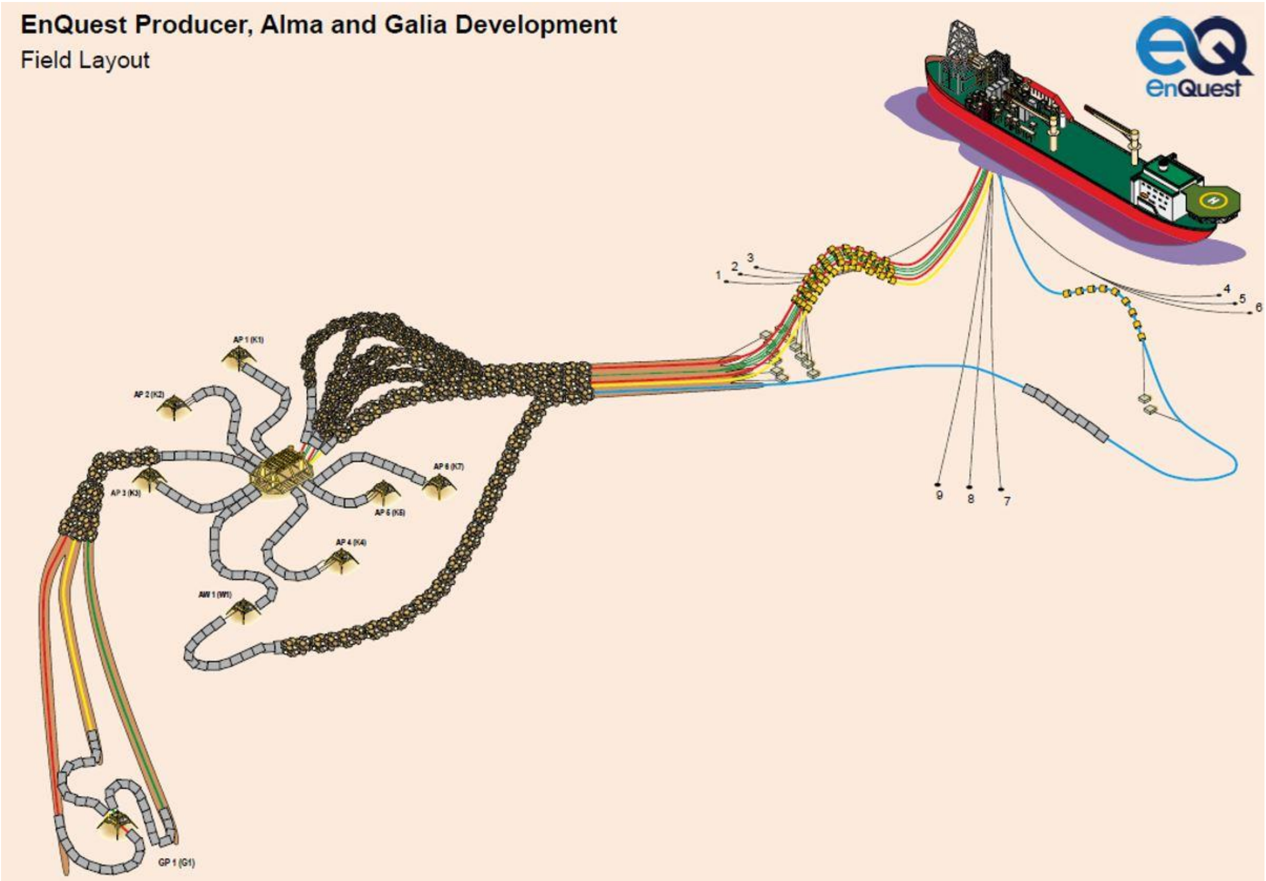
Alma & Galia Decommissioning Environmental Appraisal



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Acronym	Definition
AHV	Anchor Handling Vessel
ALARP	As Low As Reasonably Practicable
API	American Petroleum Institute
ARPA	Automatic Radar Plotting Aid
Ba	Barium
BEIS	Department of Business, Energy & Industrial Strategy
ca.	circa
CA	Comparative Assessment
CGNS MU	Celtic & Greater North Sea Management Unit
CI	Confidence Interval
CNS	Central North Sea
CO_2e	Carbon Dioxide Equivalent
CoP	Cessation of Production
Cr	Chromium
CSV	Construction Support Vessel
DP	Dip-down Point
DSV	Diving Support Vessel
EA	Environmental Appraisal
ERRV	Emergency Response & Rescue Vessel
EIA	Environmental Impact Assessment
EMS	Environmental Management System
ENVID	Environmental Impact Identification
ESP	Electrical Submersible Pump
EUNIS	European Nature Information System
FPSO	Floating Production Storage Offloading
gabion	1x1x1m bag filled with 40x25kg grout bags = 1Te gabion
GHG	Greenhouse Gas
GMG	Global Marine Group
GWP	Global Warming Potential
IBA	Important Bird Area
ICES	International Council for the Exploration of the Seas
IoP	Institute of Petroleum
LTOBM	Low Toxicity Oil Based Mud
MARPOL	International Convention for the Prevention of Pollution from Ships
MAT	Master Application Template
MCZ	Marine Conservation Zone
MFE	Mass Flow Excavator
µ	micro
MODU	Mobile Drilling Unit or Semi-Submersible Drilling Rig
MPA	Marine Protected Area
MU	Management Unit
NGO	Non-Governmental Organisation
NFFO	National Federation of Fishermen's Organisation
NIFPO	Northern Ireland Fish Producers Organisation Ltd
NORM	Naturally Occurring Radioactive Material
NS MU	North Sea Management Unit
OBM	Oil Based Mud
OGA	Oil and Gas Authority
OIW	Oil in Water
OPPC	Oil Pollution Prevention and Control
OPRED	Offshore Petroleum Regulator for Environment & Decommissioning, a department of BEIS
OSPAR	Oslo and Paris Convention
PAH	Polycyclic Aromatic Hydrocarbon
Pb	Lead

Acronym	Definition
PL	Pipeline Identification numbers (UK). Used to identify pipelines, flowlines, umbilical pipelines and power cables
Pipelines	Generic term to include flexible flowline, umbilical pipeline and power cable as defined by OPRED
Pipespools	Short sections of pipe that may be flanged and bolted or welded together
SAC	Special Area of Conservation
SAST	Seabirds At Sea Team
SAT	Subsidiary Application Template
SCI	Site of Community Interest
SFF	Scottish Fishermen's Federation
SEPA	Scottish Environment Protection Agency
SIMOPS	Simultaneous Operations
SNCB	Statutory Nature Conservation Body
SSSi	Site of Special Scientific Interest
Te	Metric tonnes (1000kg)
THC	Total Hydrocarbon Concentration
UCM	Unresolved Complex Mixture
UKCS	United Kingdom Continental Shelf
WHPS	Wellhead Protection Structure
WMS	Waste Management Strategy
Zn	Zinc

EXECUTIVE SUMMARY

Introduction and Project Overview

EnQuest Heather Ltd (hereafter referred to as EnQuest) is planning for the decommissioning of the Alma and Galia fields in Block 30/24 and 30/25, in the Central North Sea. The single Galia well and the six Alma production wells are all tied back to the Alma manifold, with produced fluids exported from the manifold to the EnQuest Producer Floating, Production, Storage, and Offloading vessel (FPSO). Cessation of production (CoP) for the Alma and Galia fields is planned within a window from Q2 2020 to Q1 2021, with decommissioning operations for both fields being undertaken in tandem between 2020 and 2027, in two separate phases of activity. Well decommissioning activities will take place separately, likely in 2025 or 2026.

Under Part IV of the Petroleum Act 1998 (as amended) and amendments to the Act through the Energy Act 2008 (as amended), operators proposing to decommission an offshore installation or submarine pipeline must submit a Decommissioning Programme. The Alma and Galia Decommissioning Programmes will be submitted covering the Alma and Galia Fields, associated pipeline infrastructure and the EnQuest Producer FPSO.

This Environmental Appraisal has been produced to support the Decommissioning Programme. It documents the Environmental Impact Assessment (EIA) process that has been undertaken to evaluate the potential environmental impact of the proposed decommissioning project on the marine environment and identify any remedial works or mitigation that may be required to reduce the level of any potential impacts and risks to 'As Low As Reasonably Practicable' (ALARP).

The Alma development is located approximately 284 km east of the nearest landfall at Seahouses on the Northumberland coast and 17.6 km west of the UK/Norway median line and is a redevelopment of the previously decommissioned Argyll (1993) and Ardmore (2006) fields. The Galia development is located 5km to the west of Alma, (279km east of the nearest landfall and 22km west of the UK/Norway median line) and is a redevelopment of the previously decommissioned Duncan (1993) field.

The mooring system from the dip-down point to the piles, and the trenched and buried pipelines, umbilicals and cables were the subject of a Comparative Assessment to determine the preferred decommissioning solution. The preferred decommissioning solution for those elements and other elements to be decommissioned in line with BEIS Guidance notes (OPRED, 2018) includes:

- The complete removal of the FPSO and mooring system down to the dip-down point;
- *In situ* burial of mooring chain ends at dip-down point to a depth of at least -1m below seabed;
- *In situ* decommissioning of 9 mooring piles;
- Complete removal of 14 riser bases;
- Complete removal of the Alma subsea manifold;
- Removal of four Alma subsea manifold piles down to a depth of at least -1m below seabed;
- Complete removal of the trenched and buried Alma pipelines and associated concrete mattresses and grout bags;
- Complete removal of the trenched and buried Galia pipelines and associated concrete mattresses and grout bags;
- Deposited rock remaining *in situ*.

Baseline Environment

Summary of environmental characteristics and sensitivities
Physical Environment Water depths are between 73 and 80 metres, with shallower depths towards the SE of the area. Tidal currents have maximum rates of 0.5 knots for spring tides, with residual currents flowing towards the south. South westerly winds predominate, and mean sea surface temperatures range from 5.7°C in March to 15.5°C in August.
Seabed Sediments and Contamination Predominantly silty slightly shelly sands of between <1m and 4m thickness, underlain by firm to very still sandy gravelly clay. The east of the area is characterised by sand ripples whilst the west of the area is more homogenous, with a higher fines content. Seabed and linear depressions from historical oil and gas developments with legacy sediment contamination from historic oil-based mud discharges. Total hydrocarbon concentrations at Alma showed slightly elevated levels above background with no evidence of contamination at Galia. No discrete cuttings pile mounds present.
Fish Alma and Galia is in spawning grounds for mackerel (May to Aug), cod and Norway pout (Jan to Apr), whiting (Feb to Jun), sprat (May to Aug), sandeel (Nov to Feb) and plaice (Dec to Mar); and in nursery grounds for mackerel, cod, whiting, Norway pout, sandeel, plaice, haddock, spurdog, herring, blue whiting, ling, hake and anglerfish (throughout the year)
Benthic Communities A generally rich, evenly distributed faunal community dominated by polychaetes typical of North Sea sandy sediments. Some species considered tolerant to hydrocarbon contamination identified but abundance considered natural and representative of the wider area. 17 juvenile Arctica Islandica identified, primarily across the Alma site.
Plankton Plankton species found in the project area are typically temperate shelf sea species.
Seabirds The wider area is important for Auks, Kittiwake, Gannet, Fulmar, Herring Gull and Great Black-Backed Gull. However, the site is >279km offshore and has a low seabird vulnerability to surface pollution throughout the year except for the months of May and June where it increases to moderate in Block 30/25 and some adjacent Blocks.
Marine Mammals Atlantic white-sided dolphin, common dolphin, harbour porpoise, white-beaked dolphin and minke whale sited within the area. They are however likely to be present in very low numbers, as are grey and harbour seals which are usually restricted to 40-50km from their haul out site.
Conservation Designations The closest designated conservation sites to Alma and Galia are Fulmar MCZ (10.3km west of Galia), Dogger Bank SAC/SCI/MAP (77.9km to the south), Swallow Sands MCZ (86.1km west of Galia), and the East of Gannet and Montrose Fields MPA (104.4km to the north west).
Commercial Fisheries Commercial fishing activity within the vicinity of the project area is very low with no data for most of the year and undisclosed data in June. The project area lies with ICES rectangle 41F2. Landings are predominantly demersal species although live weight and value of fish and shellfish landings for recent years (2015-2018) were undisclosed.
Shipping Shipping density within the area is very low, with any traffic associated with oil and gas developments or cargo vessels.
Other Offshore Industries Alma and Galia is at the southern end of the Central North Sea oil and gas development area. There are no other oil and gas developments in the Block.
Other Users of the Sea There are no dredging or dumping sites or military training areas in the area. A lightly used recreational sailing route passes through the centre of Blocks 30/24 and 30/25, approximately five kilometres and six kilometres north-west of the Galia and Alma drill centres, respectively. Two degraded wrecks were identified 2.5km north east of Galia.

Table 1.1.1: Summary of environmental characteristics and sensitivities

Environmental Impact Assessment

An Environmental Impact Identification (ENVID) workshop was undertaken to identify significant environmental impacts and risks (potential impacts) associated with each element of the project activities. Each potential Environmental impact was categorised using the EnQuest 5x5 Risk Assessment Matrix (RAM) to establish the environmental significance of any potential impact. Significance was established by combining the likelihood and consequence scores.

Most of the potential activities identified were ranked as low (green) environmental risk following standard mitigation and there were no potential activities ranked as high (orange) or very high (red) environmental risk. The impacts rated as low environmental risk were not assessed further; however, effects, controls and mitigation measures associated with these impacts are outlined in the sections below and Table 1.1.2.

The activities evaluated in the ENVID as having a potential for medium environmental risk (yellow) that required further assessment were:

- Dredging and cutting of the mooring lines at the dip-down point;
- Potential exposure of pile tops and / or mooring chains beyond the dip-down point;
- Removal of pipelines, umbilicals and power cables;
- Potential use of a seabed excavator for removing sections of deposited rock;
- Excavation, disconnection and removal of seabed structures including dredging and cutting of manifold piles to 1m below seabed level.

The potential impacts associated with these planned or contingent activities that were identified as medium environmental risk requiring further assessment were related to disturbance of seabed sediments and benthic communities, outlined in section 4.

Seabed Disturbance

Alongside the activities evaluated as posing a medium environmental risk, listed above, there were several other activities evaluated as low environmental risk to seabed sediments and benthic communities. When all the sources were added together it is estimated that up to 3.40km^2 of seabed will be temporarily disturbed by the planned Alma and Galia decommissioning activities and 0.02km^2 of seabed will be permanently disturbed.

The impact on seabed sediments from the temporary disturbance relates to resuspension and deposition of sediments and historical hydrocarbon sediment contamination from previous developments. The seabed is predominantly sandy and shelly sediments, which will settle within the local area and will not affect far field areas including any conservation designations. Similarly, as sediment contamination is at low levels and the area of resuspension is small no significant increase in sediment contamination over the wider area is expected.

The benthic species and habitats of the area are widespread over the central North Sea and therefore any localised impacts from disturbance or smothering are expected to be short lived, with re-colonisation of the dominant taxa estimated at between 100 days and four years. Fifteen juvenile and one adult of the marine bivalve, *Arctica Islandica*, were identified in benthic surveys in the Alma Gala area. Activities have the potential to impact a small number of individuals of this long lived and slow recovery species, but there are no identified aggregations in the area and any impact will not affect population levels in the wider area. Impacts from re-suspension and deposition of contaminated sediments are likely to have a limited ecological impact on the benthic species of the area. Similarly, fish are unlikely to be affected by sediment disturbance due to the small area of impact, low area of interest for demersal spawning fish such as sandeel and widespread nature of the spawning and nursery areas for known species.

Permanent disturbance to the seabed related to the decommissioning of deposited rock and mooring chains from the dip-down point to the padeye and piles *in situ*. The area of impact is very small, deposited rock is stable, with minimal scour expected and area made from small grade rock particles which are not that conducive for marine growth and associated change in structure of local benthic communities over time. Any structural degradation of the steel left buried in the seabed will occur gradually over time and given the amount left in the seabed is unlikely to cause a significant impact on local benthos.

No transboundary impacts are expected from the decommissioning work at Alma and Galia; however, there is the potential for minor cumulative impacts due to the pre-existing seabed disturbance in the area from historical decommissioning activities. As this is a small percentage of the overall Block area it will add minimal impact to an already disturbed area. The nearest oil and gas development with an approved decommissioning programme is over 27km away and so cumulative impacts are not expected.

Mitigation and control measures to limit the seabed footprint of the decommissioning activities are outlined in Table 2.

Underwater Noise

Underwater noise generated by the project activities primarily relate to vessels within the field, dredging and underwater cutting, all of which emit a low frequency continuous noise into the water column. The peak sound levels and frequency spectra from vessels and dredging activities are not likely to be capable of causing any physical injury to acoustically sensitive species. General vessel traffic is very low within the area and therefore cumulative noise impacts are not expected. Subsea cutting of the mooring chains and manifold piles will be by mechanical cutting tool, which is shown to produce noise that is not discernible above background noise during operations. In addition to the relative short durations of operations, it has been determined that the environmental risk of these aspects is considered low and the potential impacts are not significant.

Discharges to Sea

Planned discharges to sea will occur from the use of vessels and small releases of the pipeline and structure contents to sea during disconnection of the subsea infrastructure and the removal of the pipelines. The pipelines and structures will have been cleaned, flushed and filled with inhibited seawater prior to any disconnection or removal activities and therefore any discharges will be small and permitted under the relevant offshore regulations. Vessel activities such as the release of drainage water and grey water will be relatively short in duration and will be subject to separate regulatory requirements. There may be some removal of marine growth from the manifold and other structures at sea to allow access for removal equipment. Surveys have shown the marine growth to be a thin layer composed of species widely found in North Sea waters, with no species of conservation interest identified. As a result, there is not expected to be any impact on species populations by their removal.

Accidental Events

The ENVID process identified that the risks posed by the above accidental events are considered low given the mitigation measures in place. The wells will be decommissioned as part of a separate scope to this EA and therefore the worst-case source of hydrocarbon loss to sea would be from loss of the total diesel inventory of one of the DSV or CSV vessels (typically around 1,500m^3 to 2,200m^3).

Diesel modelling of a release of 3,550m^3 of diesel from the FPSO for the EnQuest Producer OPEP showed that the diesel persisted for 10 hours before dispersing naturally with no beaching occurring and a slick length of around 3.7 – 3.9km. The relatively small area of release, along with the rapid evaporation and dispersion into the water column and lack of beaching results in limited onshore impacts or impacts on marine receptors.

The offshore wind showed an incursion of the diesel over the transboundary line with Norway after 6.2 hours. However, the volumes involved were small and persisted for a short period of time, therefore no significant transboundary impacts were identified. As this assessment was undertaken on a release almost double the size of the likely inventory of a vessel involved in the Alma and Galia decommissioning activities, impacts can be expected to be further reduced and therefore have been determined as not significant in the context of these operations.

As the wells will remain suspended for up to 5 years prior to being plugged and abandoned, there is the potential for an accidental event leading to a well blowout or hydrocarbon release from the wells in the intervening time period. Barriers including depressurised annuli, blind flanges on the manifold, subsea safety zones, overtrawlable tree structures and regular monitoring will be in place for that time period. In addition, the wells currently use downhole ESPs to maintain production and are therefore unlikely to flow of their own accord.

Oil spill modelling of a blowout situation (a 3,434m^3 release volume over a 45 days release duration) shows that the majority of oil would be confined to offshore waters with only a <30% probability and a total of 4.84m^3 of oil reaching a shoreline after 55 days. The closest conservation designations are all designated for seabed features, unlikely to be affected by surface oiling. The sensitivity of seabirds to oil pollution in the wider Alma and Galia area is low for the majority of the year and fishing activity and vessel traffic is also low in the area.

Due to the location of Alma and Galia (17km from the UK/Norway median line) there is a >90% probability of released oil crossing into Norwegian waters, with the shortest arrival time being 9 hours. There is also the possibility of oil crossing into Danish, German and Dutch waters, although on timescales >21 hours.

Given the barriers in place and marginal flow rates there is a very low likelihood of an incident of this magnitude occurring in the 5 years to well P&A. The likely extent of any incident, the time taken and volume of oil likely to reach a coastline and the sensitivity of receptors within the wider area also suggests that significant impacts would not be expected.

Physical Presence of Infrastructure and Vessels

The scope of the decommissioning plan is to remove all the existing surface and subsurface infrastructure, except for the mooring piles and chain from the DP to padeye, existing deposited rock and manifold piles. The piles and chains will be buried below the seabed with no surface exposures.

The existing deposited rock will remain on the seabed. This has the potential to become a snagging hazard to fishing activity, however as it is stable and has been present in the field since 2015, it pose no additional risk. The rate of recovery of the pipelines through the rock berms will be optimised so as to minimise the displacement of rock, with post decommissioning verification of the stability of the berm to be undertaken likely by overtrawl. Sand and possibly clay based spoil heaps will form during excavation activities, however seabed remediation will take place post cutting and removal activities, as will a post decommissioning overtrawl survey.

There will be two separate phases of decommissioning activities, approximately five years apart. It is the intention that all infrastructure remaining in field between the phases will be fully protected on the seabed, either by the existing trench and burial, deposited rock, concrete mattresses and grout bags or 500m exclusion zones around the Alma manifold and Galia well. If a full clearance of the FPSO 500m zone is not completed in Phase 1, then a guard vessel will remain on site for the intervening period to ensure no interaction between fishing vessels and the remaining infrastructure.

Vessels on transit to Alma and Galia and on location present a physical obstruction in the sea and an associated navigational hazard and increased risk of collision with third-party vessels. However, the total number of vessel days for the project are low, with a proportion of activity taking place within existing 500m zones. Shipping densities and fishing vessel activity in the area are low to very low and several mitigation measures will be in place to minimise the risk of collision (refer Table 1.1.2), therefore environmental risk from these aspects are considered low and potential impacts are considered not significant.

Atmospheric Emissions and Energy Use

A total of 11,608 tonnes of CO_2 has been estimated to be generated from vessel activity associated with the Alma and Galia decommissioning project. This corresponds to 0.08% of the total annual CO_2 emissions from offshore oil and gas operations on the UKCS in 2018. The associated CO_2 equivalent from the activities also equates to 0.23% of all UKCS emissions from shipping in 2017. The predicted CO_2 emissions are low and mitigation measures detailed in Table 1.1.2 will be in place to reduce this further. Any measurable impact from the emissions will be localised, and short-lived due to the dispersive nature of the offshore environment. No transboundary or cumulative impacts are predicted.

Waste

Whilst it is the intention to use UK recycling and disposal sites for the processing of Alma and Galia waste materials brought onshore, there is the possibility that some of the waste could be shipped outside of the UK. If waste is shipped internationally, the EnQuest Waste Management Strategy details the requirements for identifying appropriately licensed international onshore facilities where waste can be treated.

Key Control and Mitigation Measures

Control and mitigation measures
Underwater Noise
• A SIMOPS plan for vessel activity in the field will be put in place • Vessel, cutting and trenching operations will use standard methods and equipment. No explosives used.
Discharges to Sea
• All contracted vessels will operate in line with IMO and MARPOL regulations • Pipelines and spool are to be flushed, filled with inhibited seawater and isolated prior to disconnection • All discharges will be permitted under applicable UK legislation
Accidental Events
• All contracted vessels will have a ship-board oil pollution emergency plan (SOPEP) in place • A Collision Risk Management Plan will be developed and implemented • Agreed arrangements in place with oil spill response organisation for mobilising resources in event of a spill • Existing field OPEP in place to reduce the likelihood of hydrocarbon release and define spill response in place • Lifting operations will be planned to manage the risk • Recovery of any dropped objects will take place • Vessel contactors will have procedures for fuel bunkering that meet EnQuest's standard • Where practicable, re-fuelling will take place during daylight hours only • A number of control measures will be in place for the wells between CoP and well P&A activities
Physical Presence of Infrastructure & Vessels
• All vessels will comply with standard marking conditions and consent to locate conditions • A SIMOPS plan for vessel activity in the field will be put in place • All seabed infrastructure will be fully protected on the seabed in the interim period between Phase 1 & 2 • If full seabed clearance of the FPSO 500m zone is not completed in Phase 1 a guard vessel will remain on site • A survey will be undertaken over the mooring chain and pile areas to confirm full burial • Remedial levelling of the seabed planned post excavation of mooring piles cutting pits and mooring chain cutting points • No additional rock or protection material is planned to be added to the area • Seabed clearance certificate issued post completion of activities, seabed debris and overtrawl surveys
Atmospheric Emissions & Energy Use
• Time vessels spend in the field will be optimised, with a SIMOPS plan in place • Reuse or recycling of materials will be the preferential option
Waste
• Onshore treatment will take place at waste management site with appropriate permits and licenses • UK waste disposal sites will be used where practicable
Seabed Disturbance
• Activities which may lead to seabed disturbance planned, managed and implemented in such a way that disturbance is minimised • Internal cutting of mooring piles will be used in preference where possible • Natural backfill of the trenched areas, no planned mechanical backfill, or remedial seabed levelling of pipeline corridors • Debris survey undertaken on completion of the activities and where possible resultant debris will be recovered • Minimising disturbance to seabed from over-trawl through liaison with fishing organisations and regulator

Table 1.1.2: Control and mitigation measures

Conclusions

Following the assessment undertaken during the EA process and implementation of additional control and mitigation measures where necessary, the level of environmental risk from the planned and unplanned decommissioning operations, is **low**. In addition, any cumulative impacts limited to seabed disturbance have been assessed and considered to be **low**. Therefore, the recommended options to decommission the Alma and Galia fields can be completed without causing significant impact to the environment.

1. INTRODUCTION

1.1 Background

EnQuest Heather Ltd (hereafter referred to as EnQuest) is planning for the decommissioning of the Alma and Galia fields in Block 30/24 and 30/25, in the Central North Sea (Figure 1.2.1). The single Galia well and the six Alma production wells are all tied back to the Alma manifold, with produced fluids exported from the manifold to the EnQuest Producer FPSO (hereafter referred to as the FPSO) (Table 1.2.1). First oil production was achieved at Alma and Galia in 2015. Cessation of production (CoP) for the Alma and Galia fields is planned to take place during a window from Q2 2020 to Q1 2021.

The purpose of this EA is to document the Environmental Impact Assessment (EIA) process that has been undertaken to evaluate the potential environmental impact of the proposed decommissioning project on the marine environment. In addition, the EIA identifies any remedial works or mitigation that may be required to reduce the level of any potential impacts and risks to 'As Low As Reasonably Practicable' (ALARP).

1.2 Overview of the Alma and Galia Fields

The Alma development is located approximately 284 km east of the nearest landfall at Seahouses on the Northumberland coast and 17.6km west of the UK/Norway median line (Figure 1.2.1). This development consists of six production wells and one water injection well tied back to the Alma subsea manifold (Figure 1.2.2). The water depth at this location is approximately 80m.

The Galia development is located approximately 279 km east of the nearest landfall at Seahouses on the Northumberland coast and 22km west of the UK/Norway median line. Produced oil form the single Galia well is exported 5km to the Alma manifold via an 8" flowline (Figure 1.2.1 & Figure 1.2.2). The water depth at this location is approximately 80m.

Location of the main elements of the Alma and Galia development		
Item	**Location**	**Comments**
FPSO	56° 11' 09.12" N, 02° 47' 03.18" E	Secured to the seabed by 9 mooring chains connected to 9 x 32-40m long piles
Alma Manifold	56° 11' 54.99" N, 02° 45' 47.38" E	Secured to the seabed by 4 piles
Galia Drill Centre	56° 11' 18.85" N, 02° 41' 19.53" E	Single well protected by wellhead protection structure, which is not piled to the seabed.

Table 1.2.1: Location of the main elements of the Alma and Galia development

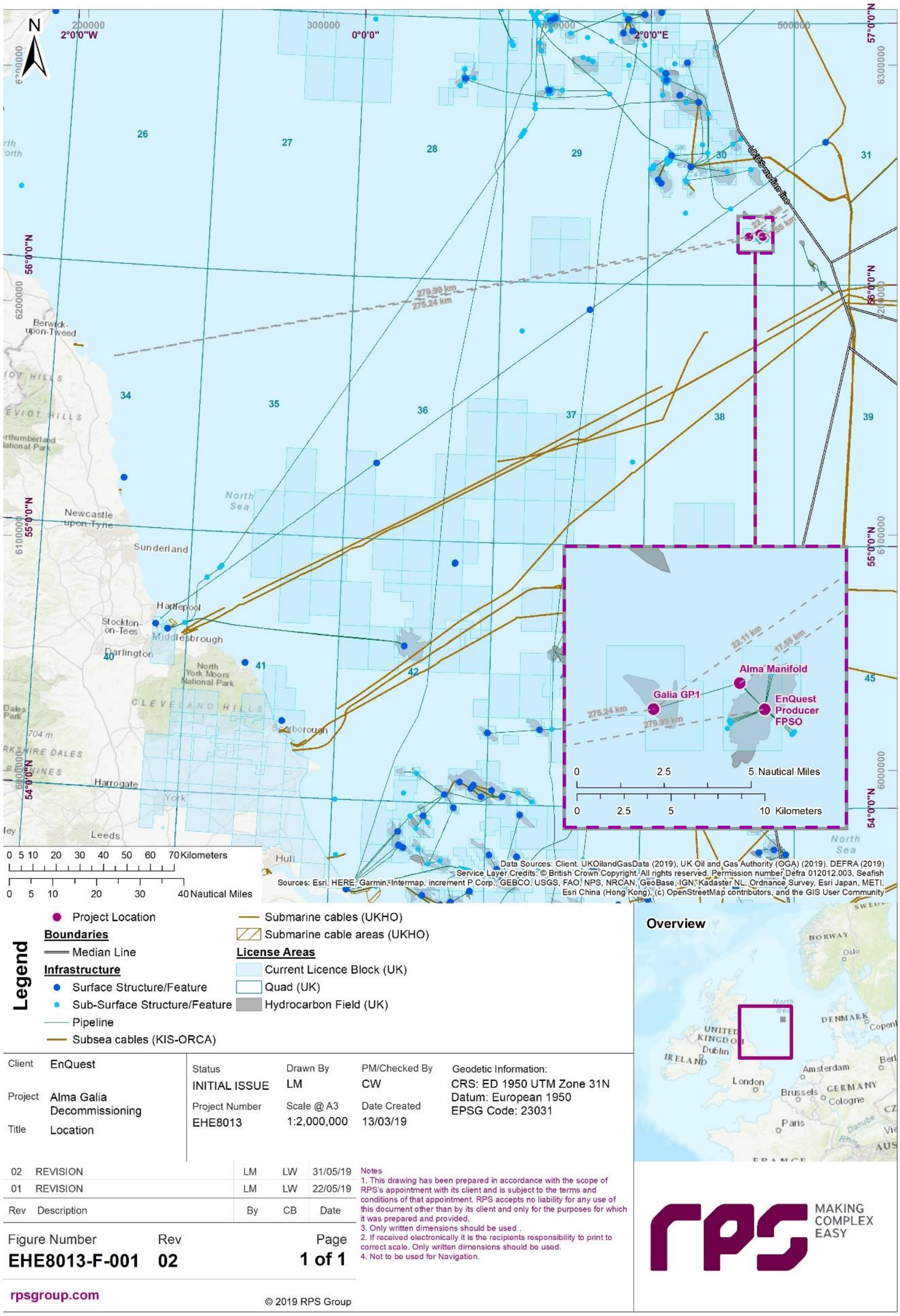


Figure 1.2.1 Location of the Alma and Galia fields

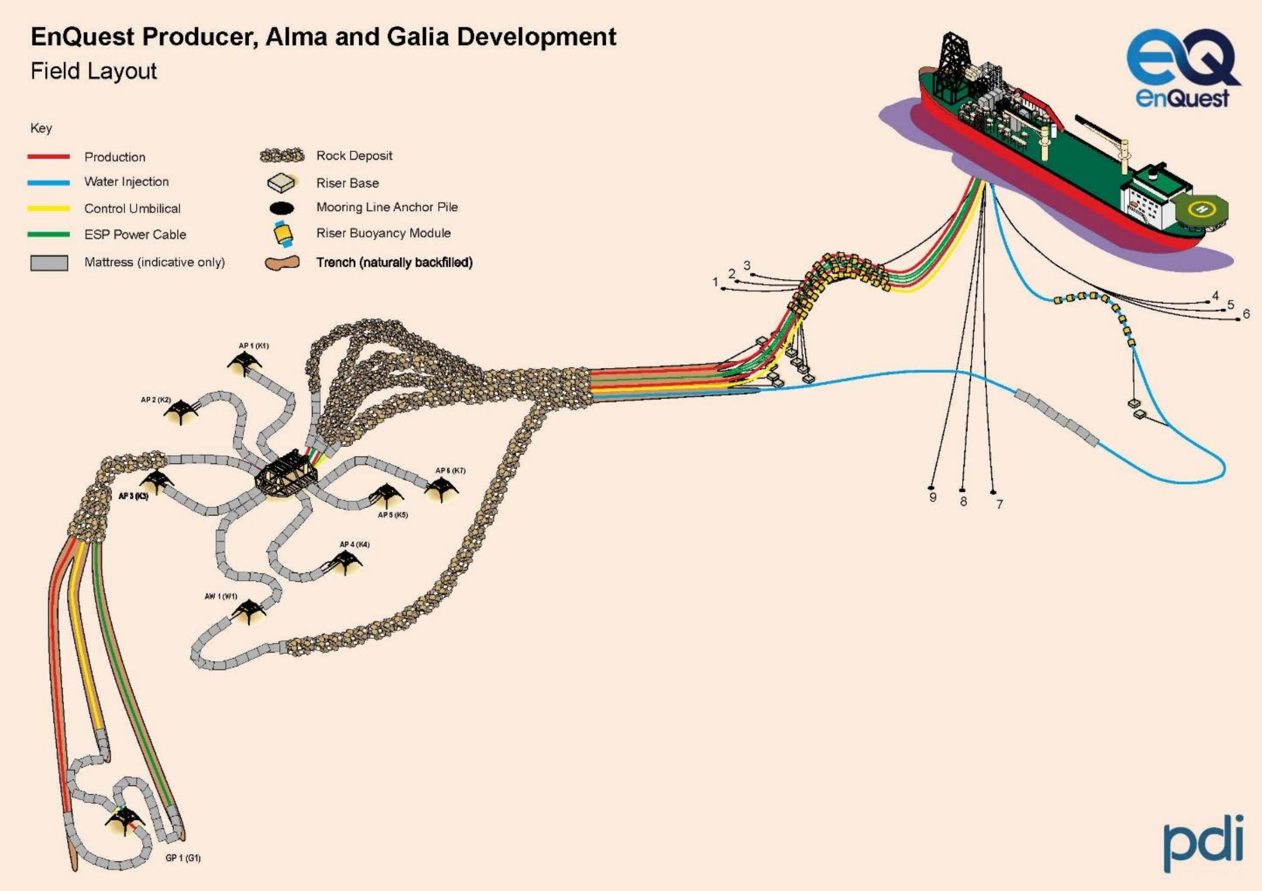


Figure 1.2.2: Layout of the Alma & Galia development

Produced oil from both developments is exported 1.8km to the FPSO from the Alma manifold via two 10" flowlines (Figure 1.2.2). The FPSO (also in Block 30/24) is operated by EnQuest, with produced oil collected from the FPSO by shuttle tanker every two weeks. The anchor chains from the FPSO extend into Block 30/25.

An 8" water injection pipeline runs from the FPSO to the AW1 water injection well in the Alma Drill Centre area and control umbilical pipelines and electrical submersible pump (ESP) power cables are also routed from the FPSO to the Alma manifold and then on to the Galia well in separate trenches.

1.2.1 Field History

The Alma field was initially developed as the Argyll field (the first UK North Sea oil field) by Hamilton Brothers, with production from July 1975 until November 1992. It was later re-developed as the Ardmore field by Tuscan and Acorn between 2003 and 2005. Production began from the Galia Field (previously known as the Duncan Field) in February 1982 and ceased in 1992.

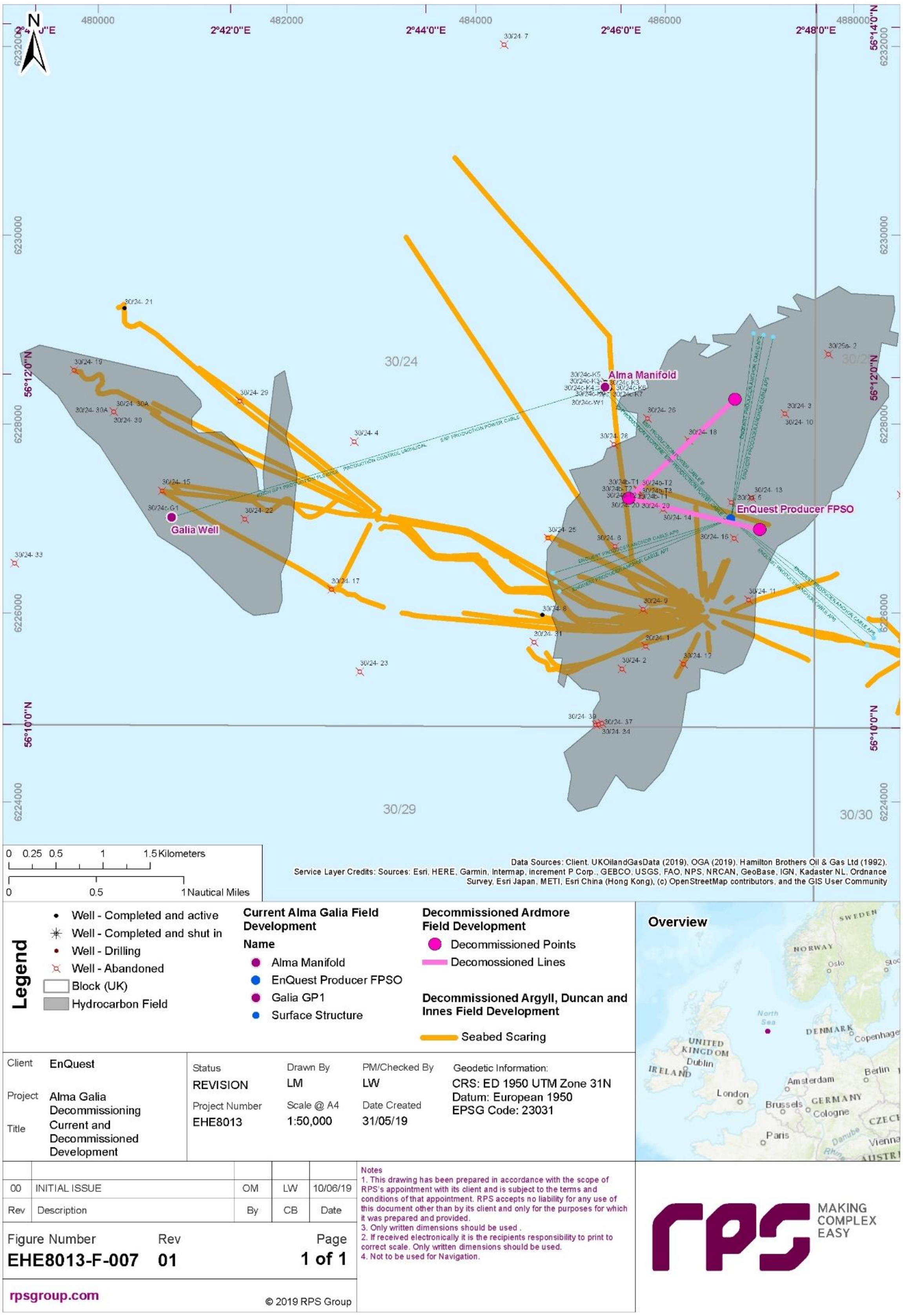


Figure 1.2.3: Previous field development in the area near to Alma and Galia infrastructure

The Duncan and Argyll fields were decommissioned in 1993 and the Ardmore field in 2006. During both decommissioning operations all the wells were decommissioned, and all the associated subsea infrastructure removed.

Figure 1.2.3 shows the location of the Ardmore, Duncan and Argyll fields in relation to the existing Alma and Galia subsea infrastructure. The layout of the Duncan, Argyll and associated Innes (10km north of Argyll and Duncan) fields is inferred from the seabed scarring evident in a 2011 survey (refer section 3.1). Further discussion on the legacy of the previous developments is provided in section 3.

1.3 Environmental Appraisal Scope

The scope of this EA is aligned with the scope of the Decommissioning Plan, based on the facilities which EnQuest has a liability to decommission under the Petroleum Act 1998. The level of detail presented and assessed in the EA is aligned with the level of engineering detail developed at the time of writing and submission. The scope covers:

- Disconnection of FPSO and tow to a suitable port;
- FPSO mooring chains (9 x 1,980m length) and nine driven piles (32-40m in depth);
- Alma subsea manifold and 4 driven piles (14.65m in length);
- FPSO riser system and 14 riser bases;
- The associated Alma pipelines, cables and stabilisation material;
  - 10-inch production flowlines (PL3006, PL3007);
  - 8-inch water injection riser / pipeline (PL3008);
  - Production control umbilical (PLU3009);
  - ESP power cables (PL3011, PL3012, & PL3013).
- The associated Galia pipeline, cables and stabilisation material.
  - 8-inch production flowline (PL3014);
  - Production control umbilical (PLU3015);
  - ESP power cable (PL3016).

The decommissioning of the Alma and Galia wells is not included in the scope of this EA, although a brief description of the process and timing is provided in Section 2.2.1. Potential environmental impacts associated with the decommissioning of the wells will be assessed through the Well Intervention Master Application Template (MAT) process, although a brief assessment of accidental events is provided in Section 4.6. Likewise, the discharges relating to the flushing and cleaning of pipelines and topside systems will be assessed through the submission of a Chemical Permit and Oil Term Permit Subsidiary Application Template (SAT) and are therefore also excluded from the scope of this EA.

The management of waste is discussed in section 2.4. The assessment of potential environmental impacts associated with the cleaning, dismantling and disposal of any facilities brought onshore is not included in the scope of this EA, with EnQuest committed to using appropriately licensed onshore facilities. Engagement with onshore regulators (e.g. SEPA and the Environment Agency) will be undertaken during the consultation process. Therefore, any potential onshore environmental effects will be managed and mitigated in accordance with the terms of the relevant environmental permits.

1.4 Regulatory Context

On the United Kingdom Continental Shelf (UKCS), the decommissioning of offshore oil and gas installations and pipelines is controlled through the Petroleum Act 1998, as amended by the Energy Act 2008. Under the Petroleum Act 1998, owners of an offshore installation or pipeline must obtain approval of a ‘Decommissioning Programme’ from OPRED before they can proceed with its decommissioning. EnQuest will submit one Decommissioning Programme document to cover both the Alma and Galia fields. The scope of the Decommissioning Programme will be for the facilities for which EnQuest have liability to decommission under the Petroleum Act 1998.

There is no statutory requirement to undertake an Environmental Impact Assessment (EIA) that satisfies the EIA Directive (Directive 2011/92/EU as amended by Directive 2014/52/EU) to support a Decommissioning Programme. However, OPRED requires that each offshore Decommissioning Programme submitted for approval must be accompanied by an EA, as set out in the Decommissioning guidance notes (OPRED, 2018).

EnQuest's existing Environmental Management System (EMS) was audited in June 2018 and was granted verification as meeting the requirements of an EMS in relation to OSPAR Recommendation 2003/5. EnQuest will ensure that the decommissioning activities will be integrated into, and carried out in accordance with, the company EMS.

1.5 Stakeholder Engagement and Consultation

Stakeholder engagement is important throughout the decommissioning process. Informal responses received to date from stakeholders have been incorporated into the Alma-Galia Decommissioning Programmes and are summarised in Table 1.5.1. Formal stakeholder consultation will begin with the submission of the draft Decommissioning Programmes, supported by this EA report, to OPRED. The consultation process at this stage will include the use of the EnQuest website to make these documents publicly available.

Summary of Stakeholder Comments		
Who	**Comment**	**Response**
INFORMAL CONSULTATIONS		
NFFO	The decommissioning proposals herein were sent via email to NFFO 11 September 2019	The NFFO had no adverse comment to make concerning the decommissioning proposals and were happy to use guidance from SFF
SFF	The decommissioning proposals herein were presented to SFF on 18 July 2019	The SFF had no adverse comment to make concerning the decommissioning proposals

Table 1.5.1: Summary of stakeholder comments

1.6 Environmental Appraisal Process

In order to evaluate the potential environmental impact of the proposed Decommissioning Programme on the environment an EIA process is conducted in accordance with the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended). This EA documents the results of the EIA process and is used to communicate the process. An overview of the EIA process is provided in Figure 1.6.1.

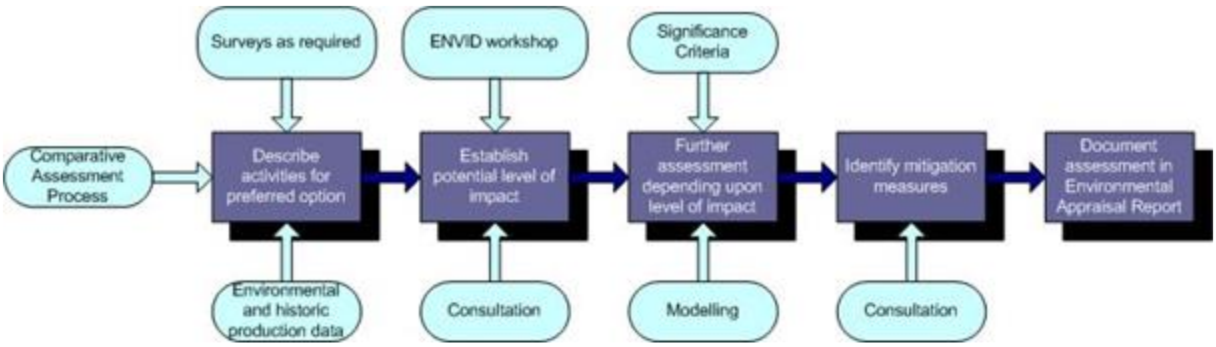


Figure 1.6.1: Principal stages in the EIA process

The EA document includes the following key elements:

- A non-technical summary of this EA;

- Description of the background to the decommissioning plans; purpose and process of this EA and legislative context (this section);
- Description of the proposed decommissioning activities and process by which the selected strategy was arrived at (section 2);
- Description of the environment and identification of the key environmental sensitivities which may be impacted by the proposed decommissioning activities (section 3);
- Description of the appraisal method adopted for the EA assessment and initial environmental impact assessment (section 4);
- Assessment of the key environmental impacts (section 5);
- Conclusions and description of the environmental management and mitigation measures (section 6);
- ENVID process and tables of consequences and likelihood (Appendix A);
- ENVID results summary (Appendix B).

2. PROPOSED DECOMMISSIONING SCOPE

2.1 Description of Infrastructure to be Decommissioned

2.1.1 Surface Installation

Surface facilities information			
Item	**Weight (Te)**	**Number of modules**	**Length (m)**
FPSO	93,300	1	N/A

Table 2.1.1: Surface facilities information

2.1.2 Subsea Infrastructure

Mooring chains & piles			
Item	**Total Length (m)**	**Outside Diameter (mm)**	**Total Combined Weight (Te)**
Mooring chains x 9	1,980 per chain	N/A	9x452.67 = 4,071.96
Mooring pile number 1-3	32 per pile	2133.6 per pile	3x63.36= 190.1
Mooring pile number 4-6	40 per pile	2133.6 per pile	3x79.2 = 237.6
Mooring pile number 7-9	34 per pile	2133.6 per pile	3x67.32 = 201.96

Table 2.1.2: Mooring chains & piles

Alma & Galia field installations					
Item	**Length (m)**	**Width (m)**	**Height (m)**	**Weight (Te)**	**Comments**
Alma subsea manifold	17.2	9.4	5.0	186	Secured by 4 piles of 14.65m length, 0.61m diameter and 5.5Te in weight. Total weight of all 4 piles is 22.0Te.
Alma trees x7	9.2	8.8	6.7	55.9	Dimensions and weight are for each Xmas tree. Includes a subsea control module, fishing friendly protection structure and guide funnel Total weight is 391.3Te
Galia tree	9.2	8.8	6.7	55.9	Includes a subsea control module, fishing friendly protection structure and guide funnel

Table 2.1.3: Alma & Galia field installations and structures

2.1.3 Riser Tethers and Bases

The riser bases and tethers are summarised in Table 2.1.4 below.

Alma riser bases and tethers					
Item	**Length (m)**	**Width (m)**	**Height (m)**	**Weight (Te)**	**Comments**
Riser bases (x14):					Dimensions and weight are for each riser and tether base 3x = 3 no. Total weight is 877.6Te.
• Flexible riser base	5.8	3.3	2.1	54.1 (3x)	
• Umbilical & power cable tether	6.0	2.8	1.2	55.5 (4x)	
• Flexible riser tether	4.9		1.4	55.7 (3x)	
• Power cable tether	5.5	2.8	1.8	88.7 (3x)	
• Umbilical tether	5.5	2.8	1.8	60.1 (1x)	

Table 2.1.4: Alma riser bases and tethers

2.1.4 Alma Pipelines, Umbilicals and Power Cables

Alma pipelines, umbilicals and power cables									
Description	**Pipeline Number (as per PWA)**	**Diameter (NB) (inches)[1]**	**Length (m)[2]**	**Description of Component Parts**	**Product Conveyed**	**From – To End Points**	**Burial Status**	**Pipeline Status**	**Current Content**
P1 Production Flowline / Hot Tap Tee / Production Riser	PL3006	10	1848	Flexible flowline Kynar® PVDF/HDPE Yellow	Produced Crude Oil	Alma manifold flange to hot tap tee tie-in flange	Trenched & buried with 4 exposures totalling 27.8m	Operational	Produced Crude Oil
		10	5	Steel pipe with Glass Flake Epoxy coating		Hot tap tee to topside tie-in flange	Surface laid		
		8	355	Flexible riser Kynar® PVDF/PA12 Black Mix		Hot tap tee 10in Production to topsides tie-in flange	Surface laid or suspended in water		
Pipe spool	PL3006JAP1	6	25	Steel pipe with Glass Flake Epoxy coating	Produced Crude Oil	Xmas tree flange to Alma manifold flange at each well	Surface laid	Operational	Produced Crude Oil
Flexible production jumper			61.8	Flexible jumper Kynar® PVDF/HDPE Yellow			Surface laid		
Pipes pool	PL3006JAP2	6	25	Steel pipe with Glass Flake Epoxy coating	Produced Crude Oil		Surface laid	Operational	Produced Crude Oil
Flexible production jumper			57.6	Flexible jumper Kynar® PVDF/HDPE Yellow			Surface laid		
Pipe spool	PL3006JAP3	6	25	Steel pipe with Glass Flake Epoxy coating	Produced Crude Oil		Surface laid	Operational	Produced Crude Oil
Flexible production jumper			44.7	Flexible jumper Kynar® PVDF/HDPE Yellow			Surface laid		
Pipe spool	PL3006JAP4	6	25	Steel pipe with Glass Flake Epoxy coating	Produced Crude Oil	Xmas tree flange to Alma manifold flange at each well	Surface laid	Operational	Produced Crude Oil
Flexible production jumper			64	Flexible jumper Kynar® PVDF/HDPE Yellow			Surface laid		
Pipe spool	PL3006JAP5	6	25	Steel pipe with Glass Flake Epoxy coating	Produced Crude Oil		Surface laid	Operational	Produced Crude Oil
Flexible production jumper			40	Flexible jumper Kynar® PVDF/HDPE Yellow			Surface laid		
Pipe spool	PL3006JAP6 (K7)	6	25	Steel pipe with Glass Flake Epoxy coating	Produced Crude Oil		Surface laid	Operational	Produced Crude Oil

[1] If diameter is expressed in mm it refers to outside diameter of electrical cable or umbilical pipeline.
[2] Final pipeline lengths are as-built lengths and as such may vary slightly from lengths detailed within the PWAs.

Alma pipelines, umbilicals and power cables

Description	Pipeline Number (as per PWA)	Diameter (NB) (inches)[1]	Length (m)[2]	Description of Component Parts	Product Conveyed	From – To End Points	Burial Status	Pipeline Status	Current Content
Flexible production jumper			57	Flexible jumper Kynar® PVDF/HDPE Yellow			Surface laid		
P2 Production riser / flowline	PL3007	10	1799	Flexible flowline Kynar® PVDF/HDPE Yellow	Produced Crude Oil	Alma manifold flange to hot tap tee tie-in flange	Trenched & buried with 3 buckles totalling 22.1m	Operational	Produced Crude Oil
		10	5	Steel pipe with Glass Flake Epoxy coating		Hot tap tee to topside tie-in flange	Surface laid		
		8	352	Flexible riser Kynar® PVDF/PA12 Black Mix		Hot tap tee 10in production to topsides tie-in flange	Surface laid or suspended in water		
Water injection riser & flowline	PL3008	8	343	Flexible riser PA12 Natural/PA12 Black Mix	Treated water	FPSO Turret J-tube to 8in WIF tie-in flange	Surface laid or suspended in water	Operational	Treated water
		8	2111	Flexible flowline Nylon PA12 /HDPE Yellow		8in WIF tie-in flange to AW1 well 8in tee piece	Trenched & buried with 4 buckles totalling 26m		
		8	2	Steel daisy chain tee piece with Glass Flake Epoxy coating		AW1 8in tee piece to AW1 Xmas tree flange	Surface laid		
Water injection flowline jumper.	PL3008JAW2	8	52	Flexible flowline Kynar® PVDF/HDPE Yellow	Treated water	AW1 8in tee piece to AW2 8in tee piece	Surface laid	Operational	Treated water
		8	2	Steel daisy chain tee piece with Glass Flake Epoxy coating		AW2 well 8in tee piece to AW2 Xmas tree flange	Surface laid		
EHC Production control umbilical	PLU3009	200mm	2138	Umbilical pipeline	Signal & power cables, 8x cores	FPSO turret J-tube to Alma manifold	Part suspended in water & trenched & buried	Operational	E/H/C
EHC production control umbilical jumpers	PLU3009JAP1	100mm	78	Umbilical jumpers	Signal & power cables, 8x cores	Alma manifold to Xmas Tree for each Production Well	Surface laid	Operational	E/H/C
	PLU3009JAP2		72				Surface laid	Operational	E/H/C
	PLU3009JAP3		60				Surface laid	Operational	E/H/C
	PLU3009JAP4		79				Surface laid	Operational	E/H/C
	PLU3009JAP5		56				Surface laid	Operational	E/H/C

Alma pipelines, umbilicals and power cables									
Description	**Pipeline Number (as per PWA)**	**Diameter (NB) (inches)[1]**	**Length (m)[2]**	**Description of Component Parts**	**Product Conveyed**	**From – To End Points**	**Burial Status**	**Pipeline Status**	**Current Content**
	PLU3009JAP6 (K7)		72				Surface laid	Operational	E/H/C
Water Injection Control jumper	PLU3009JAW1	109mm	70	Umbilical jumper	HP/LP Hydraulic	Alma manifold to each WI Xmas tree	Surface laid	Operational	Hydraulic fluids
	PLU3009JAW2		42				Surface laid	Operational	Hydraulic fluids
ESP Power Cable A	PL3011	251mm	2177	Electrical cable in plastic sheath	Electrical power	FPSO turret J-tube to Alma manifold SPCDU A	Part suspended in water & trenched & buried with 1 exposure of 3.1m	Operational	Electrical
ESP power cable jumpers	PLU3011JAP1	54mm	2x75	Electrical cable in plastic sheath	Electrical power	Alma manifold SPCDU to Xmas tree for each well	Surface laid	Operational	Electrical
	PLU3011JAP2		2x74				Surface laid	Operational	Electrical
	PLU3011JAP3		2x68				Surface laid	Operational	Electrical
	PLU3011JAP4		2x83				Surface laid	Operational	Electrical
	PLU3011JAP5		2x59				Surface laid	Operational	Electrical
	PLU3011JAP6 (K7)		2x76				Surface laid	Operational	Electrical
ESP Power Cable B	PL3012	251mm	2150	Electrical cable in plastic sheath	Electrical power	FPSO turret J-tube to Alma manifold SPCDU B	Part suspended in water & trenched & buried with 1 exposure of 3.1m	Operational	Electrical
ESP Power Cable C	PL3013	251mm	2135	Electrical cable in plastic sheath	Electrical power	FPSO turret J-tube to Alma manifold SPCDU C	Part suspended in water & trenched & buried with 1 exposure of 3.1m	Operational	Electrical

Table 2.1.5: Alma pipelines, umbilicals and power cables[3]

[3] In addition to the pipelines described here, three risers (two 8" production risers and one 8" water injection riser) will be decommissioned as part of the Alma and Galia Decommissioning Project. Note these risers tie into the FPSO from the Hot Tap Tee location and are detailed in Table 2.1.4. These will be disconnected and removed as part of the FPSO disconnection works.

2.1.5 Galia Pipeline, Umbilicals and Power Cables

Galia Pipeline, Umbilical and Power Cables									
Description	**Pipeline Number (as per PWA)**	**Diameter (NB) (inches)[4]**	**Length (m)[5]**	**Description of Component Parts**	**Product Conveyed**	**From – To End Points**	**Burial Status**	**Pipeline Status**	**Current Content**
GP1 Production Flowline	PL3014	8	1	Split gate valve with DBB	Produced Crude Oil	Future tie-in valve to GP1 flowline tee	Surface laid	Operational	Produced Crude Oil
		6	4	Steel pipe with Glass Flake Epoxy coating		GP1 Xmas tree flange to 8" flexible production flowline	Surface laid		
		8	5134	Flexible flowline Kynar® PVDF/HDPE Yellow		Hot tap tee 10in Production to topsides tie-in flange	Trenched & buried with 11 buckles totalling 66.7m		
Production control umbilical	PLU3015	200mm	8	Umbilical pipeline	Signal & power cables, 8x cores, LP/HP hydraulic	GP1 Xmas tree to SUTU on GP1 Xmas tree	Surface laid	Operational	E/H/C
			5060	Kynar® PVDF/HDPE Yellow		SUTU on GP1 Xmas tree to SUTU on Alma manifold	Trenched & buried		
ESP power cable & jumpers	PL3016 (1)	54mm	8	Electrical cable in plastic sheath	Electrical power	GP1 Xmas tree to SPCDU SP01, SP02	Surface laid	Operational	Electrical power
	PL3016 (2)	54mm							
	PL3016 (3)	145mm	5050			GP1 SPCDU to Galia SPCDU	Trenched & buried		
	PL3016 (4)	54mm	20			Galia SPCDU to Alma manifold SPCDU (A, B or C)	Surface laid		
	PL3016 (5)	54mm							

Table 2.1.6: Galia Pipeline, Umbilical and Power Cables

[4] If diameter is expressed in mm it refers to outside diameter of electrical cable or umbilical pipeline
[5] Final pipeline lengths are as-built lengths and as such may vary slightly from lengths detailed within the PWAs

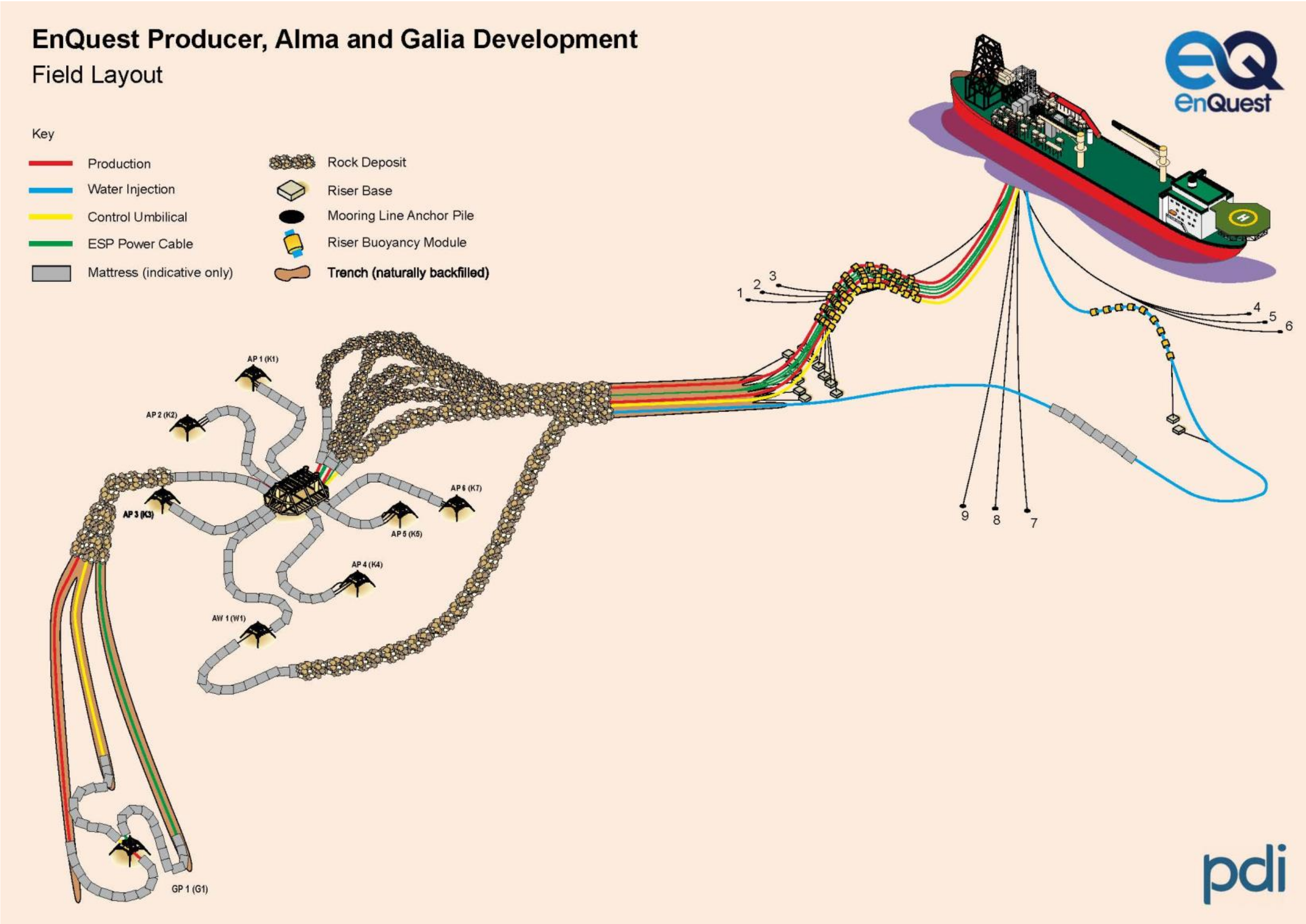


Figure 2.1.1: Layout of the Alma and Galia fields and protection features

When installed, the pipelines were trenched and left to naturally backfill, rather than being backfilled using mechanical methods.

EnQuest conducted pipeline integrity surveys in 2018 (Deepocean, 2019) using an ROV to transit the full lengths of all the pipelines. Burial profiles for the lines show that burial ranged from greater than 1m depth to exposure above the seabed. Video footage identified a few areas of free span where the pipeline had looped up and sideways out of the trench, due to either upheaval buckling or not enough natural backfill (Figure 2.1.2). The data in Table 2.1.5 and Table 2.1.6 summarise the burial status for all the pipelines and identifies which pipelines suffer from exposures. None of the free spans identified are greater than 10m in length and 0.8m in height, the criteria for reporting spans under FishSAFE. Therefore, no remedial works have been carried out to rectify the exposures.

Figure 2.1.2: Image of freespan at KP1.212 (PL3008) and KP0.312 (PL3014)

2.1.6 Pipeline Protection and Stabilisation Materials

All the protection and stabilisation material (Table 2.1.7, Table 2.1.8) is at the approaches to the Alma manifold and Galia well, where the pipelines, exit the trenches. The pipelines are protected by deposited rock followed by concrete mattresses and grout bags as the lines get closer to the manifold and well. There is no spot deposited rock or any other protection material on any of the pipelines outside these areas.

Alma Pipeline protection and stabilisation features				
Stabilisation Feature	**Total Number**	**Total Weight (Te)**	**Location(s)**	**Exposed/Buried/Condition**
Concrete mattresses (Note 1)	113	405.7	**PL3006** x9 at Alma **PL3006, PL3007, PLU3009, PL3011, PL3012, PL3013**, x9 concrete mattresses common for all pipelines at Alma **PL3008**, x12 at Alma x8 at FPSO **PLU3009**, x1 at Alma **PL3006JAP1**, x10 **PL3006JAP2**, x11 **PL3006JAP3**, x15 **PL3006JAP4**, x11 **PL3006JAP5**, x7 **PL3006JAP6**, x9 **PL3008JAW1**, x11	Latest survey information suggests the concrete mattresses are exposed.
Grout bags (1Te gabions, Note 2)	66	66	**PL3006,** x6 **PL3007,** x6 **PL3006JAP1-6** x26 **PLU3009** x4 **PL3008JAW1 PL3009JAW1** x12 **PL3011 PL3012 PL3013** x12	Latest survey information suggests these grout bags are exposed.
Grout bags (25kg, Note 2)	240	6	**PL3006JAP6, PLU3009JAP6, PL3011JAP6** x240	Grout bags are covered under mattresses
Deposited Rock (Note 4)	n/a	16,692	**PL3006**, 3,468Te **PL3007**, 2,839Te **PL3008**, 1,051Te **PLU3009**, 2,481Te **PL3011, PL3012, PL3013**, 6,853Te	Latest survey information would suggest that the deposited rock is exposed (buried under a light covering of seabed sediment.
Riser ballast modules	342 half shells 58 clamps	96.6	**PL3006** 13.7Te ballast (50 half shells & 10 clamps) **PL3007** 13.7Te ballast (50 half shells & 10 clamps) **PL3008** 12.3Te ballast (50 half shells & 10 clamps) **PLU3009** 10.1Te ballast (48 half shells & 7 clamps) **PL3011** 15.6Te ballast (48 half shells & 7 clamps) **PL3012** 15.6Te ballast (48 half shells & 7 clamps) **PL3013** 15.6Te ballast (48 half shells & 7 clamps)	Connected to risers
Riser buoyancy modules	99 Upper 67 Lower	103.3	**PL3006** 6.7Te upper (14) 7.0Te lower (9) **PL3007** 6.7Te upper (14) 7.0Te lower (9) **PL3008** 6.6Te upper (14) 5.7Te lower (9) **PLU3009** 6.2Te upper (15) 7.3Te lower (10)	Connected to risers

Alma Pipeline protection and stabilisation features				
Stabilisation Feature	**Total Number**	**Total Weight (Te)**	**Location(s)**	**Exposed/Buried/Condition**
			PL3011 8.0Te upper (14) 8.7Te lower (10) **PL3012** 8.0Te upper (14) 8.7Te lower (10) **PL3013** 8.0Te upper (14) 8.7Te lower (10)	
Fronded Mats	n/a	n/a	n/a	n/a
Other (describe briefly)	n/a	n/a	n/a	n/a

NOTES
1. Concrete mattresses are 'Pipeshield' Type 1: 6m x 3m x 0.15m c/w 16mm diameter polypropylene rope; Approx. weight each mattress 3.59Te;
2. The quantity of 1Te and 25kg grout bags is based on design information and deposit consents and so the quantities should be considered indicative only, as they are not 'as-built';
3. All JAP6 related jumpers connect to well K7;
4. The quantity of deposited rock may differ from that described on the original PWA application; the quantities quoted here are based on 'as-built' data.

Table 2.1.7: Alma Pipeline Stabilisation Features

Galia Pipeline Stabilisation Features				
Stabilisation Feature	**Total Number**	**Total Weight (Te)**	**Location(s)**	**Exposed/Buried/Condition**
Concrete mattresses (Note 1)	51 Galia 30 Alma	290.8	**PL3014**, x21 (x10 at Alma and x11 at Galia) **PLU3015**, x35 (x10 at Alma and x25 at Galia) **PL3016**, x25 (x10 at Alma and x15 at Galia)	Latest survey information suggests the concrete mattresses are exposed.
Grout bags (1Te gabions, Note 2)	9.5	9.5	**PL3014,** x6 **PLU3015**, x1.5 **PL3016**, x2	Latest survey information suggests the grout bags are exposed.
Grout bags (25kg, Note 2)	75	1.875	**PLU3015**, x50 **PL3016**, x25	The burial status of these grout bags is not known.
Deposited Rock (Note 3)	n/a	3,746	**PL3014**, 1,509Te **PLU3015**, 865Te **PL3016**, 1,372Te.	Latest survey information would suggest that the deposited rock is exposed, buried under a light covering of seabed sediment.
Fronded Mats	n/a	n/a	None found in 'as-built' documentation	n/a
Other (describe briefly)	n/a	n/a	n/a	n/a

NOTES
1. Concrete mattresses are 'Pipeshield' Type 1: 6m x 3m x 0.15m c/w 16mm diameter polypropylene rope; Approx. weight of each mattress 3.59Te;
2. The quantity of 1Te and 25kg grout bags is based on design information and deposit consents and so the quantities should be considered indicative only, as they are not 'as-built';
3. The quantity of deposited rock may differ from that described on the original PWA application; the quantities quoted here are based on 'as-built' data.

Table 2.1.8: Galia Pipeline Stabilisation Features

2.1.7 Drill Cuttings

All oil-based mud drill cuttings generated during drilling activity at Alma and Galia were skipped and shipped to shore, with only water-based mud cuttings discharged direct to the seabed or to sea from the drill rig. There is no evidence from the 2016 or 2018 moorings and pipeline integrity surveys (Deepocean 2016, 2018, 2019) of any distinct cuttings piles. Section 3.4 provides further detail and discussion on the potential sediment contamination legacy from oil-based mud discharges from the Argyll, Duncan and Innes development. However, post decommissioning seabed trawls were undertaken over the Argyll, Duncan and Innes well locations and there has been no evidence in subsequent surveys (Cordah, (1995 & 1998), Gardline (2011a & 2011b)) of discrete cuttings piles at those locations.

2.2 Decommissioning Operational Activities

This section provides a description of the proposed decommissioning activities for the subsea infrastructure.

The preferred decommissioning option involves:

- The complete removal of the FPSO and mooring system down to the dip-down point (DP);
- *In situ* burial of mooring chain ends at DP to a depth of at least 1m below seabed;
- *In situ* decommissioning of 9 mooring piles;
- Complete removal of 14 riser bases;
- Complete removal of the Alma subsea manifold;
- Removal of four Alma subsea manifold piles down to a depth of 1m below seabed;
- Complete removal of the Alma pipelines (PL3006, PL3007, PL3008, PLU3009), power cables (PL3011, PL3012, PL3013) and associated concrete mattresses and grout bags;
- Complete removal of the Galia pipelines (PL3014, PLU3015), cable (PL3016) and associated concrete mattresses and grout bags;
- Rock protection remaining *in situ*.

All the infrastructure will be decommissioned in line with OPRED guidance, with the following items being subject to a Comparative Assessment:

- Mooring system from DP to piles;
- Buried flexible and umbilical pipelines.

2.2.1 Well Decommissioning

The six production wells and one water injection well in the Alma development and the one production well in the Galia development will be decommissioned in line with the Oil and Gas UK Guidelines for the Decommissioning of Wells (OGUK, 2018). None of the decommissioning operations are taking place inside or within 70km of a European protected site, although the Fulmar MCZ (a UK protected site) is 10.3km to the west of Galia. The potential environmental impacts associated with the well decommissioning campaign will be considered under the Well Intervention and Marine License applications submitted to OPRED, and are therefore excluded from the scope of this EA. However as it is likely that the well decommissioning activities will take place within five years of the main decommissioning programme, using a semi-submersible drilling rig, a brief assessment of accidental events has been provided in Section 4.6. In the intervening time, the wells will be shut-in with their wellhead protection structures and subsea trees in place. Currently the wells use downhole Electrical Submersible Pumps (ESPs) to maintain production and therefore in the event of an incident it is unlikely that they will flow of their own accord prior to final well decommissioning activities. Removal of the subsea installations is discussed in Section 2.2.5.

2.2.2 Pipeline Preparation

The pipelines connecting the FPSO to Alma and Galia will be cleaned and flushed, using a combination of pigging and flushing, prior to disconnection. The exact cleaning method will be developed during detailed engineering design and agreed with OPRED through the environmental permitting process and associated consultation. The impacts associated with pipeline preparation are therefore not considered further within EA.

The pipeline flushing and cleaning activities will be undertaken from the FPSO prior to its tow from the field, and it is anticipated that no other vessels will be required for these activities. Further cleaning and decontamination will take place onshore prior to recycling / re-use.

2.2.3 FPSO Disconnect and Tow

The FPSO will be towed to a suitable port by likely three anchor handler vessels (AHV). The vessel will be either reused, recycled or disposed of; outside the scope of this EA report.

As part of the operations, the risers and mooring lines will be disconnected to allow the FPSO to be towed away. To allow for potential re-use the risers will be cut at the hot tap tee, with two disconnection methods for the risers at the FPSO end detailed in Figure 2.2.1. A similar disconnection method will be used for the umbilical at the FPSO end. The risers will be temporarily located on the seabed during disconnection activities.

The disconnection of the mooring chains is discussed in section 2.2.4 below.

Alma & Galia riser and umbilical decommissioning methods	
Option	**Description**
Controlled release with flange disconnection	• Disconnect riser / flexible at turret • Install pull in head and connect to FPSO winch • Pay out on winch / crane and let flexible descend in a controlled manner • Using divers, disconnect riser at tee piece • Connect vessel crane to pull in head and recover first end to reel • Recover remaining flexible section
Controlled release with cut at trench transition section (umbilical / ESP cables) / hot tap tee piece (production and water injection)	• Disconnect riser / flexible at turret • Install pull in head and connect to FPSO winch • Pay out on winch / crane and let flexible descend in a controlled manner • Using specialized 3rd party equipment, perform cut • Connect vessel crane to pull in head and recover first end to reel • Recover remaining flexible section

Table 2.2.1: Alma & Galia riser and umbilical decommissioning methods

2.2.4 Mooring System

The mooring chains consist of a 700m section of 142mm top chain, a 1,150m section of 140mm sheathed spiral wire strand and a 130m section of 142mm bottom chain (Figure 2.2.1) connected at a pad-eye (Label 1 in Figure 2.2.2) to a pile. They will be cut at the dip down point (DP: Figure 2.2.1) and under the chain table of the FPSO, likely using a mooring chain cutter or a diamond wire cutting machine. The top chain will be directly cross hauled to an anchor handler vessel (AHV) after disconnection, and the mooring line down to the DP (top chain, wire rope and bottom chain) will then be recovered to the deck of the AHV, and transported to shore for future re-use, recycling or disposal.

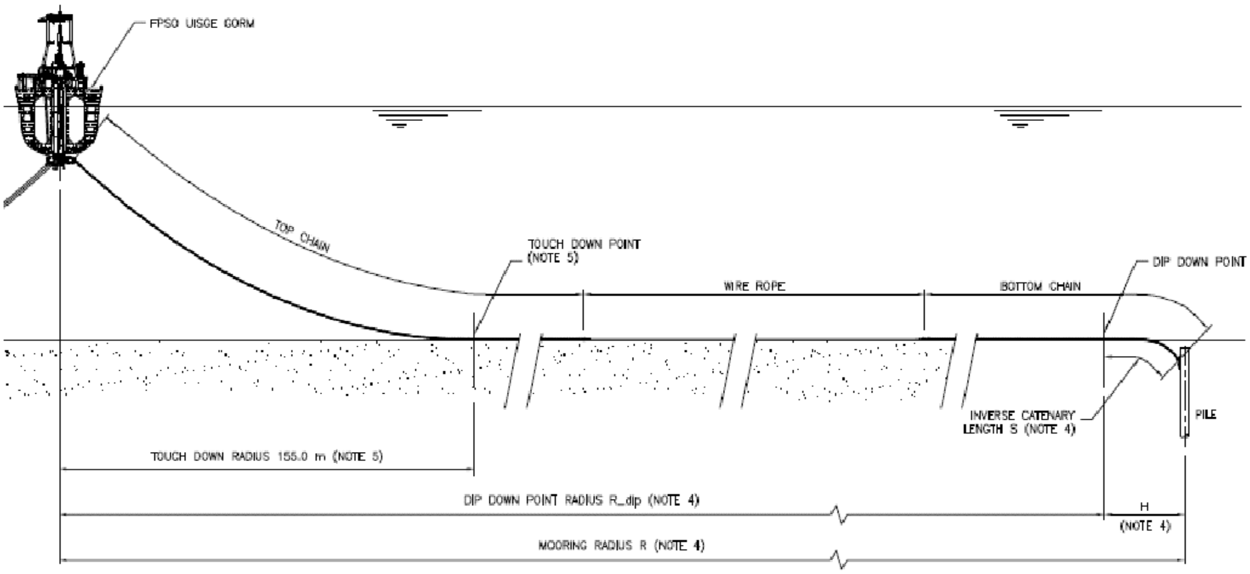


Figure 2.2.1: Mooring system components

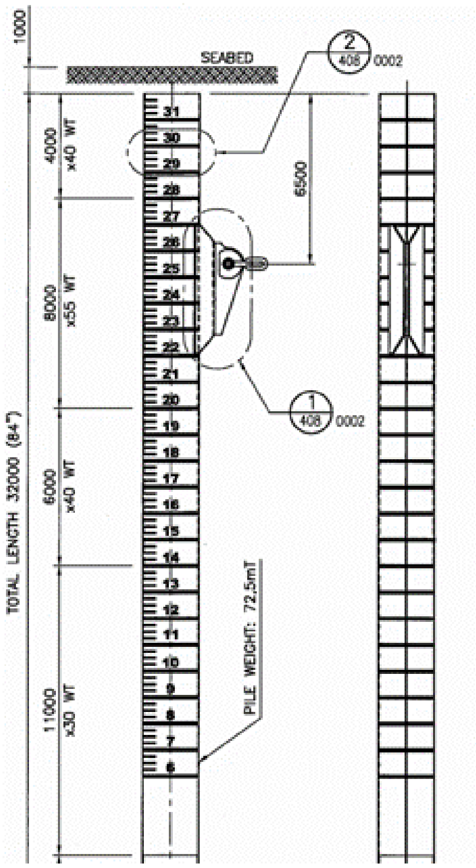


Figure 2.2.2: Schematic of the mooring piles showing pad-eye (Label 1)

The section of mooring chain from the DP to (and including the) piles, was subject to a comparative assessment.

For a partial removal option where the chain is cut at 3m below the seabed, significant excavation would be required in order to reach the point where the mooring chain is 3m below the seabed. The end of the mooring chain forms an inverse catenary between the dip down point and the padeye on the mooring piles. Due to the inverse catenary, the location at which the chain is 3m below the seabed is unknown and hence as a result, there is potential for extended excavation requirement. The chosen leave *in situ* option presents very little technical risk and only involves local excavation to the cut location mooring chain ends to 1m below seabed.

Two variants of this option are considered: one alternative would be to cut at the DP and bury the remaining chain to >1m below seabed. The other would be to excavate and cut the chain at >1m below seabed and backfill the excavation. Either way, the length of chain from the cut point will remain buried in situ along with the mooring piles.

The penetration depth and therefore depth of burial for each pile is shown in Table 2.2.2. It should be noted that these burial depths are depth at installation. No subsequent survey has been undertaken to confirm present burial status. This document and the proposed decommissioning methods assume that the pile tops remain buried.

Mooring pile penetration depths at installation			
Pile Number	**Length (m)**	**Penetration Depth (m)**	**Seabed Cover (m)**
1	32	32.75	0.75
2	32	33	1
3	32	33	1
4	40	41	1
5	40	41	1
6	40	41.4	1.4
7	34	35	1
8	34	35	1
9	34	35	1

Table 2.2.2: Mooring pile penetration depths at installation

2.2.5 Subsea Installations

The Alma manifold (Figure 2.2.4) is secured to the seabed via four corner piles which penetrate into the seabed providing trawl resistance. The manifold will be completely removed for reuse, recycling or final disposal on land. The method of removing the manifold involves reverse installation using a dive support vessel (DSV). Divers will install the recovery rigging to the structure, the piles are then severed at least 1m below seabed using one of the methods in Table 2.2.3 before the manifold is recovered to the CSV. Remedial backfilling will then be undertaken.

Alma manifold pile decommissioning options	
Option	**Description**
Internal pile cut	• Install recovery rigging to structure • Dredge debris from inside piles to 1m below seabed • Sever piles at seabed level using internal cutting tool • Recover structure to vessel deck • Dredge and sever piles 1m below seabed • Restore seabed at piled locations
External pile cut	• Install recovery rigging to structure • Dredge around piles to 1m depth • Perform exterior cut using diamond wire saw • Recover structure to vessel deck • Restore seabed at piled locations

Table 2.2.3: Alma manifold pile decommissioning options

The 14 riser bases will be recovered using a construction support vessel (CSV) and taken to shore for reuse, recycling or disposal. There may be a requirement to dredge around the riser bases to provide access for lifting but this will be kept to a minimum.

The eight subsea production and water injection tree structures (including subsea control module, fishing friendly protection structure and guide funnel – Figure 2.2.3) will be completely removed for re-use, recycling or final disposal on land. The trees have been designed with retractable legs so that they can be recovered through a CSV moon pool. Depending on seabed conditions, dredging may be required prior to retraction of the legs. As discussed in section 2.2.1, removal of these structures will take place during final well decommissioning activities.

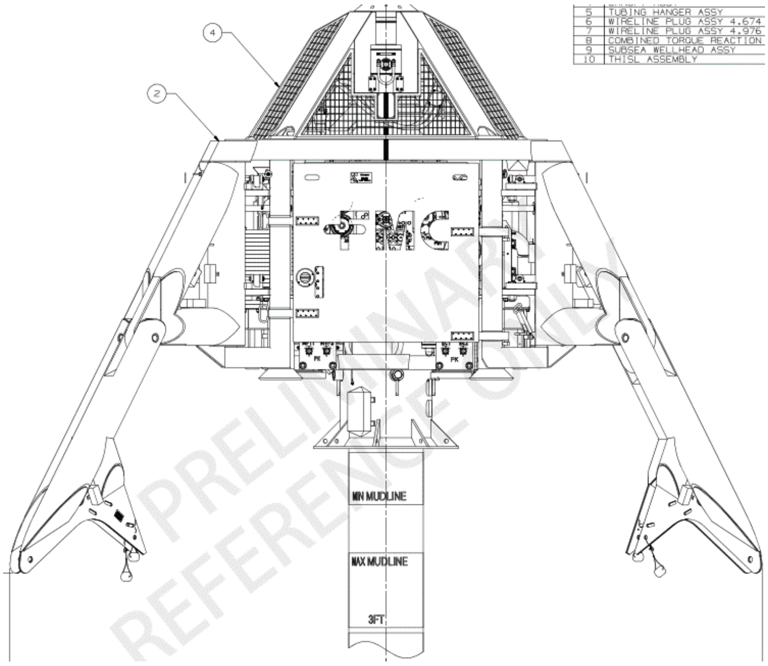


Figure 2.2.3: Alma and Galia Xmas tree and WHPS design

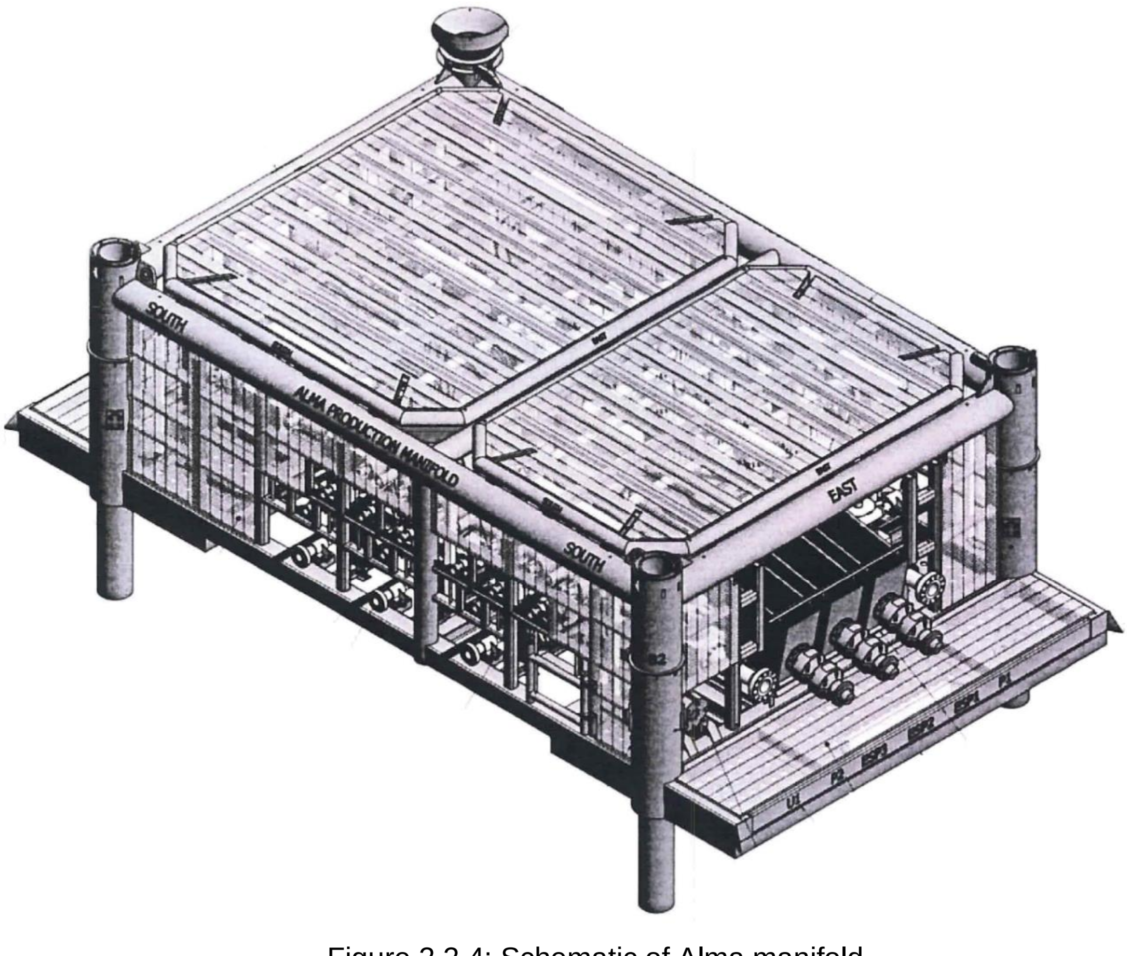


Figure 2.2.4: Schematic of Alma manifold

2.2.6 Pipelines, Pipespools and Jumpers

As discussed in section 2.2.2 all the spools and jumpers will be flushed and cleaned prior to disconnection and recovery for re-use, recycling or disposal. All concrete mattresses and grout bags will be removed prior to any subsea infrastructure removal operations. The spools and jumpers will be disconnected or cut before being transferred to the CSV.

The pipelines will either be disconnected or cut from the Alma manifold, Galia well and FPSO – at the hot-tap tee location for the flowlines or at the trench transition for the umbilicals and power cables.

The decommissioning options for the trenched and buried and rock covered sections of the pipelines were assessed using the comparative assessment process. The comparative assessment concluded that complete removal of the pipelines is to be preferred. This method will involve the following core activities:

- the attachment of recovery rigging to an end of the umbilical or cable;
- the connection of a pull-in head to the end of a flexible flowline;
- removal of the pipelines, likely onto reels on the deck of a CSV or AHV.

In this method the pipelines would be pulled through the deposited rock with no requirement to remove the rock from the pipelines in those sections prior to removal. If snagging occurs or the required tension to pull the pipelines through the deposited rock is too great for the vessel, then an MFE will be used to dislodge the deposited rock. Although an MFE will be mobilised onto the appropriate vessel and ready to use it is expected that this would only be for contingency purposes - its use will be minimal.

The pipelines will then be transported back to shore for re-use, recycling or disposal.

2.2.7 Stabilisation and Protection Features

There are 194 concrete mattresses with polypropylene rope, 315 x 25kg grout bags and 75.5 x 1000kg grout bags - also sometimes known as “builder’s bags” or “gabions” in the development. All the concrete mattresses and grout bags are located on the approaches to the Alma manifold, Alma wells and the Galia well (Figure 2.2.5 and Figure 2.2.6).

Unless buried and not overlying existing pipelines, all mattresses and grout bags will be recovered. As they were only installed in 2015, it is assumed that they can all be recovered. However, they will still be subject to a standard ‘as found’ survey and risk assessment offshore. Many of the grout bags are near the concrete mattresses and these will also be recovered. If there are any integrity issues with the concrete mattresses, then the remaining sections will likely be recovered via a debris basket.

Some of the concrete mattresses and grout bags may be partly overlain with deposited rock in order to access the pipelines underneath. Minimal excavation will be undertaken to allow safe removal. As part of the recovery process, a grapple may be used to recover the concrete mattresses or grout bags, or alternatively they will be loaded into recovery baskets placed on the seabed, and then recovered to the work vessel by crane.

The deposited rock has a design density ~2.62Te/m^3 of 1"-5" graded granite and gneiss. It is not practicable to remove all the deposited rock and so it will remain *in situ*. As discussed earlier, the method proposed for removing the pipelines will involve pulling them through the deposited rock. The rate of pull through will be optimised to minimise the dislodging of the rock, with the 3:1 berm profile being retained as much as possible. This will minimise physical disturbance to the seabed.

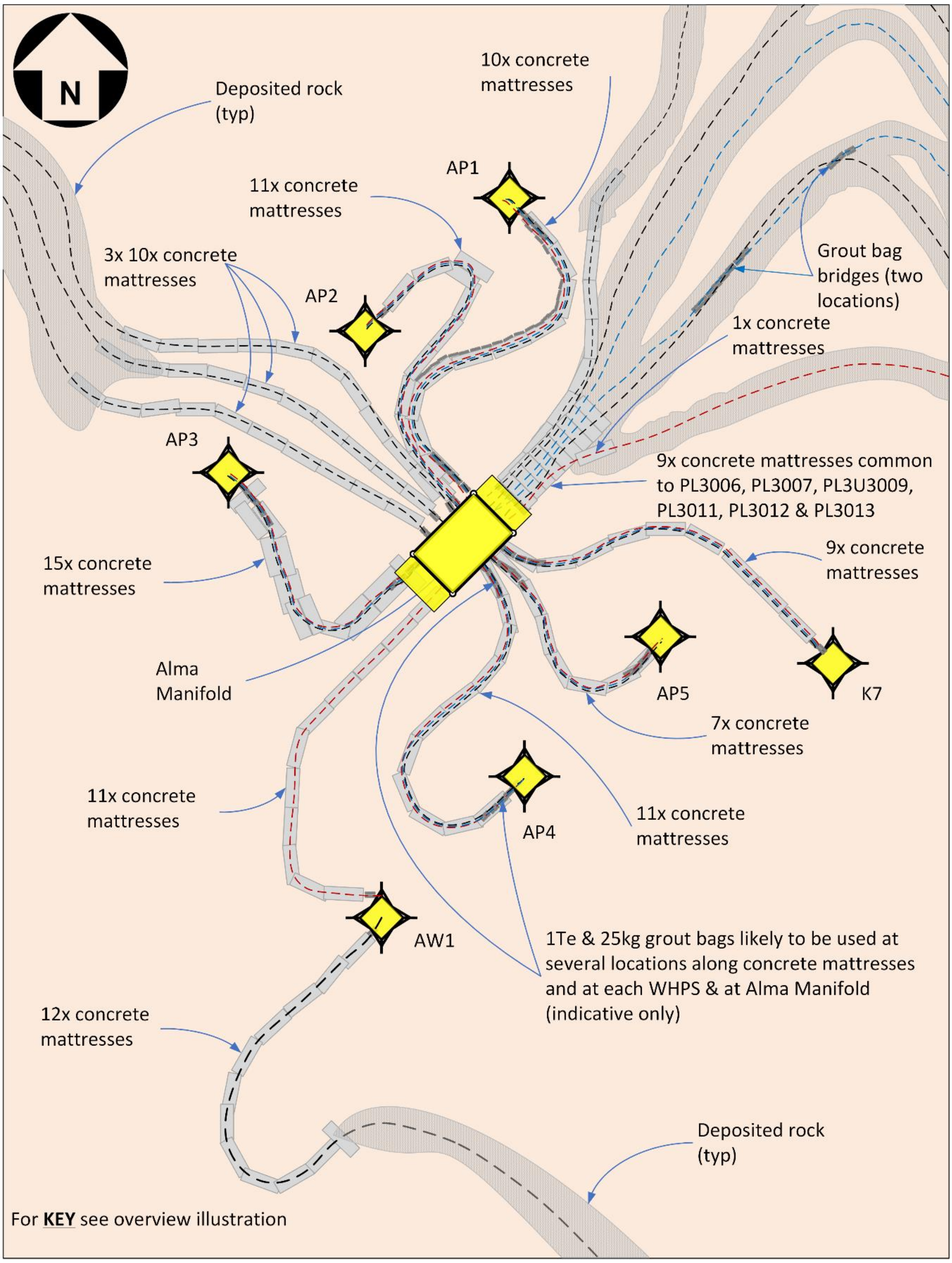


Figure 2.2.5: Layout around the Alma manifold and wells

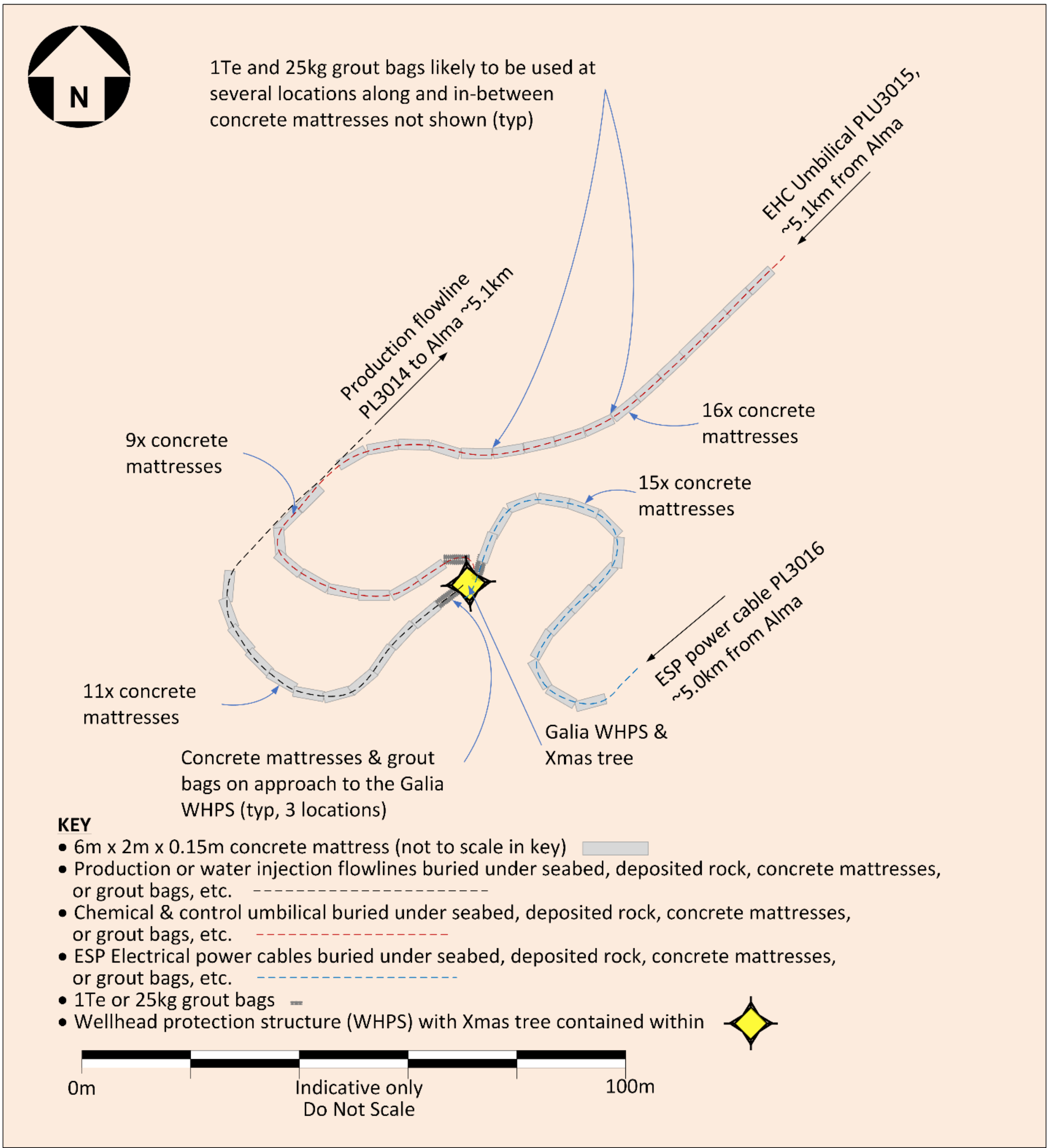


Figure 2.2.6: Layout around the Galia well approaches

2.3 Surveys

Section 3.1 outlines the surveys that have been undertaken over the development area, including the 2011 pre-development survey, 2016 moorings survey and 2018 subsea structures and pipeline integrity surveys. The spatial extent of survey coverage combined with recent nature of the development (2015) and subsequent visual surveys provides enough information to characterise the baseline environment of the Alma and Galia area.

At the end of the first and second phases of the decommissioning programme (refer section 2.5) debris surveys will be undertaken over the area of decommissioned infrastructure (FPSO 500m zone and mooring locations for Phase 1 and flowline corridors and drill centre infrastructure for Phase 2). Any remaining oil and gas seabed debris from the development will be recovered for onshore disposal or recycling in line with existing disposal methods.

After both Phases 1 and 2 independent verification of seabed state will be obtained using an evidence-based approach, the scope and method of which will be agreed in consultation with the Scottish Fishermen's Federation (SFF) and OPRED. For the purpose of this EA it is assumed that an overtrawl survey of the pipeline corridors (50m either side of the pipelines), a 25m radius area around each mooring pile, the FPSO 500m exclusion zone area and a 25m radius around the manifold will be undertaken over Phases 1 and 2. These will be followed by statements of clearance to all relevant government departments and non-governmental organisations.

Post decommissioning survey requirements and frequency will be discussed and agreed with OPRED as part of the approval process for the decommissioning programme.

2.4 Waste Management

Recovered materials will be transported to a shore base for initial laydown. Material will undergo light processing (cleaning, cutting, etc.) by a variety of plant and equipment in preparation for preferential re-use, recycling, or as a last resort, disposal to landfill at an appropriate licenced site. Where necessary and practicable to allow access for lifting operations, some marine growth will be removed offshore. The remainder will be brought to shore and disposed of at an appropriate licenced site.

Given the age of the infrastructure, where possible the subsea infrastructure associated with Alma and Galia will be cleaned and either re-used or recycled. Experience would suggest that it is unlikely that concrete mattresses and grout bags would be recovered without being damaged, so as a worst-case scenario this EA assumes that 100% will be incinerated or sent to landfill. If any of the recovered infrastructure is NORM contaminated, this will be cleaned and disposed of by a licensed contractor.

Non-hazardous material includes scrap metals (steel, aluminium and copper), concrete and plastics that are not contaminated with hazardous material will be removed and, where possible, re-used or recycled. Non-hazardous waste which cannot be reused or recycled will be disposed of to a landfill site. Hazardous waste is expected to include hydrocarbon or chemical residues, radioactive material, and small amounts of asbestos. An estimate of the quantities of materials that comprise the Alma-Galia installations; pipelines and associated protection and stabilisation features (excluding deposited rock) is provided in Table 2.4.1.

Item or Feature – Phase 1	Total (Te)	Steel (Te)	Plastic (Te)	Non-Ferrous (Te)	Grout / Concrete (Te)
FPSO	93,300	88,635	933	3,732	-
Mooring System	4,702	4,702	-		-
Pipelines, Protection & Stabilisation Features	1,466	493	178	85	711
Sub-total (Te)	**99,468**	**93,829**	**1,111**	**3,817**	**711**
Recovered (Te)	98,738	93,140	1,103	3,789	706
Decommissioned *in situ* (Te)	730	689	8	28	5
Item or Feature – Phase 2	**Total (Te)**	**Steel (Te)**	**Plastic (Te)**	**Non-Ferrous (Te)**	**Grout / Concrete (Te)**
Installations	656	656	-	-	-
Pipelines, Protection & Stabilisation Features	3,276	1,992	397	136	751
Sub-total (Te)	**3,932**	**2,648**	**397**	**136**	**751**
Recovered (Te)	3,918	2,639	396	135	748
Decommissioned *in situ* (Te)	14	9	1	1	3
All Materials	**Total (Te)**	**Steel (Te)**	**Plastic (Te)**	**Non-Ferrous (Te)**	**Grout / Concrete (Te)**
Sub-total (Te)	**103,400**	**96,477**	**1,508**	**3,953**	**1,462**
Recovered (Te)	102,656	95,779	1,499	3,924	1,454
Decommissioned *in situ* (Te)	744	698	9	29	8

Table 2.4.1: Estimated mass & proposed fate of the Alma & Galia infrastructure[6]

[6] The figures exclude the quantities of deposited rock (Alma – 16,693Te, Galia – 3,746Te) that will be left *in situ*. Note

The EnQuest corporate Waste Management Strategy (WMS) document (EnQuest, 2018) outlines standards and requirements for waste management, including:

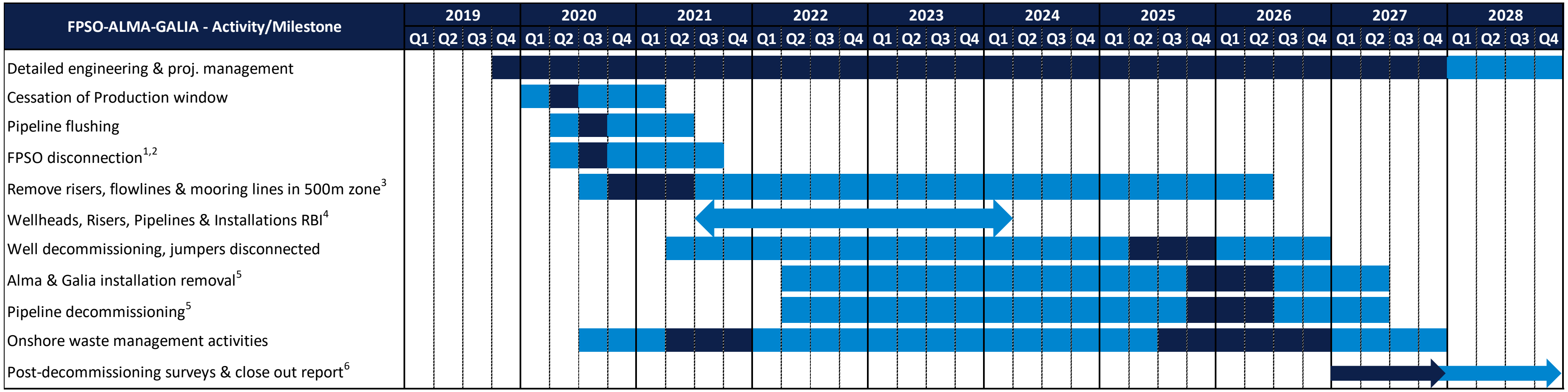
- Legislation;
- EnQuest standards;
- Waste hierarchy;
- Transfer of waste; and,
- Disposal and storage.

This strategy will be followed during the Alma and Galia decommissioning project. Where there is a requirement for the onshore disposal of large quantities of waste, a contractor specific waste management plan and an active waste management strategy will be developed which aligns with the corporate WMS.

2.5 Schedule

The proposed schedule for Alma and Galia decommissioning is shown in Figure 2.5.1. This is indicative and is subject to change.

that final fate of materials onshore is aspirational.



Notes / Key

Most likely period of activity

Activity window to allow commercial flexibility associated with well and infrastructure decommissioning activities

1. Current indications are that FPSO sailaway will be carried out Q3 2020;
2. An interim progress report will be submitted to OPRED following FPSO sailaway;
3. Removal of risers, surface laid flowlines and mooring lines within 500m zone will follow FPSO sailaway but may be deferred;
4. The Alma Galia wellheads, risers, pipelines, and installations will be subjected to a risk-based inspection regime in the intervening period between FPSO sailaway and decommissioning activities;
5. Removal of Alma & Galia installations and pipelines will be done at the same time or sometime after well decommissioning activities have been completed;
6. Post decommissioning surveys and close out reports will be prepared on completion of decommissioning activities.

Figure 2.5.1: Proposed Alma & Galia Decommissioning Schedule

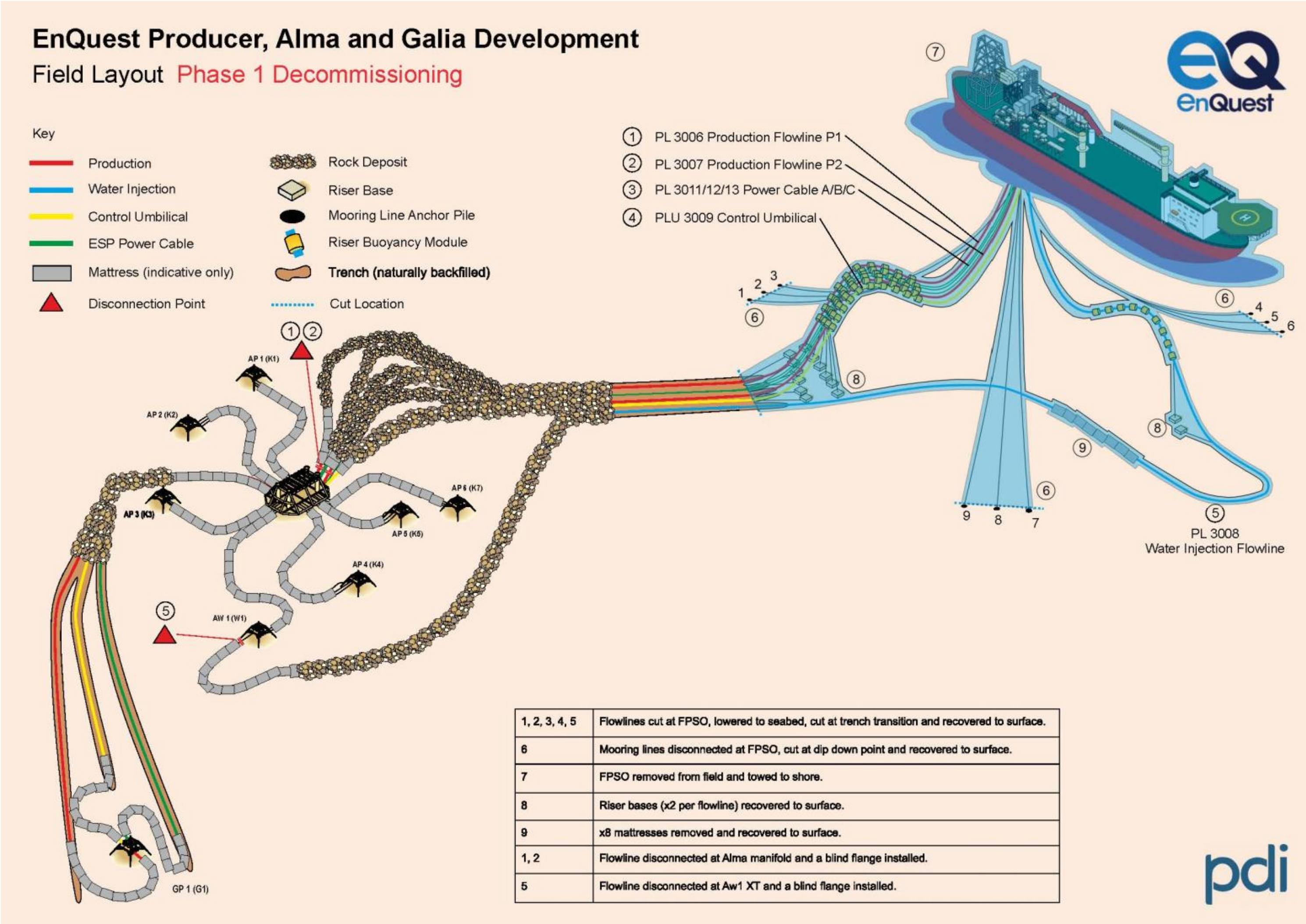
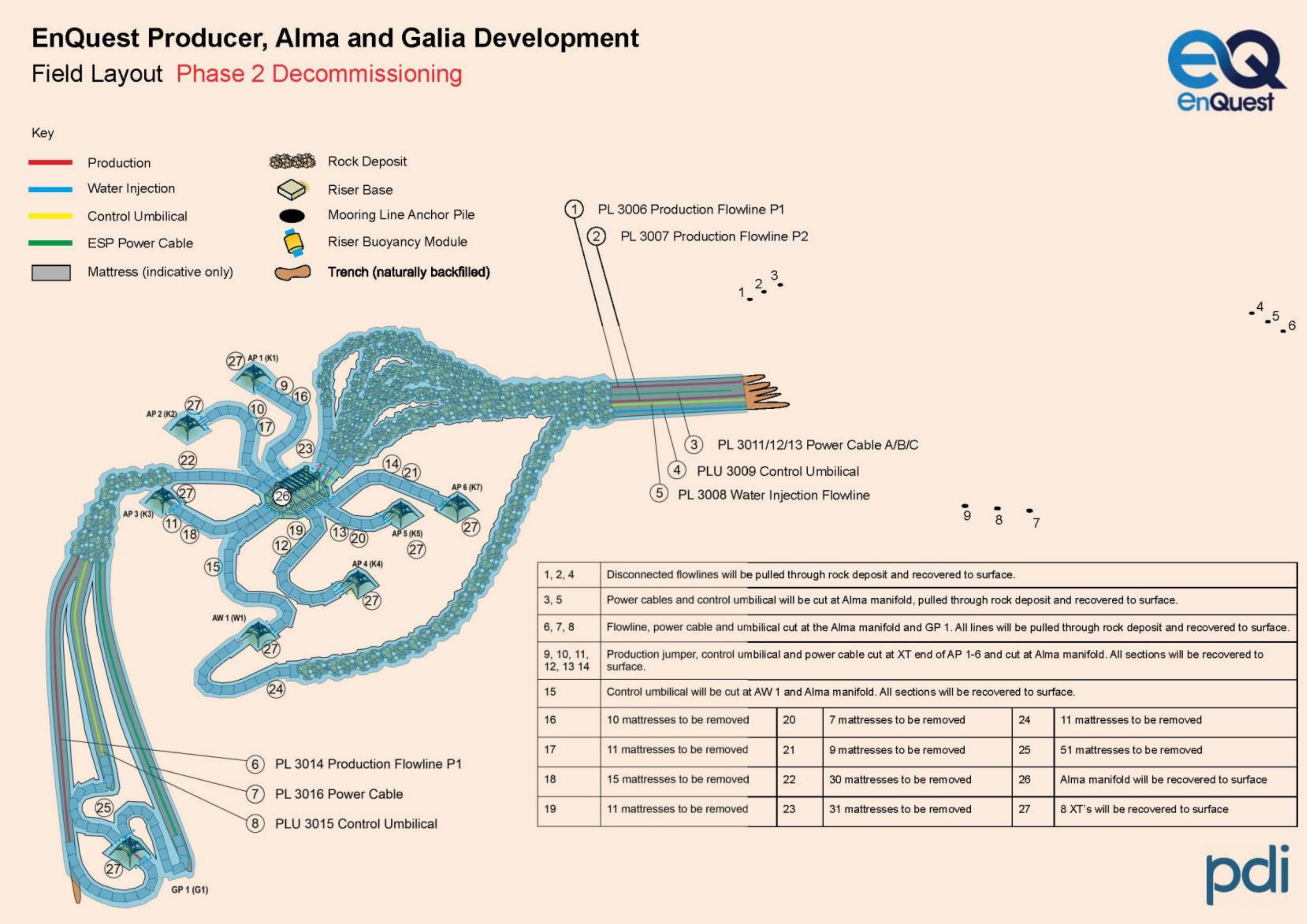


Figure 2.5.2: Field layout after Phase 1 of decommissioning activities[7]

[7] The cut pipeline ends will meantime be protected using the mattresses recovered from the water injection flowline inside the 500m zone.



1, 2, 4	Disconnected flowlines will be pulled through rock deposit and recovered to surface.				
3, 5	Power cables and control umbilical will be cut at Alma manifold, pulled through rock deposit and recovered to surface.				
6, 7, 8	Flowline, power cable and umbilical cut at the Alma manifold and GP 1. All lines will be pulled through rock deposit and recovered to surface.				
9, 10, 11, 12, 13 14	Production jumper, control umbilical and power cable cut at XT end of AP 1-6 and cut at Alma manifold. All sections will be recovered to surface.				
15	Control umbilical will be cut at AW 1 and Alma manifold. All sections will be recovered to surface.				
16	10 mattresses to be removed	20	7 mattresses to be removed	24	11 mattresses to be removed
17	11 mattresses to be removed	21	9 mattresses to be removed	25	51 mattresses to be removed
18	15 mattresses to be removed	22	30 mattresses to be removed	26	Alma manifold will be recovered to surface
19	11 mattresses to be removed	23	31 mattresses to be removed	27	8 XT's will be recovered to surface

Figure 2.5.3: Field layout after Phase 2 of decommissioning activities

3. ENVIRONMENTAL BASELINE

This section of this EA report summarises the main features and sensitivities of the environmental baseline in the project area. Only features and sensitivities which are of relevance to the EA report, as identified in the ENVID have been presented. Where the ENVID identified no potential for interaction between the project activities and certain environmental receptors, no description of the receptors has been provided.

3.1 Environmental Baseline Surveys

Several site surveys have been undertaken over the Alma and Galia fields, with environmental sampling points shown on Figure 3.1.1. Two surveys were undertaken in the area in 1995 and 1998 (Cordah, 1995 & 1998), post decommissioning of the Argyll and Duncan fields. These primarily focused on the impact on sediment characteristics, benthic fauna and hydrocarbon contamination from the oil and gas activity.

Separate pre-development surveys of the Alma and Galia fields were undertaken in 2011 (Gardline, 2011a & 2011b), with a focus on characterising the environmental baseline of the area. The seabed samples, video and photography were focused on locations of intended infrastructure and were used to verify the absence of Annex 1 or other sensitive habitats and characterise the extent of impact from previous oil and gas development. The final infrastructure locations differed from those used as the basis of the surveys, but the sample stations still provide good spatial coverage of the wider area.

Following the pre-development survey conducted in 2011, subsequent surveys have been visual only. However, as discussed below, operations in the field since 2011 have not significantly impacted the seabed and therefore visual assessments are considered adequate to characterise the current state of the seabed in the area.

An ROV survey of the FPSO mooring chains was undertaken in 2016 (Deepocean, 2016) and ROV riser and subsea infrastructure and pipeline integrity surveys were completed in 2018 for all the pipelines (Deepocean, 2018 & 2019). The footage from these surveys also provide details on the condition of the seabed and benthic environment in the Alma and Galia developments.

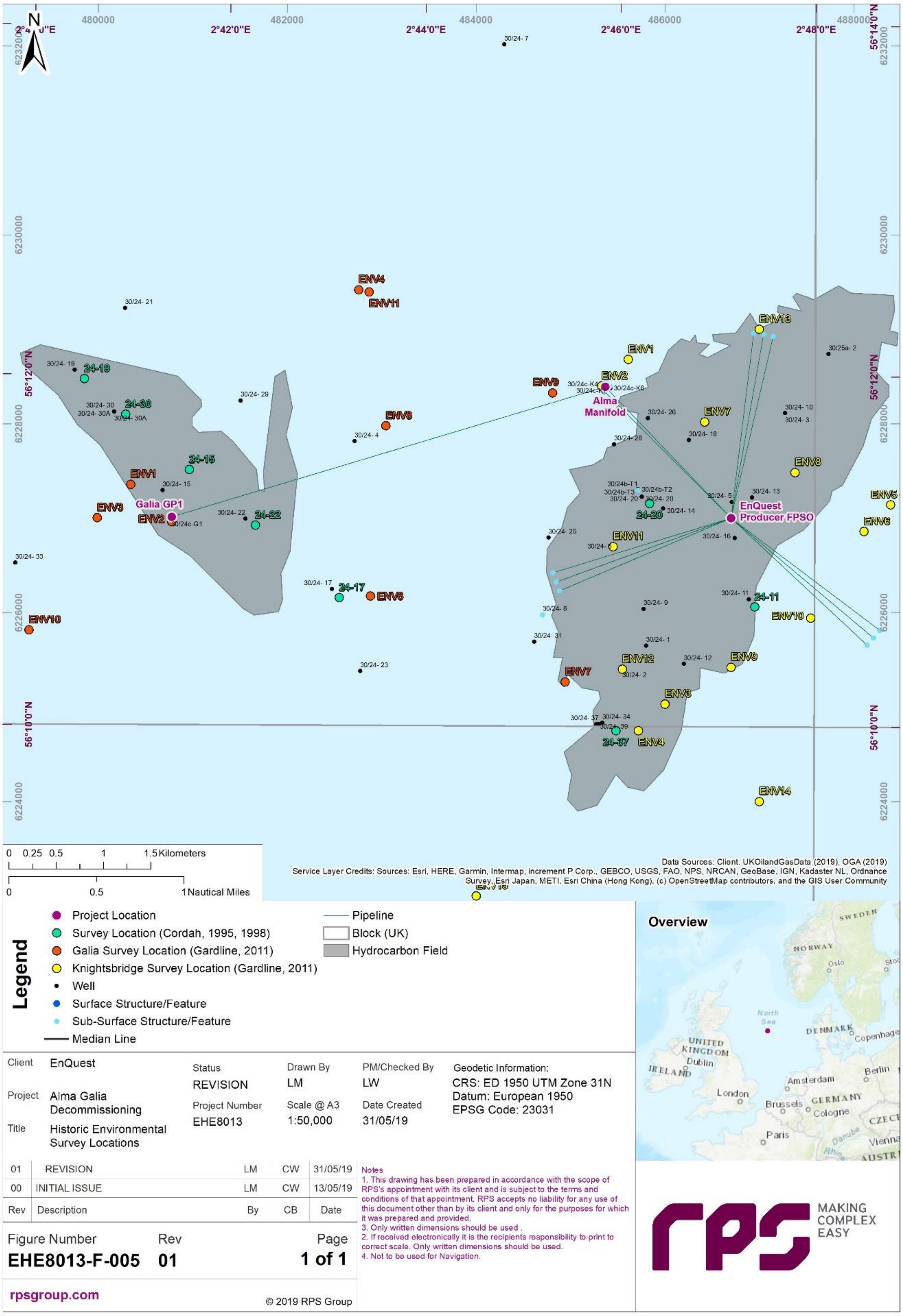


Figure 3.1.1: Environmental seabed sample locations from historical surveys

3.2 Physical Environment

Charted water depths across the project area are between approximately 73.8 and 80.3 metres, with depth decreasing towards the south east of the project area (Figure 3.3.1; Gardline, 2011a).

Wave conditions in the North Sea are strongly influenced by seasonal changes, with maximum wave heights peaking around January, although extreme waves may also be encountered at other times most notably between November and March. Significant wave height in the vicinity of the project area is 2.11-2.40 metres (Marine Scotland, 2019), although the 100-year extreme significant wave height is 13.6m and 1-year extreme is 9.4m (EnQuest, 2012).

Tidal current speed and direction measured at the nearest Admiralty tidal diamond to the project area (Tidal Diamond M, sheet 2182B, located at 56°00'N,02°24'E, approximately 27 kilometres south west of the Galia well) shows maximum tidal rates in the region are 0.5 and 0.3 knots respectively for spring and neap tides (Hydrographer of the Navy, 2007). This is slightly higher than other areas of the central North Sea. The direction of residual water movement in the CNS is generally to the south-east, with residual currents flowing towards the south with speeds of approximately 0.01 m/s (DTI, 2001; DECC, 2011 & 2016). The mean residual currents surrounding the Alma and Galia fields is approximately 0.1m/s (Wolf et al., 2016).

Prevailing wind directions vary seasonally in the project area, but on average south westerly winds predominate. The calmest months are from April to July, where winds also tend to dominate from the west and north-west (NOGAPS, 2015).

Near the project area the mean sea surface temperature ranges from approximately 5.7ºC in March to 15.5 ºC in August, with an average annual temperature 9.7ºC (Marine Scotland, 2019). Waters in the area are seasonally stratified, with weakly stratified shelf water present in the spring, stratified shelf water present in the summer and autumn, and well mixed shelf water present in the winter. To the south of the Alma and Galia fields, a thermal frontal zone exists at the southern boundary of Regional Sea 1 from Flamborough Head to the Frisian Islands, which marks a transition zone between mixed and stratified water in the North Sea (DECC, 2016).

3.3 Seabed Sediments

Substrates in the vicinity of the project area comprise mainly of sand with small areas of slightly gravelly sand and muddy sand (Marine Scotland, 2019). The EUNIS broad-scale habitat predictive map describes the habitat across the project area mainly as 'deep circalittoral sand' (A5.27) (McBreen et al., 2011; EMODnet, 2019).

The Alma site survey (Gardline, 2011a) identified a uniform seabed with occasional shell fragments. Surface sediments consist of Holocene silty slightly shelly sands (Figure 3.3.1). There are north-north-east to south-south-west orientated ripples in the east of the Alma development area, where mud in-fills troughs, and coarser sediments accumulate along the banks of the ripples (Figure 3.3.1). The sediments are characterised as "very loose" to "loose with a poor to moderate degree of sorting". Sediments typically range from fine to very fine (<63µm) in grain size, although there is occasional accumulation of coarse sediment. Gravels (sediment >2 millimetres) were virtually absent at all stations, except one where it comprised 4% of the sample. Sediments grade finer with water depth, with coarser sediments located in shallower water depth. The particle size analysis indicated that sediment is dominated by fine sand using the Wentworth classification, and dominated by sand (at 9 out of 15 stations) under the Modified Folk Classification. Occasional boulders up to 1.2 metres in height from the seabed are also distributed throughout the Alma development area.

The silty slightly shelly sand is underlain by firm to very stiff sandy gravelly clay at a depth ranging from <1m in the region of the Alma drill centre to 4m to the north and west of the FPSO location (Gardline 2011a).

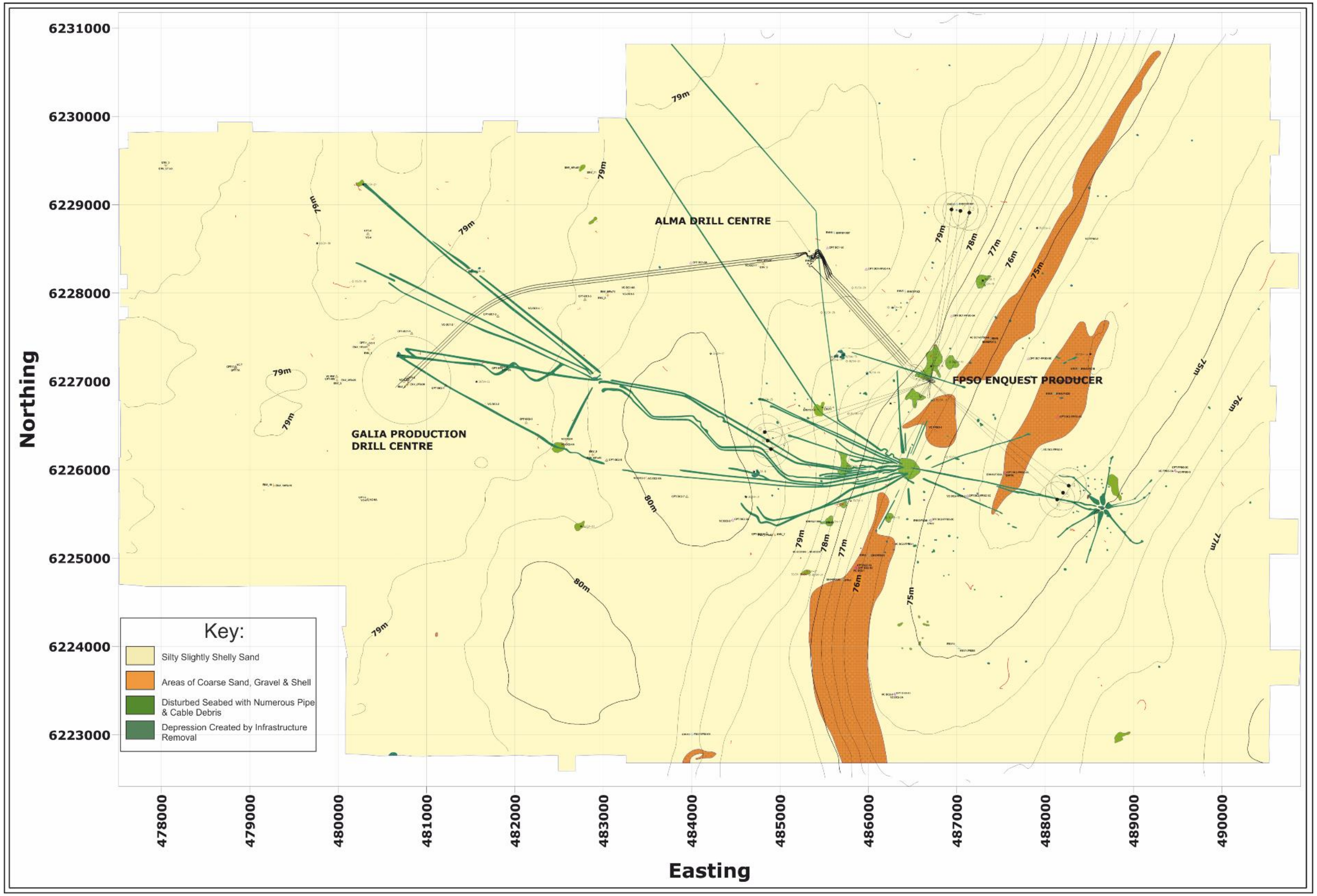


Figure 3.3.1: Bathymetry, seabed sediment and features - Alma & Galia (Gardline, 2011a)

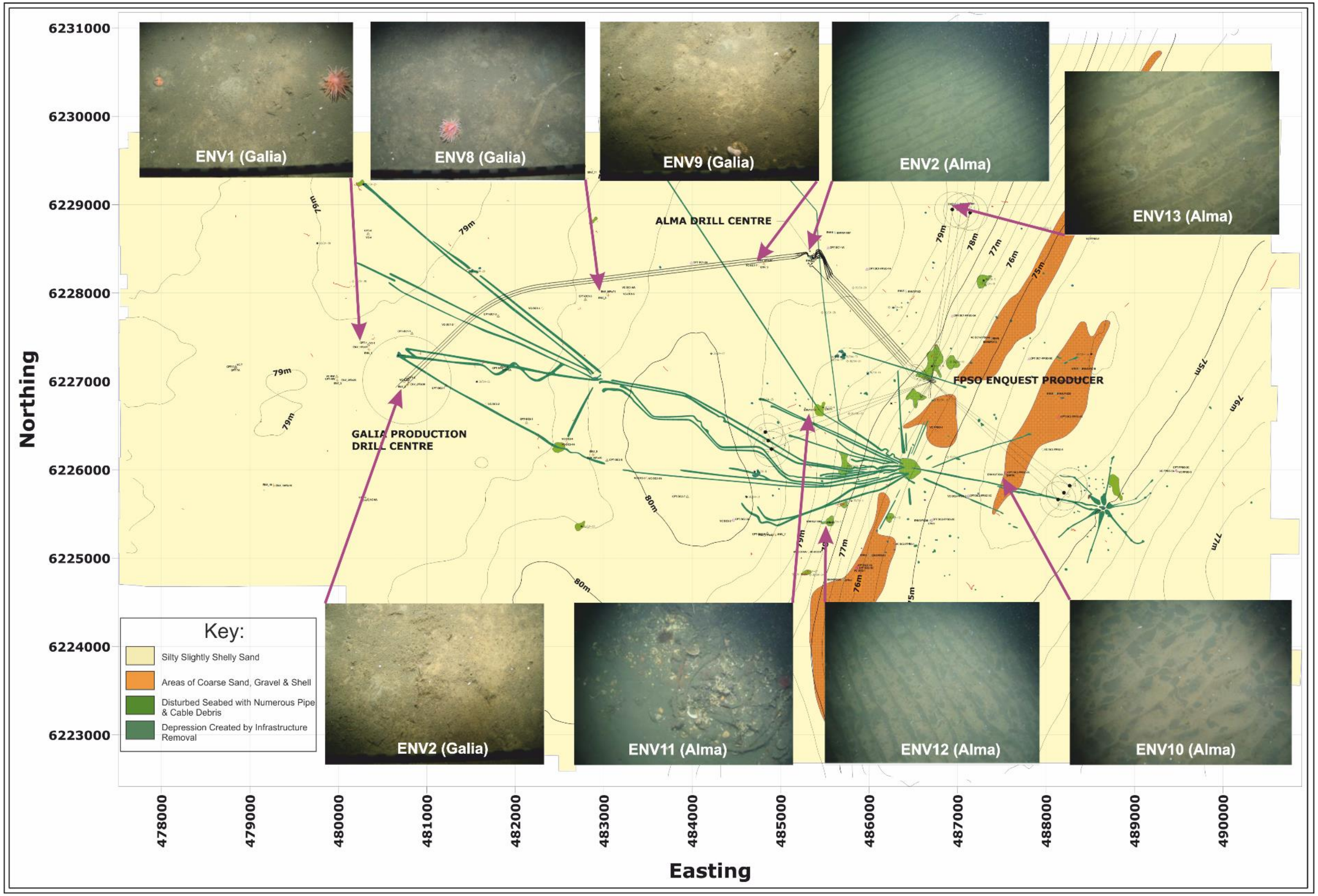


Figure 3.3.2: Seabed images from Alma & Galia surveys (Gardline, 2011a & 2011b)

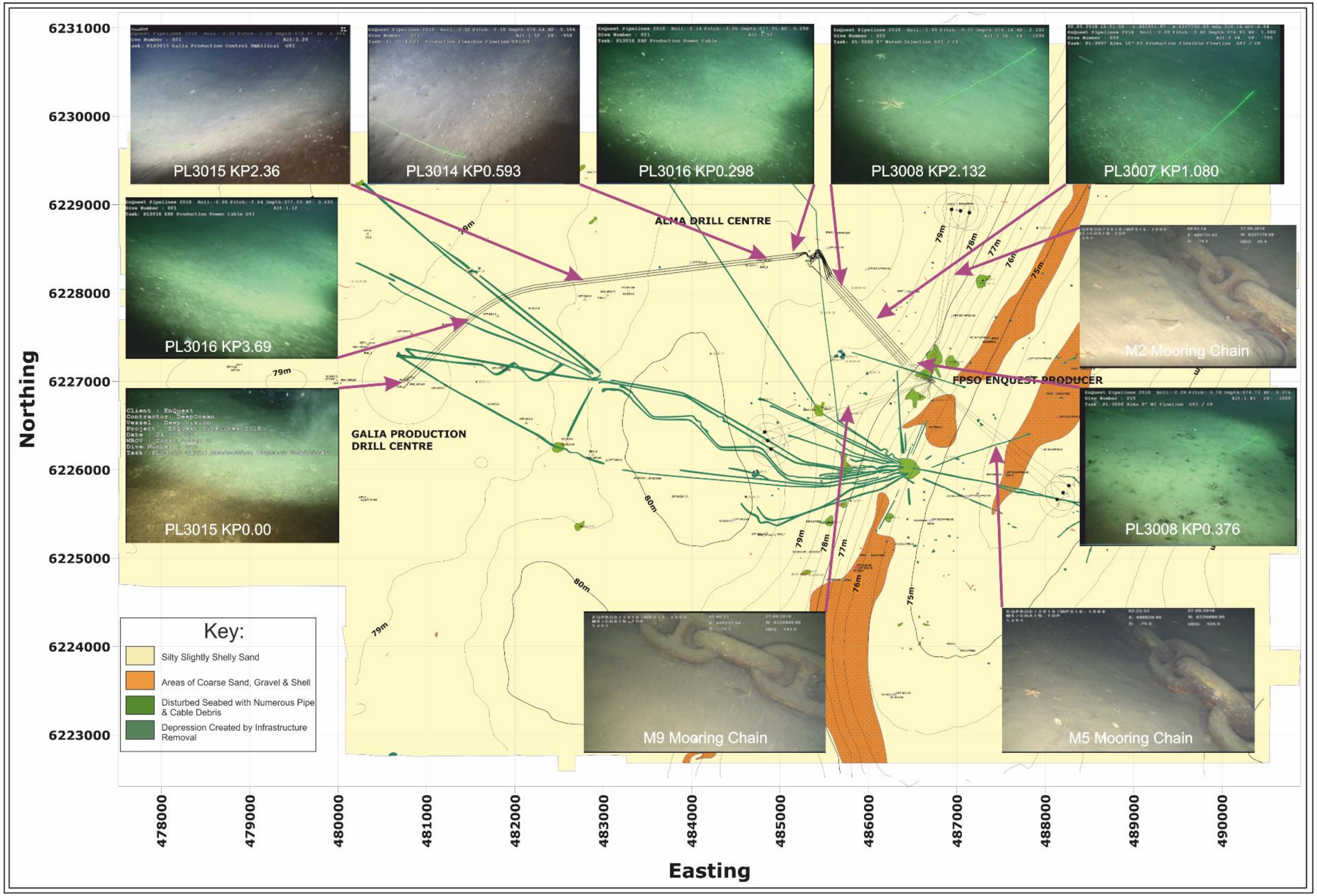


Figure 3.3.3: Seabed images from ROV surveys (Deepocean, 2016 & 2018)

There are several sites of seabed depressions located across the Alma development area, ranging from 10 to 20 metres, up to 0.5 kilometres in length, and maximum gradient of 18º, which are likely to be associated with the decommissioning of the Argyll/Ardmore field, i.e. spudcan depressions or depressions associated with the removal of infrastructure (Figure 3.3.1). A series of linear depressions (<0.5m depth) were found in the survey area, relating to previous infrastructure found at the Argyll/Ardmore fields. Anthropogenic debris, such as cables and pipes, is found in some areas, again associated with previous decommissioning. These areas are less likely to have ripples, with a more consistent veneer of mud and more shell fragments (Gardline, 2011a; EnQuest, 2012).

The Galia site survey (Gardline, 2011b) identified surface sediments consisting of Holocene silty slightly shelly sands with scattered small depressions accumulating shells (Figure 3.3.2). The sediments are characterised as “very loose” to “loose with a poor to moderate degree of sorting”. Sediments typically range from fine to very fine (<63μm) in grain size, and gravels were not identified in the area. The particle size analysis indicated that sediment is dominated by fine sand using the Wentworth classification, and classed as muddy sand under the Modified Folk Classification. Occasional boulders up to 0.5 metres in height from the seabed are also distributed throughout the Galia development area. Overall, the sediment across the Galia development area can be described as featureless and generally homogeneous. The surface sediments are in places a thin veneer over firm to very stiff sandy gravelly clay with interbedded dense silty sand. The depth of the surface sediments ranges from 0 to 1.3m below seabed. A series of linear depressions (<0.5m depth) were found in the north eastern corner of the survey area, relating to previous infrastructure found at the Argyll/Ardmore fields (Figure 3.3.1). Occasional cable/pipe debris in the northern half of the survey area and minor depressions were also apparent (Gardline, 2011b; EnQuest, 2011).

The post 2011 visual surveys (Figure 3.3.3) concentrated on the seabed along the mooring chains and pipeline route corridors and show that the seabed sediment type is consistent with that observed in 2011 (Figure 3.3.2). The east of the site shows a more shelly-sand seabed, whilst the west of the site has a slightly higher percentage of fines. There is less evidence of distinct sand waves in the east of the site in 2016 and 2018 compared to 2011. This is possibly due to the scale of the seabed images in the different surveys.

There is no evidence of any significant seabed trenches or catenary scrape caused by the mooring lines in ROV footage from the 2016 mooring survey. However, this survey covered just a short length of the mooring lines laid on the seabed.

3.4 Contamination of Sediments

The historical development of the Alma and Galia field area has resulted in legacy contamination in the sediments. The Argyll (Alma) and Duncan (Galia) fields was one of the first fields to be drilled in the UKCS and a diesel based drilling fluid was used and discharged to sea in 6 of the wells and low toxicity oil based mud (LTOBM) was used and discharged in 12 other wells (Figure 3.4.1). The cuttings piles surrounding these wells were approximately 15-20m in diameter and ¼ and ½m deep (Hamilton Brothers 1992), although as the wells were not grouped close together no overlap of cuttings piles occurred. The subsequent Ardmore (Alma) development also used LTOBM for lower-hole sections but these were contained and shipped to shore for disposal with no overboard discharge. The top-hole sections of the Ardmore wells were relatively shallow (ca. 9,000ft) and therefore no large accumulation of cuttings is evident.

At the completion of decommissioning operations for the Argyll and Duncan fields a seabed debris trawl was undertaken over a wide area (shaded light pink in Figure 3.4.1). This trawl broke up, re-suspended and re-distributed the oil-based mud (OBM) contaminated cuttings piles so that discrete piles were no longer observed in post decommissioning surveys, although sediment contamination was evident over a wide area (Cordah, 1995 & 1998).

A post decommissioning seabed debris trawl was also undertaken at Ardmore (shaded dark pink in Figure 3.4.1) including the area of the wells and cuttings piles.

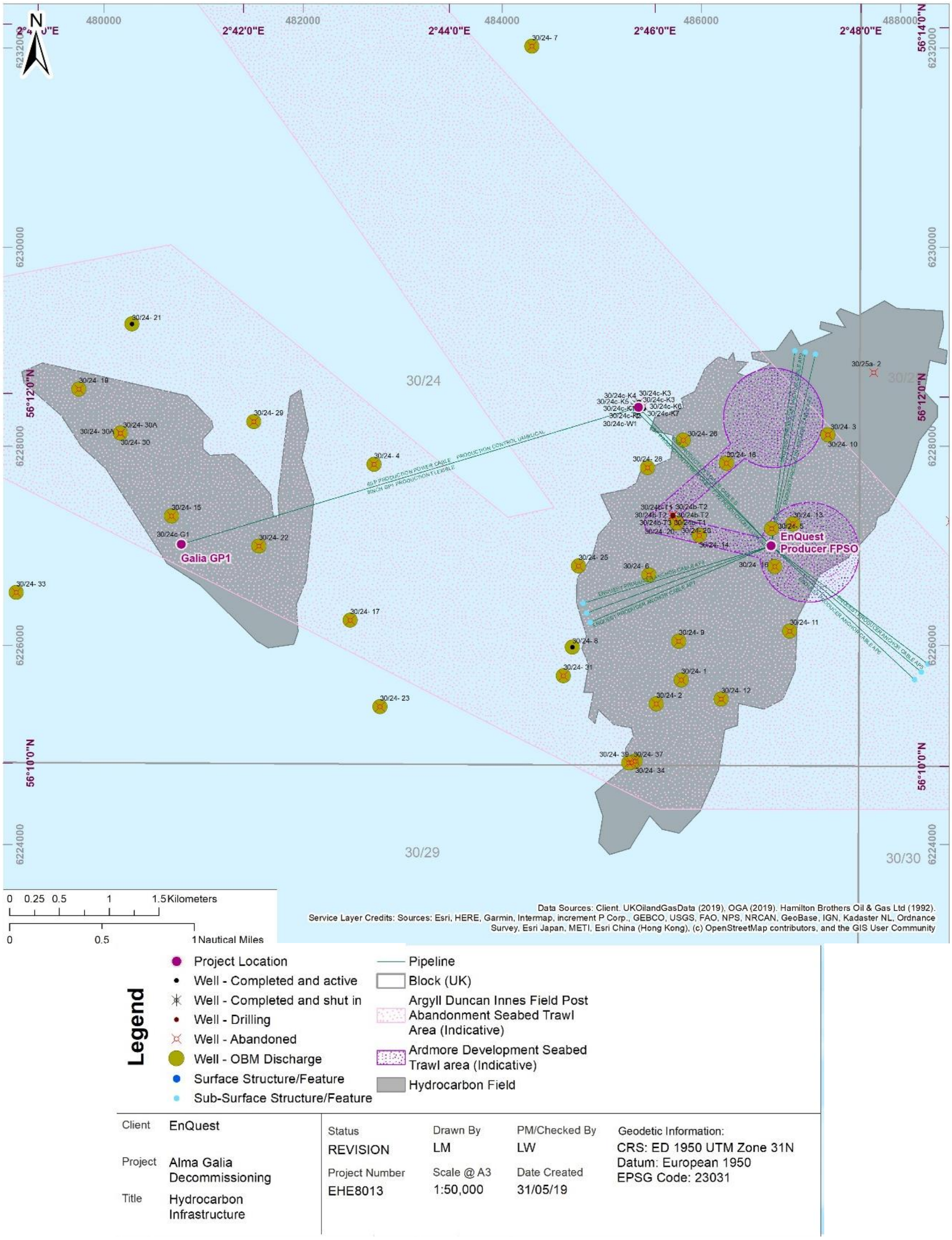


Figure 3.4.1: Alma & Galia infrastructure and historical OBM and seabed trawls

3.4.1 Argyll and Duncan Surveys (1995 and 1998)

Post decommissioning surveys were undertaken over the Argyll and Duncan fields, two and six years after decommissioning, with the same 12 stations sampled during both surveys. These 12 stations were positioned approximately 100m from one or more of the former wells drilled with diesel or LTOBM which was subsequently discharged to sea (Figure 3.1.1).

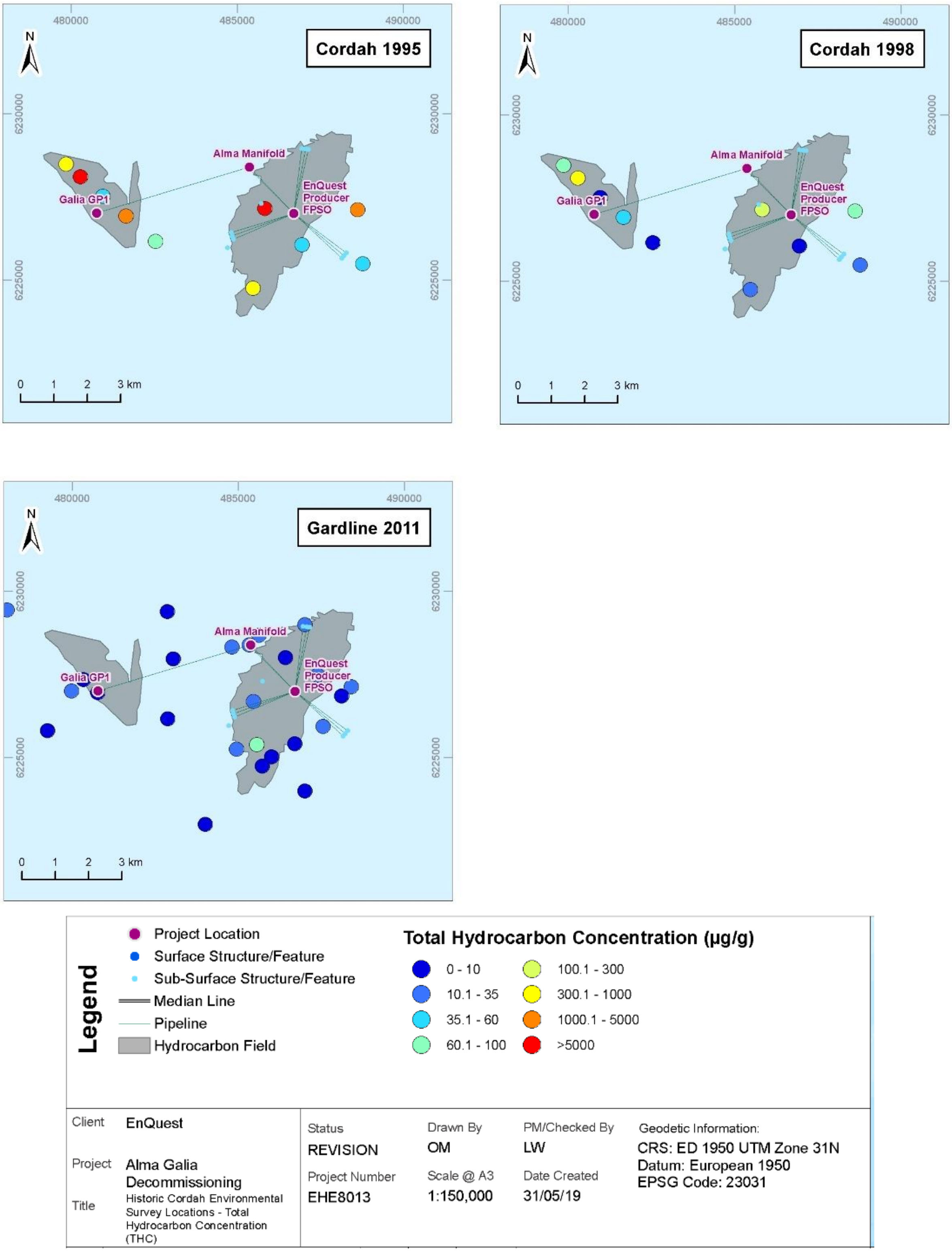


Figure 3.4.2: THC from the Alma & Galia areas – historical surveys over 17 years

The first post-abandonment survey in 1994 (Cordah, 1995) identified obvious petrogenic hydrocarbon contamination at 8 of the 12 stations. Total hydrocarbon concentrations (THC) ranged from 51.8µg.g^{-1} to 6,611.3µg.g^{-1} (Figure 3.4.2), compared to mean background THC levels for the central North Sea of 9.51µg.g^{-1}. Elevated concentrations of trace metals, particularly barium, were also found at many of the stations with the maximum values (3,129µg.g^{-1} compared to 348µg.g^{-1} for central North Sea background[8] (UKOOA, 2001)) occurring at those stations which were contaminated by diesel. Sediment lead contamination was also found to vary in line with THC, which elevated concentrations at sites with barite contamination (used in drilling muds).

Benthic macrofauna from the survey were typical of a transition zone between the more severely disturbed area, presumed to be present immediately around the well, and undisturbed fauna further away from the well. Species which are often seen to behave as secondary opportunists (e.g. the polychaetes *Chaetozone setosa, Paramphinome jeffreysii* and species of the bivalve group *Thyasira*) were numerically dominant or present at most of the stations. However, benthic diversity was not depressed at any of the stations as would be expected in areas of severe OBM impact.

Revisiting the survey stations in the 1998 survey (Cordah, 1998) showed that there had been a significant decrease in THC concentrations at all stations over the four year period (Figure 3.4.2, Table 3.4.1). Sediment hydrocarbon concentrations at three of the stations were considered to have been reduced to background levels and only three stations had THC concentrations greater than 77µg/g^{-1}. Sediment trace elements, usually associated with contamination from drilling activity, showed similar trends although there was a clear association between contaminants and the finer sediment fraction. This suggests that some variation could be down to varying mud content at the sites potentially related to the persistence of hydrocarbon contamination in finer sediments.

THC & Ba concentrations from historical environmental surveys			
Survey Station	1994 THC (µg/g^{-1})	1998 THC (µg/g^{-1})	1998 Barium (µg/g^{-1})[9]
24-11	54.1	4.0	283
24-15	57.8	3.2	515
24-17	95.5	2.1	447
24-20	6,611.3	171.8	7,087
24-22	1,550.6	48.3	1,926
24-30	5,775.2	675.6	1,609

Table 3.4.1: THC & Ba concentrations from historical environmental surveys

The composition of the macrofaunal communities found in the 1998 survey were like 1994, with several of the numerically dominant taxa being typical of the zone of transition between the heavily impacts areas around wellheads and background faunal compositions found further from sites of contamination. These included the polychaetes *Paramphinome jeffreysii* and *Pseudopolydora cf. paucibranchiata* and bivalves of the genus *Thyasira*. All three of these taxa gave significant correlations with both sediment barium content and THC, while the scaphopod mollusc *Antalis entails* correlated negatively with both barium and THC. Analysis suggested that nearly 40% of the variance in the benthic species data appeared to relate to the impacts of oil production.

The 1998 survey concluded that although there was clear evidence of an impacted fauna, it appears that the impact has reduced considerably in the four years since 1994, in line with reductions in hydrocarbons and other contaminants. Reductions in the abundance of polychaete, *Chaetozone setosa*, known as a secondary opportunist, and corresponding increases in more sensitive species such as the scaphopod mollusc, *Antalis entails,* and the amphipod, *Ampelisca diadema,* suggest that there is a degree of recovery in the benthic macrofauna.

The results of the 1998 survey suggest that whilst there remains a detectable impact of OBM

[8] Background concentration based on extractions performed by sodium fusion or similar

[9] No 1994 barium data is presented as the extraction methods differed between surveys, with the double acid extraction method potentially significantly underestimating the barium content compared to the more recent lithium metaborate fusion method using in the 1998 survey.

discharges, the impact is significantly reduced compared to 1994 and can be expected to continue to reduce further.

3.4.2 Pre-Alma and Galia Baseline Survey (2011)

Most of the stations in the 2011 pre-Alma and Galia baseline surveys (Gardline, 2011a & 2011b) were in different areas to the 1994 and 1998 survey. However, Figure 3.1.1 shows that several of the 2011 survey stations were in similar areas.

Sediment hydrocarbon analysis from the 2011 surveys			
Survey Station	**THC ($\mu g/g^{-1}$)**	**Barium ($\mu g/g^{-1}$)[10]**	**Pristane / Phytane Ratio**
Alma ENV1	11.7	418	15.5
Alma ENV2	11.7	394	-
Alma ENV3	9.77	245	14.8
Alma ENV4	8.42	293	-
Alma ENV5	16.95	353	1.0
Alma ENV6	5.58	196	-
Alma ENV7	9.27	958	12.4
Alma ENV8	13.07	240	20.5
Alma ENV9	9.05	212	-
Alma ENV10	12.45	213	14.4
Alma ENV11	21.90	749	2.4
Alma ENV12	90.75	4,500	1.7
Alma ENV13	13.54	393	-
Alma ENV14	7.19	235	-
Alma ENV15	8.66	289	9.1
Galia ENV1	9.6	249	-
Galia ENV2	9.9	215	9.5
Galia ENV3	10.7	176	6.9
Galia ENV5	15.8	154	15.8
Galia ENV6	8.9	126	-
Galia ENV7	11.3	303	9.4
Galia ENV8	7.3	198	-
Galia ENV9	10.5	281	-
Galia ENV10	7.8	143	-
Galia ENV11	7.4	105	-

Table 3.4.2: Sediment hydrocarbon analysis from the 2011 surveys

THC concentrations in 2011 ranged from $5.58\mu g/g^{-1}$ to $90.75\mu g/g^{-1}$, with one station showing values of $<25\mu g/g^{-1}$ (Table 3.4.1), significantly reduced from the values recorded in the 1998 survey (Figure 3.4.2). However, 15 out of the 25 sites (primarily at Alma not Galia) exhibited THC concentrations above the mean background level of the central North Sea ($9.51\ \mu g/g^{-1}$), suggesting that some historical sediment contamination may persist over the wider area albeit at relatively low concentrations.

The three sites with the highest THC values (Alma ENV5, Alma ENV11 and Alma ENV12) are all within 100m of a well previously drilled with OBM which was subsequently discharged. Although these sites showed elevated THC values of $16.95\mu g/g^{-1}$, $21.9\mu g/g^{-1}$ and $90.75\mu g/g^{-1}$ respectively, they were reduced from the THC values seen in 1994 and 1998 within 100m of the well sites (Table 3.4.1, Figure 3.4.2).

This pattern was also seen in the total polycyclic aromatic hydrocarbons (PAH) concentrations, pristane/phytane ratios and unresolved complex mixture (UCM) values, where most of the stations were consistent with North Sea background conditions with any contamination of a pyrogenic rather than petrogenic source (high pristane/phytane ratio; Table 3.4.2). The exceptions were stations Alma ENV5, Alma ENV11 and Alma ENV12 which recorded a higher proportion of PAH's

[10] Concentration determined following fusion with lithium metaborate and extraction with nitric acid

and a lighter UCM, interpreted to be due to weathered diesel-based drilling fluids from the Argyll wells.

There was no evidence of significant hydrocarbon contamination from anthropogenic inputs at the Galia survey sites. Heavy and trace metal analysis largely confirmed this pattern of contamination. Barium (Ba) concentrations ranged between 196µg/g^{-1} to 4500µg/g^{-1}, with all but three stations (Alma ENV7, Alma ENV11 and Alma ENV12) below the mean background concentration for the central North Sea (348µg/g^{-1}, extractions performed by sodium fusion or similar; UKOOA 2001). The three stations exceeded the 95th percentile value (720µg/g^{-1}; UKOOA, 2001) with all other stations considered to be at background levels (Gardline, 2011c).

Barium (Ba) in the form of barite is a common constituent of drilling fluids so high levels of Ba at these three stations suggests the presence of drilling related discharges. Considering the THC results this would be expected for stations Alma ENV11 and Alma ENV12, however, high levels of Ba at Station ENV7 are not reflected in the hydrocarbon analyses. Station Alma ENV5 did not show high levels of Ba, which is unexpected given the results of THC, however, this station had a relatively low percentage of fine material recorded which reduces the capacity for adsorption of metals.

Other metals often associated with drilling fluids include chromium (Cr), lead (Pb), and zinc (Zn). Cr and Zn concentrations across the Alma survey site were consistent with expected background concentrations reported for ‘pristine’ sediments in OSPAR (2005), while Pb exceeded the OSPAR (2005) threshold at Stations ENV5 and ENV12. However, Pb was below the Apparent Effects Threshold (AET) (*Buchman, 2008*). Although background concentration for Cadmium (Cd) was exceeded at Alma stations ENV1, ENV11 and ENV14, these were below the effects range low concentration reported in Long *et al.* (1995).

Fix: 26	Retention: MFA	Location: 485501 E 6225402 N

Figure 3.4.3: Seabed sediments from Alma survey station ENV12 (Gardline, 2011c)

The presence of elevated metal concentrations at stations Alma ENV7, Alma ENV11 and Alma ENV12 indicate that these stations were subject to point source pollution from discrete nearby sources (probably wells 30/24-18, 30/24-6 and 30/24-2, respectively). These contaminants are likely to be associated with finer sediments in deeper waters, due to the low energy environment where contamination is not so widely distributed. These finer sediments are also likely be composed in part from material discharged as a result of local drilling activity as well as material from the wider area (Gardline, 2011c). This is evident in seabed photos from site Alma ENV11 (Figure 3.3.2) which shows evidence of anthropogenic debris and dark, gravel-sized material identified in sieved samples from Alma station ENV12 (Figure 3.4.3), which may be remnants of drill cuttings. No discrete drill cuttings mounds have been identified in any of the surveys undertaken over the Alma and Galia area.

3.5 Benthic Communities

Unlike the 1994 and 1998 post Argyll and Duncan decommissioning surveys, the 2011 surveys of the Alma and Galia areas showed a generally rich, evenly distributed faunal community dominated by polychaetes (47% and 46% respectively) typical of North Sea sandy sediments (Figure 3.3.1). Dominance of polychaetes is typical of North Sea sediments where they are expected to represent at least 50% of macrofaunal species in a sample (Gardline, 2011b). Although camera evidence from the 2016 and 2018 ROV surveys (Figure 3.3.3) was focused on the pipeline and mooring line corridors only, the type and number of benthic fauna identified corroborate the results of the 2011 survey (Figure 3.3.2) discussed below.

Juvenile brittlestars (*Amphiuridae*) were one of the top ten most dominant taxa across the Alma survey area, representing 82% of the juvenile dataset and 16% of the total number of individuals. Further analysis showed that presence of a high number of juveniles did not significantly affect the measures of diversity in the full dataset (including juveniles) and the adult only dataset were over 95% similar (Gardline, 2011b).

3.5.1 Alma

For the Alma survey, the polychaete *Paramphinome jeffreysii* was the most abundant species across the survey area. It is tolerant to hydrocarbon contamination, although its abundance is also considered as natural and representative of the wider area and not necessarily attributed to hydrocarbon concentrations. Juvenile brittlestars (*Amphiuridae spp*) were the second most abundant species across the survey area, with the marine bivalve, *Kurtiella bidentata* third most abundant in the survey area in the full dataset.

The least abundant groups comprised 12 taxa of which two were the phyla Cnidaria (sea anemones), two from Priapulida (priapulid worm), two from Sipuncula (peanut worm), two from Chordata (*Ascidiacea*: seasquirt), and one each from Platyhelminthes (flatworms), Nemertea (ribbon worm), Phoronida (horseshoe worm) and Hemichordata (Gardline, 2011c).

The faunal pattern in the survey area was primarily due to natural variation in water depth and sediment size, however, point source anthropogenic contamination may also have an impact at some stations. The high THC values recorded at Station ENV12 appear to have limited impact on the overall faunal community. However, the low abundance of *Galathowenia oculata* and higher abundance of the hydrocarbon tolerant polychaete *Chaetozone setosa* and *P. jeffreysii* relative to the rest of the survey area may indicate an impact of hydrocarbon contamination on benthic species at this station (Gardline, 2011c).

A total of 16 juveniles of ocean quahog (*Arctica islandica*) were found across ten of the twenty-eight samples, and six of the fifteen stations. This species is on the OSPAR (2008) list of threatened and/or declining species in the North Sea and also listed as a Feature of Conservation Importance (FOCI) and Priority Marine Feature (PMF) under Marine Conservation Zone (MCZ) guidance (Natural England and JNCC Guidance; Marine and Coastal Access Act 2009; Marine Scotland Act 2010).

3.5.2 Galia

As with the Alma survey juvenile brittlestars (*Amphiuridae spp.*) were one of the top ten most dominant taxa across the survey area, representing 82% of the juvenile dataset and 16% of the total number of individuals. Analysis of the Galia samples showed a generally uniform, moderately diverse faunal community, with some patchy low and high abundance across the survey area.

The community was dominated by echinoderm individuals due to seasonality of the survey, representing 82%, and taxa dominated by polychaetes. *Pholoe assimilis, Paramphinome jeffreysii, Galathowenia oculata* dominated the adult communities, and were found to be ubiquitous across the survey area. Although *Pholoe assimilis* is considered to be tolerant to hydrocarbon contamination, its abundance is also considered as natural and representative of the wider area and not necessarily attributable to hydrocarbon concentrations.

One juvenile of ocean quahog (*Arctica islandica*) was found across the survey area. This species is on the OSPAR (2008) list of threatened and/or declining species in the North Sea and also listed as a Feature of Conservation Importance (FOCI) and Priority Marine Feature (PMF) under Marine Conservation Zone (MCZ) guidance (Natural England and JNCC Guidance; Marine and Coastal Access Act 2009; Marine Scotland Act 2010).

3.5.3 Marine Growth

The 2016 and 2018 surveys of the moorings and subsea structures (Deepocean, 2016 & 2018) identified areas of the development with existing marine growth (Figure 3.5.1). No species of conservation concern were identified, and thickness of both hard and soft growth ranged from 0mm to 60mm on the Alma manifold, wellhead protection structures and Galia wellhead protection structure. Percentage coverage of the growth ranged from 0 to 90% of the subsea structures. There were similar levels of marine growth identified on the FPSO end of the mooring chains and the hull of the vessel. For the marine growth mussels and barnacles are abundant and widespread, forming dense aggregations on the solid structures e.g. mooring chains and Alma manifold. Sea anemones (Actinaria), tunicates and faunal turfs (e.g. bryozoans and hydroids) were also present alongside the mussels and barnacles on many of the structures. Soft corals e.g. dead man's fingers (*Alcyonium digitatum*) were also recorded in locally high abundance on some structures with *Asteroidea* (likely *Asterias rubens*) on the mussel aggregations. None of the species and communities recorded colonising structures are protected or of conservation importance.

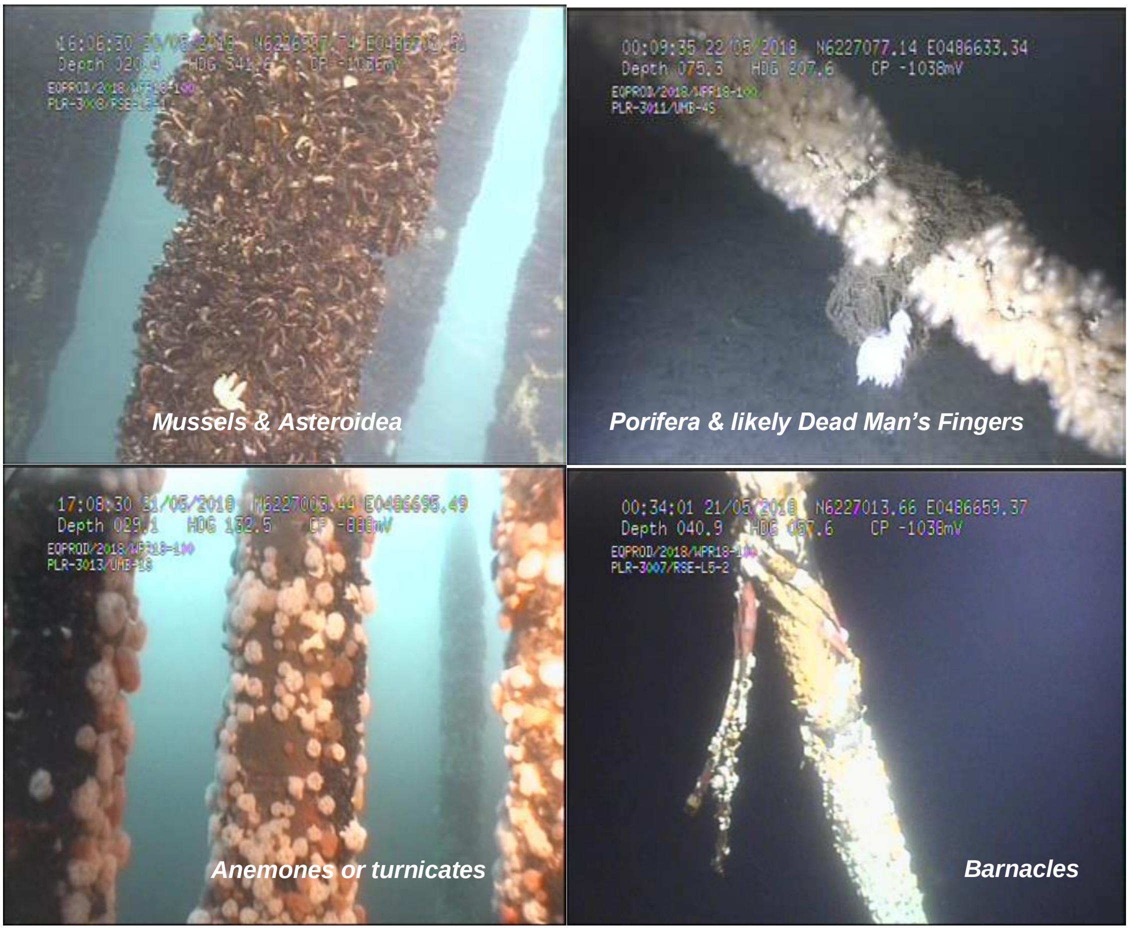


Figure 3.5.1: Sample photos of marine growth on the Alma & Galia subsea structures

3.6 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 a fundamental link in the food chain and is vulnerable to discharges to the sea and accidental chemical or hydrocarbon spills.

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). Most of the plankton occurs in the photic zone i.e. the upper 20 metres of the sea which receives enough light for photosynthesis (Johns and Reid, 2001). Natural seasonality and high small-scale variability, both in species composition and abundance, is an important feature of planktonic communities.

In the central North Sea 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. The concentrations of organisms in these blooms can be high, with chlorophyll concentrations around 2000mg chl m^{-3} (Reid et al., 1990) and a coincident elevated level of primary productivity. These blooms are important in sustaining a period of elevated biological productivity throughout marine food chains during the spring months and to a lesser extent during autumn.

Plankton species found in the project area 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).

3.7 Fish and Fisheries

Fish species known to use the project area for spawning and nursery are summarised in Table 3.7.1 and Figure 3.7.1 & Figure 3.7.2 (Ellis et al., 2012; Coull et al., 1998). It should be noted that, although potential spawning areas for fish species have been mapped, these areas are not fixed and are highly likely to vary spatially over time as fish populations naturally move through surrounding areas. Additionally, fish species may spawn earlier or later in response to seasonal variations in environmental conditions (Coull et al., 1998).

Fish spawning & nursery durations in the project area												
Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mackerel	N	N	N	N	N	N	N	N	N	N	N	N
Cod	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
Norway Pout	N	N	N	N	N	N	N	N	N	N	N	N
Sprat												
Sandeel	N	N	N	N	N	N	N	N	N	N	N	N
Plaice	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
Spurdog	N	N	N	N	N	N	N	N	N	N	N	N
Spotted ray	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
Blue whiting	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
Hake	N	N	N	N	N	N	N	N	N	N	N	N
Anglerfish	N	N	N	N	N	N	N	N	N	N	N	N
	Peak Spawning			Spawning				N	Nursery			

Table 3.7.1: Fish spawning & nursery durations in the project area[11]

[11] Coull et al. (1998) and Ellis et al. (2012)

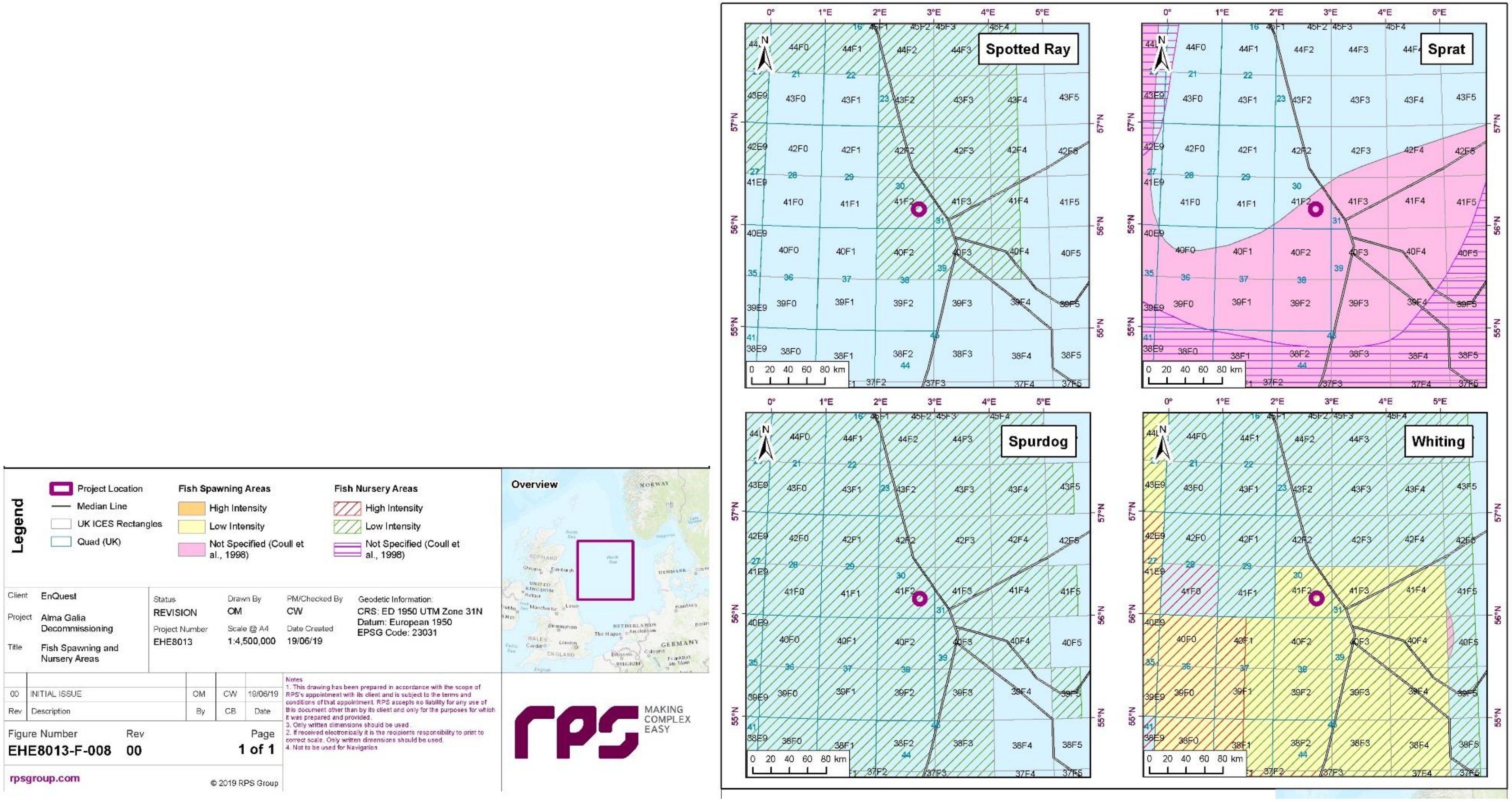


Figure 3.7.1: Spawning and nursery areas (Coull et al., 1998)

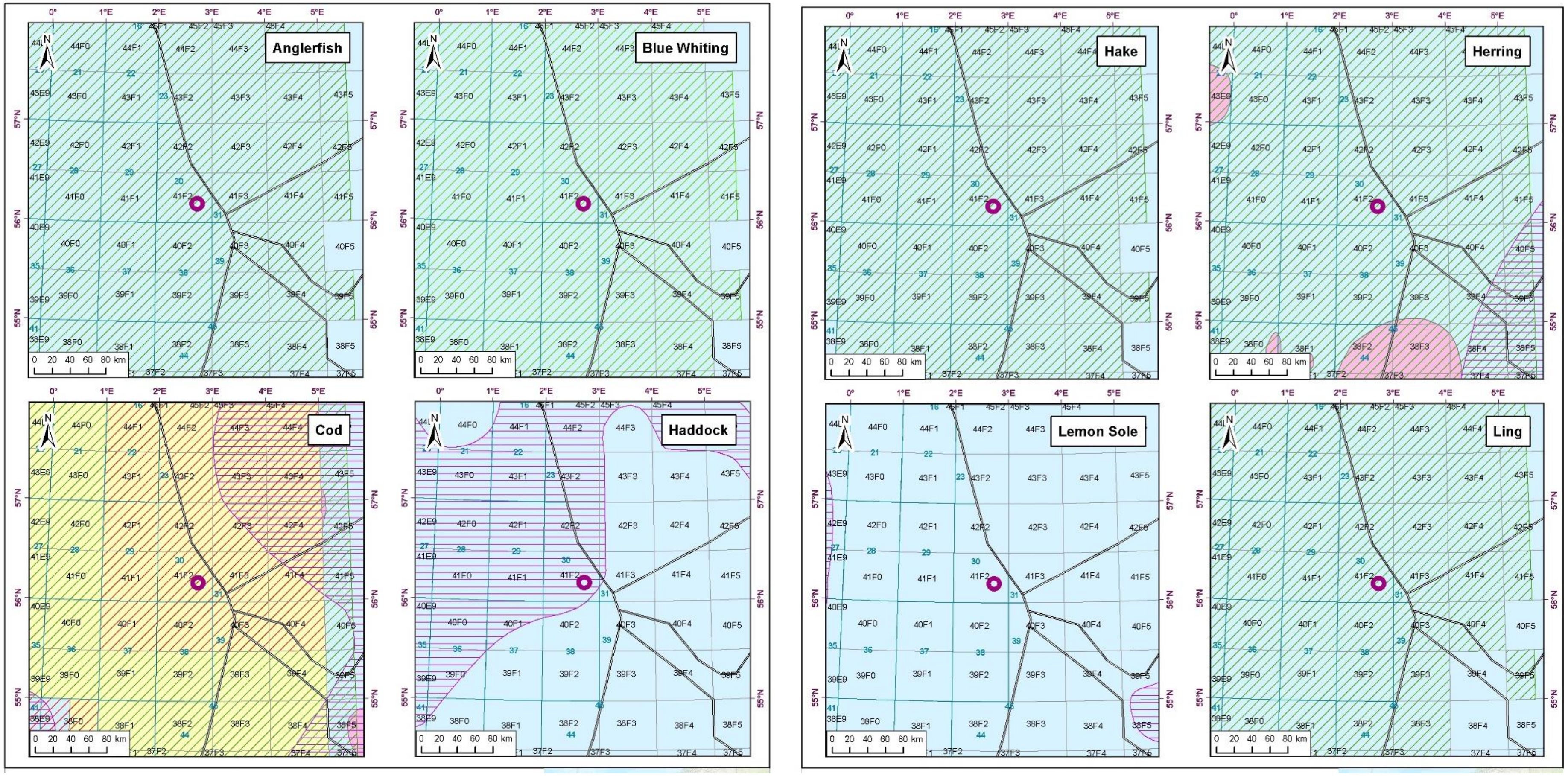


Figure 3.7.2: Spawning and nursery areas (cont'd/,,,)(Coull et al., 1998)

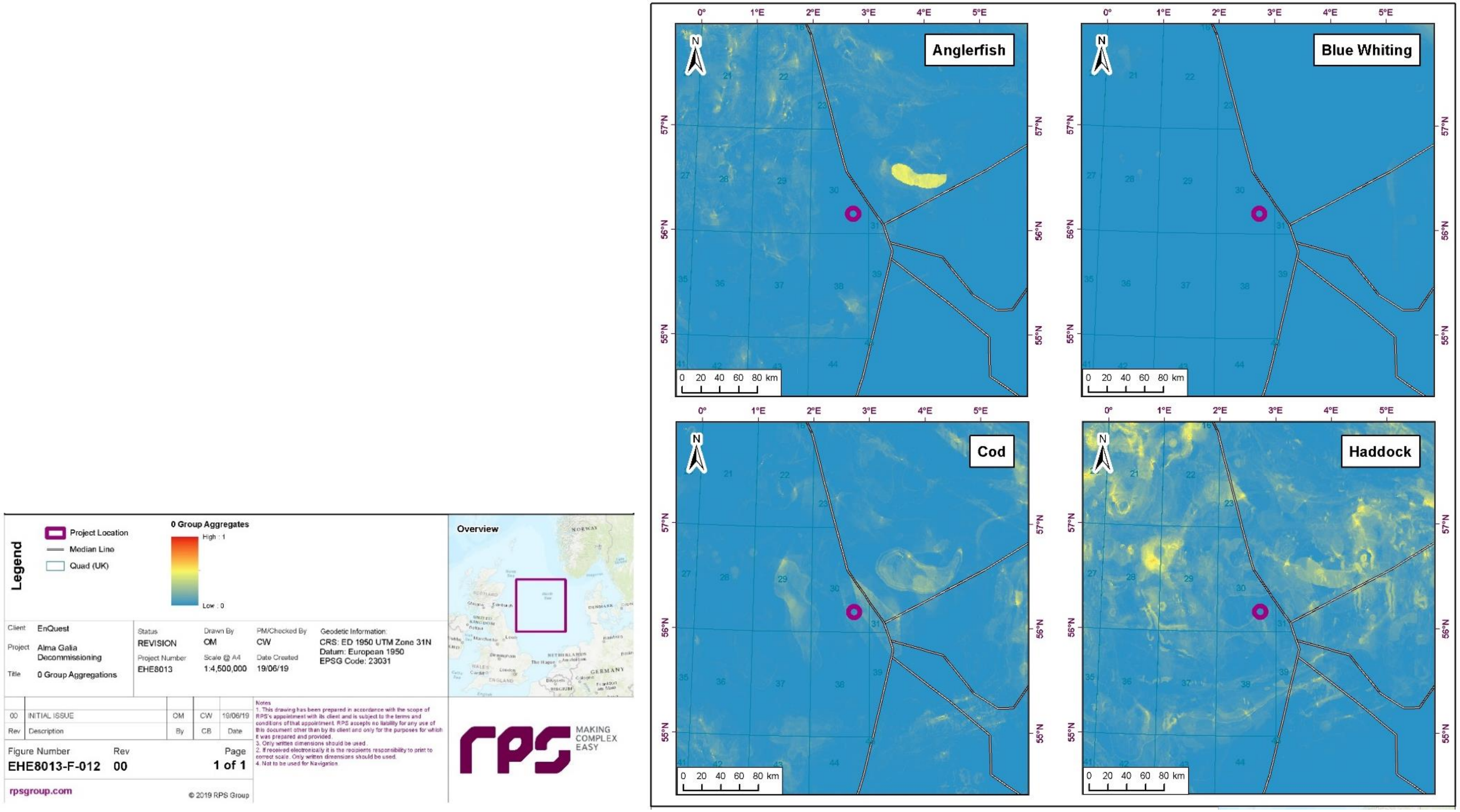


Figure 3.7.3: 0 Group fish

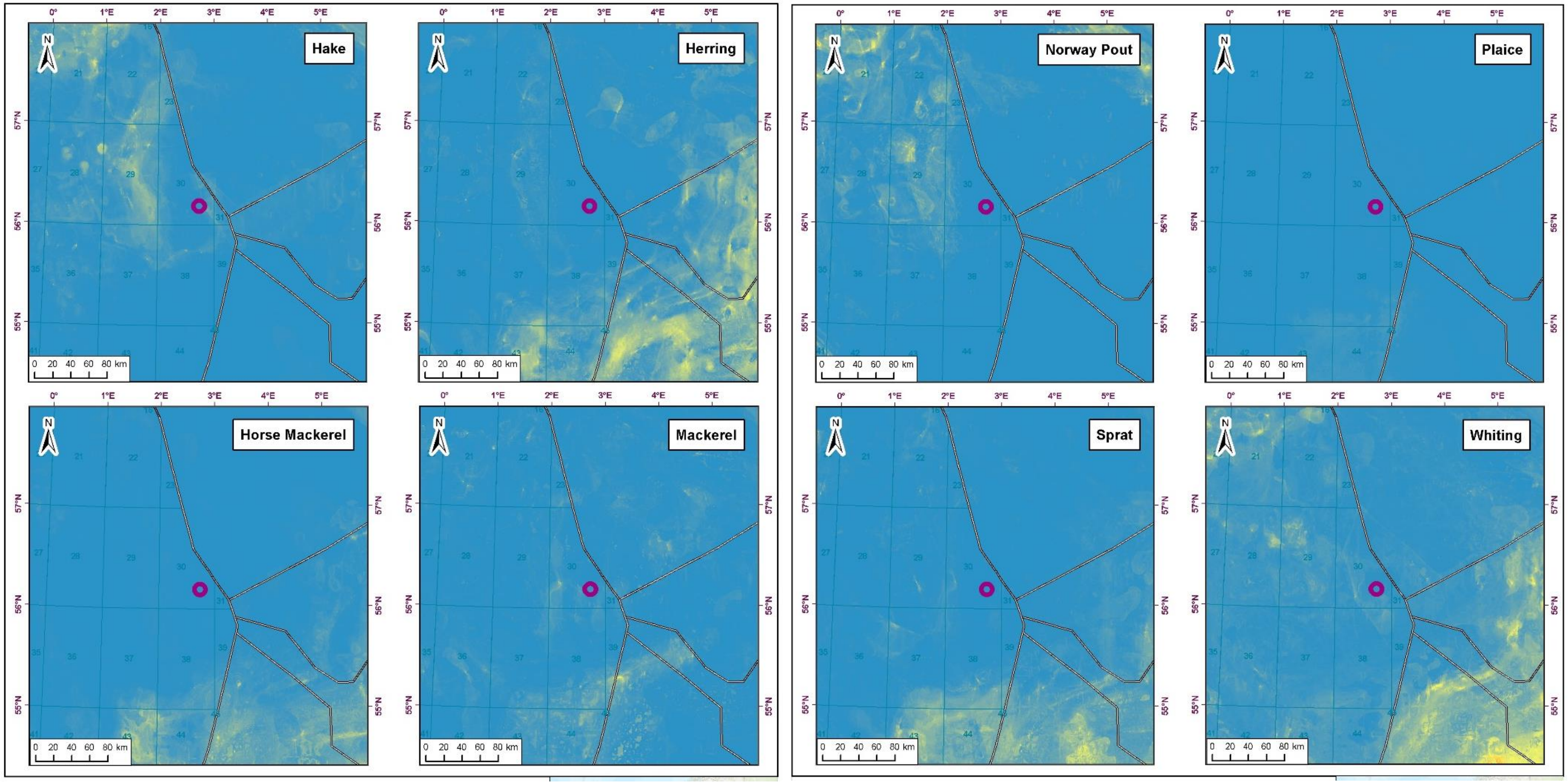


Figure 3.7.4: 0 Group fish (cont'd/…)

Within Block 30/24 there are fish spawning and nursery areas for mackerel (*Scomber scombrus*), cod (*Gadus morhua*), whiting (*Merlangius merlangus*), Norway pout (*Trisopterus esmarki*), sandeel (*Ammodytidae*), and plaice *(Pleuronectes platessa*). In addition, there are also spawning areas for sprat (*Sprattus sprattus*), and nursery areas for haddock (*Melanogrammus aeglefinus*), spurdog (*Squalus acanthias*), spotted ray (*Raja montagui*), herring (*Clupea harengus*), blue whiting (*Micromesistius poutassou*), ling (*Molva molva*), hake (*Merluccius merluccius*) and anglerfish (*Lophius piscatorius*) (Coull et al., 1998; Ellis et al., 2012).

Within the project area there is a low probability of aggregations of '0 group' fish (defined as fish in the first year of their lives), however, it may have the potential to act as an area that supports low to moderate numbers of '0 group' cod, haddock, whiting and hake (Figure 3.7.3 & Figure 3.7.4).

Sandeels are indicated as spawning in the Alma and Galia fields in the months of November to February. Sandeels prefer spawning substrate with a low clay silt fraction (<10%) (Lancaster et al., 2014). The substrate at Alma has a clay and silt (<63µm) fraction ranging from 4.3% to 15.6% (Gardline, 2011a), whilst substrate at Galia was described as silty fine sand with shell fragments. This suggests that it is possible that sandeel spawning could occur in the Alma and Galia field areas.

Recent research has suggested that there has been significant change in fish populations of the north-east Atlantic over several decades (DECC, 2016). The natural variation in population sizes through recruitment are also influenced by climatic factors and human exploitation. An analysis of 50 fish species around the UK demonstrated that 70% changed distribution and abundance in response to sea temperature warming between 1980 and 2008, with three-quarters of these species increasing in abundance (Simpson et al., 2011). Other studies have suggested that temperature variation has strongly influenced landings, and that distributions of two-thirds of fish species in the North Sea have significantly shifted in latitude over the past 25 years (Perry et al., 2005).

Many fish species are subject to considerable fishing pressure which acts to reduce population biomass. Data indicate that the biomass of fish from high trophic levels declined by two thirds in the North Atlantic in the second half of the 20th Century (Christensen et al. 2003). The latest Charting Progress report (DEFRA, 2010) states that the majority of UK stocks are still fished well above the levels expected to provide the highest long-term yield, although of 20 indicator stocks, the proportion being harvested sustainably rose from 10% in the early 1990s to about 40% in 2007. Overfishing is generally considered to make populations less resilient to the potential effects of climate change (DECC, 2016).

3.7.1 Elasmobranchs

In a survey conducted by CEFAS, twenty-six species of elasmobranch were identified and recorded throughout the North Sea and surrounding waters. Of these, only the spurdog (*Squalus acanthias*), tope shark (*Galeorhinus galeus*), starry smooth hound (*Mustelus asterias*), and starry ray (*Amblyraja radiata*) may be present within the general vicinity of the Alma and Galia fields (*Ellis et al., 2004*).

3.8 Seabirds

The CNS is an important area for Guillemot (*Uria aalge*), Fulmar (*Fulmarus glacialis*), Gannet (*Sula bassana*), Kittiwake (*Rissa tridactyla*), Herring Gull (*Larus argentatus*), Great Black-Backed Gull (*Larus marinus*), and Little Auk (*Alle alle*). In July, large concentrations of Guillemots occur in the CNS, with a gradual movement towards eastern Scotland and north-east England through August and September, and onwards dispersal to a more widespread distribution in the Southern North Sea in winter (DTI, 2001; EnQuest, 2012).

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). During this breeding period, high numbers of breeding seabirds are linked to their colonies and adjacent coastal waters for feeding. Generally, vulnerability is lowest during the pre-breeding and breeding months, increasing as the breeding season ends and birds disperse into offshore waters. After the breeding season ends in June, large numbers of moulting auks (guillemot, razorbill *Alca torda* and Atlantic puffin *Fratercula arctica*) disperse from their coastal colonies and into the offshore waters from July onwards resulting in peak numbers of seabirds during the summer. In addition to Auks, Kittiwake, Gannet, and Fulmar are also present in sizable numbers during the post breeding season. At this time, birds are particularly vulnerable to oil pollution as the adults are rendered flightless due to moulting and the juveniles are not able to fly, therefore they spend a lot of time on the water's surface, significantly increasing their vulnerability to oil pollution on the water surface, i.e. chemical or oil spills. Fulmars, Kittiwakes and Gannet are highly pelagic and capable of travelling long distances to forage. These species are also adaptable, opportunistic feeders, and are sometimes found scavenging around fishing vessels.

Table 3.8.1 identifies the sensitivity of seabirds to surface oil pollution within the project area. It shows that sensitivity is low within the area throughout the year except for the months of May and June, where it increases to moderate in Block 30/25 and the adjacent Blocks 30/19 and 30/30.

Seabird oil sensitivity index (Webb et al. 2016)												
Block	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Block 30/18		1		1	1				1	N	N	1
Block 30/19				1	1				1	N	N	1
Block 30/20	2	1		1	1				1	N	N	1
Block 30/23	2	1		1	1					1	N	N
Block 30/24	2	1		1	1					1	N	N
Block 30/25	2	1		1	1					1	N	N
Block 30/28	N	1		1	1					1	N	N
Block 30/29	N	1		1	1					1	N	N
Block 30/30	N	1		1	1					1	N	N
Block 31/21	N	1		1	N	1				1	N	N
Block 31/26	N	1		1	N	1				1	N	N
Key:												
Extremely High	Very High	High	Moderate	Low	N	No Data						

Table 3.8.1: Seabird oil sensitivity index (Webb et al., 2016)[12]

Population trends in key seabird species from 1998 to 2015	
Species	**Population change (%)**
Fulmar	-31
Gannet	+34
Kittiwake	-44
Great Black-Backed Gull	-11
Guillemot	+5

Table 3.8.2: Population trends in key seabird species from 1998 to 2015

Breeding seabird numbers of some species have shown a long-term decline, most probably as a result of a shortage of key prey species such as sandeels associated with changes in oceanographic conditions (Baxter et al., 2011). The Joint Nature Conservation Committee (JNCC)

[12] 1: These Blocks have no data coverage, however, data from adjoining months for the same Block have been used to fill the data gap (Step 1 method – JNCC, 2017).

2: These Blocks have no data coverage, however, data from adjoining Blocks for the same month have been used to fill the data gap (Step 2 method – JNCC, 2017).

N: These Blocks have no data coverage and neither Step 1 nor Step 2 methods were able to address the data gap.

has released the latest analysed trends in abundance, productivity, demographic parameters and diet of breeding seabirds, from the Seabird Monitoring Programme (JNCC, 2016a). The new data provides at-a-glance UK population trends as a % of change in breeding numbers from complete censuses. From the years 1998-2015, the following population trends for species known to use the Alma and Galia fields have been recorded (Table 3.8.2).

3.9 Marine Mammals

3.9.1 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).

Summary accounts of cetacean species near Alma and Galia	
Species	**Summary**
Atlantic white-sided dolphin	Odontocete (Toothed whale). Atlantic white-sided dolphin is very gregarious, with observed group sizes frequently numbering in tens to hundreds. It is superficially rather like the white-beaked dolphin. The two species may form mixed herds that are sometimes very large. White-sided dolphins live mainly in cool waters (7-12º C), particularly seaward or along the edges of continental shelves (typically in depths of 100-500 metres). Mainly occurs north and north west of Britain (Scotland), and is rare in the central and north-eastern North Sea.
Common dolphin	Common dolphins are gregarious animals with average group sizes observed in north-west European waters between six and ten, however, large schools of dozens or even hundreds have been recorded. In European waters the common dolphin is distributed south of 60ºN in Atlantic waters. Off the western coasts of Britain and Ireland, the species is found in continental shelf waters, notably in the Celtic Sea and Western Approaches to the Channel, and off southern and western Ireland. It has been observed occasionally in the North Sea, mainly in summer (June to September). Adult length ranges from 2.1 to 2.4 metres.
Harbour porpoise	Odontocete (Toothed whale). Adult length ranges from 1.4 to 1.9 metres. New-borns may be between 67 cm to 85 cm. Harbour porpoise generally stay below the surface of the water. However, they are occasionally spotted when resting at the surface. It is the most numerous marine mammals in north-west European shelf waters.
Minke whale	Mysticete (Baleen whale). Adult minke whales measure between 8 and 10 metres in length. They regularly occur in small groups of 2-3 animals and are often described as an inquisitive animal as a result of many sightings being made close to vessels. The species occurs mainly on the continental shelf in water depths of 200 metres or less; for example, in the northern and central North Sea.
White-beaked dolphin	White-beaked dolphins are frequently seen in the central and northern North Sea, they are present all year round in the UK near-shore waters at depths of 50 - 100m but are observed more frequently between June and October. They are usually found in small groups of 10 or less but have also been observed in large groups of 50 and more.

Table 3.9.1: Summary accounts of cetacean species near Alma & Galia

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 are 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). Fin whale are listed as 'endangered' and sperm whale are listed as 'vulnerable' on the IUCN Red List (IUCN, 2019). All species of cetacean are listed on Annex IV of the EU Habitats Directive. Under Annex IV, the keeping, sale or exchange of such species is banned as well as deliberate capture, killing or disturbance (DECC, 2016).

Of the species listed above, common dolphin, harbour porpoise, minke whale, white-beaked dolphin and Atlantic white-sided dolphin have all been sighted in the vicinity of the project area

(Reid et al., 2003), at very low to moderate levels from May to November (Table 3.9.2). All these species are listed as 'Least Concern' on the IUCN Red List (IUCN, 2019). White-beaked dolphin and harbour porpoise are the most frequently recorded cetaceans in the vicinity of the Alma-Galia fields, with sightings in six and five months of the year, respectively.

Cetacean sightings near Blocks 30/24 and 30/25												
Species	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Atlantic white-sided dolphin												
Common dolphin												
Harbour porpoise												
Minke whale												
White beaked dolphin												
Key (individuals per hour):												
	Very High (>100)		High (10-100)		Medium (1-10)		Low (0.1–1)		Very Low (0-0.1)		No Sighting (0)	

Table 3.9.2: Cetacean sightings near Blocks 30/24 and 30/25

Best available animal density information for the proposed project area has been taken from the Small Cetacean Abundance in the European Atlantic and North Sea – II (SCANS-III) 2016 survey (Hammond et al, 2017). Density data for the species identified by Reid et al., (2003) as being present within the vicinity of the project area are available from the SCANS-III data for all species (Table 3.9.3). Only harbour porpoise and minke whale are present in significant enough numbers to register.

Estimated marine mammal density near Alma & Galia		
Species	**Abundance**	**Density (animals per square kilometre) per SCANS III survey area**
Atlantic white-sided dolphin	No data	No data
Common dolphin	No data	No data
Harbour porpoise	16,569	0.333
Minke whale	348	0.007
White-beaked dolphin	No data	No data

Table 3.9.3: Estimated marine mammal density near Alma & Galia (Hammond et al., 2017)[13]

Harbour porpoise abundance was comparable between the 1994 and 2005 SCANS survey results and the population has been assessed (as part of 3rd Report by UK under article 17 on the implementation of the Habitat Directive) to be in favourable condition with a total abundance in UK waters of 177,567 animals (CV=0.15) (DECC, 2016). Following advice by SMRU and ICES, management units (MUs) for seven of the more common regularly occurring cetacean species have been agreed by the UK Statutory Nature Conservation Bodies (SNCBs). The Celtic & Greater North Seas Management Unit (CGNS MU) was deemed appropriate for the management and conservation of the common dolphin, Atlantic white-sided dolphin, minke whale and white beaked dolphin (IAMMWG 2015). The abundance of these species across the entire CGNS MU and within the UK component is listed in Table 3.9.4. The North Sea Management Unit (NS MU) was deemed appropriate for management and conservation of harbour porpoise (IAMMWG, 2015). The abundance of harbour porpoise across the entire NS MU was estimated at 227,298 (95% confidence internal (CI): 176,360 – 292,948) with the UK component estimated at 110,433 (95% CI: 80,866 – 150,811).

There has been considerable information, using both controlled exposure experiments and opportunistic observations of anthropogenic noise source operations, on the behavioural responses of particularly sensitive marine mammals, including harbour porpoises (Kastelein et al., 2008a,b; Gilles et al., 2009) and beaked whales (Caretta et al., 2008; McCarthy et al., 2011; Southall et al., 2011; Tyack et al., 2011). These studies amplify the conclusions of Southall et al.,

[13] The proposed decommissioning activities fall across SCANS-III survey area block Q

(2007) that these are particularly sensitive species.

Estimates of abundance of species in the CGNS MU				
Species	**Abundance in CGNS MU (entire area)**	**95% CI**	**Abundance in UK component of CGNS MU**	**95% CI**
Common dolphin	56,556	33,014 – 96,920	13,607	8,720 – 21,234
Atlantic white-sided dolphin	69,293	34,339 – 139,828	46,249	26,993 – 79,243
Minke whale	23,528	13,989 – 39,572	12,295	7,176 – 21,066
White-beaked dolphin	15,895	9,107 – 27,743	11,694	6,578 – 20,790

Table 3.9.4: Estimates of abundance of species in the CGNS MU

Ecosystem changes as a result of climatic change are likely to affect marine mammals, however, responses of marine mammal populations to such influences is at present poorly understood, any with and predictions largely speculative and unsubstantiated by unequivocal evidence (DECC, 2016). Range shifts in marine mammals have been reported in the north-east Atlantic, which have been linked to increasing sea temperatures, however, the mechanisms causing those changes remain uncertain and for some species, it is difficult to differentiate between short-term responses to regional resource variability and longer-term ones driven by factors such as climate change. As data on cetacean abundance are typically few and often characterised by considerable uncertainty and both seasonal and spatial gaps, the identification of long-term trends is challenging. It is generally recognised that the frequency of surveys needs to increase if changes are to be detected with a reasonable degree of confidence (DECC, 2016).

3.9.2 Pinnipeds

Grey seal (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*) are both resident in UK waters and are listed under Annex II of the EU Habitats Directive. 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, in particular, grey seals 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 with 88% of these breeding at colonies in Scotland with the main concentrations in the Outer Hebrides and in Orkney. Birth rates have grown since the 1960s, although population growth is levelling off (SCOS, 2014). In the case of harbour seals, approximately 30% of the world's population are found in the UK. Following significant population declines due to disease in 1988 and 2002, harbour seal numbers on the English east coast have been rising since 2009 (SCOS, 2014).

Grey and harbour seals will 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. Harbour seals haul out every few days on tidally exposed areas of rock, sandbanks or mud. Pupping and moulting seasons occur from May to August, during which time seals will be ashore more often than at other times of the year (Hammond et al., 2004). Seal tracking studies from the Moray Firth have indicated that the foraging movements of harbour seals are relatively local compared to grey seals and are generally restricted to within a 40–50km range of their haul-out sites (SCOS, 2014).

Grey seal pupping generally occurs in October, with moulting occurring between February and March (DECC, 2016). During this period, grey seals will be found either onshore or on foraging trips in the vicinity of their haul-out site. At this time the offshore density of grey seals will be lower. 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 project area is located 284km from the coast, so it is highly unlikely that these species may be encountered in the vicinity of the decommissioning operations. This is confirmed by a study carried out by SMRU and Marine Scotland, 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 seal density near the Alma and Galia fields is zero to one harbour seal and one to five grey seals per 25km^2 (Jones et al., 2015; SMRU and Marine Scotland 2017).

3.10 Conservation Designations

3.10.1 Potential Annex I Habitats and Annex II & IV Species

The Dogger Bank SAC/SCI/MPA, that is situated 77.9 km south of the project area (Figure 3.10.1) covers an area of approximately 12,331km^2 and is designated due to the vast expanse of Annex I habitat '*Sandbanks slightly covered by seawater all the time*' (JNCC, 2015). The southern area of the bank is covered by water seldom deeper than 20m and extends within the SAC in UK waters down to 35 - 40m deep. The bank structure slopes down to greater than 50m deep in UK, Dutch and German waters. Its location in open sea exposes the bank to substantial wave energy and prevents the colonisation of the sand by vegetation on the shallower parts of the bank. Sediments range from fine sands containing many shell fragments on top of the bank to muddy sands at greater depths supporting invertebrate communities, characterised by polychaete worms, amphipods and small clams within the sediment, and hermit crabs, flatfish, starfish and brittlestars on the seabed. Occasional, discrete areas of coarser sediments (including pebbles) were recorded on the bank, dominated by the soft coral *Alcyonium digitatum* known as dead man's fingers, the bryozoan sea chervil *Alcyonidium diaphanum* and serpulid worms. The shallow water, sandy sediments and year-round productivity of the Dogger Bank make it an ideal spawning ground for sandeels (*Ammodytes* spp.). Sandeels are a major food source for several seabird species, seals and harbour porpoise (Annex II species) and consequently the Dogger Bank area is utilised as a foraging ground for several species. Therefore, grey seal, common seal and harbour porpoise are present as a non-qualifying feature (JNCC, 2015).

There was one station in the Galia site survey (ENV4) which showed low resemblance to Annex I stony reef habitat (Gardline, 2011e). The feature covered an area of 30 metres by 60 metres of seabed, with 29% clast supported material present. It is thought that this feature is associated with the northernmost unidentified wreck located over 2.5 kilometres from the Galia well site (refer section 3.7). Apart from this, there was no evidence from the seabed imagery across the Alma and Galia site survey areas of any Annex I habitats protected under the Habitats Directive (1992).

There were 16 juveniles of ocean quahog, *Arctica islandica*, (a species listed by OSPAR (2008) as under threat and/or in decline in the North Sea) identified at six of fifteen stations during the Alma site survey (ENV 1, 2, 5, 7, 8 and 12: Figure 3.1.1). One adult was identified at one station (ENV 9 - 0.5km west of Alma manifold) during the Galia site survey. However, there was no evidence of any aggregations of *A. islandica*, or of any other threatened and/or declining species listed under OSPAR (2008) or UKBAP (2011).

The Habitats Directive requires conservation areas to be designated for species in Annex II of the Habitats Directive that occur in UK offshore waters. Pinniped species listed in Annex II of the Habitats Directive include common seals and grey seals. Common seals generally forage around their haul-out sites and are normally found within 50 kilometres of shore (DECC, 2016). Similarly, grey seals are mainly distributed around and between haul-out sites and foraging areas. Given the distance of the project area from shore (279 kilometres), it is unlikely that either common or grey seals will be present in the vicinity of the project area.

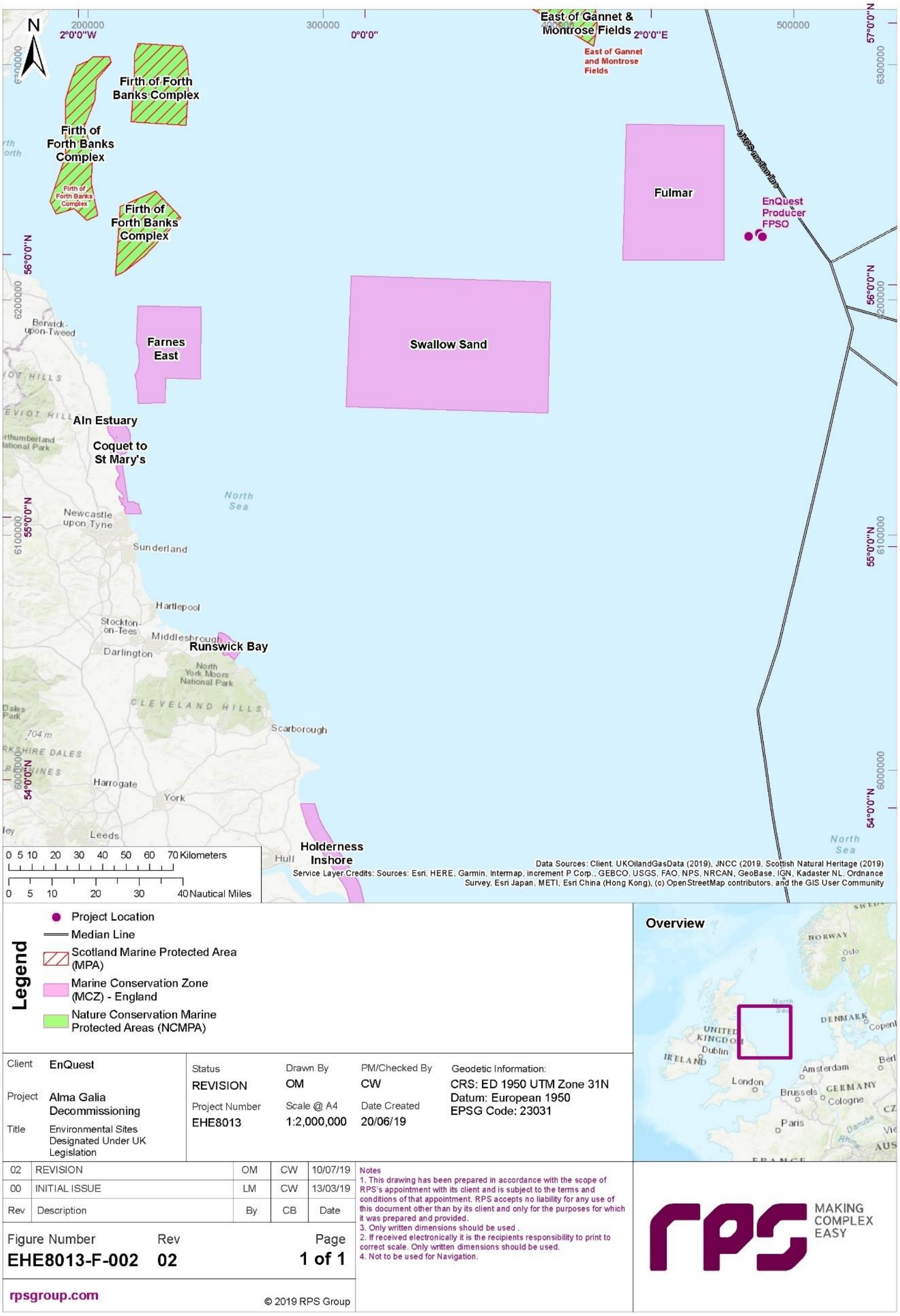


Figure 3.10.1: Protected areas near Alma and Galia using UK Designations

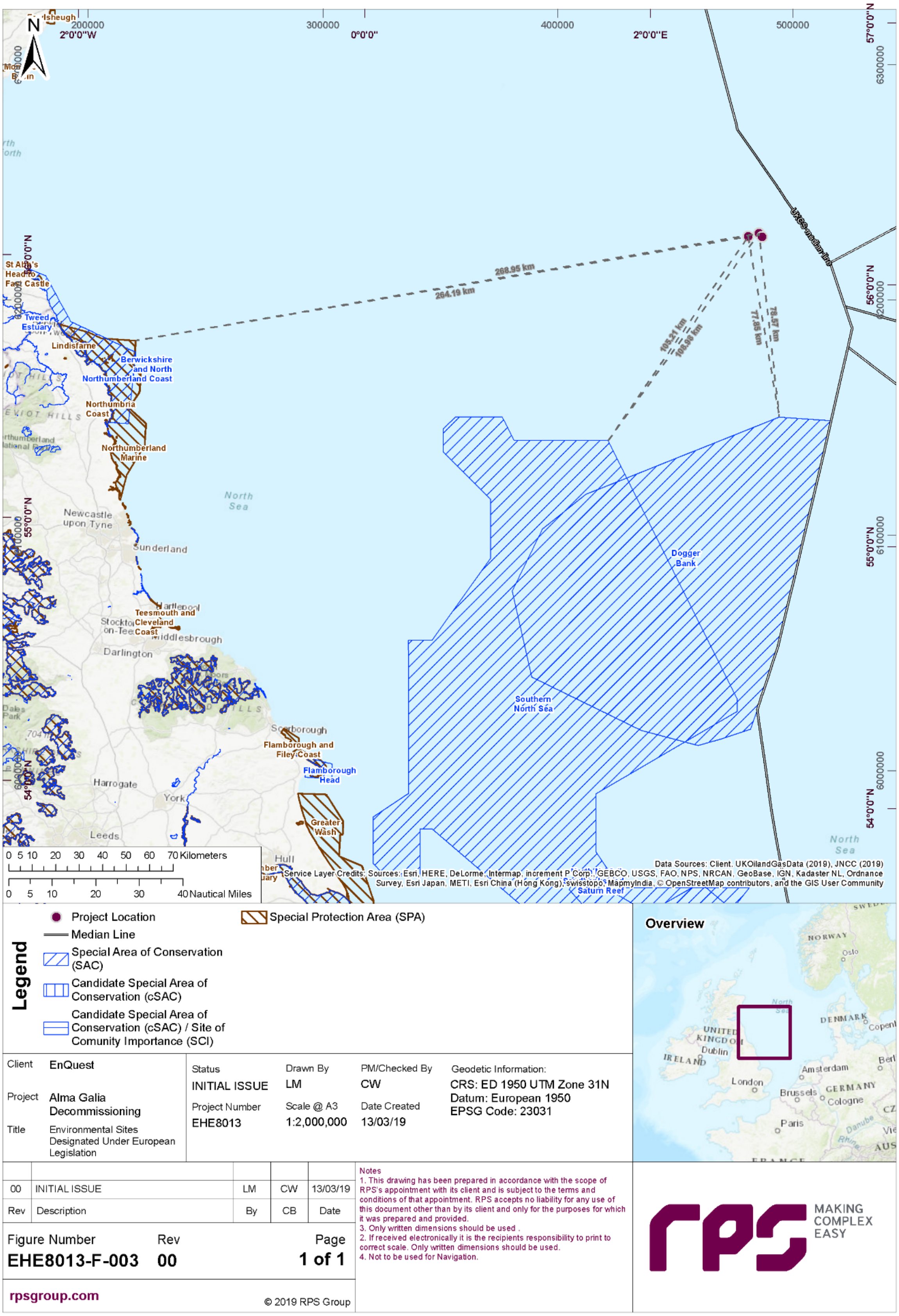


Figure 3.10.2: Protected areas near Alma & Galia using EU Designations

Cetacean species listed in Annex II include the bottlenose dolphin and harbour porpoise. The Southern North Sea MPA/SAC is located ~105 kilometres south west of the Alma and Galia area, designated for presence of harbour porpoise. The site covers an area of approximately 36,951km^2 and supports an estimated 17.5% of the North Sea Management Unit (NS MU) population. The northern part of the site is recognised as important for porpoises in the summer, whereas the southern part supports higher densities in the winter (JNCC, 2019). Harbour porpoise have been sighted near Alma and Galia between July and October in low (0.1 to 1 individuals per hour) densities (Reid et al., 2003) (Table 3.9.2).

Annex IV species are those animal and plant species of community interest in need of strict protection. They include many Annex II species. A strict protection regime must be applied across their entire natural range within the EU, both within and outside Natura 2000 sites. Harbour porpoise, common dolphin, minke whale, white-beaked dolphin, and Atlantic white-sided dolphin have all been sighted within the vicinity of the project area (Reid et al., 2003) (Table 3.9.2) and are all included on Annex IV of the Habitats Directive.

3.10.2 Coastal Protected Areas

There are several coastal protected areas along the Scottish and English coastlines to the west of the project area including SSSIs, SPAs and Important Bird Areas (IBAs). The SPAs to the west of the project area regularly support wildfowl and waders and gulls. The south eastern coast of Scotland and north eastern coast of England provide some of the most important wetlands, cliffs and bays in Europe which provide significant haul-out and breeding areas for seals and seabirds. The Northumberland Marine SPA is designated as a SPA due to breeding populations of Arctic Tern (*Sterna paradisaea*), Common Tern (*Sterna hirundo*), Guillemot (*Uria aalge*), Little Tern (*Sternula albifrons*), Puffin (*Fratercula arctica*), Roseate Tern (*Sterna dougallii*) and Sandwich Tern (*Thalasseus sandvicensis*), and breeding seabird assemblage (Natural England, 2017). As the SPA is approximately 265 kilometres from the project area these species are unlikely to be found in aggregations near Alma and Galia area.

3.10.3 Marine Conservation Zones

The Fulmar MCZ is located approximately 10.3 km west of Galia (Figure 3.10.1), covering an area of 2,437km^2. The site is designated for 'subtidal mud', 'subtidal sand' and 'subtidal mixed sediment' broad scale habitats; and presence of ocean quahog (*A. islandica*), a 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. *A. islandica* is an important food source for several species of fish, including cod. *A. islandica* is listed on the OSPAR (2008) 'list of threatened and declining habitats and species' (OSPAR, 2009). The site also supports a diverse range of marine species including worms, burrowing tube anemones (*Cerianthus lloydii*), brittlestars (including *Amphuria filiformis* and *Ophiura albida*), sea potatoes (*Echinocardium cordatum*), and sea pens (including the slender sea pen *Virgularia mirabilis*) (JNCC, 2019).

The Swallow Sand MCZ is located approximately 86.1km west of Galia (Figure 3.10.2), covering an area of 4,746km^2. The site is designated for subtidal coarse sediment, subtidal sand, and a geological/ geomorphological feature – the Swallow Hole Glacial Tunnel Valley. Depths range from 50 metres to 100 metres, with a drop down to 150 metres in the Swallow Hole Glacial Tunnel Valley in the north-west of the site. The site is low energy, providing a stable sediment habitat which supports a diverse range of marine species including worms, brittlestars, bivalves and gastropods (JNCC, 2019).

The East of Gannet and Montrose Fields MPA is located approximately 104.4 km north west of the project area (Figure 3.10.2), covering an area of 1,839km^2. The site lies within a relative shallow sediment plain in the CNS, where the sand and gravel seabed support a range of benthic species, including *A. islandica*. The East of Gannet and Montrose Fields MPA is also designated for the habitat ‘offshore deep-sea mud’. 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 two to seven kilometres wide band from the south-east to the north-west, in a water depth of approximately 100m. This habitat 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 (JNCC, 2019).

3.10.4 Marine Plan Areas

This region of the Central North Sea lies within the North East Offshore Marine Plan area which sets the framework for future development from the Scottish Borders to Flamborough Head and covers approximately 50,000km^2 of sea from 12 nautical miles out to the maritime borders with the Netherlands, Belgium, and France (MMO, 2014). Marine plans, together with the National Marine Policy Statement, underpin the planning system for England’s seas. Although the North East Offshore Marine Plan is currently being developed, EnQuest will ensure that activities are carried out in line with this plan should it be in place at the time of decommissioning activities.

3.11 Commercial Fishing

The project area lies with ICES rectangle 41F2. Commercial fishing activity within the vicinity of the project area is very low, with no data for most of the year and undisclosed data in June (Scottish Government, 2019). Data on fishing intensity in the area (Figure 3.11.1, Figure 3.11.2) shows very low to low levels of activity within the wider project area. Table 3.11.1 lists the live weight and first sale value of fish and shellfish landings from 41F2 in 2014 to 2018. Data for more recent years (2015-2018) were so low as to be undisclosed (Scottish Government, 2019), with only 2014 having data. This showed a dominance of demersal fishing with 135 tonnes of fish and shellfish landed from the area.

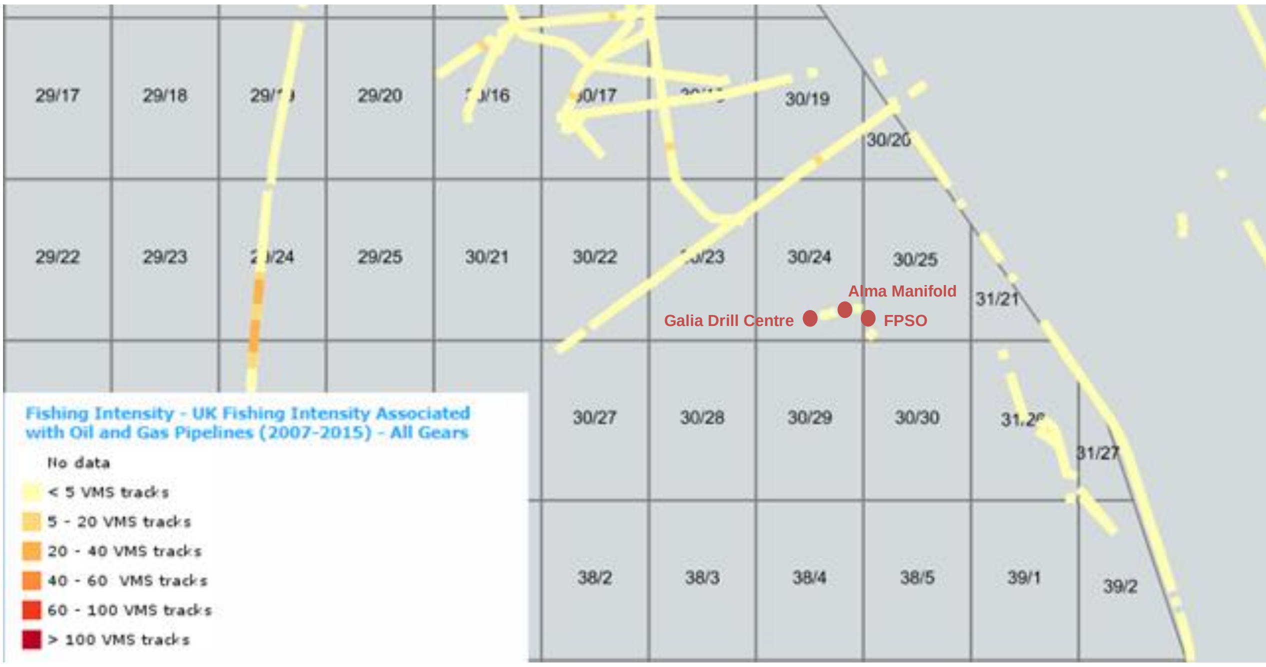


Figure 3.11.1: Fishing intensity & oil and gas pipelines - Alma & Galia (2007-2015)

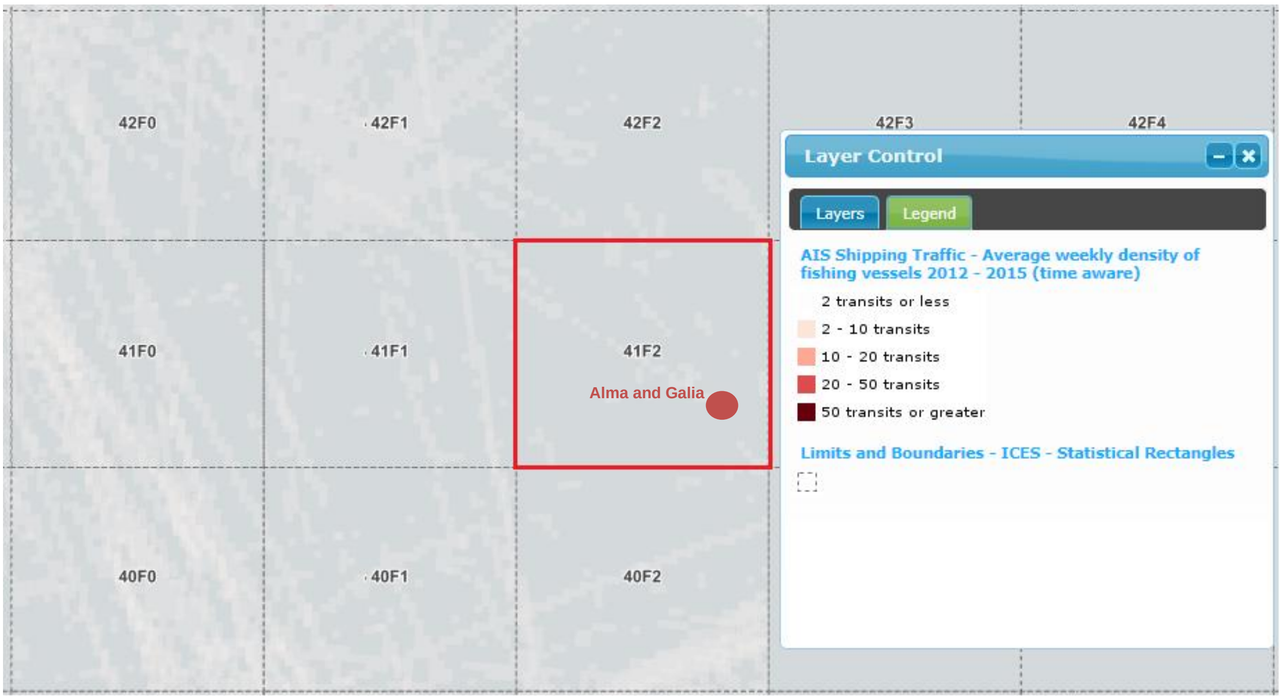


Figure 3.11.2: Weekly density of fishing vessels (2012-2015) near ICES Rectangle 41F2

Table 3.11.1 Live weight & value fish and shellfish, ICES rectangle 41F2 [14](Scottish Government 2019)										
Species type	2018 data		2017 data		2016 data		2015 data		2014 data	
	Live-weight (tonnes)	Value (£)	Live-weight (tonnes)	Value (£)	Live-weight (tonnes)	Value (£)	Live-weight (tonnes)	Value (£)	Live-weight (tonnes)	Value (£)
Demersal	-	-	-	-	-	-	-	-	134	177,347
Pelagic	-	-	-	-	-	-	-	-	0.04	65
Shellfish	-	-	-	-	-	-	-	-	0.34	1,103
Total	-	-	-	-	-	-	-	-	**135**	**178,515**

Table 3.11.1: Live weight, value of fish and shellfish - ICES rectangle 41F2

3.12 Shipping and Ports

The density of shipping traffic within the CNS is relatively high due to the presence of several international ports within the region. The closest major ports to the project area are Firth of Forth, and Tees and Hartlepool. Shipping density within Blocks 30/24 and 30/25 is, however, very low (Figure 3.12.1; OGA, 2016). The area is mainly used by cargo vessels and oil tankers (Marine Scotland, 2019).

[14] 2015-2018 data are undisclosed

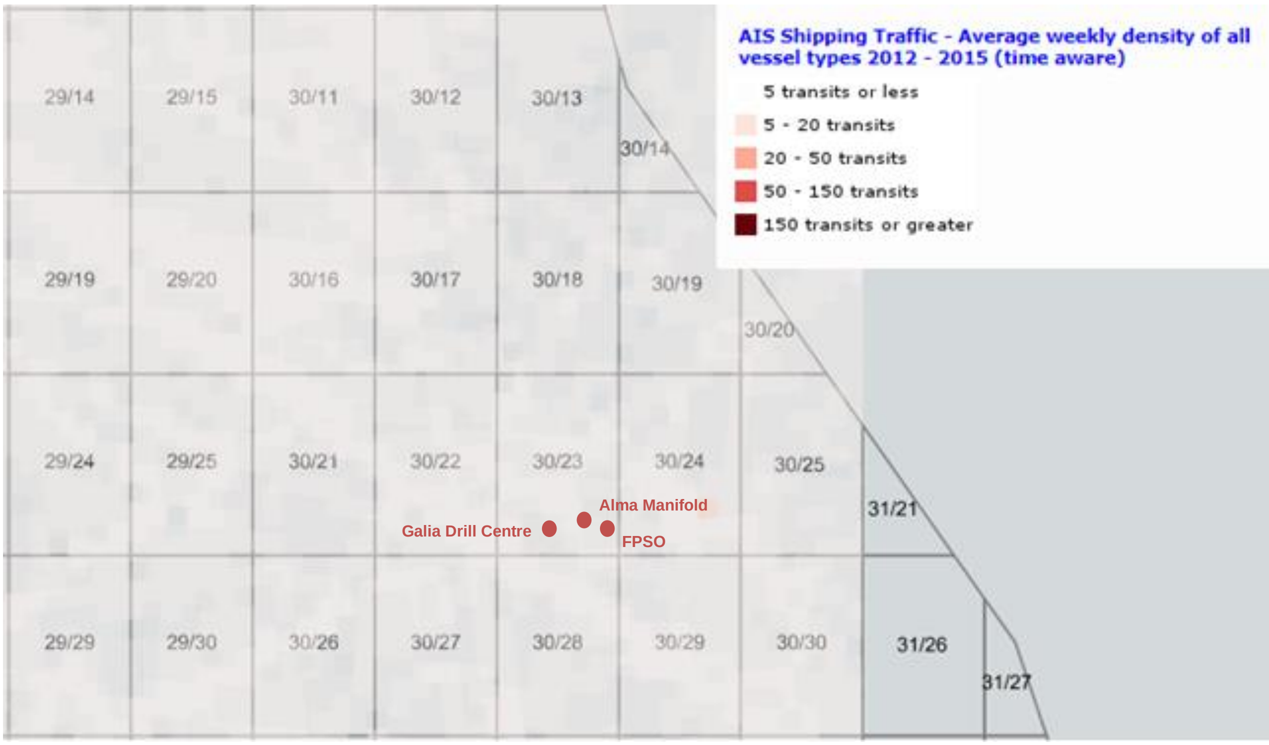


Figure 3.12.1: Weekly density of all vessel types (2012-2015) in the Alma & Galia area

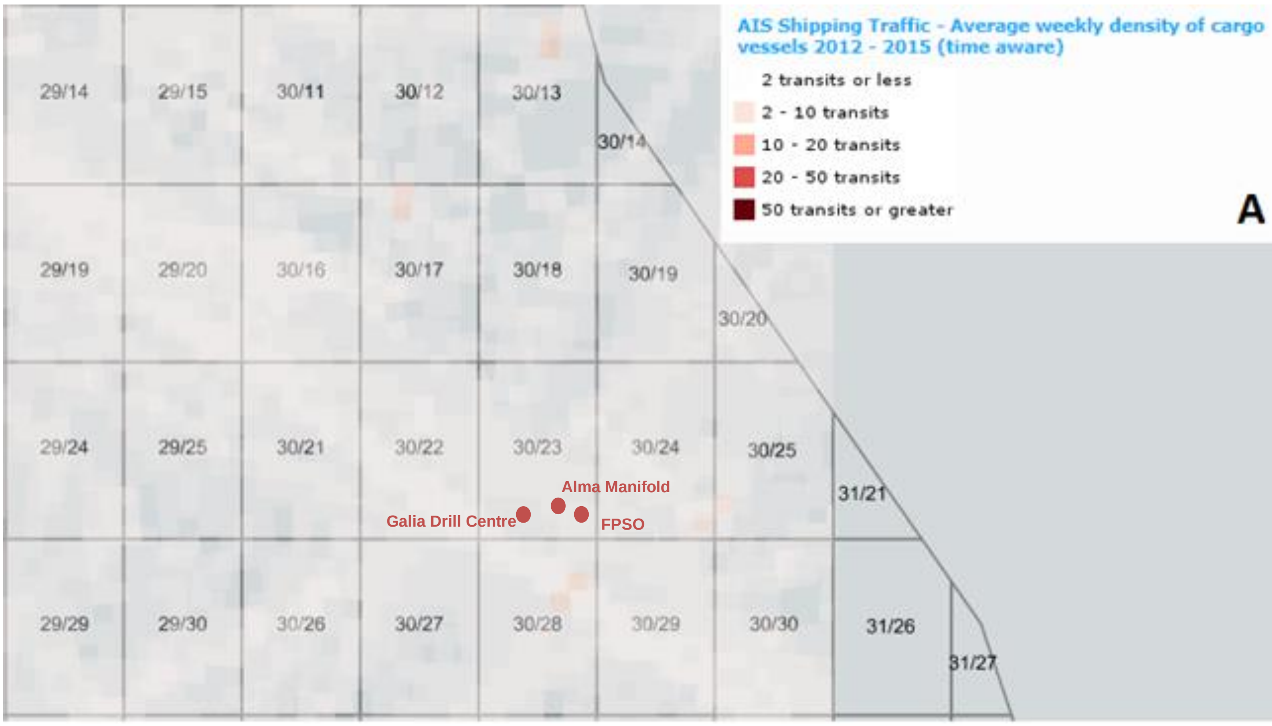


Figure 3.12.2: Weekly density of cargo vessels (2012-2015) near Alma & Galia

3.13 Oil and Gas Activity

Oil and gas activity within the project area is moderate compared to other blocks to the north east. Blocks 30/24 and 30/25 contain the Alma and Galia oil fields, and a section of the active Ekofisk 2/4J to Teesside NORPIPE oil export pipeline transecting Block 30/24 north west of the project area (Table 3.13.1, Figure 3.13.1). Block 30/24 contains 48 previously drilled wells; 22 of which have been decommissioned, 26 of which have been completed. Block 30/25 contains five previously drilled wells; all of which have been decommissioned (Figure 3.13.2; OGUK Data, 2019; Marine Scotland, 2019).

Adjacent Facilities					
Owner	**Name**	**Type**	**Distance/Direction**	**Information**	**Status**
ConocoPhillips	Judy	NORPIPE Wye Tie-In	~16.1km N of Alma ~14.1km N of Galia	24" Oil line connection to NORPIPE	Operational
EnQuest	Alma	Manifold & 7x WHPS	~4.8km NE of Galia	Connected to the EnQuest Producer	Operational
EnQuest	Galia	1x WHPS	~4.8km SW of Alma	Connected to the EnQuest Producer via Alma Manifold	Operational
Repsol Sinopec Resources Ltd	Orion	TOR Remote Wellhead	~29.8km N of Alma ~29.3km N of Galia	Tied back to the Clyde Platform	Operational
Total	Affleck	Manifold & Wellhead	~27.4km N of Alma ~28.5km N of Galia	Refer Janice, James and Affleck Decommissioning Programmes	Non-operational
Maersk Oil	Janice	Gas & Oil Export SSIVs	~38.8km NW of Alma ~36.2km NW of Galia	Refer Janice, James and Affleck Decommissioning Programmes	Non-operational

Table 3.13.1: Adjacent Facilities

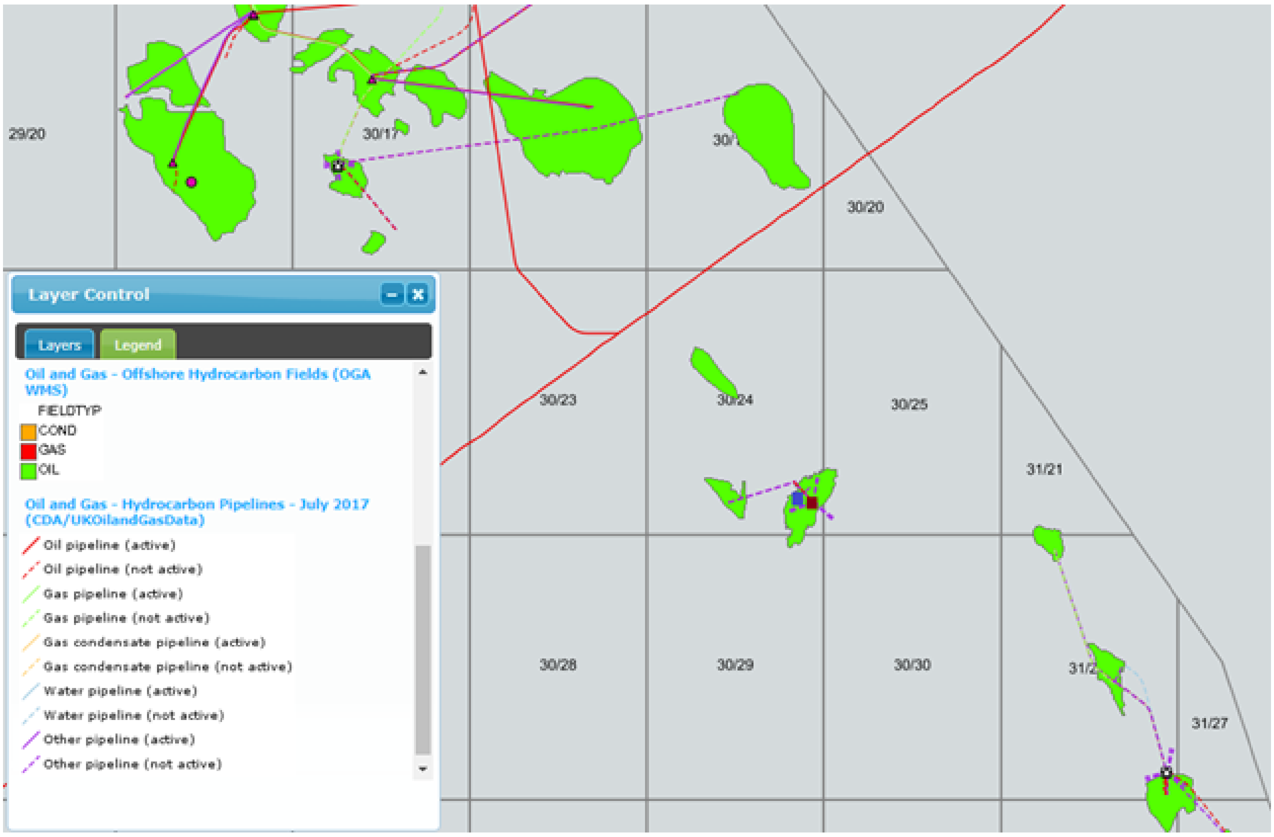


Figure 3.13.1: Adjacent fields near Alma & Galia[15]

As discussed earlier, the Alma field is a redevelopment of the Ardmore field that was previously known as Argyll, and the Galia field is a redevelopment of the Duncan field. Prior to this redevelopment, the Ardmore installation had been installed at latitude 56º11'18.57" North and longitude 2º46'04.24" East (blue square in Figure 3.13.1). In 1993 the Argyll and Duncan fields

[15] Location of the removed Ardmore installation indicated by blue marker.

were decommissioned and in 2006, the Ardmore field was decommissioned. Field infrastructure was removed, which has left scars and depressions on the seabed, evidence in Figure 3.3.1.

There are no power cables or telecommunications cables present near the Alma and Galia area (Marine Scotland, 2019; KIS-ORCA, 2019).

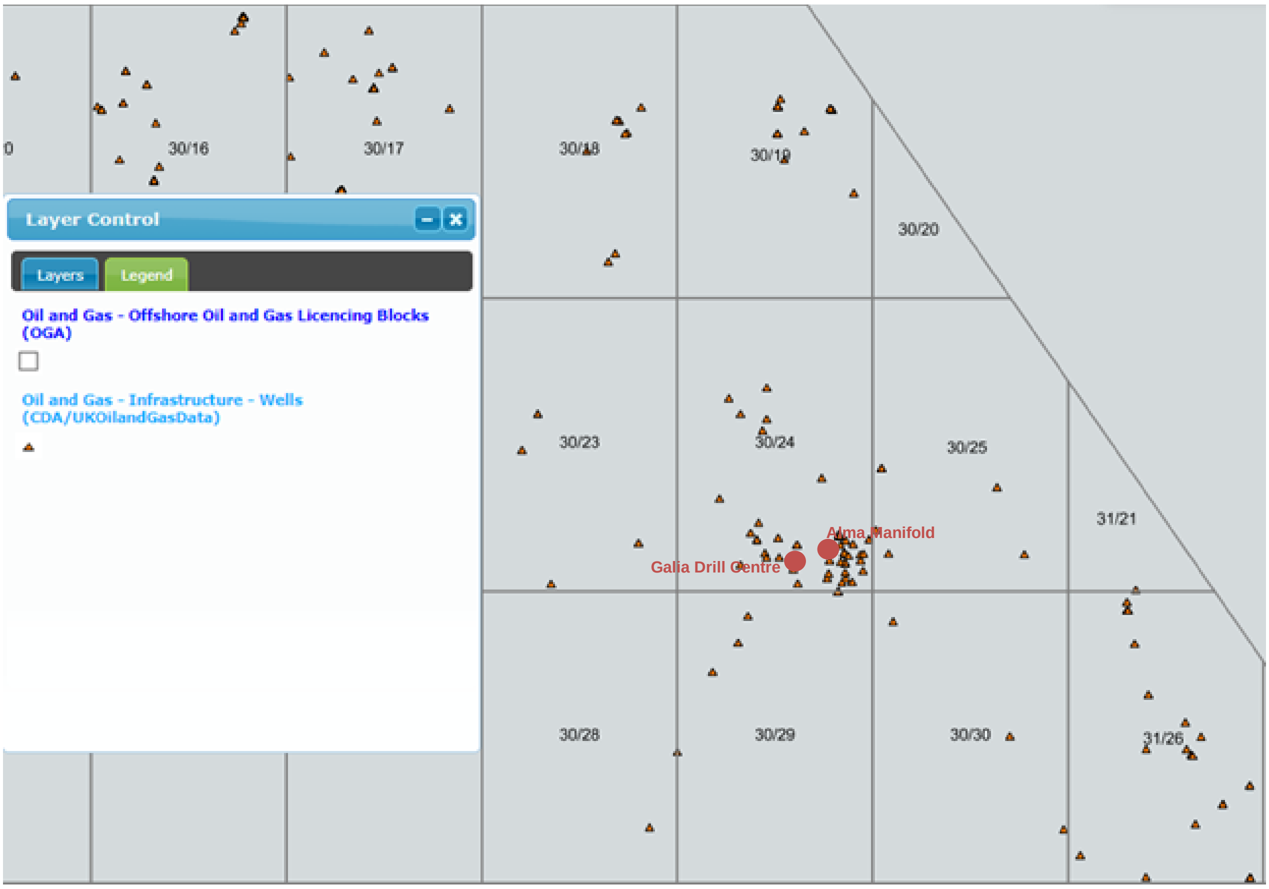


Figure 3.13.2: Wells previously drilled near Alma & Galia

3.14 Military Activity

The Blocks are not found within or close to any military exercise areas and there are no special conditions attached to these Blocks (OGA, 2017; Marine Scotland, 2019).

3.15 Dredging and Dumping

There are no dredging or dumping sites near the Alma and Galia area.

3.16 Wind Farms

There are no existing or proposed Round 1, Round 2 or Round 3 offshore wind-farm sites within the vicinity of the project area (Marine Scotland, 2019), with the closest over 188km from the Alma and Galia area (Figure 3.16.1).

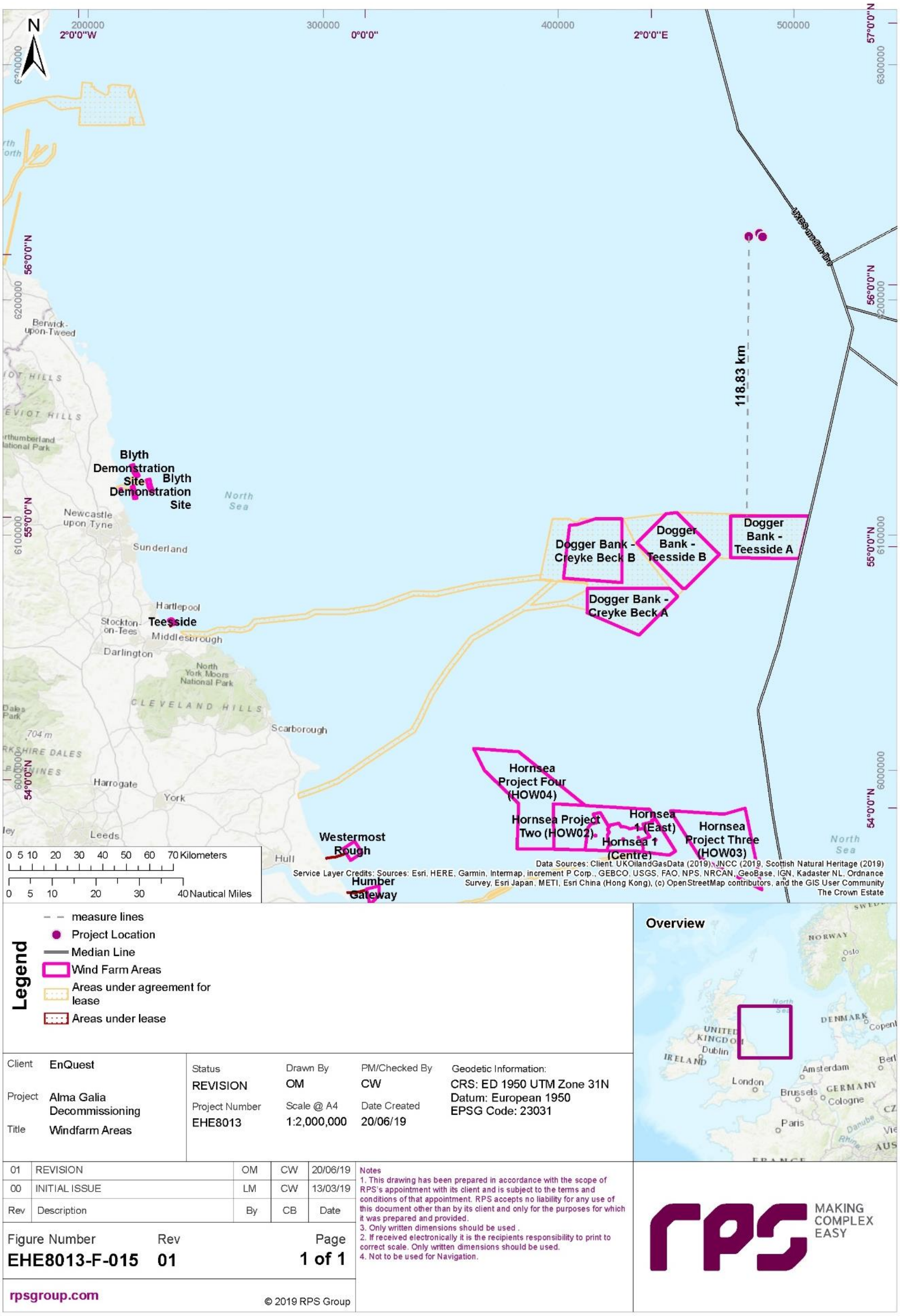


Figure 3.16.1: Alma and Galia area relative to wind farm developments

3.17 Archaeology and Wrecks

The Gardline site survey at Galia found two areas of disturbed seabed both over 2.5 kilometres north east of the Galia well interpreted as significantly degraded wrecks. The southernmost wreck correlates with wreck ID 3277, but the northernmost wreck does not correlate with any known wreck and mainly ballast/ rock remains of the structure. The northern and southern wrecks exhibit maximum measured heights of 0.5 metres and 3.5 metres, respectively (Gardline, 2011e). There is also a possible wreck located in Block 30/16, approximately 49 kilometres from the Galia well (Marine Scotland, 2019). Geophysical and geotechnical survey results do not show any anomalies typically associated with archaeological sites (Gardline, 2011).

3.18 Tourism and Leisure

The tourism industry is not likely be impacted by normal offshore oil and gas operations, but leisure activities could be threatened in the event of a major accidental spill approaching the coast. Leisure based and tourist activities are widespread along the Scottish Borders and north east coast of England; popular activities include walking, bird watching, wildfowling and golf. Sites such as the Tynemouth, Dunstanburgh and Bamburgh castles, the Lindisfarne National Nature Reserve and the Farne Islands are also popular with tourists (DECC, 2016).

A lightly used recreational sailing route passes through the centre of Blocks 30/24 and 30/25, approximately five kilometres and six kilometres north-west of the Galia and Alma drill centres, respectively. There are several yachting routes, general sailing areas and racing areas near the coast but the development is far enough offshore for general sailing not to occur in the vicinity (RYA, 2008).

4. INITIAL ENVIRONMENTAL IMPACT ASSESSMENT

4.1 Environmental Impact Identification (ENVID) Workshop

The Environmental Impact Identification (ENVID) workshop was held on the 8th April 2019, during which project aspects were identified and the associated environmental impacts and risks were assessed using EnQuest's corporate risk assessment matrix and process (described in Appendix B). Aspects that were categorised as having positive impacts, or negative impacts of low significance, were not selected for detailed assessment and are discussed briefly in section 4. Aspects that were categorised as having potential impacts of medium or high significance, are selected for further assessment and are discussed in detail in section 5 and summarised in Table 4.2.1. The results of the ENVID workshop presented in the ENVID report (EnQuest, 2019b) are also summarised in Appendix A.

As the ENVID workshop was undertaken prior to the CA it included all potential mooring and pipeline, umbilical and cable decommissioning options. Whilst the ENVID report details the assessment of all these options, this EA document only discusses the assessment of the final decommissioning options selected as a result of the CA (EnQuest, 2019a).

4.2 ENVID Findings

The ENVID workshop identified and assessed the potential environmental impacts of the decommissioning project activities. Most of the potential activities identified were ranked low (green) environmental risk following standard mitigation. The aspects ranked as low environmental risk do not require detailed assessment in the EA, therefore are summarised in sections 4.4 to 4.9 inclusive.

The activities evaluated in the ENVID as having a potential medium (yellow) environmental risk have been subject to further assessment and are presented in Table 4.2.2 and discussed in greater detail in section 5. There were no potential activities ranked as high (orange) or very high (red) environmental risk (Table 4.2.1).

The project activities and associated assessment scores have been updated as necessary following the ENVID to reflect the current understanding of the project at the time of writing the EA.

Potential environmental risks and significance		
Severity	**Environmental risk**	**Potential impact significance**
Very High	Very High Risk (intolerable risk), where the level of risk is not acceptable and control measures are required to move the risk to the lower risk categories	Considered significant
High	High Risk (intolerable risk), where the level of risk is not acceptable and control measures are required to move the risk to the lower risk categories	Considered significant
Medium	Medium Risk – requires additional control measures where possible or management / communication to maintain risk at less than significant levels. Where risk cannot be reduced to low, control measures must be applied to reduce the risk as far as reasonably practicable	Considered significant
Low	Low Risk, where the level of risk is broadly acceptable and generic control measures are already assumed in the design process but require continuous improvement.	Not significant
Positive	Positive impacts (to be enhanced if possible)	Positive significance

Table 4.2.1: Potential environmental risks and significance

Summary of initial assessment excluding aspects rated as 'low' environmental risk																			
Activity	Physical			Biological								Socio-economic							Further Assessment Section
	Marine Water Quality	Air Quality	Sediments	Terrestrial Communities	Benthic Communities	Plankton	Fish / Shellfish	Offshore Seabirds	Coastal Seabirds	Marine Mammals	Protected / Sensitive Areas	Shipping	Fishing	Oil and Gas Activity	Pipelines / Cables	Tourism / Leisure	Resource Use/ Energy Use	Coastal Populations	
Dredging & cutting of lower mooring chain at DP or excavated and cut mooring chain at –1m below seabed																			5
Potential for exposure of pile tops and/or chains beyond DP																			5
Removal of pipelines																			5
Potential use of MFE for removing deposited rock																			5
Excavation, disconnection / removal of seabed structures including dredging and cutting of manifold piles at 1m below seabed																			5
Key:		Interactions rated as medium environmental risk[16]																	

Table 4.2.2: Summary of initial assessment excl. aspects rated as 'low' environmental risk

[16] Note that there were no potential activities ranked as high (orange) or very high (red) environmental risk.

4.3 Cumulative and Transboundary Impact Assessment

Whilst the scope of this impact assessment is restricted to the decommissioning of the Alma and Galia development, there may be other marine activities which have the potential to interact with the activities completed under the decommissioning work scope. The impact assessment presented below and in section 5 considers the potential for significant cumulative impacts to occur as a result of overlapping activities.

In addition, the assessment identifies any potential transboundary impacts which could impact the environment and resources beyond the boundary of UK waters.

4.4 Underwater Noise

Anthropogenic noise in the marine environment is widely recognised as a potentially significant concern, especially in relation to marine mammals. Potential (and postulated) effects of anthropogenic noise on receptor organisms range from acute trauma to subtle behavioural and indirect ecological effects, complicating the assessment of significant effect. There is increasing recognition that masking (when an extraneous sound covers a desired signal) of communication and echolocation by marine mammals may also be a significant mechanism of effect (e.g. Weilgert 2007).

The primary sources of noise from the decommissioning activities will come from:

- Dive support vessel (DSV) and Construction Support Vessel (CSV);
- Supply and safety vessels;
- Anchor handling vessels (AHV);
- Dredging;
- Underwater cutting (likely diamond wire).

These sources will all emit low frequency continuous noise in the water column, and there is the potential for multiple vessels (and therefore sources of noise) to be present in the area at the same time.

4.4.1 Vessel Noise

Noise emissions from vessels are primarily associated with propeller noise (including cavitation), especially where active positioning by thrusters is used. 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. Generally, broadband source levels for vessels are in the range of 160-190dB re 1µPa@1m (Genesis, 2011).

Sections 3.7 and 3.9 detail fish and marine mammal abundance in the area. Only harbour porpoise and minke whale are present in significant enough numbers in the area to register in the SCANS-III survey and these still show low abundances. The peak sound levels and frequency spectra from vessels are not likely to be capable of causing any physical injury to acoustically sensitive species. Shipping density in the area is very low and therefore although several vessels may be in the field at the same time, they will not provide significant cumulative noise impacts. The duration of the individual activities will be relatively short, with standard methodologies and equipment used, and SIMOPS in place to manage vessel activity. As a result, it is not expected that any significant impacts will arise from vessel noise associated with the Alma and Galia decommissioning activities.

4.4.2 Subsea Dredging and Cutting Noise

There may be a requirement to dredge around the foundations of the Alma manifold, tie-in points and mattress corners to allow for access during removal operations. Whilst the final method is not currently known it will likely be a suction dredger, with a mass flow excavator as a contingency option. There have been few studies describing noise from dredging activities, with those that have been published focusing on large scale dredging operations. These studies have shown that suction dredging noise is typically of low frequency (below 1kHz), with sound source levels ranging from 168-186 dB (rms) re 1µPa@1m (Genesis 2011). Any dredging will be of a short duration and therefore is unlikely to have any significant impact.

The mooring chains and the Alma manifold piles will be cut subsea using a mechanical tool such as a diamond wire cutter. It is not anticipated to use explosives as part of the project. Pangere et al. (2016) measured noise characteristics of an underwater diamond wire cutting operation in a water depth of 80m in the North Sea. The study showed that the radiated sound from the wire cutting was not easily discernible above the background noise present during the operations, including several simultaneously operational vessels (a DSV, a standby vessel and a supply or tug vessel).

Subsea cutting at Alma and Galia will also take place in 73-80m water depth alongside several infield vessels. As such, it can be concluded that noise levels from the cutting operations will not be significant, with background conditions unlikely to be exceeded. The operations are also temporary, and activities are of short duration.

Based on the above, the environmental risk of these aspects is considered low and the potential impacts are not considered significant.

4.4.3 Transboundary and Cumulative Impact

The levels of shipping, fishing and other vessel movements in the area are low, and there are no wind farm construction zones within 180km of the site or other known construction activities which are likely to generate significant amounts of underwater noise. As the expected noise levels from the Alma and Galia decommissioning work are expected to be negligible and localised, no cumulative impacts from noise can be expected. In addition, no transboundary effects are expected due to the low noise generation, short propagation distances and the distance from the transboundary line (transboundary line is greater than 17km from the location).

4.5 Discharges to Sea

Planned discharges to sea will occur from the use of vessels and small releases of the pipeline and structure contents to sea during disconnection of the subsea infrastructure and the removal of the pipelines. Additionally, the potential exists for ballast water to be discharged dependent upon the vessel type engaged in the decommissioning activities.

The pipelines, spools, and manifold piping will have been cleaned and flushed prior to any disconnection activity and filled with seawater. The use of any chemicals for cleaning and flushing or for any other decommissioning activities will be permitted under the Offshore Chemical Regulations 2002 (as amended) and the discharge of any residual hydrocarbons from pipeline, spool or manifold disconnections and removal will be permitted under The Offshore Petroleum Activities (Oil Pollution Prevention and Control (OPPC)) Regulations 2005 (as amended). Any ballast water discharges will be in line with the International Maritime Organisation ballast water management convention and guidelines. Vessel activities such as the release of drainage water and grey water will be relatively short in duration and will be subject to separate regulatory requirements.

There may be a requirement to remove some marine growth from the manifold and other structures to allow access for removal equipment. Surveys have shown that marine growth forms a thin layer (0 - 60mm thick) primarily comprised of mussels and barnacles, with some sea anemones and soft corals. All these species are widely found on hard substrates in North Sea waters, are not on any species conservation lists and are not seen in large abundance on the Alma and Galia infrastructure. As a result, there is not expected to be any impact on species populations by their removal.

Based on the above, the environmental risk of these aspects is considered low and the potential impacts are considered not significant.

4.5.1 Transboundary and Cumulative Impact

The small volumes of discharges resulting from the infrastructure disconnection and removal and vessel activity will likely dissipate rapidly within the water column. A Chemical Permit covering these discharges will assess the impacts of any discharges but it highly unlikely, given the volumes and likely chemicals involved, that any cumulative impacts on water quality or marine biota will occur. It is also extremely unlikely that any transboundary effects will occur from the expected discharges, given the distance to the nearest transboundary line and the hydrodynamic regime of the area.

4.6 Accidental Events

The potential sources of accidental events to the marine environment from the project activities are:

- Loss of a vessel due to collision, resulting in loss of full diesel inventory to sea;
- Potential unintentional release of fuel or other fluids (e.g. diesel, jet fuel, hydraulic oil, lubricants or chemicals) during day to day operations (including re-fuelling);
- Dropped objects.

The ENVID process identified that the risks posed by the above accidental events are considered low given the mitigation measures in place. The ENVID used a variety of evidence to support the conclusions drawn, including audit history, past environmental performance and previous oil spill modelling studies.

The worst-case source of hydrocarbon loss to sea would be from loss of the total diesel inventory of one of the vessels. Of all the vessels planned for use in the project activities DSV and CSV type vessels have the largest fuel inventories, typically around 1,500m^3 to 2,200m^3 depending on type and size.

Oil spill modelling was undertaken for the EnQuest Producer OPEP (EnQuest, 2014) and included modelling of a diesel release of 3,550m^3. That volume represented the total inventory of the FPSO plus either a mobile drilling unit (MODU), accommodation unit or workover support vessel also undertaking work on the field. Both onshore and offshore wind scenarios were modelled for a winter month, with results showing that the diesel persisted for 10 hours before dispersing naturally with no beaching occurring and a slick length of around 3.7 – 3.9km.

The relatively small impacted area from the release, the rapid evaporation and dispersion into the water column and the lack of beaching meant that impacts would be relatively limited. Seabirds rafting on the surface of the water would potentially be affected by hydrocarbons clinging to their feathers and by the toxic effects of ingestion. Fish populations have the potential to be 'tainted' but marine mammals are not usually affected significantly by hydrocarbon spills. Given the short residence time on the sea surface (10hrs), small impacted area, the light nature of diesel oils and relatively rapid dispersion, significant impacts on fish, seabirds or marine mammals are not expected.

Fishing activity and vessel transit would likely be excluded from the area following a spill, but the duration of exclusion would be short, and the area is not heavily used by fishing vessels or other vessels, therefore the impact would be minimal. The offshore wind showed an incursion of the diesel over the transboundary line with Norway after 6.2 hours, but the volumes involved were small and persisted for a short period of time, therefore no significant transboundary impacts were identified.

The above assessment was undertaken on the results of a 3,550m^3 diesel release, likely almost double the fuel inventory of the largest vessel involved in the Alma and Galia decommissioning activities. As a result, it can be expected that impacts from an accidental diesel release would be further reduced, and therefore not significant in the context of the decommissioning operations.

4.6.1 Accidental release from the wells

Although the latest decommissioning guidance (BEIS 2018) states that well plug and abandonment operations should be covered by a Well Intervention application (WIA), in this case the wells will remain suspended for a period of time, up to 5 years, prior to being plugged and abandoned. As a result, there is the potential for an accidental event leading to a well blowout or hydrocarbon release from the wells in the intervening time period.

The following barriers will be in place for the time period between CoP and well P&A:

- All well annuli will be depressurised, associated tree valves will be closed and pressure tested, where possible (in most cases there is not enough pressure upstream of the valves to carry out a meaningful test);
- Production flowlines to the manifold will be disconnected;
- Injection Christmas tree will be disconnected;
- Sub-sea safety zones will remain at the Alma and Galia fields;
- The tree structures are over-trawlable;
- Regular monitoring will be carried out;
- An approved OPEP will be in place describing the arrangements for on-scene command.

In addition to the above barriers, the wells currently use downhole ESPs to maintain production and therefore in the event of an incident it is unlikely that they will flow of their own accord. Free flow tests in 2019 on the Galia well confirmed that after a 1.5hr weak flow of a built up gas cap the well ceased to flow.

Oil spill modelling was undertaken for a well blow out situation on the Alma AP5 well. This well was chosen as during operations it is the only well that flows naturally, although this is only done rarely and briefly during an operational black start. The Alma crude is a light oil (ITOPF Group II) with an API of 38. The results of the blowout modelling (Figure 4.6.1), using a 3,434m^3 release volume over a 45 days release duration, show that the majority of oil would be confined to offshore waters within the wider Alma Galia area. After a 55 day duration (45 day release and 10 days for observation) the model predicted that in worst-case (autumn season) only 4.84m^3 of oil would have reached a shoreline. Table 4.6.1 shows that there is a <30% probability of shoreline oiling anywhere in the wider North Sea area with the shortest beaching time of 10 days.

The closest designated sites, Fulmar MCZ (10km from Alma and Galia), Dogger Bank SAC/SCI/MPA (80km from Alma and Galia), Swallow Sands MCZ (86km from Alma and Galia) and East of Gannet & Montrose MPA (104km from Alma and Galia) are all designated for seabed sediments and features which would not be significantly impacted by surface oiling. The Southern North Sea MPA/SAC (105km from Alma and Galia) is designated for the Annex II species harbour porpoise. It has been rare for marine mammals to be affected following an oil spill (DCENR, 2011) as they are able to detect hydrocarbons in the water column and move away from contaminated areas and often have the ability to move great distances away from spills. Marine mammals are not commonly impacted by physical oiling nor are they subject to sensitivity to cold through oiling, as they have a thick insulation of internal blubber to keep them warm.

The sensitivity of seabirds to oil pollution in the wider Alma and Galia area is low throughout the year, with 2 months of moderate sensitivity (May-June). Fishing activity and vessel traffic is also low in the area and fish spawning and nursery areas are unlikely to be impacted by surface oiling.

Given the barriers in place and lack of potential for free flow from the wells, there is a very low likelihood of an incident of this magnitude occurring in the 5 years to well P&A. The likely extent of any incident, the time taken and volume of oil likely to reach a coastline and the sensitivity of receptors within the wider area also suggests that significant impacts would not be expected.

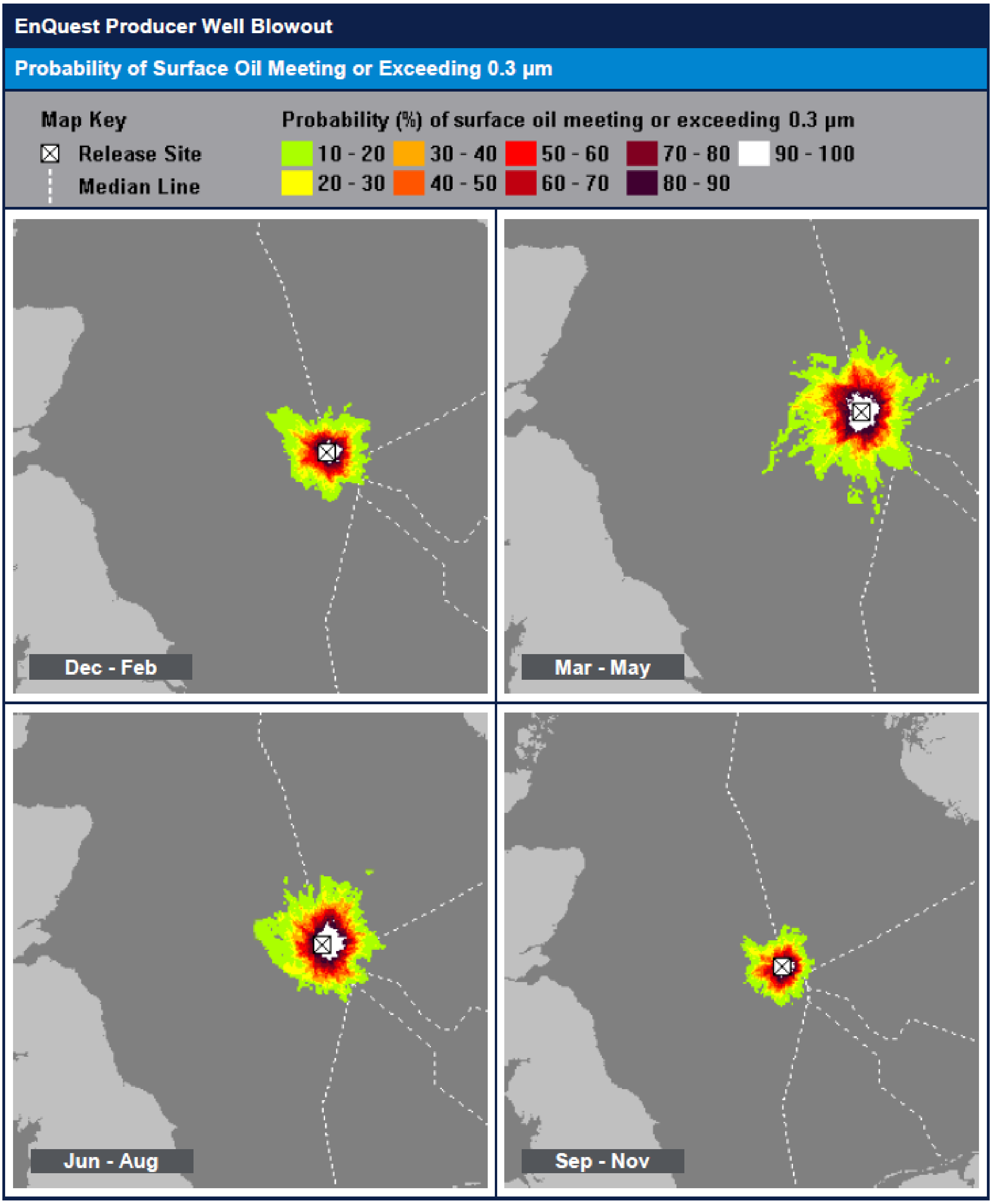


Figure 4.6.1: Probability of surface oil from a well blowout meeting or exceeding 0.3µm

Well blowout: Worst case time and probability of oil shoreline beaching and crossing the median line				
North Sea States	Shortest time for shoreline oiling	Worst case probability (≤1%) of shoreline oiling	Shortest time to crossing median line	Worst case probability (≤1%) of crossing median line
Shetland	16 days	1-5%	-	-
Grampian	> 20 days	1-5%	-	-
Tayside to Lothian	> 20 days	1-5%	-	-
Boarders	> 20 days	1-5%	-	-
North East England	> 20 days	1-5%	-	-
Norway	10 days	23-30%	9 hours	90-100%
Denmark	13 days	20-30%	21 hours	60-70%
Sweden	15 days	10-20%	-	-
German	> 20 days	1-5%	24 hours	30-40%
Netherlands	-	-	2 days	10-20%

Table 4.6.1: Well blowout: worst case time & probability of beaching & crossing median line

Transboundary Impacts

Due to the location of Alma and Galia (17km from the UK/Norway median line) there is a >90% probability of released oil crossing into Norwegian waters, with the shortest arrival time being 9 hours (Table 4.6.1). There is also the possibility of oil crossing into Danish, German and Dutch waters, although on timescales >21 hours.

The release, therefore, could present a risk to SACs and SPAs within these member states. A release could also present a risk to species protected under the Habitats and Birds Directive on the Norwegian coast. For example, Norway is known to support approximately 8% of the European harbour seal population (count at 2013) and approximately 2% of the grey seal population (count at 2008 based on seal pup production) (Special Committee on Seals, 2017).

In the event of an oil spill entering any waters of member states other than those of the origination state, it may be necessary to implement the Bonn Agreement. The Bonn Agreement sets out command and control procedures for pollution incidents likely to affect participating parties, as well as channels of communication and resources available. In the event of a major spill which is predicted to drift into Norwegian waters, the Norway-United Kingdom Joint Contingency (NORBRIT) plan will also be activated. This plan operates within the framework of the National Contingency Plans and is oriented towards major spills. The OPEP will provide details of the Bonn and NORBRIT Agreements and how to impellent them through the UK National Contingency Plan.

Although there is a potential for oil to cross various median lines, the likelihood of an event of this magnitude, spatial extent of a spill, arrival time at coastal areas (< 10 days) and volume of oil modelled to beach mean that the potential impacts from this aspect are considered not significant.

4.7 Physical Presence of Infrastructure and Vessels

4.7.1 Presence of Infrastructure

The scope of the decommissioning plan is to remove all the existing surface and subsurface infrastructure, except for the mooring piles and chains from the DP to padeye, existing deposited rock and manifold piles. The piles and chains will be buried below the seabed with no surface exposures.

The existing deposited rock will be the only material left on the seabed which could present a snagging risk to fishing activity. There is the potential that some material from the deposited rock may need to be moved if it is not possible to pull the pipelines cleanly through the rock. However, this is a contingency measure and it is expected that no movement of material will be required. If this is required, it will be small quantities, enough to free the pipelines and allow pulling through the rock to continue. Any rock will be dislodged during the removal process or moved using a mass flow excavator. However, any rock that is dislodged will remain alongside or on top of the existing rock structure and so will not significantly increase its size or change its shape. The deposited rock has been present in the field since construction in 2015 and therefore it is not anticipated to pose any additional risk to fishing vessels.

There is the potential that spoil heaps may form during excavation activities to uncover the buried protection material or lifting points on the subsea structures, but this will be of limited spatial extent. Excavation will occur to a depth of at least 1m below seabed to allow access to the manifold piles for cutting, which will also produce a potentially clay and sand spoil heap. It is the intention to internally cut the manifold piles if feasible, which will result in a smaller seabed impact than external excavation. There may be seabed remediation required post pile cutting, which will rebury the pile to 1m below seabed and backfill the spoil heap. Post-decommissioning seabed surveys will be undertaken after Phases 1 and 2, which will ensure no increased snagging risk to fishing vessels exists.

Two options are considered for decommissioning the lower mooring chains: one would be to cut at the DP and bury the remaining chain to >1m below seabed. The other would be to excavate and cut the chain at >1m below seabed and backfill the excavation. With either option, the length of chain from the cut point will remain buried *in situ* along with the mooring piles. The preferred decommissioning option for the mooring lines would likely be to cut them at the DP and bury the ends. The excavated material will be mechanically backfilled. The burial status will be confirmed by post-decommissioning surveys as described in the Decommissioning Programmes.

The seabed is expected to be moderately stable, especially compared to the Southern North Sea where currents are far stronger and bed load transport greater. In the three years between installation (2015) and pipeline integrity survey (2018), there has been a degree of natural backfill of the trenched pipeline corridors. However full backfill had not been achieved suggesting that sediments are not that mobile within the area. Any exposures identified along the pipelines relate to upheaval buckling or insufficient backfill rather than scour. Survey data from pipelines in the area (e.g. the Janice, James and Affleck Fields (Maersk 2016) also suggest a moderately stable seabed. It can therefore be expected that buried infrastructure at Alma and Galia will remain so.

Phase 1 and Phase 2 decommissioning activities will take place approximately five years apart. It is the intention that Phase 1 will remove all infrastructure currently within the FPSO 500m exclusion zone, as well as the mooring system. The FPSO 500m exclusion zone will expire when the FPSO is towed from site. All infrastructure in the interim period between Phases 1 and 2 will remain *in situ* with the pipeline protection and stabilisation features staying in place. The cut pipeline ends will be protected in the meantime using the mattresses recovered from the water injection flowline inside the 500m zone. The 500m exclusion zones around the Alma manifold and Galia well will also remain in place. Therefore, there will be no increased snagging risk in the interim period. This will be verified by risk-based pipeline inspections. Should full clearance of the 500m zone not be achieved immediately after departure of the FPSO, a guard vessel will be stationed in the area.

Once Phase 1 and Phase 2 decommissioning activities have been completed, clear seabed verification surveys will be carried out to ensure that the seabed does not pose a hazard to fishing vessels.

The wells will be decommissioned within 5 years of the main decommissioning activities and in the interim period will be protected by the fishing friendly protection structure integral to the Xmas trees.

4.7.2 Presence of Vessels used for Decommissioning Activities

Vessels on transit to Alma and Galia and on location present a physical obstruction in the sea and an associated navigational hazard and increased risk of collision with third-party vessels. Although it is expected that the Alma and Galia decommissioning activities will take place in two phases over a period of up to 7 years, the total number of days each individual vessel will be in the field is relatively low (Table 2.6.1). 500m exclusion zones are currently in place around the FPSO, Alma manifold and Galia well. Whilst the FPSO exclusion zone will expire when the FPSO is towed from the site, the exclusion zones at Alma and Galia will remain until the associated subsurface infrastructure has been completely removed. As a result, a proportion of the subsea infrastructure and protection removal activities will take place within the existing 500m exclusion zones.

Vessel collision due to the presence of these activities is considered remote, however such an event could potentially lead to elevated impacts such as injury/loss of life to vessel crew members or an unintentional release of hydrocarbons. The potential impact related to the release of hydrocarbons is addressed in section 4.6.

Shipping densities and fishing vessel activity in the area are low (refer sections 3.11 & 3.12) and a number of mitigation measures will be in place to minimise the risk of collision. Operations will be carried out in accordance with the consent to locate conditions to ensure other users of the sea are made aware of the presence of vessels. Additionally, onsite at all times during activities (and as a contingency measure during the interim Phase 1 to Phase 2 period) there will be an emergency response rescue vessel which will be equipped with automatic radar plotting aid (ARPA) which can create tracks of nearby vessels and calculate the tracked objects course thereby reducing the likelihood of collision. There is no requirement for any vessels to be anchored to the seabed and therefore no increased snagging risk for fishing vessels.

Based on the above, the environmental risk of these aspects is considered low and the potential impacts are considered not significant.

4.7.3 Transboundary and Cumulative Impacts

All infrastructure from the previous developments of the Alma and Galia fields (Argyll, Duncan and Ardmore) were removed at decommissioning and therefore there is no cumulative snagging impact from the presence of any remaining Alma and Galia materials on or in the seabed. Although the central North Sea has many oil and gas developments, there are no others in Blocks 30/24 and 30/25 therefore cumulative impacts in the wider area are also unlikely to be significant from the presence of additional vessels associated with Alma and Galia. No transboundary impacts arising from physical presence are expected.

4.8 Atmospheric Emissions and Energy Use

There is no requirement for the EA to contain an assessment of waste or waste management from onshore elements of the plan and therefore assessments of the impacts from onshore energy use and atmospheric emissions will be assessed in license applications for appropriate onshore disposal facilities. In addition, any potential onshore environmental effects will be managed and mitigated in accordance with the terms of the relevant environmental permits. As such no further assessment will be undertaken in this EA report.

The ENVID identified potential atmospheric emissions from vessel activity associated with the Alma and Galia decommissioning activities.

The decommissioning activities will be undertaken in two separate phases requiring the use of various types of vessel for different periods of time throughout the decommissioning project. Table 4.8.1 outlines the vessel fuel requirements for the decommissioning activities, with the associated CO_2 emissions using an emission factor from the EEMS Atmospheric Emissions Calculations, Issue 1.9 (EEMS, 2008). The exact vessels and schedules are not confirmed at the time of writing the EA and therefore fuel consumption rates have been based on generic vessel types. It has been assumed that all vessels will be working solely on the Alma and Galia decommissioning work.

The total CO_2 generated from vessel activity associated with the Alma and Galia decommissioning work is estimated as 11,608 tonnes. This corresponds to 0.08% of the total annual CO_2 emissions from offshore oil and gas operations on the UKCS in 2018, which were 14.63 million tonnes (Oil & Gas UK, 2019).

As it is the intention that no seabed infrastructure will be left unprotected in the interim period between Phases 1 and 2 of decommissioning, there will not be any requirement for guard vessels on site during this time period. However, a contingency measure if full removal of infrastructure from the FPSO 500m zone does not take place within Phase 1 would be the presence of a guard vessel for the interim period.

Energy & atmospheric emissions from project vessel activity						
Phase	**Vessel Type**	**No. of Days**	**Fuel Use / day (Te)**	**Total Fuel Use (Te)[17]**	**CO_2 (tonnes)**	**CO_2e (tonnes)[18]**
Phase 1	DSV or ROVSV	37	18	666	2,131	2,194
	CSV	36	18	648	2,074	2,135
	AHV[19]	25	20	500	1,600	1,647
	Survey Vessel	5	18	90	288	297
	Fishing Vessel	10	4	40	128	132
	Supply Vessels	16	5	80	256	264
	EERV	112	0.8	89.6	287	295
	Phase 1 TOTAL				**6,764**	**6,964**
Interim	Contingent Guard Vessel[20]	1825	0.8	1,460	4,672	4,810
Phase 2	CSV or ROVSV	52	18	990	3,168	3,262
	Survey Vessel	5	18	90	288	297
	Fishing Vessel	12	4	48	154	158
	Supply Vessels	11	5	55	176	181
	EERV	76	0.8	60.8	195	200
	Phase 2 TOTAL				**3,980**	**4,098**
Post Decom.	Future surveys	15	18	270	864	890
	TOTAL[21]				11,608	11,951

Table 4.8.1: Energy & atmospheric emissions from project vessel activity

CO_2 equivalent (CO_2e) is based on the radiative forcing effect of each Green House Gas (GHG) species relative to CO2 and the atmospheric residence time of each gas. The Global Warming Potential (GWP) therefore changes depending on the 'time horizon' (IPCC 2007, 2014) considered. In order to calculate the CO_2e for vessel traffic and the drill rig for a comparison with UK data, a 100-year time-horizon has been used. It should also be noted that Intergovernmental Panel on Climate Change (IPCC) consider the GWP conversion factors to have an uncertainty of ca. ± 35%. GWP for NOx and VOCs have not been included due to the greater uncertainty surrounding factors for these (IPCC, 2014). Shipping in the UKCS produced 5.3 million tonnes of CO_2 equivalent in 2017 (Defra, 2019). The CO_2e for the Phase 1 of the Alma and Galia decommissioning work totals 6,964 tonnes of CO_2e, and Phase 2 (including potential future surveys) totals 4,988 tonnes of CO_2e. This corresponds to 0.13% and 0.09% respectively of UKCS emissions from shipping in 2017.

If the contingent guard vessel is required between Phases 1 and 2, up to an additional 4,810 tonnes of CO_2e will be added to the project total. This would take the total CO_2e emissions from the project from 0.23% to 0.36% of UKCS emissions from shipping in 2017.

In addition, the activities are scheduled to be phased and therefore emissions will be spread over multiple years. Time spent by vessels in the field will be limited through optimisation of the decommissioning schedule and elevated concentrations of atmospheric gases from vessel activities will be localised, short-lived and will hardly be detectable beyond a short distance from the vessels due to the dispersive nature of the offshore environment.

Localised impacts may include elevated levels of atmospheric emissions in the immediate area. Emissions from the project will be localised, short-lived and will be limited to the areas around the

[17] Estimated fuel use per vessel type is based on The Institute of Petroleum Guidelines (IoP, 2000) except for: ERRV, based on standby vessel (1000-1500HP) – working; Fishing vessel, based on IoP (IoP, 2000) for safety vessel (working)
[18] Uses IPCC fifth assessment report (AR5: 2014) GWP values relative to CO_2.
[19] Destination for the FPSO in not currently known and so this is an indicative estimate only.
[20] As this is a contingency measure only and estimation has been based on possible maximum number of days required, it has not been included in the project total.
[21] Due to the need to remove the downhole ESPs, a MODU will likely be used for well decommissioning activities and removal of the wellhead structures. This has not been included here as well decommissioning is outside the scope of this EA but it is expected that the rig will contribute to overall project CO_2 emissions but will not significantly increase the percentage of emissions relative to the total UKCS emissions.

vessels due to the dispersive nature of the offshore environment.

Based on the above, the environmental risk of these aspects is considered low and the potential impacts are considered not significant.

4.8.1 Transboundary and Cumulative Impacts

The Alma and Galia fields are located 17.6km from the transboundary line with Norway. The atmospheric emissions will result in a minor deterioration of air quality over the local area and will dissipate to negligible levels within a short distance from their source, before transboundary air quality deterioration is a factor. Therefore, transboundary impacts upon air quality are not expected.

The Alma and Galia area is located at a distance far enough away from other industrial activities (including other offshore oil and gas activity) for there to be any likely cumulative effects in terms of local air quality or health impacts. No other major projects within the wider Alma and Galia area have been identified which could contribute to cumulative impacts. The nearest wind farm area is over 180km away and there are no other oil and gas developments within the Block, in addition the area is relatively lightly used by vessel traffic and fishing vessels. As a result, cumulative atmospheric impacts are not expected.

4.9 Waste

Section 2.4 describes in detail the breakdown of expected waste streams from the Alma and Galia decommissioning works. Whilst it is the intention to use UK recycling and disposal sites for processing of waste materials brought onshore, there may be the requirement to transport waste outside of the UK depending on the type and availability of facilities at the time of decommissioning. If transfrontier shipment of waste is deemed to be the most appropriate approach for disposal, the EnQuest Waste Management Strategy (EnQuest, 2018) details the requirements for identifying appropriately licensed international onshore facilities where waste can be treated. This will form part of a contractor specific waste management strategy and active waste management strategy.

4.9.1 Transboundary and Cumulative Impacts

The UK is a well-developed area of oil and gas infrastructure with many mature assets and as such the cumulative impacts of decommissioning waste should be considered. The timing of the Alma and Galia decommissioning activities may overlap with other decommissioning projects in the area, although exact timelines are yet to be defined. Discussions will be held with waste management contractors to ensure that there is enough capacity and suitable recycling and disposal routes for materials. In addition, EnQuest will work with other operators in the area to identify opportunities to collaborate where possible. The significance of cumulative impacts associated with waste production has therefore been assessed as low. It is not currently known whether the shore base for receiving recovered materials will be in the UK or abroad. Only permitted facilities would be used for recycling or disposal and movement of waste out with the UK will be undertaken in compliance with Transfrontier Shipment of Waste legislation, in co-ordination with the receiving country's regulatory authority. Therefore, the significance of any transboundary impacts associated with the production of waste has been assessed as low.

5. SEABED DISTURBANCE

5.1 Introduction

This section presents the further environmental assessment, undertaken by identifying and assessing the temporary and permanent environmental impacts from the various sources of seabed disturbance associated with the planned decommissioning activities. The discussion assesses both the potential for environmental impacts and outlines mitigation measures to minimise these impacts.

5.2 Sources of Potential Impact

The list below and Table 5.2.1 summarises the short and long-term environmental impacts identified from the ENVID associated with seabed disturbance during the proposed decommissioning activities, including those ranked as low and medium. They represent the worst-case scenarios for the Alma and Galia decommissioning works that will require operational activities at, below or near the seabed and all contribute to the cumulative seabed impacts:

- Temporary placement of the risers on the seabed during disconnection and removal;
- Excavation and cutting of mooring lines at DP or >1m below seabed;
- Lifting of mooring lines off the seabed, from touchdown point to DP;
- Excavation and burial of exposed ends of mooring chains at DP;
- Contingency burial of mooring pile tops and / or chain section from DP to padeye;
- Recovery of Alma and Galia concrete mattresses and grout bag protection;
- Lifting and pulling of pipelines up to the vessel through trenched sections and deposited rock;
- Contingency use of seabed excavator to remove areas of deposited rock if pipelines cannot be cleanly pulled through;
- Contingency seabed levelling post pipeline removal;
- Leaving deposited rock *in situ* following completion of decommissioning activities;
- Excavation and cutting of Alma manifold piles at least 1m below seabed. It is the intention to internally cut the piles, which would require a smaller volume of sediment to be excavated than external cutting;
- Remediation of seabed at manifold pile locations;
- Disconnection and removal of other subsea structures, including riser bases, which may require some excavation to access points;
- Post decommissioning seabed trawl survey[22].

5.2.1 Temporary

Short-term potential environmental impacts associated with seabed disturbance can include direct mortality or physical injury to benthic species, and mobilisation and re-suspension of sediment.

5.2.2 Permanent

In situ decommissioning of the existing deposited rock, mooring chains from the DP to pile and mooring piles may cause permanent disturbance to the seabed. The amount of disturbance is related to the dimensions of the deposited rock, their stability over time and the potential for changes to benthic communities from reef species and the degradation rate and composition of buried mooring lines and piles.

[22] After both Phases 1 and 2 independent verification of seabed state will be obtained using an evidence-based approach, the scope and method of which will be agreed in consultation with the Scottish Fishermen's Federation (SFF) and OPRED. As a worst case, it has been assumed that an overtrawl will be carried out.

Energy of potential sources of seabed disturbance and estimate of area impacted			
Source of impact	**Dimension of disturbance and assumptions made**	**Temporary or Permanent**	**Estimated area of direct impact (km^2)**
Temporary laydown on risers on seabed during removal[25]	Based on 204mm diameter and individual riser lengths.	Temporary	0.000214
Excavation & cutting of 9 mooring lines at DP or >1m below seabed	Either removal of seabed around each of the mooring lines at DP to allow access for diamond wire cutter or mechanical shears. Assumption that the amount of seabed to be removed at each DP location will be $9m^3$, with a seabed footprint of $6m^2$ per mooring line. Or excavation of seabed in a trench until mooring chain is >1m below seabed and then to allow access for diamond wire cutter or mechanical shears. Assumption that worst case trench length to chase the chain to >1m below seabed is 20m for cluster 1, 30m for cluster 2 and 10m for cluster 3, with a trench width of 3m.	Temporary	0.000054[23] 0.00054[23]
Lifting of 9 mooring lines to vessel	Assumes that mooring lines will be disconnected and recovered in a single operation, without additional placement on the seabed. Approximately 1,350m of chain per mooring line is currently laid on the seabed. Assumes a worst case 5m corridor of impact from any lateral movement during recovery from a DP vessel. Total is for 9 mooring lines.	Temporary	0.060750
Burial of 9 mooring line ends at DP to at least 1m below seabed or backfill of excavation trench	Either, removal of seabed to at least 1m below seabed at DP. Assumption that the amount of seabed to be removed at each mooring line DP location will be $4m^3$, equating to a seabed footprint of $4m^2$ per mooring line. Once the excavation or burial activity have been completed, the excavated area will be backfilled. Or, backfill of excavated trench to mooring chain cut point at >1m below seabed	Temporary	0.000036[23] 0 [23] [24]
In situ decommissioning of remaining mooring lines from DP to pile and mooring piles	Approximately 22.5m of 3 mooring chains, 39m of 3 mooring chains and 14.5m of 3 mooring chains will be left in the seabed (DP to padeye) along with all the mooring piles. The mooring lines have a footprint based on their length and a width of 0.142m. The piles have a footprint based on an area of $3.57m^2$.	Permanent	0.000065
Recovery of all mattress and grout bag protection[25]	Total of 194 concrete mattresses with dimensions of 6m x 2m Total of 315 x 25kg grout bags with dimensions of 0.5m x 0.3m Total of 75.5 x 1000kg grout bags with dimensions of 1m x 1m	Temporary	0.002328 0.00004725 0.0000755
Removal of Alma manifold to FPSO lines (PL3006, PL3007, PLU3009, PL3011, PL3012, PL3013)[25]	Most of the lengths of the lines are trenched and buried by natural backfill so little lateral movement during removal is assumed as the lines are confined to the trench area. The areas of deposited rock protection will remain *in situ* and therefore no additional impact on the seabed from removal of the lines underneath the deposited rock has been calculated. A 3m corridor of impact has been assumed for the full lengths minus the areas under deposited rock.	Temporary	0.029604
Removal of Alma water injection pipeline from well AW1 to FPSO water injection riser (PL3008)25	Most of the lengths of the pipeline is trenched and buried by natural backfill so little lateral movement during removal is assumed as it is confined to the trench area. The area of deposited rock protection will remain in situ and therefore no additional impact on the seabed from removal of the pipeline underneath the deposited rock has been calculated. A 3m corridor of impact has been assumed for the full length minus the area under deposited rock.	Temporary	0.005865
Removal of Galia to Alma manifold lines	Most of the lengths of the lines are trenched and buried by natural backfill so little lateral movement during	Temporary	0.043938

[23] Only one of these options will be chosen. As the excavation of the mooring chain to >1m below seabed, cut and remedial backfill produces the greatest seabed footprint this is the option used to calculate total seabed impact.
[24] Area impacted by backfill will be the same footprint as impacted by the excavation of a trench already calculated above.

Energy of potential sources of seabed disturbance and estimate of area impacted			
Source of impact	**Dimension of disturbance and assumptions made**	**Temporary or Permanent**	**Estimated area of direct impact (km^2)**
(PL3014, PLU3015, PL3016)25	removal is assumed as the lines are confined to the trench area. The areas of deposited rock protection will remain in situ and therefore no additional impact on the seabed from removal of the lines underneath the deposited rock has been calculated. A 3m corridor of impact has been assumed for the full lengths minus the areas under deposited rock.		
Deposited rock left *in situ*	Area calculated is based on as-laid report of width and length of the deposited rock being left	Permanent	0.0184434
Excavation, cutting to at least 1m seabed and seabed remediation of 4 manifold piles[25]	Assumes that internal cutting fails due to technical reasons on all 4 piles. Therefore, piles cut externally using a diamond wire cutter mounted on an ROV. Removal of seabed around each of the piles to ~1.5m below seabed. Assumption that the amount of seabed to be removed at each pile location will be 296m^3, equating to a seabed footprint of 197m^2 per pile.	Temporary	0.000788
Recovery of 14 riser bases[25]	Additional 1m added to all sides of the riser bases (2.12m x 5.37m) to allow for disturbance including localised excavation.	Temporary	0.0000004
Recovery of 8 trees / wellhead protection structures	Additional 1 m added to all sides of the trees (9.17m x 8.81m) to allow for disturbance including localised excavation.	Temporary	0.000001
Post decommissioning seabed trawl[25]	Assumption of worst case is a seabed trawl covering: • 25m radius around each of the 9 mooring piles • FPSO 500m exclusion zone • 50m corridor either side of pipelines (calculations assumes separate trench for each pipeline, except PL3011, PL3012 & PL3013 which share 1 trench, with >50m separation between lines) • 25m radius around Alma manifold	Temporary	0.017667 0.785398 2.531700 0.001963
Contingency burial of mooring pile tops and / or chain	For the purposes of this assessment, we assume remedial burial of all 9 mooring piles is required, equating to a seabed footprint of 0.00000625km^2 per pile	Temporary	0.000057
Contingency use of excavator to remove sections of deposited rock	Any impact from this activity will cover the same area as the post decommissioning seabed trawl and therefore has not been included.	Temporary	0
Contingency seabed levelling post decommissioning[25]	Any impact from this activity will cover the same area as the removal of pipelines and the post decommissioning seabed trawl and therefore has not been included.	Temporary	0
Anchoring of MODU for well decommissioning activities	This is not part of the scope of this EA but for indicative cumulative impact purposes the mooring line footprint from typical a semi-submersible rig is provided.	Temporary	0.002700
TOTAL TEMPORARY SEABED IMPACT[25]			**3.40km^2**
TOTAL PERMANENT SEABED IMPACT			**0.02km^2**

Table 5.2.1: Potential sources of seabed disturbance and area impacted

[25] It should be noted that the area of seabed impacted by the seabed trawl activities covers areas already impacted during the removal of the risers, pipelines, umbilicals and cables; Alma manifold pile excavation, cutting and remediation; recovery of all concrete mattresses and grout bags and; recovery of riser bases. In order to avoid including seabed impact for an area twice, the total seabed impact includes the seabed trawl area and excludes the other activities listed above (shaded grey in table).

5.3 Impact on Sensitive Receptors

5.3.1 Temporary Disturbance

The total area of seabed that could potentially be temporarily disturbed from decommissioning activities is estimated at a maximum area of 3.4km^2 including contingency and well decommissioning activities (Table 5.2.1). Direct impacts from these activities can cause mortality or displacement of benthic species in the impacted area, whilst indirect impacts could arise from the increased amount of suspended sediment in the water column in the nearby vicinity. The potential impacts to the seabed from decommissioning activities, however, are influenced by the nature of the seabed sediments, the prevailing sediment transport system and the total area of seabed in contact with items. It is expected that any suspended sediment would be rapidly dispersed and drop out of the water column, settling back on the seabed within a short period given the prevailing tidal and current conditions in the area. Therefore, any disturbance from suspended sediment is predicted to be short-term in nature.

The trenched lines were left to naturally backfill during installation, with subsequent surveys showing that this has produced cover ranging from 0m to greater than 1m, although some of the identified pipeline exposures may be due to upheaval buckling rather than insufficient backfill cover. Trenched areas will be left to naturally backfill, post removal of the pipelines. As a result, no additional seabed footprint from mechanical backfill is expected.

Impacts on Sediments

Sediments at the Alma and Galia fields were classified as predominantly silty slightly shelly sand underlain by sandy gravelly clay at depths ranging from less than 1m to 4m below seabed level. The decommissioning activities are likely to result in the suspension of a proportion of the sediments in the bottom few metres of the water column. Sandy and shelly sediments should drop out of suspension quickly, and in the immediate area, however, some of the finer silts and underlying clays may remain in the water column for some time. These finer sediments can be transported away from the immediate area on the prevailing currents, giving rise to indirect impacts on other areas of seabed when they finally settle out of the water column. The primary sediment type in the area, however, would tend to suggest that settlement of suspended material will occur in the vicinity of the activities with limited further afield sediment transport occurring. This also indicates that any smothering effects on seabed fauna will be limited and localised.

The Alma and Galia areas have a persistent low level of historical hydrocarbon sediment contamination resulting from the discharge of oil based mud from previous developments. These contaminated sediments were further spread by post-decommissioning seabed trawls. However, there was no evidence of distinct cuttings piles in the area from the previous Argyll, Duncan and Ardmore developments. Of all the sites with THC levels above background conditions only four (ENV 2, 11 and 13 for the Alma 2011 survey and ENV 9 for the Galia 2011 survey) are in areas potentially impacted by the project activities. However, contamination levels are still relatively low at those sites (THC vales < 22µg/g^{-1}, below the 95th percentile concentration for the central North Sea (UKOOA 2001)). Therefore, although it is likely that some re-suspension of small amounts of sediment contamination will occur, given the size of the area of seabed to be impacted and the relatively low levels of persistent contamination this will not result in significant increases in sediment contamination over the wider area.

The Alma and Galia area is 10.3km from the Fulmar MCZ, which is designated for ‘subtidal mud’, ‘subtidal sand’ and ‘subtidal mixed sediment’ broad scale habitats; and the presence of ocean quahog (*A. islandica*), a species sensitive to smothering due to their short inhalant siphon. Although there will be an increase in suspended sediment, possibly with low levels of hydrocarbon contamination, as a result of the decommissioning activities, but as discussed above, these will likely resettle over very localised areas and are unlikely to impact any of the designations of the Fulmar MCZ. All other areas of conservation designation are at least 77km from the project area and are therefore not likely to be impacted by any increase in suspended sediment.

Impacts on Benthic Communities

The seabed habitat types and associated communities are widespread over adjacent areas of the central North Sea. The most abundant macrofaunal species in the Alma and Galia project area are consistent with the faunal community type typical of sandy sediments in the wider Central North Sea area. These species are widely distributed and are typically short lived and would be expected to rapidly recolonise disturbed sediment.

Given that the direct impacts from temporary seabed disturbance sources are largely physical through natural disturbance and smothering, it is anticipated that the impacted sediment communities will begin to recover as soon as activities are completed. Re-colonisation of the impacted area can take place in several 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 this type of 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. With this type 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, which tend to dominate the data set, 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.

Sixteen juvenile and one adult of the ocean quahog, *A. islandica*, were identified in the 2011 benthic surveys over the Alma and Galia areas. *A. islandica* are a long-lived bivalve species considered to have very low to medium population resilience to mortality events (MarLIN 2019) depending on environmental factors such as size of local population, hydrography and local reproductive isolation from other populations. Although there have been limited studies on recovery rates for *A. islandica* populations following mortality events, estimations suggest greater than 10 years for significant mortality events (MarLIN 2019, Witbaard and Bergman 2003) with potentially reduced recovery times for smaller mortality events due to low levels of continuous recruitment. The size of the *A. islandica* adult and juvenile populations in the Alma and Galia area is low and does not constitute aggregations. As a result, any impacts associated with the project are likely to affect at worst case a small number of individuals, not significantly affecting population levels in the wider area.

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). Sites were sampled for macrofauna and habitat characteristics following disturbance in order to examine the relationship between physical and biological recovery rates. Of the four sediment types investigated, the communities from clean sands had the most rapid recovery rate following disturbance and mud the slowest. This mirrors findings of other studies (e.g. Kaiser, 1998, Ferns et al., 2000) which conclude that less stable habitats (coarse, clean sands) recover more quickly from disturbance than stable (muddy sands and muds) habitats. The seabed sediments in the Alma and Galia project area are predominantly silty slightly shelly sands and therefore can be expected to recover at a comparatively faster rate than other seabed sediments dominated by silts and muds.

Once absorbed by aquatic organisms, trace metals and PAHs may be converted to more toxic organic complexes which may pose a risk to pelagic and benthic species. Studies looking at the ecological impacts of the resuspension of contaminated sediments (e.g. Roberts, 2012, Burton & Johnson, 2010) suggest that whilst toxicity may result from both exposure to contaminants released into the water column and through ingestion, resuspension can both increase and decrease the bioavailability and toxicity of contaminants. There are persistent low levels of hydrocarbon sediment contamination over large parts of the Alma and Galia area, a proportion of which will be disturbed and re-suspended during the decommissioning works. There is the potential for ecological impacts on the benthic species of the area, although it is likely that this will be limited given the small area of sediments to be disturbed, the low and spatially variable contamination levels, biota present in the area and short duration of disturbance activities.

There is not anticipated to be a significant long-term impact on the benthic communities from the temporary decommissioning activities, given the relatively small footprint (3.40km^2) and absence of potential Annex I habitats from the site survey results (refer section 3.10.1), therefore the impact from seabed disturbance to benthic communities is considered to be low.

Impacts on Fish and Shellfish

A number of species of fish, including mackerel and cod are known to spawn within the project area, whilst others use the area as a nursery and for both life cycle phases (refer Table 3.7.1). Seabed disturbance including the deposition of sediment is more likely to affect those species that lay their eggs on the seabed (demersal spawning) as opposed to species that release their eggs and sperm into the water column (broadcast spawning) after which they are carried by the currents and widely distributed.

Sandeel are a UK BAP priority marine species and are an important prey source for a variety of fish, seabirds and cetacean. Sandeels are indicated as potentially spawning in the Alma and Galia area in the months of November to February and using the area as a nursery (Ellis et al., 2012). Sandeel distribution is primarily driven by the availability of suitable substrates for settlement and burrowing, with areas of >4% of silt/clay being avoided and absence of the species in areas where silt/clay or very fine sand content is greater >10% (Wright et al., 2000; Holland et al., 2005). On review of the particle size composition of the sediments within the Alma and Galia field areas (Gardline, 2011a & 2011b), all stations at Galia and 5 out of the 15 stations at Alma had a fines (<63µm) content >10%, theoretically making these areas unsuitable sandeel habitats. Of the remaining Alma stations, all had fines contents >4% suggesting that sandeels would avoid these areas and at best be present in very low abundances.

The Alma and Galia areas do not present a unique spawning or nursery area for species when compared to the wider central North Sea and the potential disturbance area is considered to be relatively small therefore the impact from seabed disturbance to fish species is considered to be low.

5.3.2 Permanent Disturbance

Permanent disturbance to the seabed from the project activities relates to the decommissioning of the existing deposited rock *in situ*, impacting an area of 0.018km^2. The deposited rock comprises of 1"-5" graded granite / gneiss rock, between 0.5m and 1m in height and with a total length of 3.5km split into individual lengths ranging from 0.15km to 4.5km. No new rock is planned to be added to the seabed during the decommissioning activities, so any impact will be associated only with the existing deposited rock.

The rate of recovery of the pipelines through the rock will be optimised so as to minimise any displacement of the rock from the berms. There will be post decommissioning verification of the stability and snagging potential of the berm, likely through an overtrawl, which will ensure the berms do not pose a snagging hazard to fishing vessels.

It is unlikely that the individual rock particles would be mobilised by local currents over time. They were installed with a 3:1 slope to increase stability and facilitate overtrawl by fishing vessels and there is no evidence from the ROV surveys of any stability issues with any of the deposited rock.

The introduction of a hard substrate to an area with a soft bottom has the potential to act as an artificial reef, which may in the long-term impact benthic communities in the local area. The deposited rock comprises of gravel rather than boulder sized rocks. Langhamer (2012) suggested that such gravel protection may result in a lower biodiversity increase and abundance of organisms, compared to boulders, due to the more unstable environment they provide. Whilst marine growth was evident on the subsea structures and mooring system during the 2016 and 2018 ROV surveys, little was evident on the deposited rock. This suggests that although there may be expected to be a change in structure of local benthic communities over a long period of time, due to the reef effect, this would be localised and limited only to the deposited rock.

In areas with mobile seabed sediment it is possible that scour will occur locally around any deposited rock that remains in situ once decommissioning has been completed. (Pidduck et al., 2017). Some small areas of scour have been identified in recent surveys around the Alma manifold, but none have been identified around any of the deposited rock features. The effect of any scour on habitat loss depends on the stability of the rock, existing seabed conditions and the presence of stabilising fauna or flora. As with the potential impact on benthic communities associated with the reef effect, the gravel nature of the rock and their small height means that any scour will likely be minimal.

Permanent disturbance of the seabed also relates to the *in situ* decommissioning of the mooring chains from the DP to the pile and the piles themselves. Over time, structural degradation of the steel will occur due to corrosion and will release metals into the surrounding sediments. These will break down and may potentially become bioavailable to benthic fauna in the immediate area. However, given the amount of steel being left in the seabed is small and corrosion will occur over an extended period, it can be expected not to cause a significant impact on local benthos.

5.4 Transboundary and Cumulative Impacts

The Alma and Galia area is over 17km from the nearest transboundary line. Any seabed disturbance and resuspension of sediment associated with the decommissioning activities will have a localised affect and therefore no transboundary impacts from seabed disturbance are expected.

Both the Alma and Galia field areas are redevelopments of previous oil and gas fields (Argyll and Ardmore for Alma and Duncan for Galia). As part of the decommissioning activities of the previous developments, all subsea infrastructure was removed, leaving a legacy of seabed scaring and sediment contamination in the area. Figure 3.3.1, Figure 3.4.1 and section 3.4 detail the extent of the seabed disturbance evident from surveys prior to the Alma and Galia development. Whilst the exact spatial area of this disturbance is hard to quantify, the decommissioning of Alma and Galia will add 3.4km^2 to that pre-existing disturbance. This is a small percentage of the overall Block area (additional 7.7%) and will add minimal impact to an existing contaminated area.

Although the pre-development surveys identified areas of seabed scaring and sediment contamination, benthic analysis suggested that the fauna of the area had largely recovered and was typical of North Sea sandy sediments. This suggests that any benthic faunal impact from the Alma and Galia decommissioning works will not act cumulatively with impact from the previous developments.

The Alma and Galia areas are at the southern end of the central North Sea oil and gas development region. Within the area, the Janice (36km northwest of Galia), James (30km northwest of Galia) and Affleck (27km north of Alma) fields have an approved decommissioning plan, with a schedule suggesting that decommissioning activities may take place at the same time as the Alma and Galia activities. Although seabed disturbance is expected from the decommissioning of these fields and may occur at the same time as seabed disturbance from Alma and Galia activities, there is over 27km separating the developments with limited infrastructure in the in between area. Benthic fauna therefore has plenty of opportunities to migrate back into both affected areas from the surrounding seabed and total cumulative seabed footprint from the combined decommissioning activities will only affect a very small percentage of the total seabed area in the region.

5.5 Mitigation and Control Measures

All activities which may lead to seabed disturbance will be planned, managed and implemented in such a way that disturbance is minimised. Cutting and lifting operations will also be controlled to ensure accurate placement of cutting and lifting equipment and internal cutting will be preferentially used.

The requirements for contingency excavation and remediation work will be assessed on a case by case basis and will be minimised where possible. Any debris identified during the debris surveys resulting from decommissioning activities will be recovered from the seabed where possible. In order to minimise disturbance to the seabed from the overtrawl assessment the method and area that requires assessment will be optimised through liaison with fishing organisations and the regulator.

Best practices will be followed when planning the decommissioning project to ensure, where possible, the smallest possible footprint of operations to reduce potential seabed disturbance.

5.6 Conclusions

When put into context with the size of the Alma and Galia licence blocks (44km^2) the estimated total area of seabed that could be temporarily disturbed forms 7.7% of the total licence blocks area and the estimated total area of seabed that could be permanently disturbed forms a smaller 0.05% of the total licence blocks area. The disturbance will add to existing seabed disturbance from historical oil and gas developments in the blocks, but this will be minimal and will not add to sediment contamination levels in the area.

The decommissioning activities discussed above have the potential to cause short term, localised modification to the benthic fauna, sediments and fish and shellfish species. These impacts will be mitigated through careful planning of removal and recovery procedures and equipment selection. Based on the relatively small area, and the expected recovery from temporary disturbance, the significance of the impact is considered low.

6. CONCLUSIONS AND ENVIRONMENTAL MANAGEMENT

EnQuest intend to decommission the Alma and Galia field facilities between 2020 and 2027, with well decommissioning activities taking place in 2025 - 2026. It is proposed to completely remove the FPSO and mooring system down to the DP of the mooring chains and recover onshore. The project will completely remove the fourteen riser bases, the Alma subsea manifold and all spools, jumpers and mattress and grout bag protection material. The Alma subsea manifold piles will be cut at a depth of 1m below seabed level. The CA concluded that the most preferred option is for complete removal of the trenched and buried Alma and Galia pipelines, and burial of the mooring lines at the DP down to at least 1m below seabed level. The remaining buried mooring chain from the DP to the piles, the buried mooring piles and the existing deposited rock will remain *in situ*. Decommissioning of items *in situ* will be subject to the results of an over trawl assessment to ensure they do not present a snagging hazard.

The Alma and Galia seabed is dominated by silty slightly shelly sands, with some persistent historical contamination from previous drilling activity. The benthic species and habitats seen are widespread throughout this part of central North Sea and not unusually sensitive to the proposed decommissioning plans. The nearest conservation designation is 10.3km to the west and vessel traffic and fishing effort are both very low within the area.

This EA report documents the results of the EA process undertaken to consider the impact of the planned activities and possible accidental events associated with the decommissioning of the Alma and Galia field facilities. The impact was determined considering each of the planned activities and assessing the level of environmental risk using a standard risk assessment method. An ENVID workshop was undertaken to determine the level of environmental risk of all project aspects, taking existing control and mitigation measures into consideration. The level of environmental risk was assessed as **low** and therefore not significant apart from disturbance to the seabed.

Following further assessment and with the implementation of additional control and mitigation measures where necessary, the level of environmental risk from disturbance to the seabed was determined to be **low**. In addition, the cumulative impact from seabed disturbance was also determined to be **low** significance.

In summary, it is the conclusion of this EA that the recommended options to decommission the Alma and Galia fields can be completed without significant impacts to the environment.

6.1 Environmental Management

EnQuest's existing Environmental Management System (EMS) was audited in 2018 and was granted verification as meeting the requirements of an EMS in relation to OSPAR Recommendation 2003/5. EnQuest will ensure that the decommissioning activities will be integrated into, and carried out in accordance with, the company EMS. The EA process has concluded that the activities associated with the decommissioning of the Alma and Galia fields facilities are unlikely to significantly impact the environment if control and mitigation measures are effectively applied.

A summary of the control and mitigation measures is presented in Table 6.1.1.

Control and mitigation measures
Underwater Noise
• A SIMOPS plan for vessel activity in the field will be put in place • Vessel, cutting and trenching operations will use standard methods and equipment. No explosives used.
Discharges to Sea
• All contracted vessels will operate in line with IMO and MARPOL regulations • Pipelines and spool are to be flushed, filled with inhibited seawater and isolated prior to disconnection • All discharges will be permitted under applicable UK legislation
Accidental Events
• All contracted vessels will have a ship-board oil pollution emergency plan (SOPEP) in place • A Collision Risk Management Plan will be developed and implemented • Agreed arrangements in place with oil spill response organisation for mobilising resources in event of a spill • Existing field OPEP in place to reduce the likelihood of hydrocarbon release and define spill response in place • Lifting operations will be planned to manage the risk • Recovery of any dropped objects will take place • Vessel contactors will have procedures for fuel bunkering that meet EnQuest's standard • Where practicable, re-fuelling will take place during daylight hours only • A number of control measures will be in place for the wells between CoP and well P&A activities
Physical Presence of Infrastructure & Vessels
• All vessels will comply with standard marking conditions and consent to locate conditions • A SIMOPS plan for vessel activity in the field will be put in place • All seabed infrastructure will be fully protected on the seabed in the interim period between Phase 1 & 2 • If full seabed clearance of the FPSO 500m zone is not completed in Phase 1 a guard vessel will remain on site • A survey will be undertaken over the mooring chain and pile areas to confirm full burial • Remedial levelling of the seabed planned post excavation of mooring piles cutting pits and mooring chain cutting points • No additional rock or protection material is planned to be added to the area • Seabed clearance certificate issued post completion of activities, seabed debris and overtrawl surveys
Atmospheric Emissions & Energy Use
• Time vessels spend in the field will be optimised, with a SIMOPS plan in place • Reuse or recycling of materials will be the preferential option
Waste
• Onshore treatment will take place at waste management site with appropriate permits and licenses
• UK waste disposal sites will be used where practicable
Seabed Disturbance
• Activities which may lead to seabed disturbance planned, managed and implemented in such a way that disturbance is minimised • Internal cutting of mooring piles will be used in preference where possible • Natural backfill of the trenched areas, no planned mechanical backfill or remedial seabed levelling of pipeline corridors • Debris survey undertaken on completion of the activities and where possible resultant debris will be recovered • Minimising disturbance to seabed from overtrawl through liaison with fishing organisations and regulator

Table 6.1.1: Control and mitigation measures

7. REFERENCES

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

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

[3] British Oceanographic Data Centre (BODC) (1998), United Kingdom Digital Marine Atlas. Third Edition, July 1998. National Environmental Research Council.

[4] Burton G. A & Johnson E. L. (2010). Assessing contaminated sediments in the context of multiple stressors. Environmental Toxicology and Chemistry 29 (12), pp. 2625-2643

[5] Carretta, J.V., J. Barlow, and L. Enriquez. 2008. Acoustic pingers eliminate beaked whale bycatch in a gill net fishery. Marine Mammal Science 24:956-961.

[6] Christensen, V., Guenette, S., Heymans, J. J., Walters, C. J., Watson, R., Zeller, D. & Pauly, D. (2003). Hundred-year decline of North Atlantic predatory fishes. Fish and Fisheries, 4: 1-24.

[7] Collie, J. S., Hall, S. J., Kaiser, M. J., Poiner I. R., (2000). A quantitative analysis of fishing impacts on shelf-sea benthos. Journal Animal Ecology 69: 785–799

[8] Cordah (1995). The post abandonment environmental seabed survey of the Argyll, Duncan and Innes oilfields. Report for Hamilton Oil Company Lts. 16pp. plus tables, figures and appendices

[9] Cordah (1998). Second post-abandonment seabed environmental survey of the Argyll, Duncan and Innes fields. Report to BHP Petroleum Ltd. Report No. BHP.005. 19pp. plus tables, figures and appendices

[10] Coull, K.A., Johnstone, R., and Rogers, S.I. (1998). Fisheries Sensitivity Maps in British Waters. Published and distributed by UKOOA Ltd.

[11] DCENR (2011). Environmental report for IOSEA4 – Irish and Celtic Seas, [Available at: http://www.dcenr.gov.ie]

[12] DECC (2011). UK Offshore Energy Strategic Environmental Assessment 2, OESEA2. [Available at: https://www.gov.uk/government/consultations/uk-offshore-energy-strategic-environmental-assessment-2-oesea2]

[13] DECC (2016), OESEA3 Future Leasing/Licensing for Offshore Renewable Energy, Offshore Oil & Gas, Hydrocarbon Gas and Carbon Dioxide Storage and Associated Infrastructure [Online] Available from; https://www.gov.uk/government/consultations/uk-Genesis offshore-energy-strategic-environmental-assessment-3-oesea3

[14] Defra (2010), Charting Progress 2 - Feeder report: Healthy and biologically diverse seas. Draft published by the Department for Environment Food and Rural Affairs on behalf of the UK Marine Monitoring and Assessment Strategy community, London, 744pp.

[15] Defra (2019). Final UK greenhouse gas emissions national statistics: 1990-2017 – data tables. https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-2017.

[16] Deepocean (2016) Alma and Galia moorings integrity survey: ROV footage

[17] Deepocean (2018) Alma and Galia pipeline integrity survey: ROV footage.

[18] Deepocean (2019) Alma and Galia pipeline integrity survey: ROV footage.

[19] Dernie, K. M., Kaiser. M. J., Richardson, E. A., Warwick, R. M. (2003). Recovery of soft sediment communities and habitats following physical disturbance. Journal of Experimental Marine Biology and Ecology 285-286: 415-434.

[20] DTI (2001). Strategic Environmental Assessment of the Mature Areas of the North Sea (SEA2). Consultation Document, H.M.S.O, London

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

[22] EEMS (2008) Guidelines for the compilation of an atmospherics emissions inventory.

[23] Ellis, J. R.; Cruz-Martínez, A.; Rackham, B. D. and Rogers S. I. (2004) The Distribution of Chondrichthyan Fishes Around the British Isles and Implications for Conservation

[24] Ellis, J.R., Milligan, S., Readdy, L., South, A., Taylor, N. & Brown, M. (2010) Mapping spawning and nursery areas of species to be considered in MPAs (MCZs): http://randd.defra.gov.uk/Document.aspx?Document=MB5301_9578_FRP.pdf].

[25] Ellis, J.R., Milligan, S.P., Readdy, L., Taylor, N. & Brown, M.J. (2012) Spawning and nursery grounds of selected fish species in UK waters: http://www.cefas.defra.gov.uk/publications/techrep/TechRep147.pdf.

[26] EMODnet (2019) Seabed Habitats: https://www.emodnet-seabedhabitats.eu/access-data/launch-map-viewer/.

[27] EnQuest Heather Limited (2011). Alma Field Development Environmental Statement. DECC Reference D/4110/2011. ENQ-KN501-HS-001-ENS-0001.

[28] EnQuest Heather Limited (2012). Galia Field Development Environmental Statement. DECC Reference D/4127/2011.

[29] EnQuest (2014). EnQuest Producer Offshore Oil Pollution Emergency Plan: ENQ-EQP-HS-PLN-00001.

[30] EnQuest (2018). Central North Sea Regional Offshore Oil Pollution Emergency Plan: ENQ-CRS-EN-PLA-00002

[31] EnQuest (2018). Waste management strategy. RevC3: ENQ-HSE-EN-STR-00002, 25pp.

[32] EnQuest (2019a). Alma and Galia Decommissioning Programmes.

[33] EnQuest (2019b). Alma and Galia decommissioning ENVID report. 29pp.

[34] Ferns, P.N., Rostron, D.M. & Siman, H.Y. (2000) Effects of mechanical cockle harvesting on intertidal communities. Journal of Applied Ecology, 37, 464–474.

[35] Gardline Geosurvey Limited (2011a), UKCS Blocks 30/24, 30/25, 30/29 and 30/30 Knightsbridge Field Development December 2010 to January 2011 Survey report.

[36] Gardline Geosurvey Limited (2011b), Galia East Anchoring Conditions Survey UKCS 30/24 and 30/29. Ref 8826.2.

[37] Gardline Geosurvey Limited (2011c), UKCS Blocks 30/24, 30/25, 30/29 and 30/30 Knightsbridge Field Development December 2010 to January 2011 Environmental Baseline Report.

[38] Gardline Geosurvey Limited (2011d), Galia Site Survey and Pipeline Route UKCS 30/24 and 30/25. Ref 8826.5.

[39] Gardline Geosurvey Limited (2011e), Galia Site Survey UKCS 30/24. Ref 8826.1.

[40] Genesis (2011). Review and assessment of underwater sound produced from oil and gas sound activities and potential reporting requirements under the Marine Strategy Framework Directive. Report for DECC. 64pp.

[41] Gilles, A., M. Scheidat, and U. Siebert. 2009. Seasonal distribution of harbour porpoises and possible interference of offshore wind farms in the German North Sea. Marine Ecology Progress Series 383:295-307.

[42] Hamilton Brothers Oil & Gas Limited (1992). Argyll, Duncan and Innes Abandonment Plan. Final submittal to Department of Trade and Industry, 15th October 1992. 76pp.

[43] Hammond, P.S., Northridge, S.P., Thompson, D., Gordon, J.C.D., Hall, A.J., Sharples, R.J., Grellier, K. and Matthiopoulos, J. (2004). Background Information on Marine Mammals Relevant to Strategic Environmental Assessment 5. April 2005.

[44] Hammond, P.S., Lacey, C., Gilles, A., Viquerat, s., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M.B., Scheidat, M., Teilmann, J., Vingada, J. and Øien, N. (2017). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. SCANS-III project report 1, 39 pp.

[45] Holland, G. J., Greenstreet, S. P. R., Gibb, I. M., Fraser, H. M., Robertson, M. R., (2005). Identifying sandeel Ammodytes marinus sediment habitat preferences in the marine environment. Marine Ecology Progress Series 303: pp. 269-282.

[46] Hydrographer of the Navy (2007) International Chart Series No. 2182B.

[47] IAMMWG (2015). Management Units for cetaceans in UK waters (January 2015). JNCC Report No. 547, Joint Nature Conservation Committee, Peterborough, UK, 42pp.

[48] Institute of Petroleum (IOP) (2000). Guidelines for calculation of estimates of energy use and gaseous emissions in the decommissioning of offshore structures. Report by the Institute of Petroleum, London.

[49] IPCC (2007). Climate Change 2007: synthesis report. An assessment of the Intergovernmental Panel on Climate Change.

[50] IPCC (2014). Climate Change 2014: The Scientific Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). JT Houghton, Y Ding, DJ Griggs, M Noguer, PJ van der Linden and D Xiaosu Eds. Cambridge University Press, UKpp 944.

[51] International Union for the Conservation of Nature (IUCN) (2019), The IUCN Red List of Threatened Species: http://www.iucnredlist.org/search.

[52] JNCC (1999). Seabird Vulnerability in UK Waters: Block Specific Vulnerability, 1999. Joint Nature Conservation Committee, Aberdeen.

[53] JNCC (2015) Marine Protected Areas: http://www.jncc.gov.uk/page-4524.

[54] JNCC (2016a). Seabird Population Trends and Causes of Change: 1986-2015: http://www.jncc.defra.gov.uk/page-3201.

[55] JNCC (2017), Using the Seabird Oil Sensitivity Index to inform contingency planning. Joint Nature Conservation Committee, Aberdeen.

[56] JNCC (2019) Marine Protected Areas in the UK: http://jncc.defra.gov.uk/page-5201.

[57] Johns, D.G. and Reid, P.C. (2001) DTI SEA2 Technical report TR_005: An Overview of Plankton Ecology in the North Sea.

[58] Jones, E.L., McConnell, B.J., Smout, S.C., Hammond, P.S., Duck, C.D., Morris, C., Thompson, D., Russell, D.J.F., Vincent, C., Cronin, M., Sharples, R.J. & Matthiopoulos, J. (2015). Patterns of space use in sympatric marine colonial predators reveals scales of spatial partitioning. Marine Ecology Progress Series, 534: 235-249. DOI: 10.3354/meps11370.

[59] Kaiser, M.J., Collie, J.S., Hall, S.J., Jennings, S. & Poiner, I.R. (2002) Modification of marine habitats by trawling activities: prognosis and solutions. Fish and Fisheries, 3, 114–136

[60] Kastelein, R.A., L. Hoek, and C.A.F. de Jong. 2008b. Hearing thresholds of a harbor porpoise (Phocoena phocoena) for sweeps (1–2 kHz and 6–7 kHz bands) mimicking naval sonar signals. J. Acoust. Soc. Amer. 129:3393-3399.

[61] KIS-ORCA (2019) Offshore Renewable & Cables Awareness. [Online] Available from; http://www.kis-orca.eu/map#.Wc5ltGdwZUN.

[62] Lancaster, J., McCallum, S., Lowe, A.C., Taylor, E., Chapman, A. and Pomfret, J. (2014). Development of detailed ecological guidance to support the application of the Scottish MPA selection guidelines in Scotland's seas. Scottish Natural Heritage Commissioned Report No. 491. Sandeels – supplementary document.

[63] Langhamer O. (2012). Artificial reef effect in relation to offshore renewable energy conversion: State of the art. The Scientific World Journal, 386713.

[64] Long, E. R., MacDonald, D. D., Smith, S. L., & Calder, F. D. (1995). Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management, 19: pp. 81-97.

[65] Maersk (2016) Janice, James and Affleck Decommissioning Programme. Document number: COPD-JAN-00-SU-PA-0001, 115pp.

[66] Marine Management Organisation (MMO) (2014) North East Marine Plan: https://www.gov.uk/government/collections/north-east-marine-plan.

[67] Marine Scotland (2019) National Marine Plan interactive (NMPi): http://www.gov.scot/Topics/marine/science/MSInteractive. Accessed 11/03/19.

[68] MarLIN (2019) Icelandic cyprine (Arctica islandica) species information: https://www.marlin.ac.uk/species/detail/1519.

[69] McBreen, F., Askew, N., Cameron, A., Connor, D., Ellwood, H. and Carter, A. (2011), UKSeaMap 2010: Predictive mapping of seabed habitats in UK waters. JNCC Report, No. 446.

[70] McCarthy, E., D. Moretti, L. Thomas, N. DiMarzio, R. Morrissey, S. Jarvis, J. Ward, A. Izzi, and A. Dilley. 2011. Changes in spatial and temporal distribution and vocal behavior of Blainville's beaked whales (Mesoplodon densirostris) during multiship exercises with mid-frequency sonar. Mar. Mamm. Sci. 27(3):E206-E226.

[71] Natural England and JNCC (2019). Marine Conservation Zone (MCZ) Guidance: http://publications.naturalengland.org.uk/publication/1745100?category=11003.

[72] Natural England (2017) Natural England Conservation Advice for Marine Protected Areas: Northumberland Marine SPA: https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9020325&SiteName=MCZ&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=.

[73] NOGAPS (2015), U.S. Navy Operational Global Atmospheric Prediction System (NOGAPS) wind dataset 2008-2015, hosted by the U.S. Global Ocean Data Assimilation Experiment (USGODAE) wind data at 10 metres above sea surface at 0.5 degree horizontal resolution with 3-hour time step, with National Aeronautics and Space Administration (NASA) Quick Scatterometer Earth Observation Satellite (QuikSCAT) correction applied by the HYbrid Coordinate Ocean Model (HYCOM) Consortium. Data extrapolated for position 56°30'0"N, 2°30'0"E.: http://www.usgodae.org/cgi-bin/datalist.pl?generate=summary.

[74] Oil and Gas UK (2018). Guidelines for the Decommissioning of Wells. Issue 6, July 2018.

[75] Oil and Gas UK (2019) Environmental Report 2019. 64pp.

[76] Oil & Gas Authority (2016), Information on levels of shipping activity: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/540506/29R_Shipping_Density_Table.pdf.

[77] Oil & Gas Authority (2019), Other Regulatory Issues: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/547696/29R_Other_Regulatory_IssuesV2.pdf.

[78] OPRED (2018). Decommissioning of offshore oil and gas installations and pipelines: Guidance notes. November 2018.

[79] OSPAR (2005). Agreement on background concentrations for contaminants in seawater, biota and sediment. OSPAR agreement 2005-6

[80] OSPAR (2008). Case Reports for the OSPAR List of threatened and/or declining species and habitats. OSPAR Commission. Available online at: http://qsr2010.ospar.org/media/assessments/p00358_case_reports_species_and_habitats_2008.pdf. [Accessed on 02/05/2017].

[81] OSPAR (2009). Background document for ocean quahog (Arctica islandica). OSPAR biodiversity series. Prepared by the Coastal and Marine Nature Conservation Unit of the German Federal Agency for Nature Conservation (BfN): https://qsr2010.ospar.org/media/assessments/Species/P00407_Ocean_quahog.pdf.

[82] Pangere, T., Robinson, S., Theobold, P. & Galley, L. (2016). Underwater sound measurement data during diamond wire cutting: First description of radiated noise. Proceedings of Meetings on Acoustics 27 (040012): 11pp.

[83] Perry, A. L., Low, P. J., Ellis, J. R. & Reynolds, J. D. (2005), Climate change and distribution shifts in marine fishes. Science, 308: 1912-1915.

[84] Pidduck, E., Jones, R., Daglish, P., Farley, A., Morley, N., Page, A. & Soubies, H. (2017). Identifying the possible impacts of rock dump from oil and gas decommissioning on Annex I mobile sandbanks. JNCC Report No. 603. JNCC, Peterborough.

[85] Pollock, C.M., Mavor, R., Weir, C.R., Reid, A., White, R.W., Tasker, M.L., Webb, A. and Reid, J.B. (2000). The distribution of seabirds and marine mammals in the Atlantic Frontier, north and west of Scotland. JNCC report.

[86] Rees, H. L., Rowlatt, S. M., Limpenny, D. S., Rees, E. I. S. & Rolfe, M. S. (1992). Benthic studies on dredged material disposal sites in Liverpool Bay, Ministry of Agriculture.

[87] Reid, J.B., Evans, P.G.H. & Northridge, S.P. (2003), Atlas of Cetacean distribution in north-west European waters, Joint Nature Conservation Committee (JNCC), Peterborough.

[88] Reid, P. C., Lancelot, C., Gieskes, W. W. C., Hagmeier, E. and Weichart, G. (1990). Phytoplankton of the North Sea and its dynamics: a review. Netherlands Journal of Sea Research 26 (2-4): 295-331.

[89] Roberts D.A. (2012). Causes and ecological effects of resuspended contaminated sediments (RCS) in marine environments. Environmental International 40, pp. 230-243

[90] RYA (2008). UK Coastal Atlas of Recreational Boating. Recreational Cruising Routes, Sailing and Racing Areas around the UK Coast. Second Edition.

[91] SCOS (2014). Scientific advice on matters related to the management of seal populations 2013: http://www.smru.st-and.ac.uk/documents/1803.pdf

[92] Scottish Government (2019). Scottish Government Marine Division – Fisheries Statistics by ICES rectangle: http://www.gov.scot/Topics/Statistics/Browse/Agriculture-Fisheries/RectangleData.

[93] Simpson, S. D., Jennings, S., Johnson, M. P., Blanchard, J. L., Schön P-J, Sims, D. W. & Genner, M. J. (2011), Continental shelf-wide response of a fish assemblage to rapid warming of the sea. Current Biology, 21: 1565-1570.

[94] SMRU (2011). Utilisation of space by grey and harbour seals in the Pentland Firth and Orkney waters. Scottish Natural Heritage commissioned report No. 441.

[95] SMRU and Marine Scotland (2017). Estimated at-sea distribution of grey and harbour seals – updated maps 2017. https://data.marine.gov.scot/dataset/estimated-sea-distribution-grey-and-harbour-seals-updated-maps-2017.

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

[97] Southall, B.L., J. Calambokidis, P. Tyack, D. Moretti, J. Hildebrand, C. Kyburg, R. Carlson, A. Friedlaender, E. Falcone, G. Schorr, A. Douglas, S. DeRuiter, J. Goldbogen, and J. Barlow. 2011. Project report: Biological and Behavioral Response Studies of Marine Mammals in Southern California, 2010 (SOCAL-10).

[98] Stone, C.J., Webb, A., Barton, C., Ratcliff, N., Reed, T.C., Tasker, M., Camphuysen, C. J. and Pienkowski, M.W. (1995). An atlas of seabird distribution in the north-west European waters. Joint Nature Conservation Committee, Peterborough.

[99] Tyack, P.L., W.M.X. Zimmer, D. Moretti, B.L. Southall, D.E. Claridge, J.W. Durban, C.W. Clark, A. D'Amico, N. DiMarzio, S. Jarvis, E. McCarthy, R. Morrissey, J. Ward, and I.L. Boyd. (2011). Beaked whales respond to simulated and actual navy sonar. PLoS ONE 6(3):e17009: http://www.plosone.org/article/info:doi/10.1371/journal.pone.0017009.

[100] UKOOA (2001) An analysis of UK offshore oil and gas environmental surveys 1975-95: http://www.ukooa.co.uk/issues/ukbenthos/docs/analysissurveys.pdf.

[101] UK Oil and Gas Data (2019), Interactive GIS Map: https://www.ukoilandgasdata.com.

[102] van Dalfsen, J. A., Essink, K., Toxvig Madsen, H., Birklund, J., Romero, J. & Manzanera, M. (2000). Differential response of macrozoobenthos to marine sand extraction in the North Sea and the Western Mediterranean. ICES Journal of Marine Science, 57, 1439-1445.

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

[104] Weilgart LS (2007). The impacts of anthropogenic ocean noise on cetaceans and implications for management. Canadian Journal of Zoology 85: 1091-1116.

[105] Witbaard, R. and Bergman M. (2003). The distribution and population structure of the bivalve Arctica islandica L. in the North Sea: what possible factors are involved? Journal of Sea Research, 50, 11-25.

[106] Wolf, J., Yates, N., Brereton A., Buckland H., De Dominicis M., Gallego, A. & O'Hara Murray R. (2016) The Scottish shelf model. Part 1: shelf wide domain. Scottish Marine Freshwater Science: 7. 151pp.

[107] Wright, P.J., Jensen, H., & Tuck, I., (2000). The influence of sediment type on the distribution of the lesser sandeel, *Ammodytes marinus*. Journal of Sea Research 44, 243-256.

APPENDIX A THE ENVID PROCESS

Appendix A.1 ENVID Objectives

The purpose of the ENVID was to identify any environmental aspects associated with the decommissioning project and to document the associated environmental risks. It was also used as a tool to document risk reduction where this has been identified.

The objectives of the workshop were to:

- Ensure all potential environmental risks have been identified;
- Assist in the understanding of the causes, consequences (impacts) and significance of environmental impacts;
- Establish the priority environmental areas and potential significant impacts for discussion in the Environmental Appraisal;
- Identify effective controls and mitigation measures to reduce or eliminate impact from environmental aspects;
- Provide a process for evaluation, which is transparent and can be understood by the regulator and stakeholders if necessary.

Appendix A.2 ENVID Method

The ENVID process involved:

- Assembling an appropriate team to encompass expertise in all the key project functions to ensure a valid ENVID process;
- Explaining the use of the risk matrix to provide a qualitative assessment of environmental risk. Discuss and agree assessment criteria to ensure they are fit for purpose;
- Defining the consequences of identified environmental issues (please refer see key word list below);
- Identifying controls required to either minimise or mitigate against the environmental risks associated with the identified issues;
- Describing the action(s) required to achieve minimisation/mitigation;
- Assessing the environmental risks that remain (residual risk) after identified controls have been implemented;
- Recording summaries of issues, consequences, risk ratings, control and mitigation measures, actions and residual risk on the ENVID Register.

Appendix A.3 Environmental Significance

Each Environmental Aspect identified was categorised using the EnQuest 5x5 Risk Assessment Matrix (RAM), presented in Table A.3.1, to establish the environmental significance of any potential impact.

EnQuest risk assessment matrix					
Likelihood	**Risk Assessment Matrix**				
Highly Likely [5]	5	10	15	20	25
Likely [4]	4	8	12	16	20
Possible [3]	3	6	9	12	15
Unlikely [2]	2	4	6	8	10
Very Unlikely [1]	1	2	3	4	5
Consequence	**Negligible [1]**	**Minor [2]**	**Serious [3]**	**Severe [4]**	**Major [5]**

Table A.3.1: EnQuest Risk Assessment Matrix

The significance of any potential impact was determined using a standard risk assessment method which employs the risk philosophy as follows:

Likelihood x **Severity of potential impact (consequence)** = **Risk (impact)**

Consequence of Potential Impact

The consequence of each impact was given a score between one and five as shown in the Tables above and involves the consideration of two key drivers:

- **Environmental Receptors:** Consideration of the potential environmental sensitivities and receptors and published scientific evidence on the potential environmental impacts. This includes consideration of the geographical area over which an impact could occur.
- **Social Receptors:** Consideration of potential impacts on other users of the sea (potential conflict or resolution of concern), interest groups and the general public and perceived potential impacts. This includes consideration of impacts that may result in negative feedback from the local community, from the regulator and from NGOs.

Each receptor was assessed separately for an aspect and then the worst consequence is chosen to represent the overall consequence of that aspect.

Likelihood

In order to assess the significance of a potential impact, the overall consequence was combined with the likelihood of the potential impact occurring. The likelihood of an aspect resulting in a potential impact is based on the frequency of occurrence within the proposed project timeframe and is scored, from one to five.

Combining Likelihood and Consequence to Establish Significance

Significance of potential impacts was assessed by combining the likelihood and consequence as per the Environmental Risk Matrix (Table A.3.1). The resulting scores are presented in the ENVID Register (Table B.1.1). The overall risk in terms of potential impact was then assessed. Where potentially significant impacts were identified after standard control and mitigation measures were taken into consideration, the impacts were identified for further assessment.

Definitions of environmental consequence (severity categories)		
Rank	**Severity**	**Description**
5	Major	• Major environmental impact, National plan implemented • Extensive impact on a sensitive environment • Wide scale impact on a non-sensitive environment • Restoration of damage >10 years
4	Severe	• Severe environmental impact, National plan implemented • Large scale impact on a sensitive environment • Extensive impact on a non-sensitive environment • Restoration of damage within 1 to 10 years
3	Serious	• Controllable impact, external response required • Moderate impact on a sensitive environment • Large scale impact on a non-sensitive environment • Restoration of damage within weeks or months
2	Minor	• Minor environmental impact, no lasting effect, local response • Localised impact on a sensitive environment • Insignificant impact on a non-sensitive environment • Restoration of damage within days or weeks
1	Negligible	• Minimal/contained spill • No impact on a sensitive environment • Minimal impact on a non-sensitive environment • Restoration of damage within days

Table A.3.2: Definitions of environmental consequence - severity categories

Definitions of societal consequences - severity categories					
Criterion	Score				
	1 (low)	2	3	4	5 (high)
Commercial impact on fisheries and other users	Neither operations nor end-points would have any effect on commercial fisheries or other users.	Short-term disruption may occur during operations, but similar to existing disruptions caused from time to time by oilfield activities.	Option results in additional areas of ground or water column becoming inaccessible to fishing or other users to extent that up to 1% additional area is lost.	Option results in additional areas of ground or water column becoming inaccessible to fishing or other users to extent that 1 to 10% additional area is lost.	Option results in additional areas of ground or water column becoming permanently inaccessible to fishing to extent where area is lost.
Socio-economic impact to amenities	No change or impact on amenities.	Short-term localised impact on amenities for some or all of the operations, but would cease and revert to previous condition on completion of operations, without the need for mitigation.	Some impact on local amenities, leading to some actual deterioration in quality of life. Deterioration would exist while actual operations were being carried out. Some mitigation/ work would be required when operations were completed to restore amenities to pre-operational condition.	Significant and long-term impact on local amenities, leading to noticeable deterioration in quality of life. Extensive mitigation/ work, taking less than 1 year, would be required when operations were completed to restore amenities to pre-operational condition.	Significant and long-term impact on local amenities, leading to noticeable deterioration in quality of life. Extensive mitigation/ work, taking between 1 to 5 years, would be required when operations were completed to restore amenities to something resembling pre-operational condition, although full restoration would be unlikely.
Socio-economic impact on communities	No change or impact on communities.	Short-term localised impact on communities for some or all of the operations, but would cease and revert to previous condition on completion of operations.	Some impact on local communities, leading to some actual deterioration in quality of life. Deterioration would exist while actual operations were being carried out, but would essentially cease as soon as operations were completed, and quickly revert to pre-operation condition.	Significant and long-term impact on local communities, leading to noticeable deterioration in quality of life. This would persist for less than 1 year after actual operations had ceased.	Significant and long-term impact on communities, leading to noticeable deterioration in quality of life. This would persist for several years after actual operations had ceased.

Table A.3.3: Definitions of societal consequences - severity categories

Definitions of likelihood		
Rank	**Likelihood**	**Description**
5	Highly Likely	• The incident is highly likely to occur during the period of exposure to the hazard or during activity completion • An incident will occur without any additional factors • There is no basis for confidence that the incident will not occur • Limited definition and understanding of method, hazards and equipment
4	Likely	• The incident is likely to occur during the period of exposure to the hazard or during activity completion • An incident may occur if common or frequent adverse factors are present • There is low degree of confidence that the incident will not occur • Basic definition and understanding of method, hazards and equipment
3	Possible	• The incident may occur during the period of exposure to the hazard or during activity completion • An incident may occur if additional adverse reasonably foreseeable factors are present • There is a limited degree of confidence that the incident will not occur • General definition and understanding of method, hazards and equipment
2	Unlikely	• The incident is unlikely to occur during the period of exposure to the hazard or during activity completion • A rare combination of factors would be required for an incident to occur • There is a reasonable degree of confidence the incident will not occur • High level of definition and understanding of method, hazards and equipment
1	Very Unlikely	• The incident is very unlikely to occur during the period of exposure to the hazard or during activity completion • A freak combination of factors would be required for an incident to occur • There is a high degree of confidence the incident will not occur • Detailed definition and understanding of method, hazards and equipment

Table A.3.4: Definitions of likelihood

APPENDIX B ENVID RISK REGISTER

Appendix B.1 ENVID Workshop Output Table

ENVID Risk Register - Workshop Output Tables																						
				Residual Risk to Receptors (After mitigation)																		
				Physical			Biological					Socio-economic										
Aspect (Activity)	ENVID Keyword	Description of potential Impact	Existing mitigation/ control measures	Marine Water Quality	Air Quality	Sediments	Terrestrial Communities	Benthic communities	Plankton	Fish/ Shellfish	Offshore Seabirds	Coastal Seabirds	Marine Mammals	Protected/ Sensitive Areas	Shipping	Fishing	Oil and Gas activity	Pipeline/ Cables	Tourism/Leisure	Resource Use/ Energy Use	Coastal populations	Additional Comments
General activities																						
Vessels on location and in transit, including FPSO tow	Discharge to Sea	Water quality impact and potential seabed deposition. Impact on marine flora and fauna. Localised Impacts.	Operating in line with IMO regulations. MARPOL regs.																			
	Atmospheric Emissions	Localised deterioration of air quality for duration of operations and contribution to GHG.	Maintenance of vessel combustion equipment and certification. Adherence to company standards																			Relatively low number of vessel days spread over at least a 12-month period.
	Vessel presence and operations, impacts to other sea users (e.g. fishing vessels)	Potential for navigation hazard and interference with shipping activities. Potential emergency due to collision. Potential exclusion of fishing vessels from area	Notice to Mariners prior to operations commencing. Kingfisher Bulletins issued prior to operations commencing. Collision Risk Management Plan developed and implemented.																			Very low to low levels of vessel traffic, fishing activity and oil and gas traffic in the area.
	Noise (air and subsea) and vibration	Vessel noise including DP, general deconstruct activity noise. Potential disturbance to marine mammals, fish and seabirds. Potential behavioural changes in fish and marine mammals due to increase in background marine noise levels. Indirect impact to fisheries caused by potential behavioural changes in fish.	Operations will draw on standard methodologies and equipment, SIMOPS for vessel activity will be in place.																			
Dropped Objects	Unplanned events	Potential for breakup of concrete mattresses during lift operations. Dropped objects have the potential to cause disturbance to the seabed and benthic faunal communities. They also pose a potential risk of snagging gear to fisheries.	All items will be securely stowed. Lifting operations will be planned to manage the risk, meet requirements of Lifting Operations and Lifting Equipment Regulations (LOLER) 1998 and will use the correct lifting equipment that is tested and certified. Recovery of dropped objects will take place. Dropped object reporting as per PON2 requirements. Dropped Object sweep of seabed. Incident log/register.																			
An emergency incident (e.g. vessel collision), leading to potential unintentional releases.	Unplanned events	Potential total loss of containment of entire inventories of diesel, utility fuels and chemicals from vessels potentially causing significant hydrocarbon and chemical pollution. Potential impacts on water quality and marine wildlife in the affected area.	Only diesel will be present, no other hydrocarbons. All contracted vessels will have a ship-board oil pollution emergency plan (SOPEP) in place. An Emergency response plan (ERP) in place prior to operations commencing. A contract with an oil spill response organisation will be in place to ensure a timely and efficient mobilisation of oil spill response resources and competent response personnel. The ERRV will have 5 cubic metres of dispersant on board.																			Diesel spill modelling for FPSO inventory (double the largest vessel diesel inventory) shows spill only travels <4km and disperses within 10hrs.

ENVID Risk Register - Workshop Output Tables

Aspect (Activity)	ENVID Keyword	Description of potential Impact	Existing mitigation/ control measures	Residual Risk to Receptors (After mitigation)																		Additional Comments
				Physical			Biological					Socio-economic										
				Marine Water Quality	Air Quality	Sediments	Terrestrial Communities	Benthic communities	Plankton	Fish/ Shellfish	Offshore Seabirds	Coastal Seabirds	Marine Mammals	Protected/ Sensitive Areas	Shipping	Fishing	Oil and Gas activity	Pipeline/ Cables	Tourism/Leisure	Resource Use/ Energy Use	Coastal populations	
Potential unintentional releases of fuel or other fluids (e.g. diesel, jet fuel, hydraulic oil, lubricants or chemicals) during day-to-day operations (including re-fuelling)	Unplanned events	During general operations there is the potential for unintentional releases. These releases have the potential to cause localised toxic effects on marine fauna and flora and localised pollution, which may impact local marine wildlife and rafting seabirds on the sea surface.	Vessels fitted with closed drainage containment and monitoring systems in all environmentally critical areas as part of their specification. Vessel contractors to have procedures for fuel bunkering which will be required to meet EnQuest's standard. Subject to audit/assessment prior to decommissioning operations commencing. Where practicable, re-fuelling will be undertaken during daylight hours only. Transfer operations will be supervised at all times. Breakaway couplings will be used in transfer hoses and transfer operations will be undertaken by trained and competent personnel.																			
Removal of mooring system																						
Cutting of mooring lines at DP & -1m LAT	Seabed disturbance, presence of infrastructure	Disturbance of cuttings piles both WBM and possible OBM. Water and sediment quality impact. Impact on marine flora and fauna.																				No OBM cuttings piles have been identified, although a low of level of contamination exists across parts of the site.
	Noise (subsea) and vibration	Potential disturbance to marine mammals, fish and seabirds. Potential behavioural changes in fish and marine mammals due to increase in background marine noise levels. Indirect impact to fisheries caused by potential behavioural changes in fish.	Mechanical cutting tools to be used No explosives are planned,																			Noise from mechanical cutting tools are at or near background levels
Dredging to required depth to cut mooring chain	Vessel presence and operations, impacts to other sea users (e.g. fishing vessels)	Potential to form spoil heaps which may cause a snagging risk to fishing vessels.	Remedial levelling of the area will be undertaken post cutting. Overtrawl trials/survey will also be undertaken post activities																			
	Seabed disturbance, presence of infrastructure	Modification of seabed and suspension of sediments in water column. Smothering of benthic species.	Dredging will be minimised where possible to reduce affected seabed footprint																			
Dredging to required depth to cut mooring chain	Presence of infrastructure	Potential exposure of pile tops and / or parts of chain between -1m LAT cut and pile. Potential snagging risk for fishing activity and remedial modification of seabed.	ROV survey will be undertaken over area to confirm full burial of remaining chain and piles Remedial action will be taken to bury any exposures																			
	Noise (subsea) and vibration	Potential disturbance to marine mammals, fish and seabirds. Potential behavioural changes in fish and marine mammals due to increase in background marine noise levels. Indirect impact to fisheries caused by potential behavioural changes in fish.																				

ENVID Risk Register - Workshop Output Tables

Aspect (Activity)	ENVID Keyword	Description of potential Impact	Existing mitigation/ control measures	Residual Risk to Receptors (After mitigation)																		Additional Comments
				Physical			Biological					Socio-economic										
				Marine Water Quality	Air Quality	Sediments	Terrestrial Communities	Benthic communities	Plankton	Fish/ Shellfish	Offshore Seabirds	Coastal Seabirds	Marine Mammals	Protected/ Sensitive Areas	Shipping	Fishing	Oil and Gas activity	Pipeline/ Cables	Tourism/Leisure	Resource Use/ Energy Use	Coastal populations	
Lifting of mooring chains	Seabed disturbance, presence of infrastructure	Temporary modification of seabed and suspension of sediments in water column	Mooring chains from FPSO to DP will not be placed on seabed prior to removal.																			
Removal of pipelines, umbilicals & power cables																						
Removal of pipeline sections -Lifting & pulling to end of flexible section & reverse installation of pipeline with recovery to vessel deck.	Discharge to Sea	Discharge of chemicals / residual hydrocarbons. Damage to aquatic environment, impact on marine flora and fauna. Localised Impacts	Pipelines to be flushed and isolated prior to operations and filled with inhibited seawater. The umbilicals may contain some hydraulic fluid but discharge of this would be permitted. The flexibles may have some hydrocarbon residues but any discharged will be permitted.																			
	Seabed disturbance, presence of infrastructure	Disturbance of cuttings piles both WBM and possible OBM. Water and sediment quality impact. Impact on marine flora and fauna.																				No OBM cuttings piles have been identified, although a low of level of contamination exists across parts of the site.
	Seabed disturbance, presence of infrastructure	Modification of seabed and suspension of sediments in water column																				Corridor of impact is moderate due to trenched nature of pipeline which will confine its lateral movement during removal.
Use of MFE to remove deposited rock	Seabed disturbance, presence of infrastructure	Physical disturbance to seabed and suspension of sediment into the water column from the scattering of rock dump.	This will only take place if it is not possible to pull the pipelines out through the rock dump sections Amount to be moved will be minimised Overtrawl survey will be undertaken post decommissioning																			Any rock removed will be minimal and placed on or next to existing deposited rock and will not affect shape. Small grade rock only.
Permanent presence of stabilisation material on seabed.	Vessel presence and operations, impacts to other sea users (e.g. fishing vessels)	Rock currently in place on seabed will not be removed. Interference with fishing gear with associated economic impact. Potential loss of livelihood, national interest/reputation risk. Loss of access for commercial fishing & other users (e.g. drilling rigs)	Surface stabilisation material already in place, no additional material will be installed.																			
Recovery of mattresses and grout bag	Seabed disturbance, presence of infrastructure	Physical disturbance to seabed and suspension of sediment into the water column from the recovery of concrete mattresses and grout bags	Lifted vertically Minimise dredging to allow access to lifting points																			
Seabed levelling post pipeline removal	Seabed disturbance, presence of infrastructure	Modification of seabed.	Natural backfill method to be used Seabed levelling is not planned and will only be undertaken if issues from overtrawl survey are apparent Operations will draw on standard methodologies and equipment																			
Full recovery of subsea installations																						
Disconnection of subsea structures, including dredging & cutting of manifold	Discharge to Sea	Potential discharge of chemicals / oil residues. Damage to aquatic environment, impact on marine flora and fauna. Chemical discharges. Localised Impacts	Structures to be flushed and isolated prior to operations and filled with inhibited seawater only.																			

EnQuest

ENVID Risk Register - Workshop Output Tables																						
				Residual Risk to Receptors (After mitigation)																		
				Physical			Biological					Socio-economic										
Aspect (Activity)	ENVID Keyword	Description of potential Impact	Existing mitigation/ control measures	Marine Water Quality	Air Quality	Sediments	Terrestrial Communities	Benthic communities	Plankton	Fish/ Shellfish	Offshore Seabirds	Coastal Seabirds	Marine Mammals	Protected/ Sensitive Areas	Shipping	Fishing	Oil and Gas activity	Pipeline/ Cables	Tourism/Leisure	Resource Use/ Energy Use	Coastal populations	Additional Comments
piles to -3m LAT	Seabed disturbance	Protective material and sediment removed to expose tie-ins - sediment disturbance. Reduced number, type and size of habitats Modification of seabed and suspension of sediments in water column. Smothering of benthic species.	Dredging will be minimised where possible to reduce affected seabed footprint																			
	Noise (air and subsea) and vibration	Cutting noise and vibration below sea level. Potential disturbance to marine mammals, fish and seabirds. Potential behavioural changes in fish and marine mammals due to increase in background marine noise levels. Indirect impact to fisheries caused by potential behavioural changes in fish.	Mechanical cutting tools to be used Internal cutting method to be used where possible No explosives are planned.																			Noise from mechanical cutting tools are at or near background levels
Potential removal of marine growth and release of organic material at offshore site	Discharges to sea	Water quality impact. Impact on marine flora and fauna. Localised Impacts																				Relatively low levels of growth identified. No species of conservation concern
Removal and recovery of riser bases	Seabed disturbance	Sediment removed and disturbed during protection removal. Reduced number, type and size of habitats	Excavation to attach lifting mechanisms will be minimised																			

Table B.1.1: ENVID Risk Register - Workshop Output Tables[26]

[26] Score colours only are shown. Not scores.