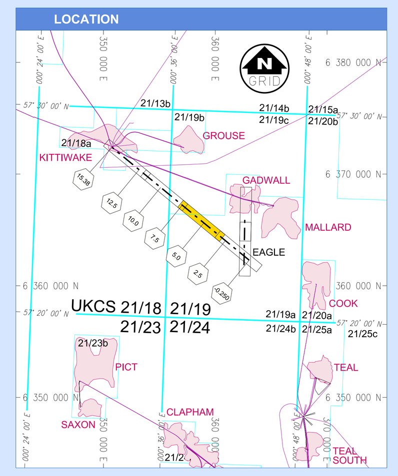
SHALLOW SOILS

ASSUMED SEISMIC VELOCITY = 1700m/s

GENERAL AREA



LOCATION



GEODETIC REFERENCE SYSTEM

GEODETIC DATUM:	EUROPEAN DATUM 1950
ELLIPSOID:	INTERNATIONAL 1924
PROJECTION:	UTM ZONE 31 N (CENTRAL MERIDIAN 3° E)
COORDINATE TRANSFORMATION:	FROM WGS84 (GPS SATELLITE DATUM) TO ED50 EPSG TRANSFORMATION CODE 1311

SURVEY INFORMATION

SURVEY VESSEL:	M.V. OCEAN ENDEAVOUR
SURVEY DATE:	24-MAY-2019 TO 03-JUN-2019
POSITIONING SYSTEM:	FUGRO STARFIX DGNSS SONARDYNE RANGER USBL
NAVIGATION SYSTEM:	VOYAGER 5
ECHO SOUNDER (MULTI-BEAM SYSTEM):	SIMRAD EM2040
ECHO SOUNDER (SINGLE-BEAM SYSTEM):	SIMRAD EA400
SIDE SCAN SONAR:	EDGETECH 4200FS
SUB-BOTTOM PROFILER:	INNOMAR
MAGNETOMETER:	GEOMETRICS G882
VIBROCORER:	AIMERS MCLEAN
CONE PENETROMETER:	GTec-1
ENVIRONMENTAL CAMERA:	KONGSBERG OE14-208
ENVIRONMENTAL GRAB:	DAY GRAB

SCALE (A0 ORIGINAL)

1 : 5 000 (Horizontal)

50 0 250 500
METRES

TITLE

SURVEY CONTRACTOR

Gardline

GARDLINE LIMITED
ENDEAVOUR HOUSE, ADMIRALTY ROAD, GREAT YARMOUTH, NORFOLK NR30 3NG. ENGLAND
TELEPHONE +44 (0) 1493 845600 FAX +44 (0) 1493 852106 WEBSITE WWW.GARDLINE.COM

CLIENT

EnQuest

PROJECT TITLE

UKCS BLOCKS 21/18 AND 21/19
EAGLE TO KITTIWAKE UMBILICAL ROUTE SURVEY

DRAWING TITLE

ALIGNMENT SHEET 2 OF 4
(KP 2.953 TO KP 7.628)

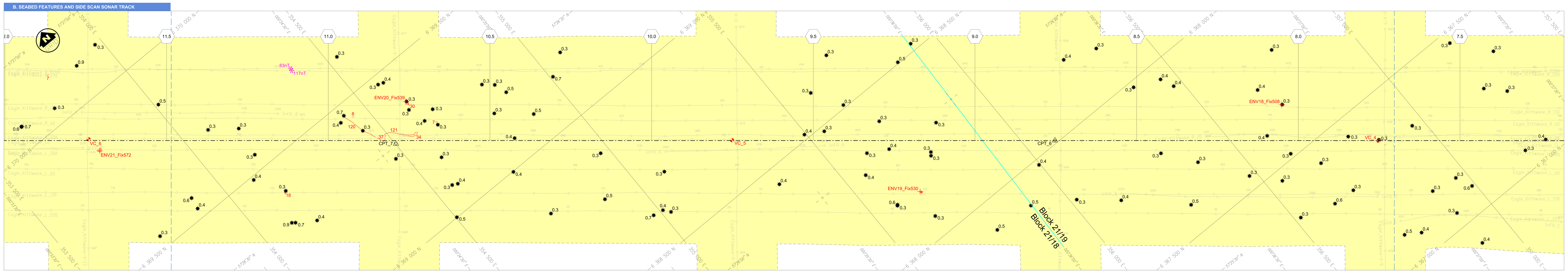
REVISION

NO.	DATE	DESCRIPTION	AUTHOR	DRAWN	CHECKED	APP'D
0	02-JUL-2019	DRAFT	LOB/KD	MCB	ES	DIG
1	16-JUL-2019	FINAL			ES	DIG

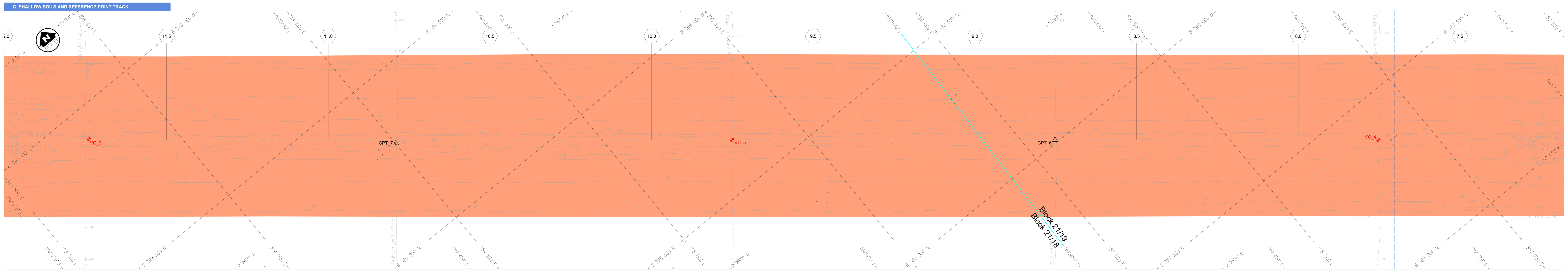
REVISION REFERENCE 1/16-JUL-2019/FINAL | REPORT REFERENCE 11373.1 | DRAWING NO 11373.102

A. BATHYMETRY AND SHADED RELIEF

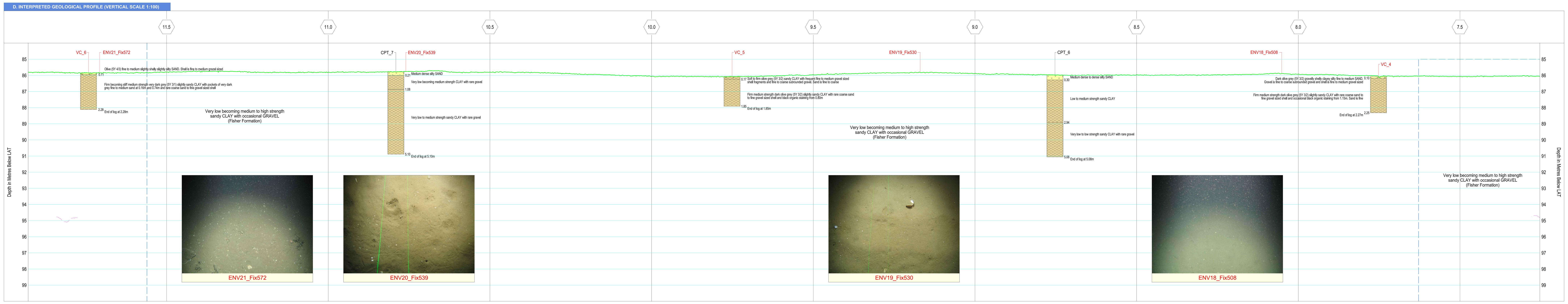
B. SEABED FEATURES AND SIDE SCAN SONAR TRACK



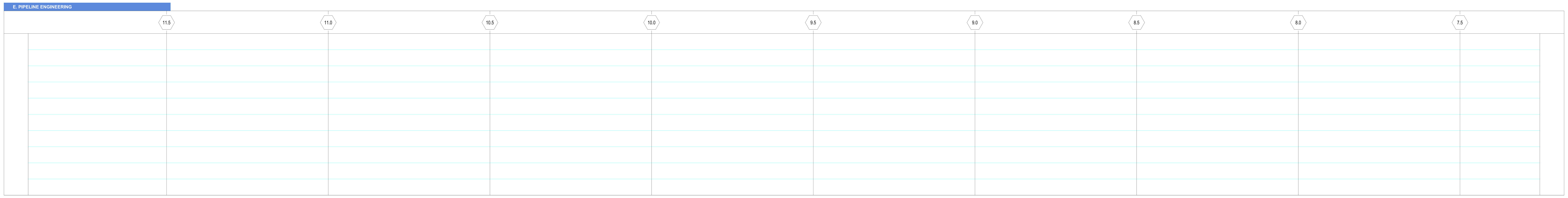
C. SHALLOW SOILS AND REFERENCE POINT TRACK



D. INTERPRETED GEOLOGICAL PROFILE (VERTICAL SCALE 1:100)



E. PIPELINE ENGINEERING



LEGEND

PROPOSED PIPELINE ROUTE WITH KILOMETRE POSTS
EAGLE WELL LOCATION (362 841 E, 6 362 448 N)
KITTIWAKE PLATFORM CENTRE (350 782.82 E, 6 372 396.23 N)
INFRASTRUCTURE (POSITION FROM ENQUEST HEATHER)
WELL (POSITION FROM UKOILANDGASDATA)
PIPELINE (POSITION FROM UKOILANDGASDATA)
BLOCK BOUNDARY

A: BATHYMETRY AND SHADED RELIEF

90.00 BATHYMETRIC CONTOURS SHOWN AT 1 METRE INTERVALS LAT
89.75 BATHYMETRIC CONTOURS SHOWN AT 1 METRE INTERVALS LAT

DEPTH IN METRES BELOW LAT
-92.0 m -91.0 m -90.0 m -89.0 m -88.0 m -87.0 m -86.0 m -85.0 m

B: SEABED FEATURES AND SIDE SCAN SONAR TRACK

SIDE SCAN SONAR TRACK
SILTY SAND
AREA OF POSSIBLE MDAC
TRENCH
MOUND
OBJECT WITH HEIGHT IN METRES
LINEAR DEBRIS WITH LENGTH IN METRES
MAGNETOMETER ANOMALY WITH FIELD STRENGTH IN nT
ANCHOR SCAR
CPT LOCATION
VIBROCORE LOCATION
ENVIRONMENTAL CAMERA LOCATION
ENVIRONMENTAL VIDEO TRANSECT
LIMIT OF SONAR COVERAGE

C: SHALLOW SOILS AND REFERENCE POINT TRACK

REFERENCE POINT TRACK
6 DEPTH IN METRES BELOW SEABED TO BASE FORTH FORMATION, CONTOURED AT 0.5 METRE & 1 METRE INTERVAL
BASE FORTH FORMATION GREATER THAN 10 METRES BELOW SEABED
FORTH FORMATION ABSENT (FISHER FORMATION PRESENT)
CPT LOCATION
VIBROCORE LOCATION

DEPTH IN METRES BELOW SEABED TO BASE FORTH FORMATION
10 9 8 7 6 5 4 3 3 2 1 0.5

D: INTERPRETED GEOLOGICAL PROFILE (VERTICAL SCALE 1:100)

SEABED
BASE FORTH FORMATION
INTERNAL FORTH FORMATION REFLECTOR
INTERNAL FISHER FORMATION REFLECTOR

NOTES

BATHYMETRY AND SHADED RELIEF

OBSERVED SOUNDINGS HAVE BEEN REDUCED TO LAT TIDAL DATUM USING GNSS HEIGHT DATA PROCESSED USING PPP (PRECISE POINT POSITIONING) TECHNIQUES AND THE UKHO VORF MODEL.

LAT TO MSL IS 1.00m

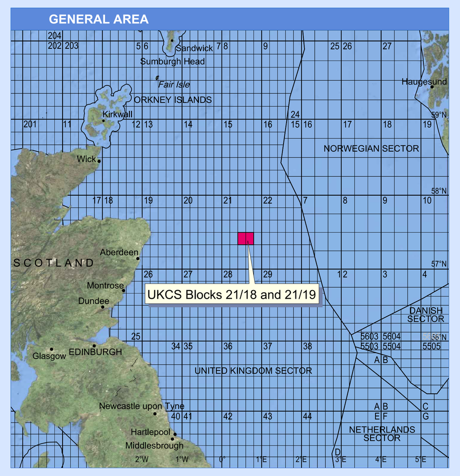
DATA GRIDDED AT 1 x 1m

SHADED RELIEF IMAGE - AZIMUTH=45°, ELEVATION=55°ASSUMED SEISMIC VELOCITY = 1600m/s.

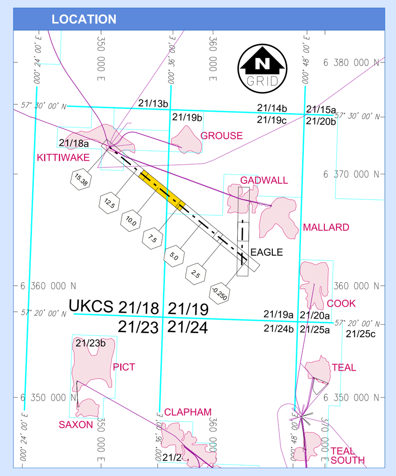
SHALLOW SOILS

ASSUMED SEISMIC VELOCITY = 1700m/s

GENERAL AREA



LOCATION



GEODETIC REFERENCE SYSTEM

GEODETIC DATUM:	EUROPEAN DATUM 1950
ELLIPSOID:	INTERNATIONAL 1924
PROJECTION:	UTM ZONE 31 N (CENTRAL MERIDIAN 3° E)
COORDINATE TRANSFORMATION:	FROM WGS84 (GPS SATELLITE DATUM) TO ED50 EPSG TRANSFORMATION CODE 1311

SURVEY INFORMATION

SURVEY VESSEL:	M.V. OCEAN ENDEAVOUR
SURVEY DATE:	24-MAY-2019 TO 03-JUN-2019
POSITIONING SYSTEM:	FUGRO STARFIX DGNSS SONARDYNE RANGER USBL
NAVIGATION SYSTEM:	VOYAGER 5
ECHO SOUNDER (MULTI-BEAM SYSTEM):	SIMRAD EM2040
ECHO SOUNDER (SINGLE-BEAM SYSTEM):	SIMRAD EA400
SIDE SCAN SONAR:	EDGETECH 4200FS
SUB-BOTTOM PROFILER:	INNOMAR
MAGNETOMETER:	GEOMETRICS G882
VIBROCORER:	AIMERS MCLEAN
CONE PENETROMETER:	GTec-1
ENVIRONMENTAL CAMERA:	KONGSBERG OE14-208
ENVIRONMENTAL GRAB:	DAY GRAB

SCALE (A0 ORIGINAL)

1 : 5 000 (Horizontal)

50 0 250 500
METRES

TITLE

SURVEY CONTRACTOR

Gardline

GARDLINE LIMITED
ENDEAVOUR HOUSE, ADMIRALTY ROAD, GREAT YARMOUTH, NORFOLK NR30 3NG. ENGLAND
TELEPHONE +44 (0) 1493 845600 FAX +44 (0) 1493 852106 WEBSITE WWW.GARDLINE.COM

CLIENT

EnQuest

PROJECT TITLE

UKCS BLOCKS 21/18 AND 21/19
EAGLE TO KITTIWAKE UMBILICAL ROUTE SURVEY

DRAWING TITLE

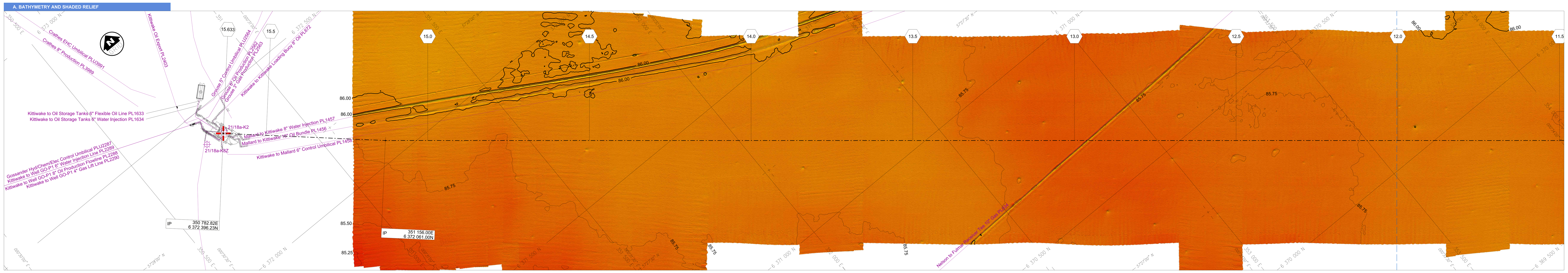
ALIGNMENT SHEET 3 OF 4
(KP 7.253 TO KP 11.928)

REVISION

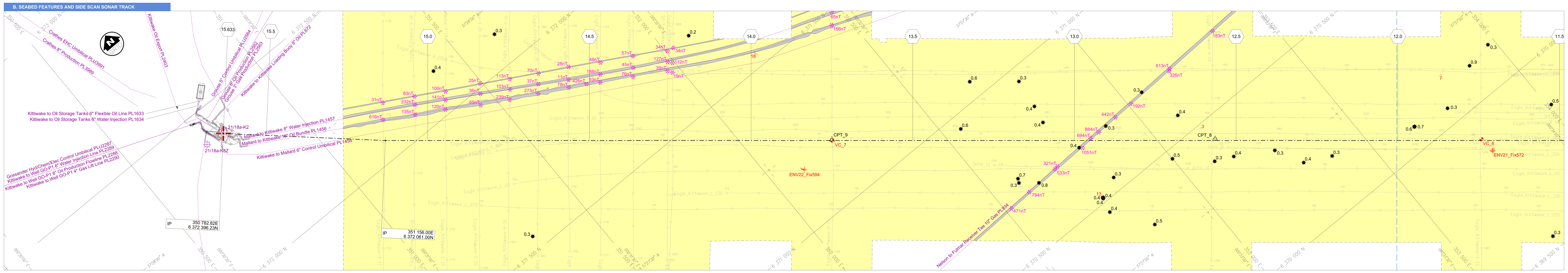
NO.	DATE	DESCRIPTION	AUTHOR	DRAWN	CHECKED	APP'D
0	02-JUL-2019	DRAFT	LOB/KD	MCB	ES	DIG
1	16-JUL-2019	FINAL			ES	DIG

REVISION REFERENCE 1/16-JUL-2019/FINAL REPORT REFERENCE 11373.1 DRAWING NO 11373.103

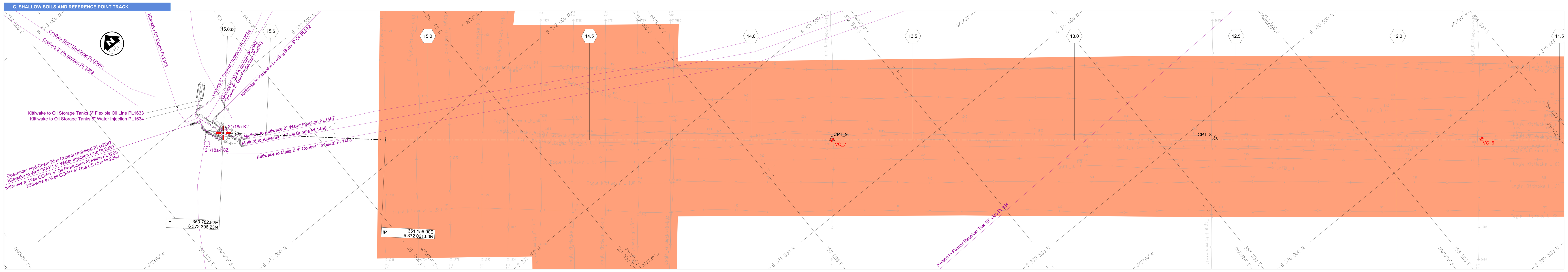
A. BATHYMETRY AND SHADED RELIEF



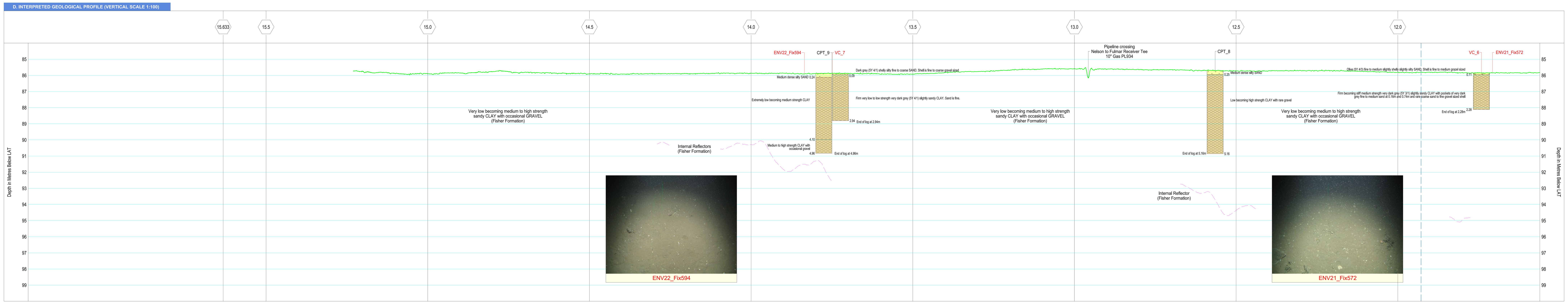
B. SEABED FEATURES AND SIDE SCAN SONAR TRACK



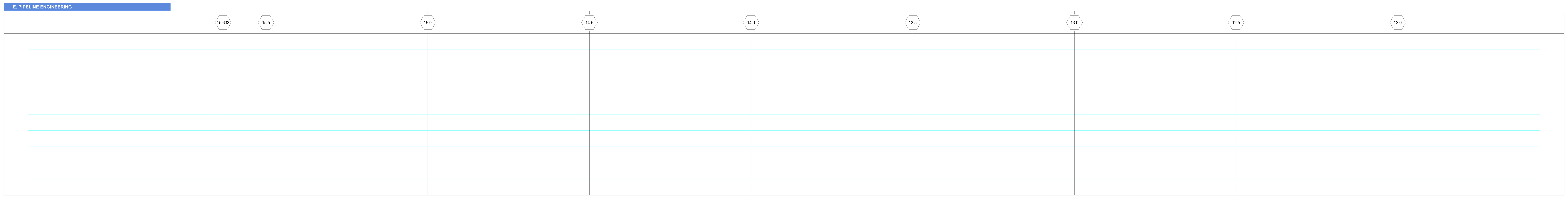
C. SHALLOW SOILS AND REFERENCE POINT TRACK



D. INTERPRETED GEOLOGICAL PROFILE (VERTICAL SCALE 1:100)



E. PIPELINE ENGINEERING



LEGEND

3.0	PROPOSED PIPELINE ROUTE WITH KILOMETRE POSTS
	EAGLE WELL LOCATION (362 841 E, 6 362 448 N)
	KITTIWAKE PLATFORM CENTRE (350 782.82 E, 6 372 396.23 N)
	INFRASTRUCTURE (POSITION FROM ENQUEST HEATHER)
	WELL (POSITION FROM UKOILANDGASDATA)
	PIPELINE (POSITION FROM UKOILANDGASDATA)
	BLOCK BOUNDARY

A: BATHYMETRY AND SHADED RELIEF

90.00	BATHYMETRIC CONTOURS SHOWN AT 1 METRE INTERVALS LAT
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DEPTH IN METRES BELOW LAT: -92.0 m, -91.0 m, -90.0 m, -89.0 m, -88.0 m, -87.0 m, -86.0 m, -85.0 m

B: SEABED FEATURES AND SIDE SCAN SONAR TRACK

- SIDE SCAN SONAR TRACK
- SILTY SAND
- AREA OF POSSIBLE MDAC
- TRENCH
- MOUND
- OBJECT WITH HEIGHT IN METRES
- LINEAR DEBRIS WITH LENGTH IN METRES
- MAGNETOMETER ANOMALY WITH FIELD STRENGTH IN nT
- ANCHOR SCAR
- CPT LOCATION
- VIBROCORE LOCATION
- ENVIRONMENTAL CAMERA LOCATION
- ENVIRONMENTAL VIDEO TRANSECT
- LIMIT OF SONAR COVERAGE

C: SHALLOW SOILS AND REFERENCE POINT TRACK

	REFERENCE POINT TRACK
6	DEPTH IN METRES BELOW SEABED TO BASE FORTH FORMATION, CONTOURED AT 0.5 METRE & 1 METRE INTERVAL
	BASE FORTH FORMATION GREATER THAN 10 METRES BELOW SEABED
	FORTH FORMATION ABSENT (FISHER FORMATION PRESENT)
	CPT LOCATION
	VIBROCORE LOCATION

DEPTH IN METRES BELOW SEABED TO BASE FORTH FORMATION: 10, 9, 8, 7, 6, 5, 4, 3, 3, 2, 1, 0.5

D: INTERPRETED GEOLOGICAL PROFILE (VERTICAL SCALE 1:100)

- SEABED
- BASE FORTH FORMATION
- INTERNAL FORTH FORMATION REFLECTOR
- INTERNAL FISHER FORMATION REFLECTOR

NOTES

BATHYMETRY AND SHADED RELIEF

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LAT TO MSL IS 1.00m

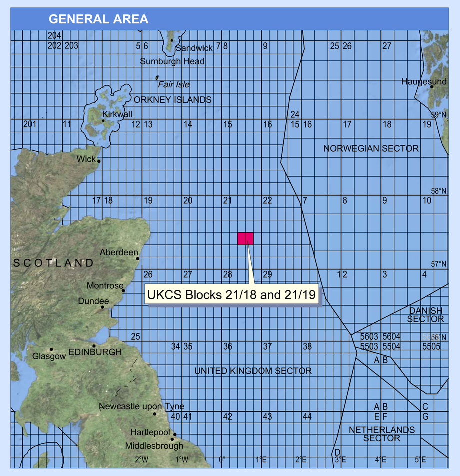
DATA GRIDDED AT 1 x 1m

SHADED RELIEF IMAGE - AZIMUTH=45°, ELEVATION=55°ASSUMED SEISMIC VELOCITY = 1600m/s.

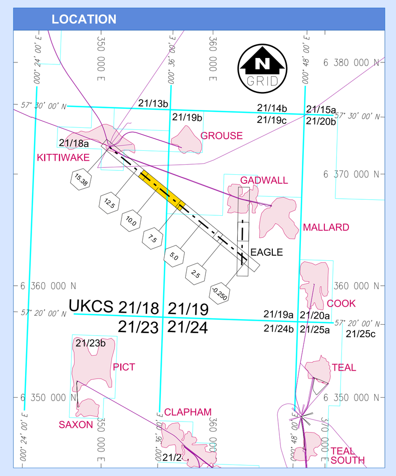
SHALLOW SOILS

ASSUMED SEISMIC VELOCITY = 1700m/s

GENERAL AREA



LOCATION



GEODETIC REFERENCE SYSTEM

GEODETIC DATUM:	EUROPEAN DATUM 1950
ELLIPSOID:	INTERNATIONAL 1924
PROJECTION:	UTM ZONE 31 N (CENTRAL MERIDIAN 3° E)
COORDINATE TRANSFORMATION:	FROM WGS84 (GPS SATELLITE DATUM) TO ED50 EPSG TRANSFORMATION CODE 1311

SURVEY INFORMATION

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ECHO SOUNDER (SINGLE-BEAM SYSTEM):	SIMRAD EA400
SIDE SCAN SONAR:	EDGETECH 4200FS
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MAGNETOMETER:	GEOMETRICS G882
VIBROCORER:	AIMERS MCLEAN
CONE PENETROMETER:	GTec-1
ENVIRONMENTAL CAMERA:	KONGSBERG OE14-208
ENVIRONMENTAL GRAB:	DAY GRAB

SCALE (A0 ORIGINAL)

1 : 5 000 (Horizontal)

50 0 250 500

METRES

TITLE

SURVEY CONTRACTOR

Gardline

GARDLINE LIMITED
ENDEAVOUR HOUSE, ADMIRALTY ROAD, GREAT YARMOUTH, NORFOLK NR30 3NG. ENGLAND
TELEPHONE +44 (0) 1493 845600 FAX +44 (0) 1493 852106 WEBSITE WWW.GARDLINE.COM

CLIENT

EnQuest

PROJECT TITLE

UKCS BLOCKS 21/18 AND 21/19
EAGLE TO KITTIWAKE UMBILICAL ROUTE SURVEY

DRAWING TITLE

ALIGNMENT SHEET 4 OF 4
(KP 11.561 TO KP 15.633)

REVISION

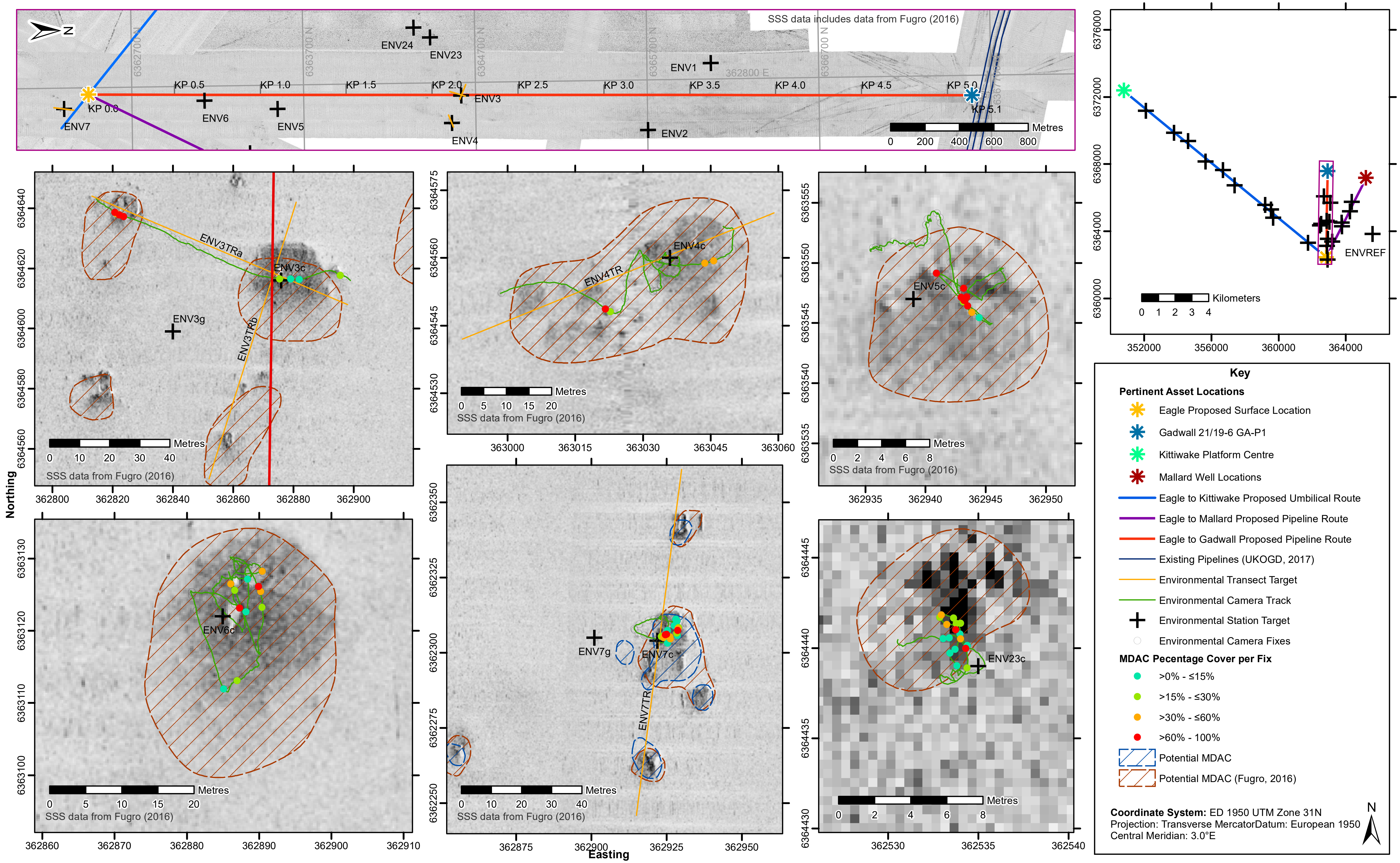
NO.	DATE	DESCRIPTION	AUTHOR	DRAWN	CHECKED	APP'D
0	02-JUL-2019	DRAFT	LOB/KD	MCB	ES	DIG
1	16-JUL-2019	FINAL			ES	DIG

REVISION REFERENCE 1/16-JUL-2019/FINAL | REPORT REFERENCE 11373.1 | DRAWING NO 11373.104

Appendix B – 2019 Pipeline Route Site Survey: MDAC Distribution – Eagle to Gadwall

Figure 3.10 - MDAC Distribution - Eagle to Gadwall proposed pipeline route (*Gardline, 2019d*).

Figure 3.10 MDAC Distribution - Eagle to Gadwall Proposed Pipeline Route



Appendix C – 2019 Pipeline Route Site Survey: Seapen and Burrows Habitat Distribution

Figure 3.7 - Sea Pen and Burrows Habitat Distribution - Eagle to Gadwall Proposed Pipeline Route (*Gardline, 2019d*).

Figure 3.9 - Sea Pen and Burrows Habitat Distribution - Eagle to Kittiwake Proposed Umbilical Route (*Gardline, 2019d*).

Figure 3.7 Sea Pen and Burrows Habitat Distribution - Eagle to Gadwall Proposed Pipeline Route

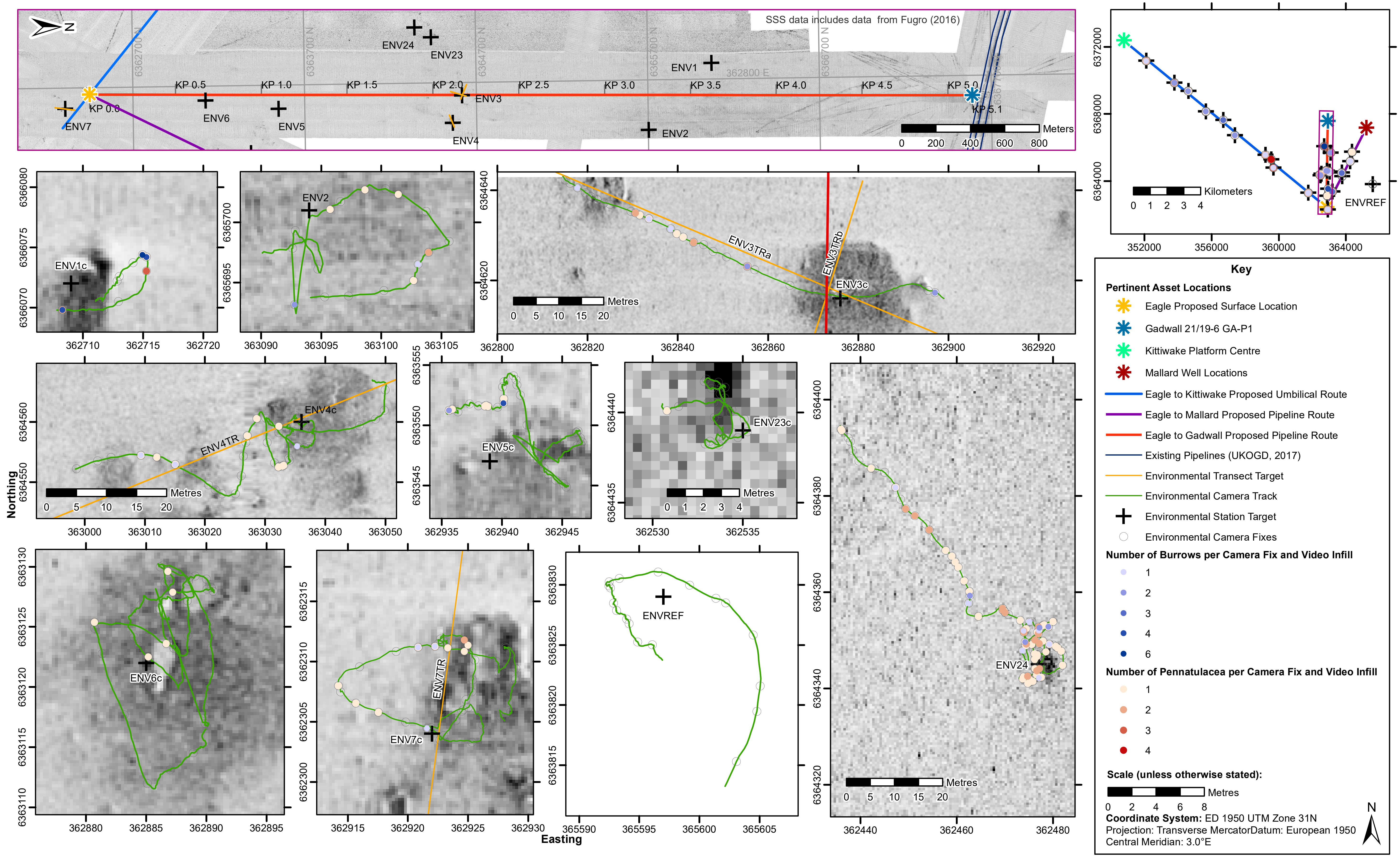
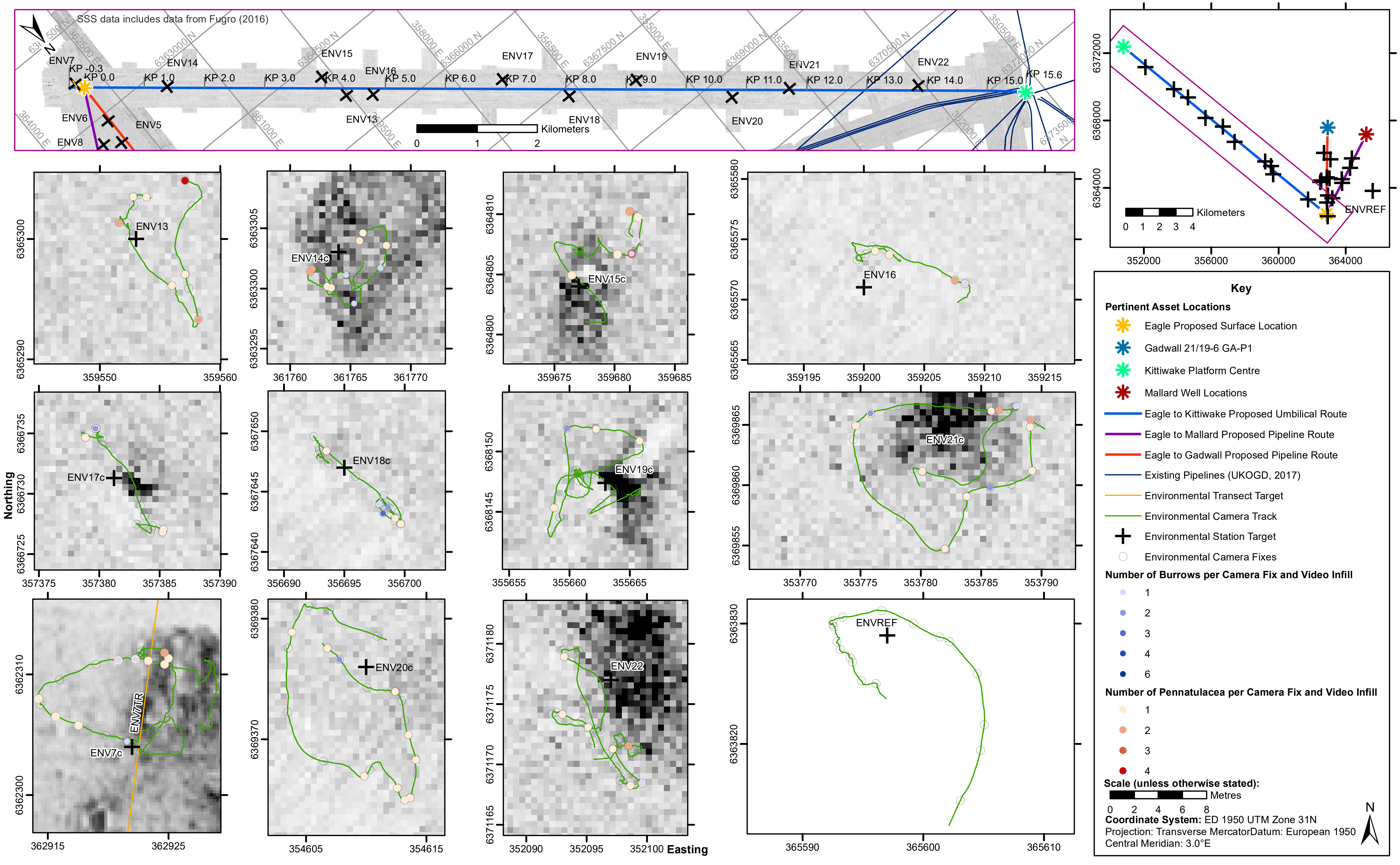


Figure 3.9 Sea Pen and Burrows Habitat Distribution - Eagle to Kittiwake Proposed Umbilical Route



Appendix D – Environmental Management Commitments

No.	Section number	Issue	Mitigation or management action
1	5.1	Physical presence	In the event a semi-submersible drilling unit is used, EnQuest will undertake a rig mooring study, which will examine the MDAC features identified and provide an anchor plan to avoid these features. Where possible, the previous anchor plan (as used for the Eagle discovery well) will be used, which will occupy the same anchor bedding locations and chain marks to limit any new disturbance to the seabed.
2	5.1	Physical presence	In the event a jack-up drilling unit is used, EnQuest will undertake a rig positioning study, which will examine the MDAC features identified and provide a jack-up placement plan to avoid these features. The study will also take into account any potential spud-can rock dump requirements to ensure that if rock dump is required for spud-can placement, this contingency will also not affect the MDAC features.
3	5.1	Physical presence	Should the drilling unit need to leave the site during the operations, for unexpected weather for example, on its return the same anchor pattern/ placement will be used.
4	5.1	Physical presence	EnQuest will ensure that the subsea XT, double-isolation valve, SDU and tie-in manifold incorporate fishing-friendly protection structures and will limit the use of protection structures placed on the seabed (concrete mattresses, grout bags and potential rock dump) to restrict the seabed impact and to keep the risk of fishing gear snagging to a minimum.
5	5.1	Physical presence	SFF will be notified, in writing, a minimum of 30 calendar days before the start of any operations, so that fishing vessels can plot the drilling location and/or the location of installation vessels on marine charts and plan their sea passage to/from favoured fishing grounds and their fishing activities accordingly. EnQuest will also forward as-built survey data on the pipeline and umbilical to SFF.
6	5.1	Physical presence	EnQuest will route the export pipeline around the MDAC features identified during the 2016 and 2019 site survey operations using an 80-metre-wide installation corridor (further details on how this will be achieved are provided below).
7	5.1	Physical presence	EnQuest will ensure that no sandbags for use as turning bollards will be deployed in the vicinity of MDAC features
8	5.1	Physical presence	EnQuest will re-visit the MDAC features during the post-installation as-built surveys, to investigate the condition of the MDAC features following the installation works.
9	5.2	Atmospheric Emissions	Activities associated with the Eagle development will be carefully planned to reduce the duration of operations.
10	5.2	Atmospheric Emissions	The duration of any clean-up and well testing, if applicable, will be limited as far as is practicable to reduce the requirement to flare. The well-test package used on board the drilling unit will incorporate the latest 'green burner' technology.
11	5.2	Atmospheric Emissions	EnQuest will ensure that all combustion equipment will be subject to regular monitoring and inspections to ensure an effective maintenance regime is in place, ensuring all combustion equipment runs as efficiently as possible.
12	5.3	Underwater Noise	During the piling activities (if conducted), EnQuest will adhere to JNCC guidelines for reducing the potential for injury and disturbance to marine mammals (*JNCC, 2017*), which include:

No.	Section number	Issue	Mitigation or management action
			• A suitably trained marine mammal observer (MMO) will conduct a pre-shooting search over a 30-minute period prior to the commencement of piling. This will involve a visual assessment to determine if any marine mammals are within a 500 m monitoring zone (measured from the location of the pile). Should operations cease for ten minutes or more, a search will be undertaken before the re-commencement of activities. • Should any marine mammals be detected within 500 m of the piling operations, these operations will be delayed until marine mammals have moved outside the mitigation zone. In this case, there will be a 20-minute delay from the time of the last marine mammal sighting to the commencement of activities. • The piling hammer power will be ramped up slowly over 20 minutes in order to give marine mammals time to leave the area. Build-up of power will occur in uniform stages to provide a constant 'ramp-up' in amplitude. These soft start procedures will also be undertaken if the operations are stopped for at least 10 minutes, to allow for checking of the visual observation zone to determine if any marine mammals have entered the area whilst the piling activities were suspended. If marine mammals have re-entered the observation zone, restart of the operations will be delayed until 20 minutes after the last sighting of the marine mammal. • If piling is required to commence in sub-optimal conditions for visual monitoring, consideration will be given to using passive acoustic monitoring (PAM) in addition to MMOs. Use of PAM in conditions that are sub-optimal for visual monitoring enhances the probability of detecting marine mammals (when vocalising), reducing the likelihood of potential negative impacts.
13	5.4	Accidental Events	EnQuest will implement a well examination scheme, operated by independent well examiners, to ensure there is an independent check on well design, construction, maintenance and operations.
14	5.4	Accidental Events	The development well and associated subsea infrastructure will be designed as per Oil and Gas UK best practice.
15	5.4	Accidental Events	The drilling rig will have a minimum 10,000 pound per square inch BOP stack (standard for drilling rigs).
16	5.4	Accidental Events	EnQuest has a verification scheme for Safety and Environmentally Critical Elements (SECEs) and will identify SECEs in future design stages.
17	5.4	Accidental Events	A simultaneous operations (SIMOPs) report will detail the precautions and controls to be implemented during the installation of the pipeline, umbilical and subsea infrastructure.
18	5.4	Accidental Events	EnQuest will ensure the development of, and conformance to, appropriate equipment containment maintenance procedures.
19	5.4	Accidental Events	All relevant installation and vessel personnel will be given full training in chemical release prevention and actions to be taken in the event of an accidental hydrocarbon/ chemical release.