

GAUPE

Environmental Appraisal



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Final Environmental Appraisal



Non-Technical Summary

Introduction

This Environmental Appraisal (EA) report, documents the environmental and societal impact assessment carried out in support of the Gaupe Decommissioning Programme (DP). The DP and associated documentation, including this EA, contains details of A/S Norske Shell's (Shell) recommendations to decommission the Gaupe offshore infrastructure more particularly set out in the DP, although some information has been repeated in this report to aid the understanding of the context for assessing the significance of potential environmental and societal impact.

The Gaupe field includes two production wells in the Norwegian sector, Gaupe North and Gaupe South. Fluid from the two drill centres was commingled at the Gaupe SSIV manifold, located close to the Armada Platform in the UKCS. The Gaupe wells are tied back to the Armada Platform via two 8" / 12" pipe-in-pipe systems and a flexible riser which has been installed within a platform conductor caisson. Controls for the field are provided by the Armada Facilities via an electro-hydraulic control umbilical.

The Armada Complex is located approximately 250 kilometres east of Aberdeen, in a water depth of about 89 metres. Gas and condensate are sent towards the North Everest platform, with gas entering CATS at the CATS Riser Platform which is bridge linked to the North Everest platform. The condensate enters the North Everest owned Everest Lomond System pipeline before joining the FPS pipeline at Forties Charlie. The Armada Complex, CATS Riser and facilities beyond are not in the scope of the decommissioning programmes presented here.

Gaupe was tied back to the Armada Complex and came on stream in Q1 2012.

Gaupe was originally included within draft decommissioning proposals for the Armada Hub developed by BG Group plc. In February 2016, the entire issued and to be issued share capital of BG Group plc was acquired by Royal Dutch Shell plc with no effect on the scope of the project as Shell planned to proceed with hub decommissioning. Approval-in-principle from the OGA for cessation of production (CoP) of the Armada Hub and associated tiebacks was granted in August 2016.

In November 2017, the Armada Hub was divested to Chrysaor Holdings with the intent of extending field life and CoP has been deferred. The Gaupe wells and associated subsea infrastructure are not part of the divestment and remain within the Shell portfolio.

This appraisal presents the environmental issues for the subsea infrastructure in the UKCS associated with the Gaupe field. For the NCS associated scope, Norske Shell has received an exception for an Environmental Impact Assessment from the Ministry of Petroleum and Energy.

Summary of Planned Decommissioning Works

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

The Gaupe SSIV co-mingling manifold along with production riser PL 2783 and umbilical riser PLU 2786 will be fully removed during decommissioning, in line with the requirements of OSPAR Decision 98/3. Removal of SSIV and risers is scheduled after Armada Hub CoP, to enable efficient and safe operations and facilitating possible synergies with Armada decommissioning operation. Re-use options for the SSIV manifold and associated risers are



being investigated and the infrastructure will be preserved if any credible re-use opportunities arise. Any use of preservation chemicals will be selected in a later stage, which also will be subject for application and approval. If CoP of Armada Hub is delayed beyond 2028, Shell will contact OPRED and a revised schedule will be agreed by both parties. The proposal for decommissioning the subsea pipelines and umbilicals, meanwhile, have been prepared in line with the OPRED Guidance Notes following a comparative assessment of feasible options and are as follows:

- Trenched and buried pipelines will be decommissioned in situ with the pipeline ends removed and returned to shore for recycling or disposal. This recommendation applies to the Gaupe North production line (PL2781) and Gaupe South production line (PL2782).
- The Gaupe umbilicals (PLU2784 & PLU2785), trenched and naturally backfilling, will be decommissioned in situ with the ends removed and returned to shore for recycling or disposal.

The decommissioning activities will utilise a variety of vessels, with an anticipated aggregate of approximately 90 vessel-days service.

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

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

Environmental Baseline Summary

The Environmental baseline covers the Armada Hub area and not only Gaupe in particular.

The seabed in the Armada Hub area exhibits low values for total organic carbon (<0.1% to 0.13%) and total organic matter content (0.77% to 2.03%), reflecting the dominance of sands and coarser fractions and the generally low silt/clay content (Benthic Solutions, 2016b).

The mean total hydrocarbon content (THC) across the Armada Hub area was 9.36 µg.g⁻¹ (Benthic Solutions, 2016b), which is below the average background level for sandy sediments in this region of the North Sea (9.51 µg.g⁻¹, UKOOA, 2001). THC levels are consistent with those recorded in previous surveys in the Armada Hub area (7.39 – 9.2 µg.g⁻¹). Higher THC values were recorded within 500 m of the Armada platform 11.64 µg.g⁻¹ – 90.91 µg.g⁻¹ (Benthic Solutions, 2016b). Evidence of hydrocarbons was observed within 2 km north and south of the platform and 250 m east and west. Beyond a radius of 1 km from the platform, carbon compounds of biological origin (biogenic) dominate, but closer to the platform there is evidence of hydrocarbons associated with the synthetic-based mud used to drill wells at Armada.

Total polycyclic aromatic hydrocarbon (PAH) concentrations recorded by Benthic Solutions (2016b) (14.44 to 84.43 ng.g⁻¹) were below the UKOOA mean background level for the Central North Sea (233 ng.g⁻¹).

Heavy metal concentrations (arsenic, vanadium, zinc, aluminium, iron, lithium and manganese) correlated with the gravel component of sediments, particularly in the megarippled gravelly sand



in the Maria area and were consistent with previous surveys (Benthic Solutions, 2016b). Barium, which is associated with drilling, is present throughout the Armada Hub area at concentrations generally ranging from 222 $\mu\text{g.g}^{-1}$ – 364 $\mu\text{g.g}^{-1}$. Higher levels (1,140 – 3,460 $\mu\text{g.g}^{-1}$) were recorded 250 m south and north of the Armada platform (Benthic Solutions, 2016b).

In 2014, the Norwegian Boundary Sediment Plain NCMPA was designated for the conservation of aggregations of the ocean quahog (*Arctica islandica*) and the sand and gravel habitat that supports them. The Maria field is located within the boundary of this Marine Protected Area.

JNCC and Marine Scotland Science surveys identified one small ocean quahog within 1 km north of the Maria manifold (O'Connor, 2016). The Armada Hub pre-decommissioning survey observed relic ocean quahog shells, especially within areas of scour surrounding infrastructure and large dropstones (Benthic Solutions, 2016a). No live specimens were recorded in the vicinity of the Maria field or in the NCMPA, but one live individual was recorded 7 km south of Armada on the export route to the CATS Riser platform (Benthic Solutions, 2016b). Hence no species were observed in the Gaupe area.

Environmental Description of the area

The Environmental description covers the Armada Hub area and not only Gaupe in particular.

Based on previous experience, studies (including project-specific surveys), review of scientific data and consultation, it has been possible to identify the key environmental sensitivities in the Armada Hub area; these are summarized in Table 1-1.

Table 1-1 Summary of the key environmental sensitivities of the Armada Hub (with Gaupe infrastructure)

Animals living on or in the seabed

The habitat assessment undertaken for the project determined the sediments to be mainly Offshore circalittoral sand, Megarippled gravelly sand and Muddy gravel. The visible animals found across the survey area generally were dominated by polychaete worms. These results compare to those recorded from previous surveys in the Armada Hub area and the central North Sea. The pre-decommissioning survey found species that tend to disappear first from baseline communities affected by contamination, suggesting the Armada Hub is generally free of significant contamination.



Fish



The fish populations in the area are characterised by species typical of the central North Sea, including anglerfish, bib, cod, haddock, hagfish, lemon sole, ling, plaice, poor cod, saithe and tusk. High-density shoals of sandeels have also been observed. The Armada Hub area supports spawning and nursery habitats for a number of commercially important species. However, these are part of much wider spawning and nursery areas and cod is the only species that is thought to spawn in the Armada Hub project area with high intensity.

Seabirds

The project area is important for northern fulmar, black-legged kittiwake and the common guillemot, but many more seabird species will make use of the area at various times of the year. The seasonal vulnerability of seabirds to oil pollution in the immediate vicinity of the project area has been derived from Joint Nature Conservation Committee data. The highest seabird vulnerability occurs later in the year, when birds (some of which will become flightless whilst they change plumage) have moved offshore following breeding.



Whales, dolphins and seals



Spatially and temporally, harbour porpoises, minke whales, killer whales, white-sided dolphins and white-beaked dolphin are the most regularly sighted cetacean species in the central North Sea.

Given the distance to shore, species such as the bottlenose dolphin and grey and harbour seals are unlikely to be sighted in the project area.

Conservation

None of the survey work undertaken in the project area has identified any seabed habitats or species that are of specific conservation significance, apart from low numbers of ocean quahog, which is a threatened species. Parts of the Maria pipeline and umbilicals, and the wells themselves, sit within the Norwegian Boundary Sediment Plain Nature Conservation Marine Protected Area. This site has been designated for the conservation of aggregations of the ocean quahog and the sand and gravel habitat that supports the species. Gaupe dedicated decommissioning activities are outwith the MPA boundaries (approximately 5 km away) and therefore will not have impact on the protected site.

Fisheries and other sea users

The five-year average value of commercial fisheries within 2 km of the Armada Hub is just under £4,500 per year, relating to approximately 250 hours fishing per year. This indicates that the area is not significantly important to commercial fisheries, and this is consistently reflected in data from the past five years. Fishing that has taken place is likely to be of exploratory nature, rather than the consistent targeting of known fishing grounds, as can be seen elsewhere in the region.

Although, the North Sea has substantial traffic of commercial ships trading between North Sea and Baltic ports, the density of shipping in the Armada Hub area is low, with approximately 0.2 – 0.5 vessels passing each week.

There is limited other activity in the area, with only a small number of oil and gas installations and no offshore renewable activity.

Nearshore and onshore

At this stage of the project, the onshore dismantling and disposal sites are unknown, and therefore it is not possible to describe the specific locations where activity may take place. Site will be selected following the HSE and commercial review and only yards compliant with relevant legislation and good industry practices will be selected.

Summary of Key Findings of the EA

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

Where potentially significant impacts have been identified, mitigation measures have been considered. The intention is that such measures should remove, reduce or manage the potential impacts to a point where the impacts are not significant. Table 1-2 presents the findings of the Environmental appraisal process completed for the Armada and Gaupe decommissioning projects, taking into account any mitigation that has been proposed (i.e. these are ‘residual impacts’). No impacts are rated as either moderate or major in the Environmental appraisal.

**Table 1-2 Potential environmental impact of the decommissioning of the Gaupe infrastructure**

Key impacts assessed	Significance
Physical Presence - Seabed	
<p>Impact assessment: Interaction with the seabed will occur during decommissioning activities. In the main, this will come from the removal of infrastructure, burial of pipeline/umbilical ends, minor rock placement and potential overtrawls that will be conducted to ensure the seabed is left in a suitable condition for future use by fisheries. The activities are expected to be localised, short-term and in line with natural variability, with no cumulative or transboundary impact expected. While some habitats have been assessed as medium sensitivity (owing to the level of conservation importance), given the general uniformity of the central North Sea habitats, very localized scale of habitat change (47m²) and temporary nature of the main seabed disturbance the impact is expected to be slight and thus not significant.</p> <p>Effects on protected sites: Gaupe decommissioning activities will be undertaken away from the nearest protected site, the Norwegian Boundary Sediment Plain, and therefore no impacts are envisaged</p> <p>Cumulative: The predicted recovery of the seabed from the short-term activities means that there is no likelihood of the decommissioning activities causing impact through cumulative means.</p> <p>Transboundary: Potentially, decommissioning activities might be undertaken on the entire Gaupe infrastructure, i.e. on the UK and Norwegian Continental Shelf, at the same time and therefore there might be transboundary impacts. However, these would be localised and temporary.</p>	Not significant
Physical Presence - Underwater noise	
<p>Impact assessment: Noise emitted from vessel use, pipeline survey equipment and cutting of some of the seabed structures could impact upon marine mammal and fish use of the project area. However, the noise emissions are predicted to be sufficiently quiet that there is no prospect of injuring the animals or damaging their hearing. Since the survey and cutting activities will occur for limited period of time and since only a few vessels will be on site at any one time, there is no real prospect of disturbing animals sufficiently to disrupt feeding or breeding activities.</p> <p>Effects on protected sites: Although it is possible that marine mammals from protected sites nearshore or in the Central North Sea could experience noise emissions from the project as they move through the project area, there is expected to be no mechanism for impacting those species and thus no impact on the protected sites to which they belong.</p> <p>Cumulative: Given that the project area is not of key importance to marine mammals or fish and that noise-emitting activities will generally be limited to vessel use, there is no likelihood of the decommissioning activities causing impact through cumulative means.</p>	Not significant



Key impacts assessed	Significance
Transboundary: There might be limited noise impact across the median line as the decommissioning activities might be undertaken on the entire scope of the Gaupe infrastructure at the same time. The noise levels are however anticipated to be minimal and short in period.	
Physical Presence - Other sea users	
<p>Impact assessment: The limited number of vessel days required to execute the decommissioning project means there is no real prospect of significantly affecting fisheries users through temporary exclusion (i.e. existing 500 m exclusion zone or where project vessels stop them using the sea area). Additionally, the Gaupe infrastructure will generally either be removed or decommissioned in a buried or sufficiently rockdumped state to mean that it will pose no risk to fisheries through snagging</p> <p>Cumulative: Since there will be no real short or long term exclusion resulting from the decommissioning activities, there will be no negative cumulative impact.</p> <p>Transboundary: There are a number of non-UK vessels using the project area. However, seabed that was previously excluded from use will be re-opened and these fisheries will not be negatively affected by the decommissioning activities.</p>	Not significant
Discharges to sea	
<p>Impact assessment: Prior to disconnection, Gaupe umbilical line will be flushed. Majority of chemicals present in the cores will be displaced to the Armada platform. Some chemicals however will not be cleaned due to either existing blockage or leakage in a core, or lack of circular pathway. It is therefore anticipated that approximately 16,300 litres of chemicals will be left <i>in situ</i> and will be discharged to sea when line is cut and disintegrates in time. This small release of relatively benign contents has been risk assessed as having no potential to significantly impact species using the seabed or the water column around the project area.</p> <p>Some wax will be left in the northern pipeline. Discharge is expected to be in small concentrations over a long period of time.</p> <p>No scale (with NORM) or heavy metals is expected left in the pipe.</p> <p>Effects on protected sites: No impacts on the nearby MPA are envisaged as discharges will occur approximately 5 km away. This is also supported by the Osborn-Adams Risks Assessment that shows discharges to have no negative effects on the receiving environment.</p> <p>Cumulative: Planned discharges are of small volume and they are not envisaged to have cumulative impacts.</p> <p>Transboundary: Despite the proximity to the UK/Norway median line, the disconnection of the umbilical will be at the riser base so at the distance that the small volumes will not have transboundary impacts.</p>	Not significant



Key impacts assessed	Significance
Energy use and atmospheric emissions	
<p>Impact assessment: Using energy to power vessels results in emissions to the air, which can contribute to local air quality issues. However, the absence of vulnerable receptors in the offshore area means this is not an issue for the project. Emissions to air can also act cumulatively with those from other activities (such as onshore power generation and use of cars) to contribute to global climate change. These emissions from the project may come from vessel use but also through linked activities such as the recycling of materials brought onshore.</p> <p>Cumulative: Since emissions to air offshore is largely a cumulative issue, it is important to consider how the Armada Hub decommissioning activities sit in the context of other UK emissions. Relative to UK offshore emissions, subsea decommissioning activities will contribute only 0.4% of annual emissions in the year in which they take place. Compared to the emissions that occurred annually from the Armada Hub when it produced hydrocarbons, the total emissions from the decommissioning activities represent little more than the annual production emissions for one year. With such a small contribution during the activities themselves, and since the activities are proposed to facilitate the removal of the emissions associated with the operations of the Armada Hub, there is considered to be no cumulative impact.</p> <p>Transboundary: In the same way as described for cumulative impacts, there is considered to be no transboundary impact from the emissions, since the contribution of the emission to global climate change is negligible.</p>	Not significant
Accidental events	
<p>Impact assessment: The main potential impact from an accidental event associated with the Gaupe infrastructure decommissioning activities is the release of fuel from a vessel involved in a collision. Such fuel would likely be marine diesel and not a heavy oil. Fuel spill modelling undertaken to understand how a release in the offshore Armada Complex area could interact with the environment showed that the area over which the fuel might disperse would be limited. The conditions in the offshore environment would also mean that any release would disperse relatively quickly. Given that fuel released from the vessel would not result in oiling of species using the area of any fuel release (since it is not a heavy oil like seen during tanker groundings), there is expected to be no significant impact from any release.</p> <p>Effects on protected sites: The fuel spill modelling showed that it would not reach shore and would be unlikely to cross the boundaries of offshore sites. As such, there is expected to be no mechanism for impacting protected sites.</p> <p>Cumulative: Any accidental hydrocarbon release in the offshore project area is predicted (from modelling) to dissipate within days. It is considered very unlikely that additional accidental releases from other sources would occur in the same timeframe and produce a cumulative impact.</p> <p>Transboundary: The fuel spill modelling showed that fuel may cross the</p>	Not significant



Key impacts assessed	Significance
UK/Norway median line. Even if it did, however, the limited volumes and quick dispersion mean there is likely to be no significant transboundary impact.	
Onshore and nearshore	
<p>Impact assessment: There is the potential for the onshore phase of decommissioning to interact with communities in the vicinity of the dismantling yard. Nearshore activities, such as movement of vessels between the dismantling yard and the offshore Armada Complex area may interact with other users of the nearshore environment. Decommissioning of the recovered subsea infrastructure will be carried out at existing sites, which will have in place site management plans and the correct licences for the proposed dismantling operations and as such will limit potential impacts to the environment and to local communities. Nearshore activities will occur within areas that are already established for use for such activity (e.g. the laydown area will be a dedicated laydown area adjacent to the quayside).</p> <p>Effects on protected sites: Activities will occur at established yards, the ongoing management of which will ensure no effect on protected sites.</p> <p>Cumulative: Activities will occur at established yards, with no new facilities required. The ongoing management of the existing site will ensure no significant cumulative impact.</p> <p>Transboundary: The onshore (and associated nearshore) location has yet to be confirmed, but locations in both the UK and continental Europe are currently being considered. Regardless of whether a UK or continental Europe location is selected, any transboundary impacts will be managed in the same manner under site management plans and relevant licensing.</p>	Not significant

Stakeholder Engagement

The development of proposals has recognised that involving stakeholders as partners in the decommissioning journey would be valuable because of their respective areas of specialist knowledge and interest. The approach also acknowledges that engagement is only meaningful if it is based upon a genuine exchange of views and with the objective of influencing decisions and outcomes. Stakeholders have therefore been provided with information to enable discussion and comment in order to be certain that the basis on which decisions are taken is well-founded and properly informed.

ENVID

Potential environmental and societal risks identified in the DP were determined through an Environmental Impact Identification (ENVID) workshop. The ENVID uses standard definitions for rating the magnitude of impact based on the sensitivity of the receptor and the scale and duration of the activities.

The ENVID, along with additional evaluation of options and subsequent analysis and study, concluded that the decommissioning of Gaupe would give rise to no impacts categorised as “major” or “moderate”. Identified risks can be mitigated using standard control measures and



procedures due to the relatively small scale of the facilities to be decommissioned, the nature of the activities to be carried out and the relatively short duration of these activities.

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

Conclusion

The Environmental Appraisal undertaken for the Gaupe infrastructure has been informed by extensive stakeholder engagement, by the Comparative Assessment process and by specialist environment studies (such as the environmental baseline surveys). This has facilitated the development of a robust environmental baseline and a focussed but comprehensive impact assessment, which has considered the likelihood of the decommissioning project resulting in significant environmental impact. An integral part of the impact assessment has been the development of appropriate mitigation measures, which will ensure that environmental impact is minimised as far as is practicable.

Taking into account the environmental sensitivities of the Gaupe, the proposed decommissioning activities and the mitigation measures that will be deployed, it is concluded that the Gaupe decommissioning project will result in no significant environmental impact.

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1. Introduction

In accordance with the Petroleum Act 1998, the Section 29 notice holders of the Gaupe field are applying to OPRED (Offshore Petroleum Regulator for Environment and Decommissioning) to obtain approval for decommissioning the Gaupe installation and associated subsea elements.

Under the Petroleum Act 1998 there is a requirement to provide an assessment of the impact of the decommissioning activities on the marine environment. In accordance with OPRED guidelines, the environmental assessment shall be documented in an environmental appraisal report. This Environmental Appraisal is submitted for due consideration for the approvals process for final approval by the Minister for BEIS.

This EA is submitted on behalf of the Section 29 Notice Holders, to satisfy the regulatory requirement for environmental assessment and to inform the planning and execution of the activities required to fulfil the Gaupe Decommissioning Programme.

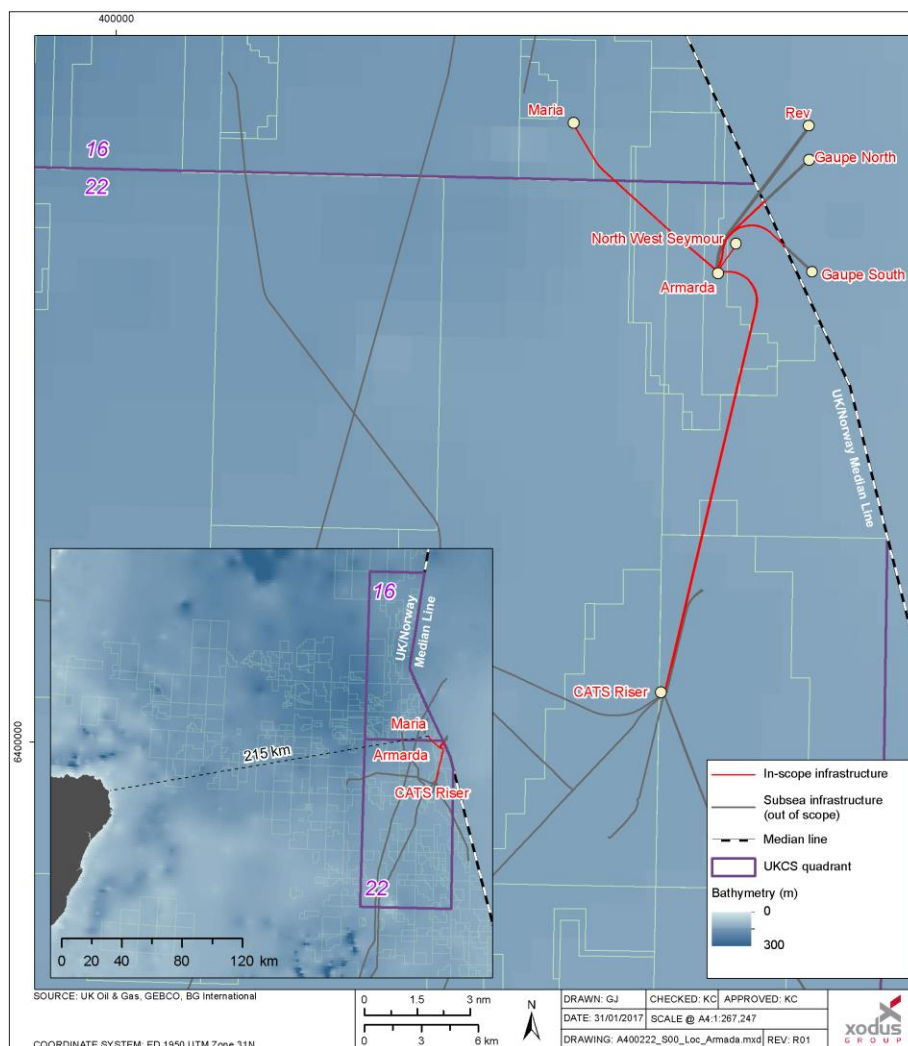
This EA report is intended to be read in conjunction with the DP and the referenced documentation, to which it refers for certain details although some information from the DP is repeated here, or further elaborated on, to enhance understanding of the assessment of impacts on the environment.

1.1. Location of Armada hub and Gaupe infrastructure

The Gaupe North and Gaupe South subsea wells on the Norwegian Continental Shelf were developed in 2011 and tied back to the Armada platform by trenched and buried production flowlines that cross the UK/Norway median line (Figure 1-1 and Figure 1-3). An SSIV structure for the Gaupe fields was installed on the seabed approximately 360 meters away from the Armada platform. The Gaupe field are controlled from the Armada platform via umbilicals that have chemical and hydraulic cores and electrical cables. The Gaupe umbilicals were trenched and left to fill by natural processes. Approximately 4.3 km of the Gaupe north flowline and umbilical and 5.2 km of the Gaupe south flowline and umbilical are located on the UKCS. A/S Norske Shell is operator of the Gaupe fields and Lundin Norway AS is a partner in the licence.



Figure 1-1 Location of the Armada Hub



1.2. Production History

The wells were temporary shut-in in 1st October 2018. Integrity testing is done every 6 months. Cessation of Production (CoP) is planned in Q4 2019.

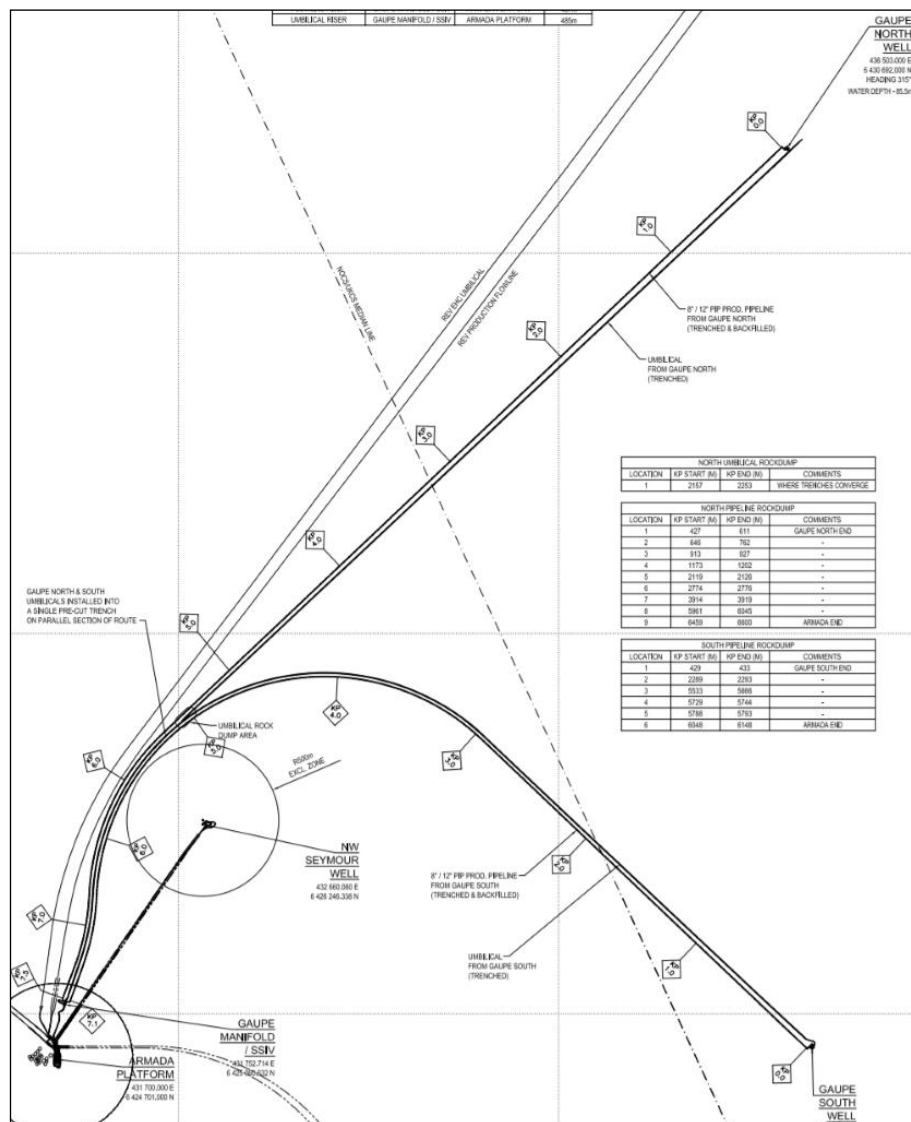
1.3. Armada Field and Gaupe Installation Facilities and Infrastructure

The Armada Hub consists of a four-legged, steel-piled jacket and an integrated deck installed in 89m of water in the UK Continental Shelf (Figure 1-2). The Armada Hub is owned and operated by different parties than the Gaupe tieback. The Armada Hub is currently producing with no current plans for Cessation of Production.

Doc. no. GP50-BGNO-S-RA-0001



Figure 1-3 Location of the Gaupe subsea structure



Well stream fluids are routed through separate “pipe-in-pipe” flowlines to a subsea commingling manifold located on the UK Continental Shelf (UKCS) and about 360m from the Armada platform. From there, production fluid is routed to the Armada Hub topsides via a flexible production riser.

Power, chemical injection and hydraulic control of the wells and SSIV is provided from the Armada Hub topsides via an umbilical riser to the SSIV manifold and, from there, separate Electro-Hydraulic Control umbilicals to the two drill centres on the NCS.



1.4. Scope of the Gaupe Decommissioning Programme

The Gaupe infrastructure located on the UKCS that is considered in this document comprises:

- Gaupe North 8" / 12" pipe-in-pipe production pipeline (PL2781)
- Gaupe South 8" / 12" pipe-in-pipe production (PL2782)
- Gaupe 7.5" production flexible riser (PL2783)
- Gaupe North 5.5" umbilical (PLU2784)
- Gaupe South 5.5" umbilical (PLU2785)
- Gaupe 8.2" riser umbilical (PLU2786)
- J-tube attached to Armada (connected to Gaupe wells and will be removed with Armada)
- The Gaupe Sub Sea Isolation Valve (SSIV) manifold within the Armada platform 500 m zone

The activities related to Gaupe decommissioning in Norwegian Waters comprise and consequently not included in this EA are the following:

- Plugging and abandoning of Gaupe North and Gaupe South wells;
- Flushing and cleaning and decommissioning of the production pipelines, flowlines and umbilicals;

1.4.1. Subsea Infrastructure Decommissioning

The main sections of the Gaupe North and South production pipelines from the SSIV manifold to the Gaupe North and South wells are currently trenched and buried to a depth of approximately 2m. Similarly the main sections of the umbilicals from the SSIV manifold to the Gaupe North and South wells are currently trenched and naturally back filled to a depth of approximately 1m. A comparative assessment for decommissioning options for the pipelines and umbilicals recommended that the trenched and buried sections of these pipelines and umbilicals should be decommissioned in situ, with the exposed sections at the ends of the pipeline being removed and returned to shore for recycling or disposal.

The following will be removed during the campaign or later in connection with decommissioning of the Armada:

- the Gaupe SSIV manifold
- all tie-in spools and jumpers
- the flexible production and umbilical risers in the J-tubes within the Armada jacket
- all mattresses and grout bags

The Gaupe SSIV co-mingling manifold along with production riser PL 2783 and umbilical riser PLU 2786 will be fully removed during decommissioning. The SSIV manifold is a gravity-base manifold, with a footprint of 10.8m x 6m and height of 4m, located 360m from the Armada platform. The manifold weighs 82.1 tonnes and will be removed by a simple lift from the seabed.

The Gaupe production and umbilical risers are laid on the seabed and connect the SSIV to the Armada platform. Both of the risers are covered by mattresses to protect from dropped objects, the mattresses will be removed and recovered prior to removal of the risers.



The SSIV manifold and riser sections are fully within the Armada safety zone and will be removed while the Armada safety zone remains in place or mitigating actions are put in place and within 3 years of Armada Complex Decommissioning Programme approval. Removal after then Armada Complex cessation of production will enable efficient and safe operations and facilitate synergies with Armada Complex decommissioning operation.

The two flexible jumpers and umbilicals which connect the SSIV to the trenched and buried Gaupe North and Gaupe South production pipelines and umbilicals are also covered in mattresses which will require removal prior to recovery of the jumpers and umbilical sections.

Approximately 292 mattresses and 4000 grout bags are exposed and will be removed during decommissioning.

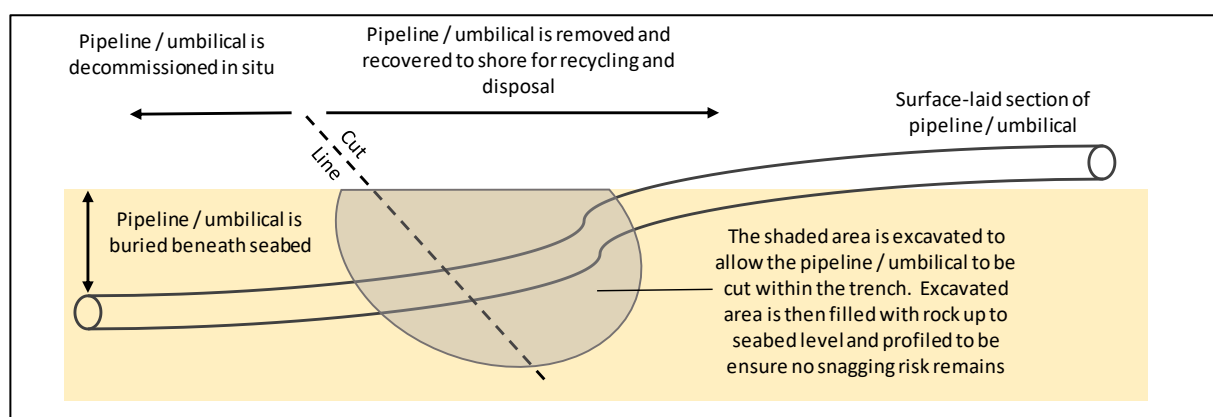
The following is considered for grout bags and mattresses:

1. It is intended that all mattresses and grout bags will be removed to shore; however, in the event of practical difficulties, OPRED will be consulted.
2. The exact distribution of grout bags (rock covered or exposed) is not known, however it is intended that all exposed bags will be recovered to shore.
3. The numbers provided for mattresses are estimates based on the design drawings and may be subject to some variation.

1.4.2. Cut ends of Pipelines and umbilicals

To facilitate recovery of the exposed sections of the pipelines and umbilicals close to the Armada platform, the pipeline / umbilical will be cut within the trench at a point where the burial depth is in line with OPRED requirements. Precise method is not selected yet. However, one method is to recover the cut section to the back deck of a CSV and returned to shore for recycling and disposal. To ensure the cut end remains buried and does not present a future snagging risk 5 – 10 tonnes of rock, as required, would be placed over the cut end and profiled flush with the surrounding seabed. An illustration of the cut location and rock placement is shown in Figure 1-4 below.

Figure 1-4 Example of cut location





1.4.3. Pipeline Burial Survey

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

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

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

1.4.4. Over trawl Trials

Following recovery of subsea infrastructure and debris the seabed will be subjected to surveys to confirm that the seabed is clear and safe for fishing.

The default OPRED policy requirement is for clear seabed verification to be undertaken using non-intrusive means, such as video or side scan sonar. This will form the base case for Gaupe decommissioning.

If the survey results prove to be inconclusive, or identify areas where there are specific safety concerns, such as at pipeline ends, it may be necessary to supplement the surveys with over trawl trials to demonstrate that the seabed has been left in a safe state. Over trawl surveys as a means to locate debris and /or verify clear seabed, are likely only to be approved in cases where it is deemed necessary.

For the purposes of estimating environmental impact, a worst-case assessment has been taken in this EA with the assumption that over-trawling may be required for areas of rock cover. Actual methods of verification will be discussed and agreed with OPRED on a case-by-case basis with an assumption that less intrusive methods of clear seabed verification are the base case.

1.4.5. Post-Decommissioning Survey

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

1.4.6. Onshore Dismantling

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

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



1.4.7. Vessel Usage

Estimates of use for various vessel types expected for the decommissioning programme are summarised in Table 1-1.

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

VESSEL TYPE	MOBILIS ^N & TRANSIT	OPERAT ^N	INTERIM MOBILIS ^N	WEATHER DISRUP ^N	TRANSIT & DEMOB ^N	TOTAL
Light Construction Vessel flushing	2.25	6.75		2.1	1.5	12.6
Light Construction Vessel Infrastructure	4.75	17.25	1.75	5.5	4.75	34
MRV	3.00	12.75	4	4.15	3.5	27.4
MSV	2.75	3		3.5	2.5	11.75
Rock placement vessel	1.75	1		0.75	1	4.5

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

The duration of operation of the barge is dependent on the onshore destination of the material. The decommissioning yard has not yet been appointed but the vessel estimates have assumed that a UK port will be used. No HLV is required. Furthermore, there is high flexibility over the duration that a guard vessel will be on station.

Helicopter access will not be required.

1.5. Environmental Appraisal Process

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



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

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

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

1.5.1. Scope of the EA Report

The scope of the Gaupe DP is limited to offshore installations, offshore pipelines and umbilicals. The offshore section of the pipelines will be decommissioned *in situ* in their current, buried state and are outside the scope of this EA.

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

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

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

The ENVID identified several relevant aspects, but all aspects had minor or negligible risk with insignificant impact.

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

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

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



1.6. Stakeholder Consultation

To ensure all environmental issues associated with the Gaupe decommissioning could be identified, Shell has held a number of sessions to inform stakeholders of decommissioning plans and to seek feedback on any issues of concern to interested parties. Consultations on Gaupe were conducted as part of the wider Armada complex decommissioning consultations. Table 1-2 below provides a summary of stakeholder comments specific to Gaupe and how they were addressed in the EA and DP submissions. Table 1-3 provides a list of all consultations undertaken in relation to the wider Armada complex decommissioning including Gaupe.

Table 1-2: Stakeholder Issues and Concerns Raised during Consultation Activities.

Consultee	Issue/Concern	Shell Response
16/01/2017 Engagement with BEIS EMT, BEIS ODU, Marine Scotland, JNCC		
Marine Scotland	Where feasible chemicals should be flushed and cores cleaned prior to be removed or left in situ.	Where possible pipelines and umbilicals will be flushed and cleaned. However, the LP and HP hydraulic fluids lines in the umbilical, which are filled with HT2N/HT2, are constructed with no return line, hence flushing of the line will go directly to sea. Two of the methanol lines in Gaupe North umbilical are leaking. Flushing of these lines will also partly go to sea, or will partly be unable to be flushed. One of the asphaltene inhibitor lines in the Gaupe South umbilical has a blockage and is impossible to flush. See Section 4.6 – the impact is assessed as slight.
Marine Scotland	Osborne Adams calculations should be produced for all discharges to sea (excluding methanol) and submitted directly to MS	Osborne Adams calculations for discharges to sea from pipeline and umbilical and flushing, or leave in situ options have been undertaken and demonstrate that these releases would result in a slight environmental impact. These calculations have been provided to Marine Scotland as requested. Results are summarised in Section 4.6.3.
Marine Scotland	Please provide details on the leak rate of the Gaupe North umbilical	The methanol leak on Gaupe North only occurs during well integrity testing and varies slightly between each test. It is typically 200 litres per test, but can be up to 240-500 litres per test. The leak will not occur during decommissioning activities.
Nov 2016 Armada Comparative Assessment Workshop		
SFF	The SFF provided specific input into the CA scoring for sub-criteria 'legacy risk to other users of the sea' and 'commercial impact on fisheries'.	This scoring was part of the CA decision-making process. See Gaupe Comparative Assessment Report.
26/10/2016 Armada Hub Stakeholder Workshop		
Unattributed	The potential for leakages from the umbilicals needs to be taken into account if they are left in place without flushing the contents.	On decommissioning some chemicals will be left in the umbilicals where flushing is not possible. Osborne Adams calculations for discharge of the full contents once the umbilical ends have been cut indicates the impact would only be slight. Results are summarised in section 4.6.3.

**Table 1-3 Wider Armada complex stakeholder engagement**

Date	Engagement
Quarterly from 2014 to date	Meetings with the Offshore Decommissioning Unit (ODU) to update on project planning progress. Other ad hoc meetings, email contact and telephone conversations to clarify understanding where required.
May 2015	Meeting with ODU Environmental Management Team (EMT), JNCC (also representing Scottish Natural Heritage (SNH)) and Marine Scotland to discuss scope of work for the Pre-Decommissioning Environmental Baseline Survey.
October 2015	Visit to Fraserburgh Harbour (with SFF) to meet those working at sea and gain first-hand insights into the experiences of fishermen and the challenges they face at sea.
February 2016	SFF presentation on seabed clearance and restoration.
March 2016	All stakeholders: introductory contact established with invitation to comment on scope of Draft Environmental Impact Assessment before studies commissioned.
April – May 2016	Liaison with ANChor research project (Heriot Watt University, now at Edinburgh University) to examine marine growth on video surveys of Armada Jacket.
May 2016	SFF meeting to initiate project discussions, seek early stage input and follow up on socio-economic impact study.
June 2016	Stakeholder engagement workshop. All stakeholders invited to introductory workshop setting out the project, with advance briefing and post-workshop report provided to all (whether or not attended) for additional comment. 27 external stakeholders from 22 organisations attended the independently-facilitated meeting.
July 2016	Scottish Enterprise meeting to discuss onshore disposal opportunities for supply chain.
August 2016	Presentation made to JNCC of current status of the project with discussion of key features and comments made at the stakeholder workshop in June which they could not attend.
August 2016	Presentation to ODU, EMT and Marine Scotland on project status.
September 2016	SFF meeting held to share details of studies for spud can depression slopes and depths, together with rock berm heights and coverage.
September 2016	Scottish Environment Protection Agency (SEPA) meeting to provide overview of current status of planning with discussion on flushing cleanliness standards, waste issues and expectations on what might be expected to be brought back to shore, including marine growth if this cannot be stripped offshore.
October 2016	ODU consulted on treatment of drill cuttings and whether a comparative assessment would be required if proposals were to be brought forward for their disturbance.



Date	Engagement
October 2016	Second stakeholder workshop held with particular reference to environmental findings following Pre-Decommissioning Environmental Baseline Survey, decommissioning of control umbilicals and remediation of spud can depressions. All stakeholders invited and provided with advance briefing and post-workshop report for additional comment. 26 external stakeholders from 21 organisations attended the independently-facilitated meeting.
November 2016	SFF participated in the comparative assessment safety workshop for scoring pipeline decommissioning options.
December 2016 and March 2017	SFF briefed on preliminary outcomes of the comparative assessment.
January 2017	Guidance sought from ODU on monitoring regime to test comparative assessment inputs which resulted in leave <i>in situ</i> decommissioning option for export pipeline emerging as recommended option.
January 2017	EMT and ODU, JNCC and Marine Scotland: meeting to discuss aspects of drill cuttings in relation to seabed clearance and certification via ROV post decommissioning, rather than the standard overtrawl trials, to minimise disturbance. Umbilical flushing also discussed, including issue of blockages in some of the cores, for advice on how to proceed. Pile cut depths were discussed in the context of the low seabed movement in the Armada area and the technical challenges that would be associated with cuts below 1 m of the seabed.
February 2017	Project overview (status update) given to OGA.
March 2017	SFF update meeting held to discuss findings following December 2016 meeting.
June 2018	Meeting with BEIS (OPRED and ODU) presenting status and reuse opportunities for Gaupe
August 2018	Technical note to BEIS regarding future activities on Gaupe
May 2019	Presentation to OPRED/BEIS of status Gaupe decom and wax studies



2. Environmental Baseline

2.1. Introduction

An understanding of the environment along the pipelines from the Armada Complex to the wellhead on Gaupe has been compiled to provide a basis for assessing the potential interactions of the decommissioning activities with the environment. This section describes the current nature and status of the environment in the Gaupe area.

2.2. Surveys

This section describes the environmental conditions of the UKCS sections of the Gaupe infrastructure including the location of the Gaupe SSIV.

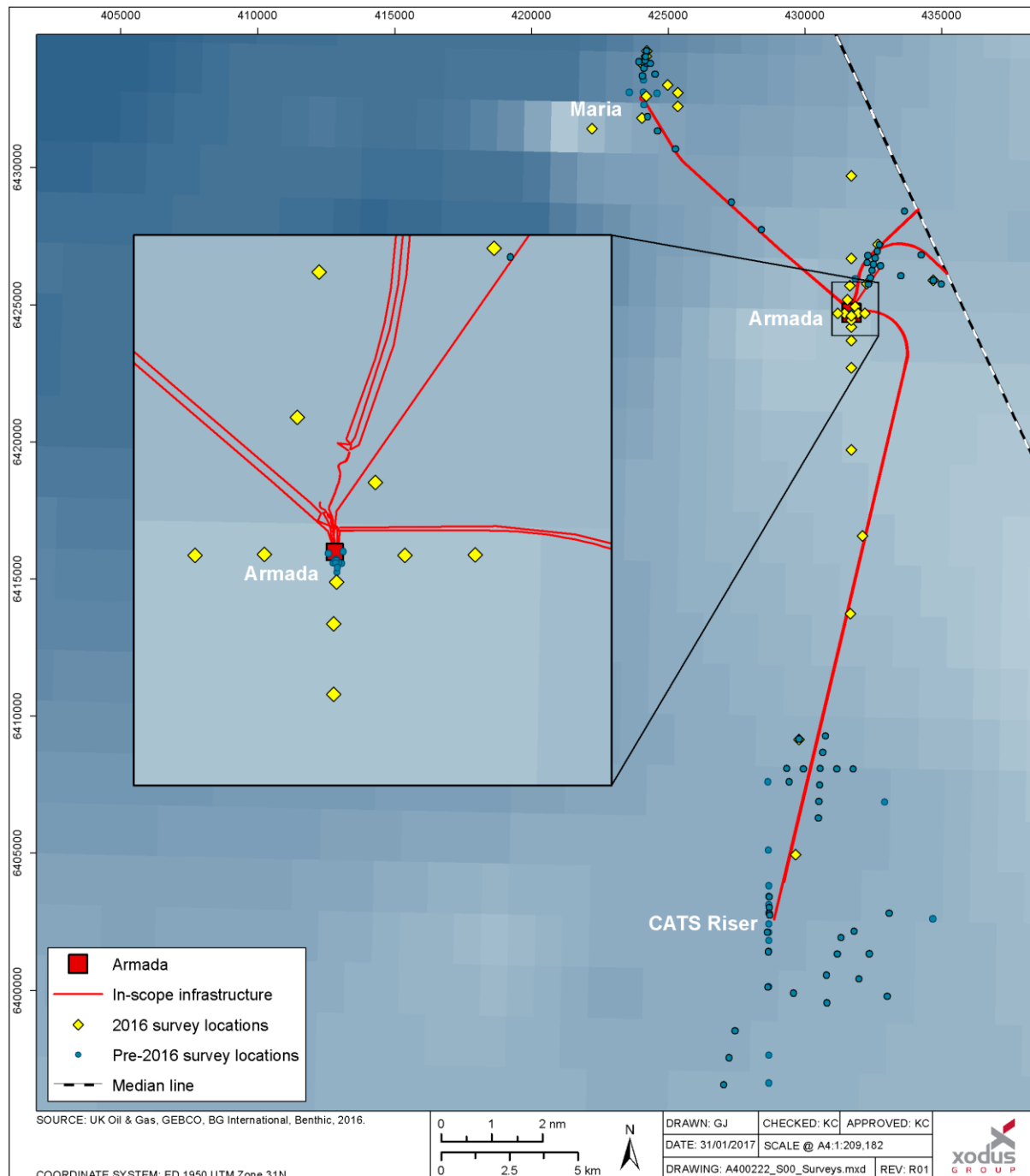
This section has been prepared with reference to regional programmes and publications and other scientific and academic literature, including:

- ‘Offshore Energy Strategic Environmental Assessment (SEA) 3’ (DECC, 2016a);
- ‘Scotland’s National Marine Plan’ (Scottish Government, 2015) and its interactive online data resource (NMPI, 2016);
- The ‘Offshore Seabird Vulnerability Assessment’ (Joint Nature Conservation Committee (JNCC) 1999); and
- ‘Small Cetacean Abundance in the North Sea’ (SCANS) and ‘Small Cetaceans in the European Atlantic and North Sea’ (SCANS-II and III) projects (JNCC, 2010a, Hammond et al., 2013).

The EA has also been informed by the Armada Complex Pre-Decommissioning Environmental Survey carried out by Bibby Offshore Ltd (now Rever Offshore Ltd.) and Benthic Solutions Ltd in May 2016. The survey scope included the following for Gaupe:

- A corridor 200 m wide along the routes of the Gaupe export pipelines, flowlines and umbilicals (only those sections on the UKCS);
- Ten seabed grab sampling stations located 250 m, 500 m, 1 km, 2 km and 5 km north and south of the Armada platform, that being the main axis of the surface currents and four cross-current seabed sampling stations at 250 m and 500 m from the platform;

The survey vessel deployed high resolution multibeam echosounder to record bathymetry, side-scan sonar to record seabed features, a pipe-tracker and video cameras to confirm the burial status of the pipelines, cameras to image the seabed at sampling stations and a double 0.1 m² grab to collect sediment samples for physico-chemical and biological analysis. The environmental findings were published in a Habitat Assessment Report (Benthic Solutions, 2016a), Environmental Baseline Survey Report and Cuttings Pile Assessment (Benthic Solutions, 2016b). The 2016 pre-decommissioning survey adds to extensive information from surveys previously carried out in the Armada Hub area. This EA has also given due consideration to surveys of NW Seymour (Gardline, 2004), Maria (Fugro, 2004a, Gardline, 2005), North Everest (Gardline, 2007, 2009, 2010a) and pipeline routes to Gaupe (Gardline, 2010b). The extent of seabed sampling associated with the pre-decommissioning and historical surveys of relevance is shown in Figure 2-1.

**Figure 2-1 Environmental survey sample stations in the Armada Hub area**

2.3. Physical Environment

2.3.1. Wind

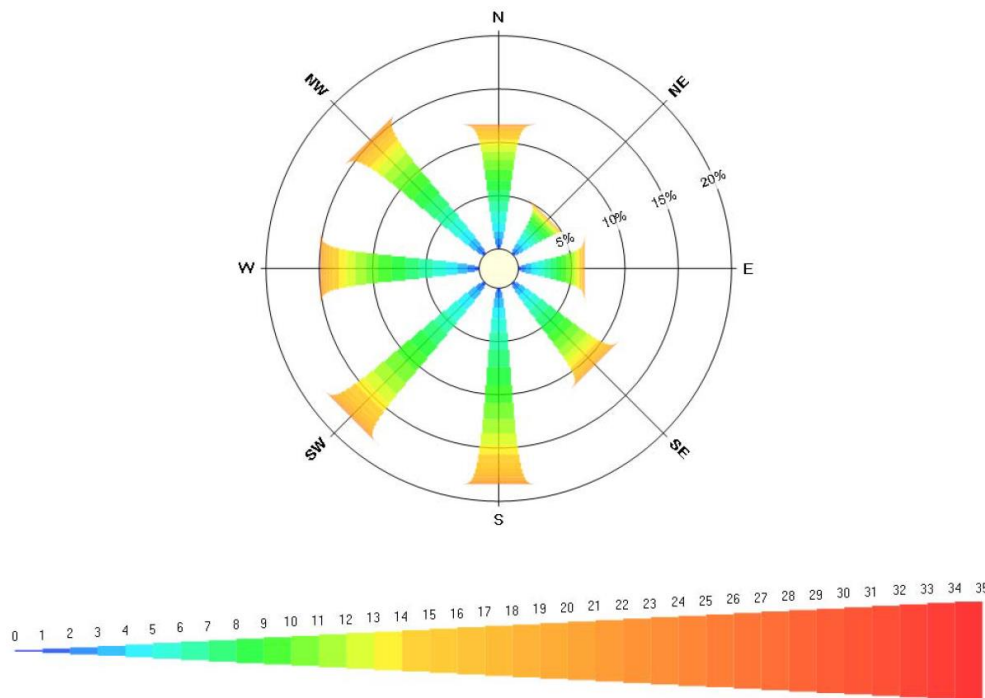
Meteorological Office wind data for the Central North Sea region (1854 – 1994) show southerly and south-south-westerly winds prevailing, with average wind speeds throughout the year of 6 – 13 m/s representing moderate to strong breezes (DTI, 2001).

PhysE (2010) consider the prevailing winds near the Armada platform to be southerly and south-westerly, and between April and September the wind speeds only exceed 20 m/s for 2% of the



time (Figure 2-2). The 100-year maximum gust lasting 1 minute at 10 m above sea level is 42.4 m/s.

Figure 2-2 Wind direction and speed (m/s) probability for the Armada Hub area (PhysE, 2010)



2.3.2. Water Currents

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

Atlantic Water enters the North Sea around Shetland and through the Fair Isle Channel, driving an anti-clockwise circulation in the Central North Sea. At the Armada platform, PhysE (2010) report a 0.56 m/s 1-year maximum current speed near the sea surface and a 0.33 m/s maximum current speed at the seabed. However, the persistence of anchor chain marks on the seabed in sidescan sonar images (e.g. Benthic Solutions, 2016a) suggests that seabed currents are seldom strong enough to move significant quantities of sediment.

The mean spring tidal range at Armada is in the range 0.1 – 1 m (NMPi, 2016).

2.3.3. Wave height

The Scottish National Marine Plan (NMPi, 2016) reports the average wave height in the Armada Complex area to be 2.1 – 2.4 m, whilst the annual mean wave power ranges from 18.1 – 24 kW/m. Peak kinetic energy at the seabed due to waves in the Armada Hub is classed as moderate (0.21 – 1.2 N/m²; McBreen et al., 2011). PhysE (2010) gives the 1-year significant wave height within the vicinity of the Armada platform as 9.6 m and the maximum wave height in a 100-year period to be 24.4 m.



2.3.4. Water temperature and salinity

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

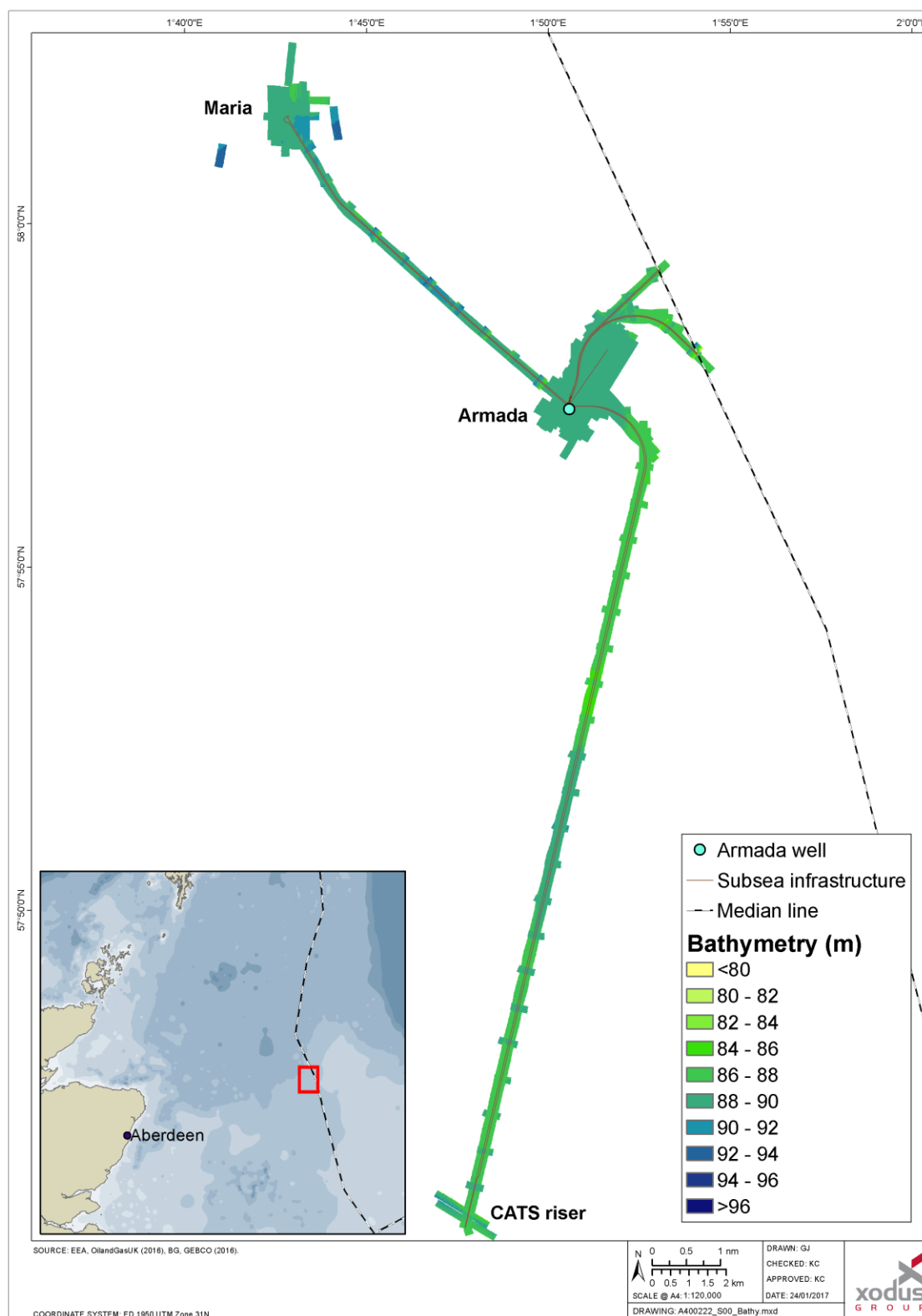
The Central North Sea becomes thermally stratified in spring when air temperatures increase. A thermocline between warm surface waters and colder deeper waters develops below 30 m depth. Marex (1993) reports summer surface temperatures in the range 10 – 16.5°C, with a mean summer surface temperature of 13.5°C, whilst the water temperature at the seabed is in the range 5.1 – 11.6°C, with a mean summer seabed temperature of 6.9°C. Stratification breaks down in autumn as more frequent and severe storms mix the water column and cool the water (van Leeuwen et al., 2015). Marex (1993) reports the winter surface water temperatures in the vicinity of the Armada platform to be in the range 3.7 – 7.2°C throughout the water column, with a mean winter temperature of 5.7°C. Surface salinity in the Armada Hub area varies from 34.5‰ in winter to 35.0‰ in summer (NMPi, 2016).

2.3.5. Bathymetry

The 2016 pre-decommissioning survey measured water depths in the Armada Hub area ranging from 82 – 94 m. Bathymetry of area around Gaupe range between 84.5 and 85.3 meters. The seabed was observed to be generally flat and featureless with no obvious gradient and only minor undulations (Figure 2-3) (Benthic Solutions 2016b).



Figure 2-3 Bathymetry of the Armada Area



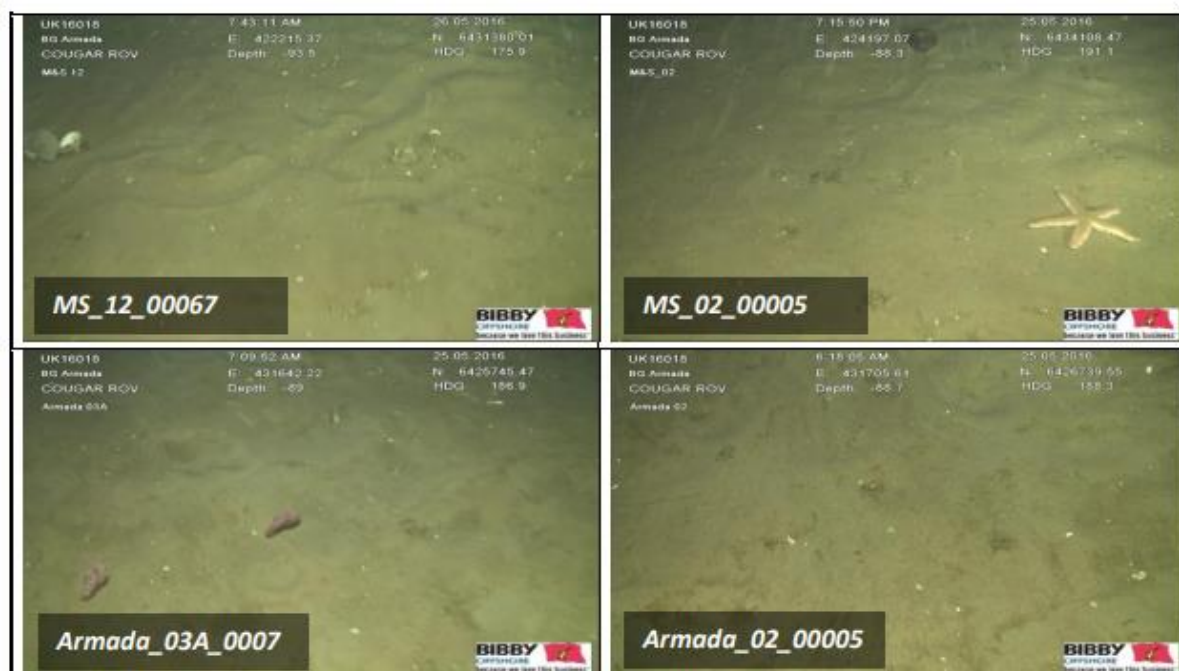


2.3.6. Seabed sediments and habitat

The pre-decommissioning survey identified three main sediment types forming natural habitats along the Gaupe pipeline and umbilical routes, distributed as shown in Figure 2-5 and described as follows:

- Close to the Armada platform and extending out to the Gaupe SSIV Offshore circalittoral sand was the predominant habitat type (class A5.27 in the European Nature Information System (EUNIS) habitat classification, and SS.SSa.Osa in the JNCC biotope classification). Pre-decommissioning survey samples from this habitat had a fine sand content of greater than 88%. Hundreds of glacial drop stones were identified throughout the survey area. Example images of the Offshore Circalittoral Sand Habitat is shown in Figure 2-4.
- In places the survey found the sand slightly gravelly (EUNIS class A.4 habitat).

Figure 2-4 Example of an Offshore Circalittoral Sand Habitat

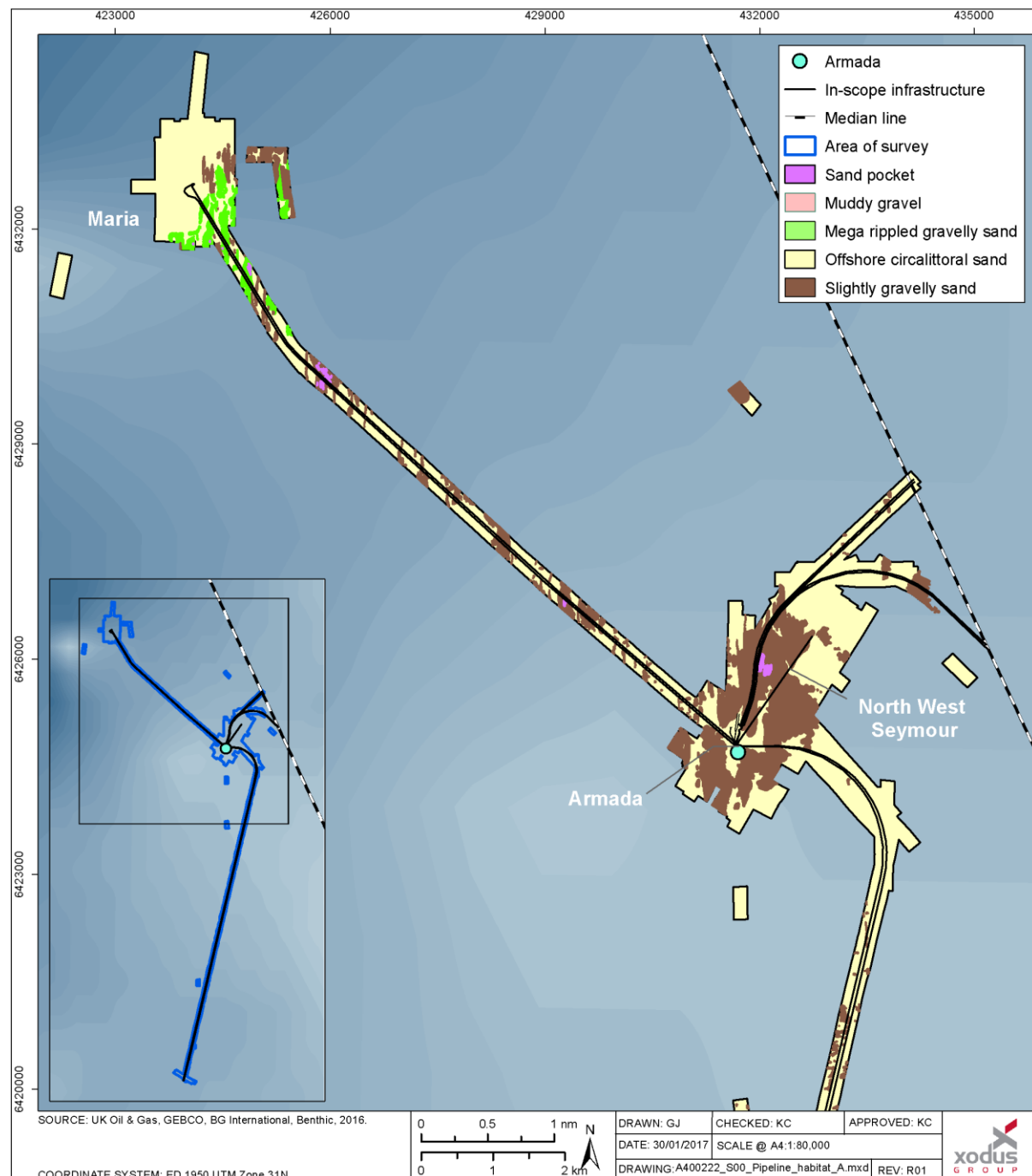


The habitat distribution broadly corresponds with the seabed types in the area predicted by JNCC's (2010 and 2018b) UKSeaMap programme. However, anthropogenic habitats were also present providing:

- Hard substrate (including the Armada jacket, subsea structures, pipelines, mattresses, rock cover and debris); and
- Relief (spud can imprints on the seabed);



Figure 2-5 Sediments of the Armada Hub - northern section



2.3.7. Sediment chemistry

The seabed in the Armada Complex area exhibits low values for total organic carbon (<0.1% to 0.13%) and total organic matter content (0.77% to 2.03%), reflecting the dominance of sands and coarser fractions and the generally low silt/clay content (Benthic Solutions, 2016b).

The mean total hydrocarbon content (THC) across the Armada Hub area was 9.36 $\mu\text{g}\cdot\text{g}^{-1}$ (Benthic Solutions, 2016b), which is below the average background level for sandy sediments in this region of the North Sea (9.51 $\mu\text{g}\cdot\text{g}^{-1}$, UKOOA, 2001). THC levels are consistent with those



recorded in previous surveys in the Armada Hub area (7.39 – 9.2 $\mu\text{g.g}^{-1}$). Higher THC values were recorded within 500 m of the Armada platform 11.64 $\mu\text{g.g}^{-1}$ – 90.91 $\mu\text{g.g}^{-1}$ (Benthic Solutions, 2016b). Evidence of hydrocarbons was observed within 2 km north and south of the platform and 250 m east and west. Beyond a radius of 1 km from the platform, carbon compounds of biological origin (biogenic) dominate, but closer to the platform there is evidence of hydrocarbons associated with the synthetic-based mud used to drill wells at Armada.

Total polycyclic aromatic hydrocarbon (PAH) concentrations recorded by Benthic Solutions (2016b) (14.44 to 84.43 ng.g^{-1}) were below the UKOOA mean background level for the Central North Sea (233 ng.g^{-1}). The highest concentrations in this range were recorded around the Maria field.

Heavy metal concentrations (arsenic, vanadium, zinc, aluminium, iron, lithium and manganese) correlated with the gravel component of sediments, particularly in the megarippled gravelly sand in the Maria area and were consistent with previous surveys (Benthic Solutions, 2016b). Barium, which is associated with drilling, is present throughout the Armada Hub area at concentrations generally ranging from 222 $\mu\text{g.g}^{-1}$ – 364 $\mu\text{g.g}^{-1}$. Higher levels (1,140 – 3,460 $\mu\text{g.g}^{-1}$) were recorded 250 m south and north of the Armada platform (Benthic Solutions, 2016b).

2.4. Biological environment

2.4.1. Plankton

The composition of planktonic communities that form the basis of marine ecosystem food webs is seasonal. Phytoplankton abundance and productivity is driven by sunlight intensity and nutrient availability, which ultimately depends on mixing and thermal stratification in the water column (Johns and Reid, 2001, Edwards et al., 2010). In the 10-year period between 1997 and 2007, Central North Sea phytoplankton levels peaked in April with a second, smaller peak in August. Abundance and productivity decrease through the winter months when light and temperature conditions are less favourable (SAHFOS, 2015).

The dinoflagellate genus *Ceratium* dominates the phytoplankton community in the Central North Sea (DECC, 2016a). The most abundant zooplankton species in the North Sea are the calanoid copepods, in particular *Calanus* spp. and smaller copepod species such as *Para-Pseudocalanus* spp. and *Acartia* (Johns and Reid, 2001). Historically *Calanus finmarchicus* dominated the North Sea zooplankton, however, its abundance and biomass has declined significantly over the last 60 years, while populations of *C. helgolandicus* and other boreal and temperate Atlantic and neritic species have increased (DECC, 2016a, Baxter et al., 2011, Edwards et al., 2013). This is attributed to changes in seawater temperature and salinity (Beare et al., 2002, FRS, 2004). In Continuous Plankton Recorder data, these changes are increasingly evident on a gradient from north to south through the North Sea.

The distribution of many species of fish, birds and cetaceans that feed on plankton is influenced by its movement with the water circulation.

2.4.2. Benthos

Infauna

The same species dominate throughout the Armada Hub area including Gaupe, (Benthic Solutions, 2016b). The polychaetes worms *Paramphinoe jeffreysii* and *Spiophanes bombyx* were present in all samples collected during the pre-decommissioning survey and dominated in terms of abundance. The ten most abundant species also included the polychaetes *Scoloplos*



armiger, *Myriochele heeri*, *Owenia fusiformis*, *Goniada maculata* and *Phyllodoce* (*Anaitides*) *groenlandica*, the burrowing brittlestar *Amphiura filiformis*, the cumacean shrimp *Eudorellopsis deformis*, and the small bivalve mollusc *Abra alba* (Benthic Solutions, 2016b).

Some less abundant species found in the pre-decommissioning survey are considered characteristic of the sandy sediments present in the survey area, including the small sea urchin *Echinocyamus pusillus*, the burrowing sea urchins *Echinocardium* spp. and *Spatangus raschi*, and the burrowing sea anemones *Cerianthus lloydii* and *Edwardsia clapedii* (Benthic Solutions, 2016b).

These results compare well to those recorded from previous surveys in the Armada Hub area, and the top-ranked species correspond to those identified as characteristic of the Central North Sea by Reiss et al. (2009), specifically *P. jeffreysii*, *Spiophanes* spp., *A. filiformis* and *Myriochele* spp.

Epifauna and shellfish

In seabed photography and video from the pre-decommissioning survey, echinoderms such as the brittle star *Amphiura filiformis*, the burrowing anemones *Cerianthus lloydii* and *Edwardsia clapedii*, and sea pen *Pennatula phosphorea* were observed throughout the Armada Hub area including Gaupe (Benthic Solutions, 2016b). Hermit crabs were frequently observed in areas of sand, but other crab species such as *Hyas coarctatus* were only observed occasionally. Molluscs (including the common whelk *Buccinum undatum*) were found to be poorly represented and consisted mostly of juveniles. Species assemblages identified in the pre-decommissioning survey are consistent with the results of previous surveys in the Armada Hub and are representative of the homogenous nature of Central North Sea epifauna (Benthic Solutions, 2016b).

2.4.3. Fish

The pre-decommissioning survey observed anglerfish (*Lophius piscatorius*), bib (*Trisopterus luscus*), cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), hagfish (*Myxine glutinosa*), lemon sole (*Microstomus kitt*), ling (*Molva molva*), plaice (*Pleuronectes platessa*), poor cod (*Trisopterus minutus*), saithe (*Pollachius virens*) and tusk (*Brosme brosme*) in the Armada Hub area (Benthic Solutions, 2016a). The Armada Hub area supports spawning and nursery habitats for a number of commercially species (Coull et al., 1998, Ellis et al., 2012; Figure 2-6 and Figure 2-7). With regards to spawning and nursery grounds, cod is the only species that is thought to make use of the Armada Hub area with a high intensity.



Figure 2-6 Spawning and nursery grounds within the offshore project area (Coull et. al., 1998, Ellis et. al., 2012)

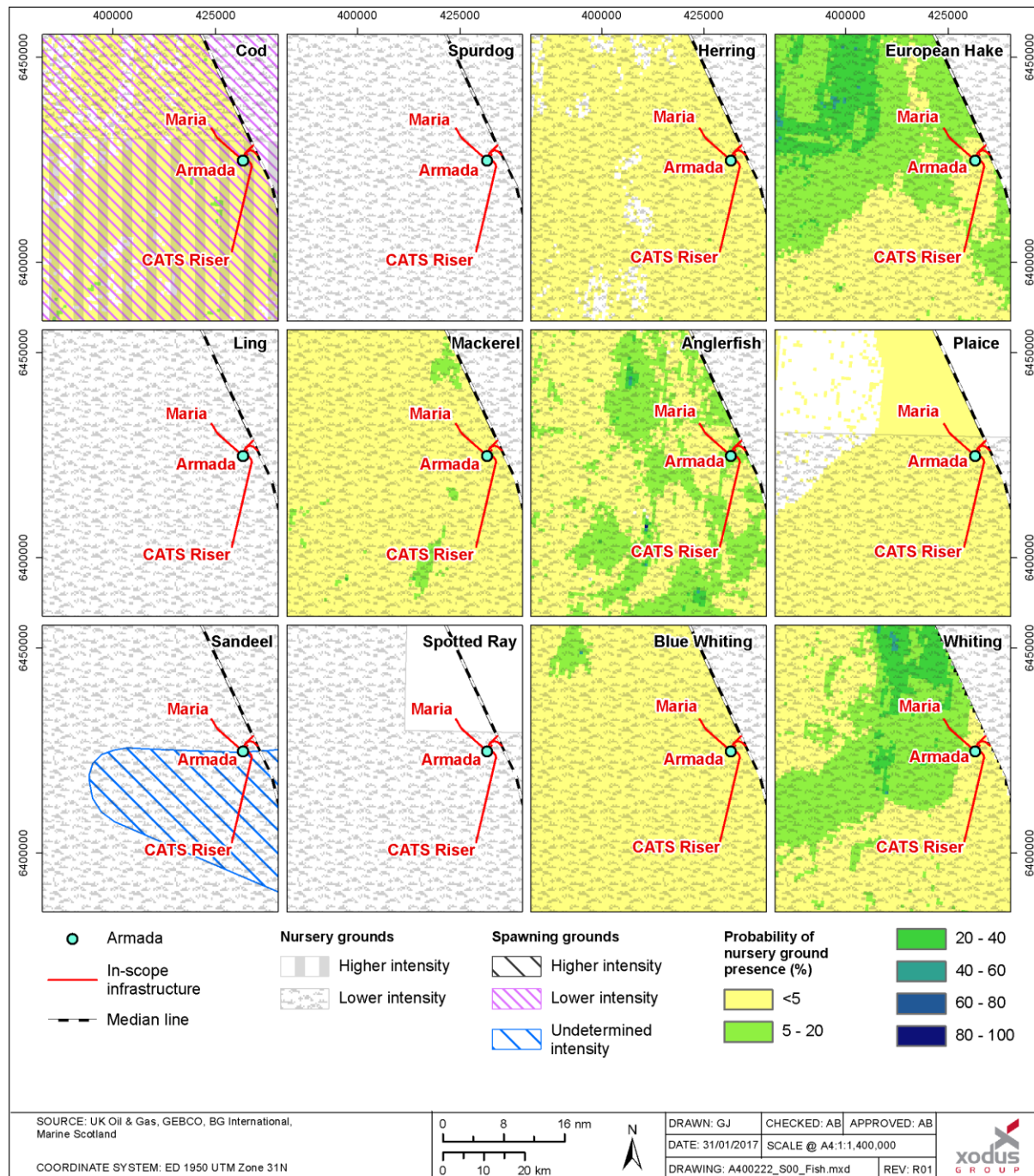
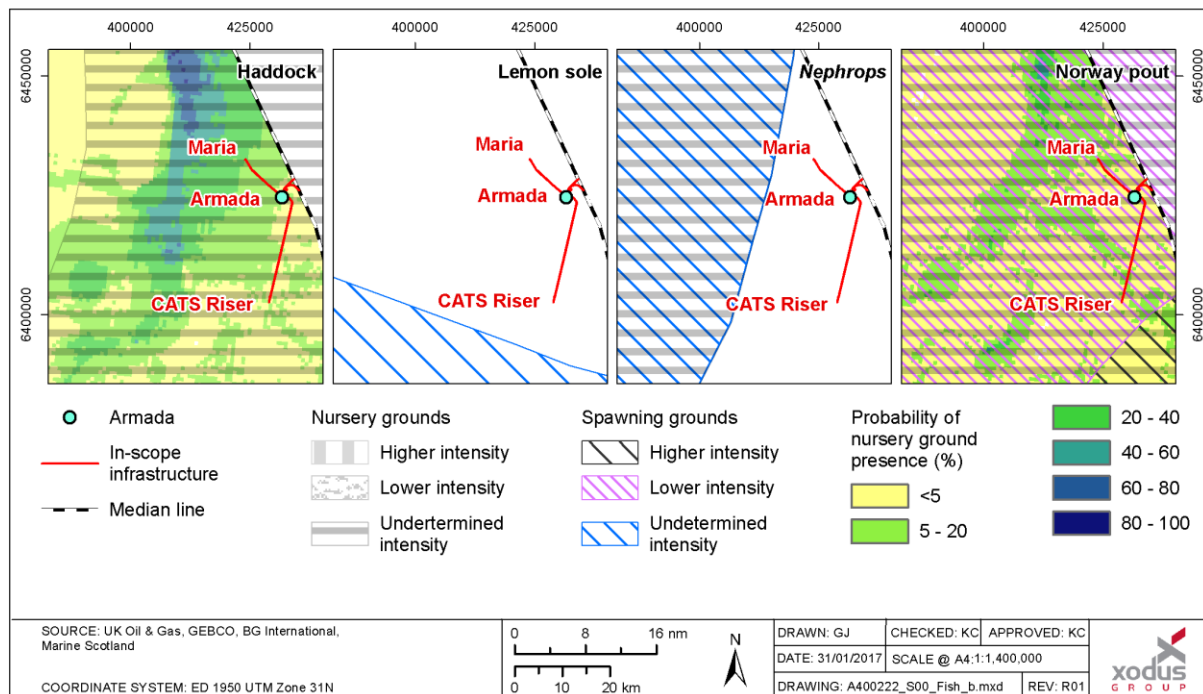




Figure 2-7 Spawning and nursery grounds within the offshore project area (Coull et al., 1998, Ellis et al., 2012) (continued)



2.4.4. Seabirds

Much of the coastline and offshore waters of the North Sea are internationally important breeding and feeding habitats for seabirds. The most numerous species likely to be present in the Armada area including Gaupe are northern fulmar (*Fulmarus glacialis*), black-legged kittiwake (*Rissa tridactyla*) and common guillemot (*Uria aalge*) (DECC, 2016a). JNCC (2016a) report the population change between 1998 – 2002 and 2015 for these species as -31% for northern fulmar, -44% for black-legged kittiwake and +5% for common guillemot. JNCC consider the reduction in the quantity of offal discharged from the North Sea whitefish industry fleet to have contributed to the decline in breeding numbers of northern fulmar and black-legged kittiwake. Black-legged kittiwake and common guillemot populations have been closely linked to variations in the sand eel abundance (JNCC, 2016a).

Predicted maximum monthly abundance of seabirds in the Armada and Gaupe area is based on an analysis of the European Seabirds at Sea data collected over 30 years (Kober *et al.*, 2010). Continuous seabird density surface maps were generated using the spatial interpolation technique 'Poisson kriging' and fifty-seven seabird density surface maps were created to show particular species distribution in specific areas. Data from the relevant maps has been summarised for the Armada and Gaupe area in Table 2-1.

Distribution and abundance of these bird species vary seasonally and annually. Most species occur only at low densities of less than five individuals per km² and between 5-10 individuals per km² for all species combined.

The Seabird Oil Sensitivity Index (SOSI) is a tool which aids planning and emergency decisions making with regards to oil pollution. SOSI identifies areas at sea where seabirds are subject to being sensitive for oil pollution. The index is based on data from 1995 to 2015 and combined



with individual seabird species sensitivity index. These values are again based on factors which are considered to contribute towards the sensitivity of seabirds to oil pollution.

Figure 2-8 presents the vulnerability of seabirds in the Armada Hub area, based on the JNCC (1999) data. The highest seabird vulnerability occurs later in the year, when birds (some of which will become flightless whilst they change plumage) have moved offshore following breeding.

It is recognised that JNCC has released further data on vulnerability, as reported by Hi Def (2016). For the project area, review of these data indicate vulnerability of similar or lower magnitude. However, there are significant data gaps at times of the year, and this assessment has retained the higher sensitivity figures to ensure it is not underestimated.

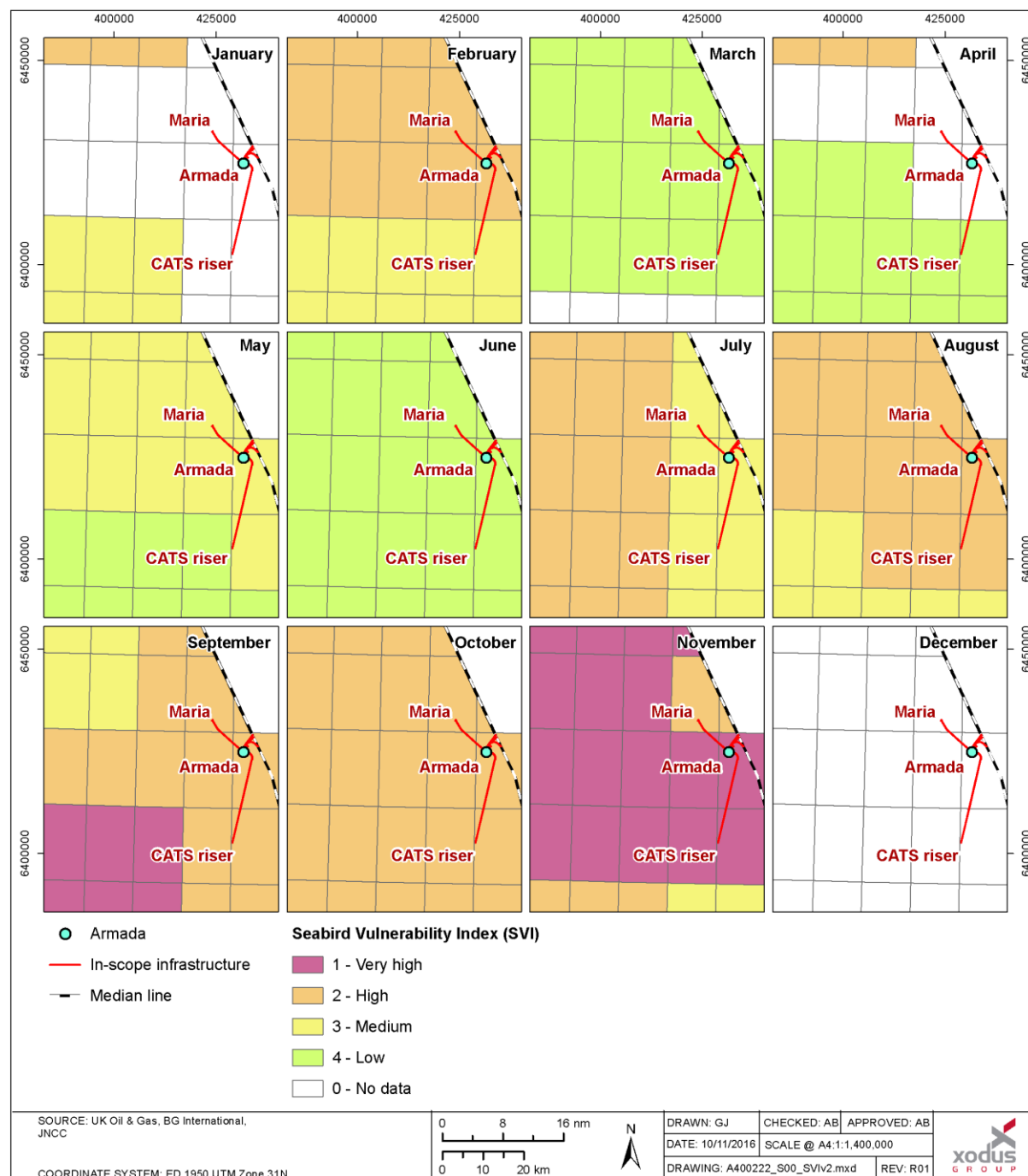
Table 2-1: Predicted seabird density (maximum number of individuals per km²).

Species	Season	J	F	M	A	M	J	J	A	S	O	N	D
Northern Fulmar	All year												
European storm-petrel	Breeding												
Northern gannet	All year												
Great skua	Breeding												
Black legged kittiwake	All year												
Black headed gull	Breeding												
Great black backed gull	All year												
Herring gull	Winter												
Common guillemot	All year												
Little auk	Winter												
Atlantic puffin	Breeding												
	Winter												
All species	Breeding/summer												
	Winter												
Key	Not Recorded			<1		1-5		5-10		10-20		>20	

Source: Kober et al. 2010



Figure 2-8 Seasonal seabird vulnerability to surface oil pollution (JNCC, 1999)





2.4.5. Sea mammals

Cetaceans

Of the 19 cetacean species recorded in UK waters (Reid et al., 2003), the harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), minke whale (*Balaenoptera acutorostrata*), killer whale (*Orcinus orca*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*) and white-beaked dolphin (*Lagenorhynchus albirostris*) are most regularly recorded in the North Sea (NMPI, 2016, Reid et al., 2003).

The species most likely to be encountered in the Armada Hub area including Gaupe are harbour porpoise, white-beaked dolphin and minke whale. Following the successful completion of the SCANS-III survey in 2016, there are now three estimates of abundance for harbour porpoise, white-beaked dolphin and minke whale in the North Sea from SCANS, SCANS-II and SCANS-III. For minke whale in the North Sea, there are five additional estimates from the Norwegian Independent Line Transect Surveys (NILS) (Bøthun et al. 2009; Schweder et al. 1997; Skaug et al. 2004; Solvang et al. 2015). In the Central North Sea, SCANS-II and SCANS-III surveys estimated densities of 0.52 harbour porpoise animals per km², 0.007 white-beaked dolphins per km², 0.040 white-sided dolphin per km², 0.011 minke whales per km² and 0.001 bottlenose dolphins per km² (JNCC, 2010a/2017). During the pre-decommissioning survey (Benthic Solutions 2016c), one harbour porpoise was observed in the CATS Riser platform area.

Seals

The harbour seal (*Phoca vitulina*) is widespread along the coastline of eastern Scotland. Seal tracking studies from the Moray Firth indicate that harbour seals forage within 40 – 50 km of their haul-out sites (SCOS, 2013), so harbour seals are unlikely to be observed in the Armada Hub area.

The population of grey seal (*Halichoerus grypus*) tends to be concentrated close to shore, particularly during the pupping and moulting season, but the grey seal is known to make occasional trips of several hundred kilometres from one haul-out to another (SMRU, 2011). Jones et al., (2013) mapped a grey seal density of 0 – 1 seals per 25 km² around the Armada Hub area. It is possible, but unlikely, that grey seals will be encountered at Gaupe .

2.5. Protected environment

2.5.1. Offshore conservations

Special areas of conservation

The UK has designated ‘Special Areas of Conservation’ (SACs) to protect important examples of the habitats listed in Annex I of the European Union (EU) Habitats Directive (92/409/EEC). The closest SAC to the Armada Hub is the Scanner Pockmarks SAC located approximately 49 km to the north west (Figure 2.9). The SAC was designated to conserve the biodiversity associated with submarine structures made by leaking gases (JNCC, 2016b).

The pre-decommissioning survey (Benthic Solutions, 2016a, 2016b) found no habitats listed in Annex I of the EU Habitats Directive and it is unlikely that the offshore project area contains any significant examples of such habitat.



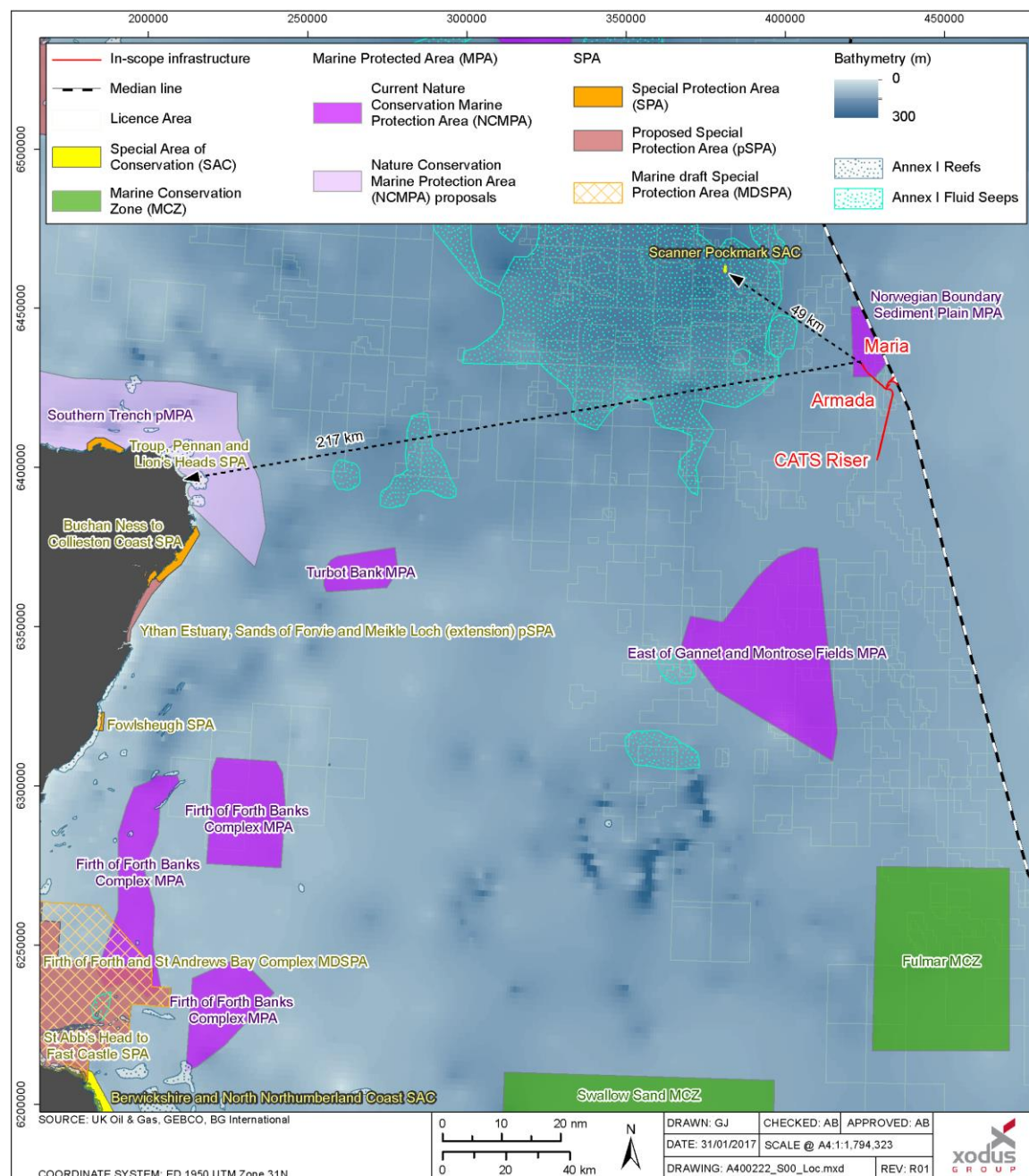
Marine protected areas

Marine Scotland has put forward areas with Priority Marine Features (PMF) for designation as NCMPAs under the Marine (Scotland) Act (2010). The Marine Management Organisation (MMO) has put forward areas with features of conservation importance (FOCI) for designation as Marine Conservation Zones (MCZs) under the UK Marine and Coastal Access Act (2009).

In 2014, the Norwegian Boundary Sediment Plain NCMPA was designated for the conservation of aggregations of the ocean quahog (*Arctica islandica*) and the sand and gravel habitat that supports them. The Gaupe field is located outside the boundary of this Marine Protected Area.

JNCC and Marine Scotland Science surveys (Figure 2-10) identified one small ocean quahog within 1 km of the Maria manifold (O'Connor, 2016) but no species was identified in the Gaupe area.

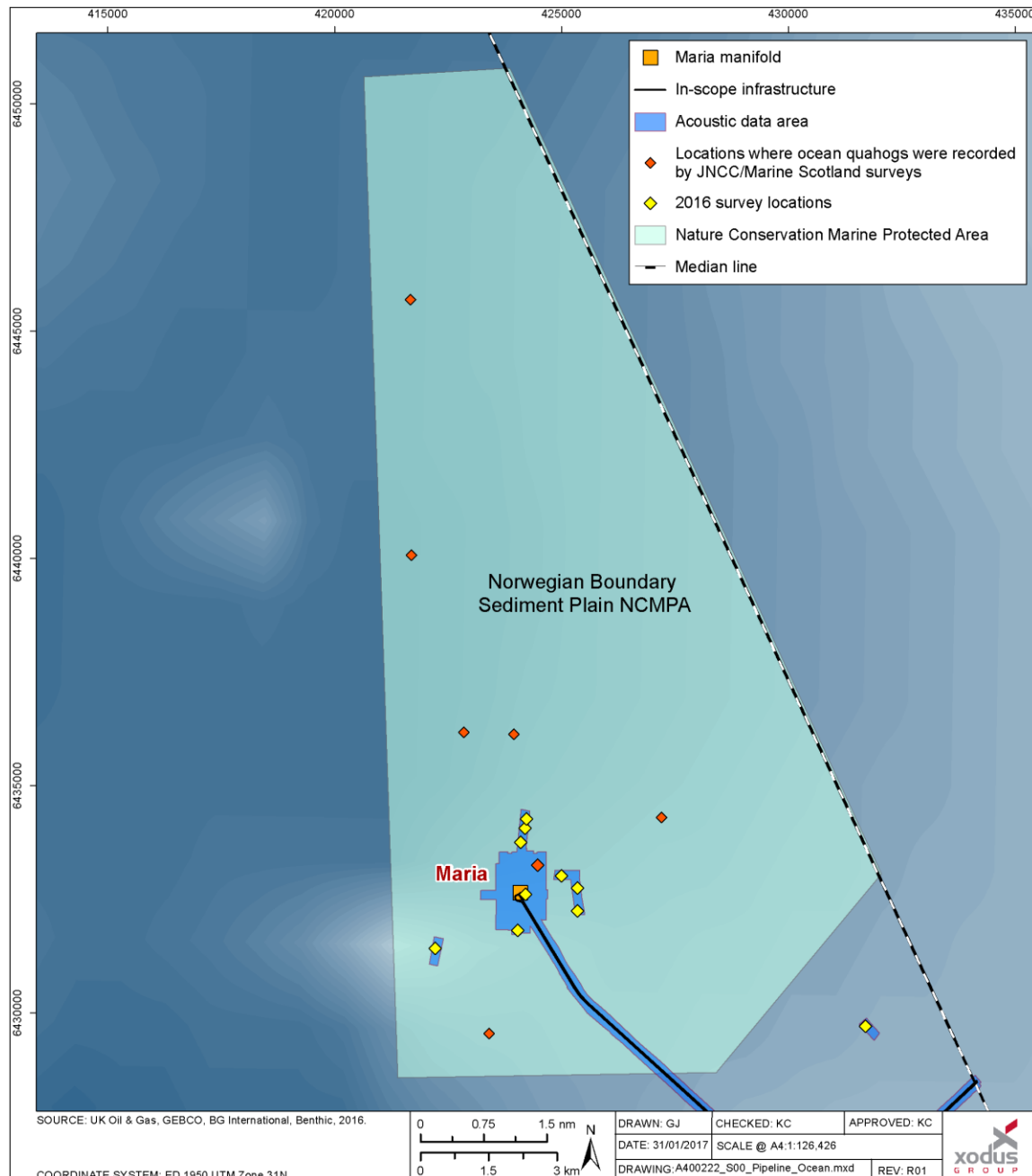
Figure 2-9 Sites of conservation interest relative to the Armada Hub





The wider Armada Hub area may support ‘seapen and burrowing megafauna communities’, which are a Scottish PMF and are listed by OSPAR List as ‘threatened and or declining species and habitats’ (OSPAR, 2008). However, although the pre-decommissioning survey observed seapens, the low proportions of sediment fines, the low frequency of burrows observed and the absence of conspicuous burrowing crustaceans such as *Nephrops norvegicus* and *Callinassa subterranean* makes classification of the area as this type of threatened habitat unlikely (Benthic Solutions, 2016b).

Figure 2-10 Survey stations in the Norwegian Boundary Sediment Plain NCMPA

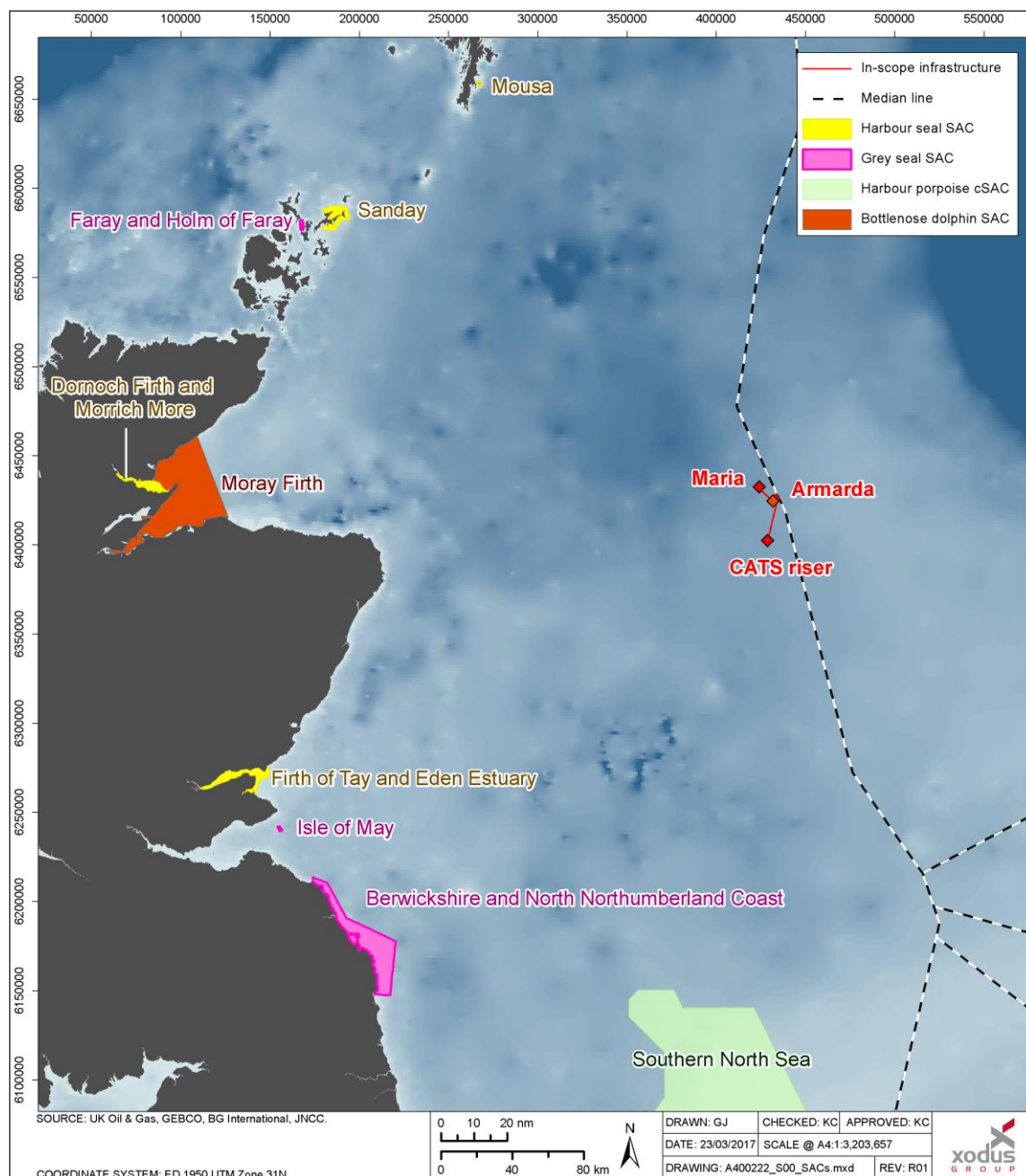




Species

Annex II of the EU Habitats Directive gives protection to, amongst others, certain marine mammal species. As part of this protection, SACs have been established for seals, harbour porpoise and bottlenose dolphins but, as can be seen from Figure 2-11, these sites are many hundreds of kilometres from the Armada Hub. All cetacean species are listed as European Protected Species (EPS) in Annex IV of the EU Habitats Directive, and it is an offence under the Conservation (Natural Habitats etc.) Regulations (1994) to 'deliberately or recklessly disturb any dolphin, porpoise or whale' species.

Figure 2-11 Protected sites for marine mammals (cSAC for harbour porpoise was designated as an SAC in 2019)





Some species listed by OSPAR as ‘threatened and/or declining species’ are likely to be present in the Gaupe area, including the black-legged kittiwake and cod (OSPAR, 2008). Species listed as Scottish PMFs including commercial fish species, non-commercial fish species and sharks (in particular basking sharks) are also likely to be present in the Gaupe area (SNH, 2014).

European Red List Habitats

The EUNIS biotope ‘offshore circalittoral sand’ (A5.27) has been identified in the vicinity of the Armada platform and Gaupe infrastructure (Benthic Solutions, 2016). ‘Offshore circalittoral sand’ (A5.27) is also a component of the broad PMF habitat ‘offshore subtidal sands and gravels’ (Tyler-Walters *et al.*, 2016). Although this habitat is relatively common, with a large natural range it is listed as ‘Endangered’ on the European Red List of Habitats, with threats from over fishing as well as pollution and climate change (EU, 2016). Areas of ‘Circalittoral mixed sediment’ (A5.44) were also noted (Benthic Solutions, 2016) and are listed as ‘Vulnerable’ on the European Red List of Habitats.

2.6. Socio-economic environment

2.6.1. Overview

The key socio-economic features of the Gaupe area:

- Oil and gas activities;
- Commercial fishing; and
- Commercial shipping.

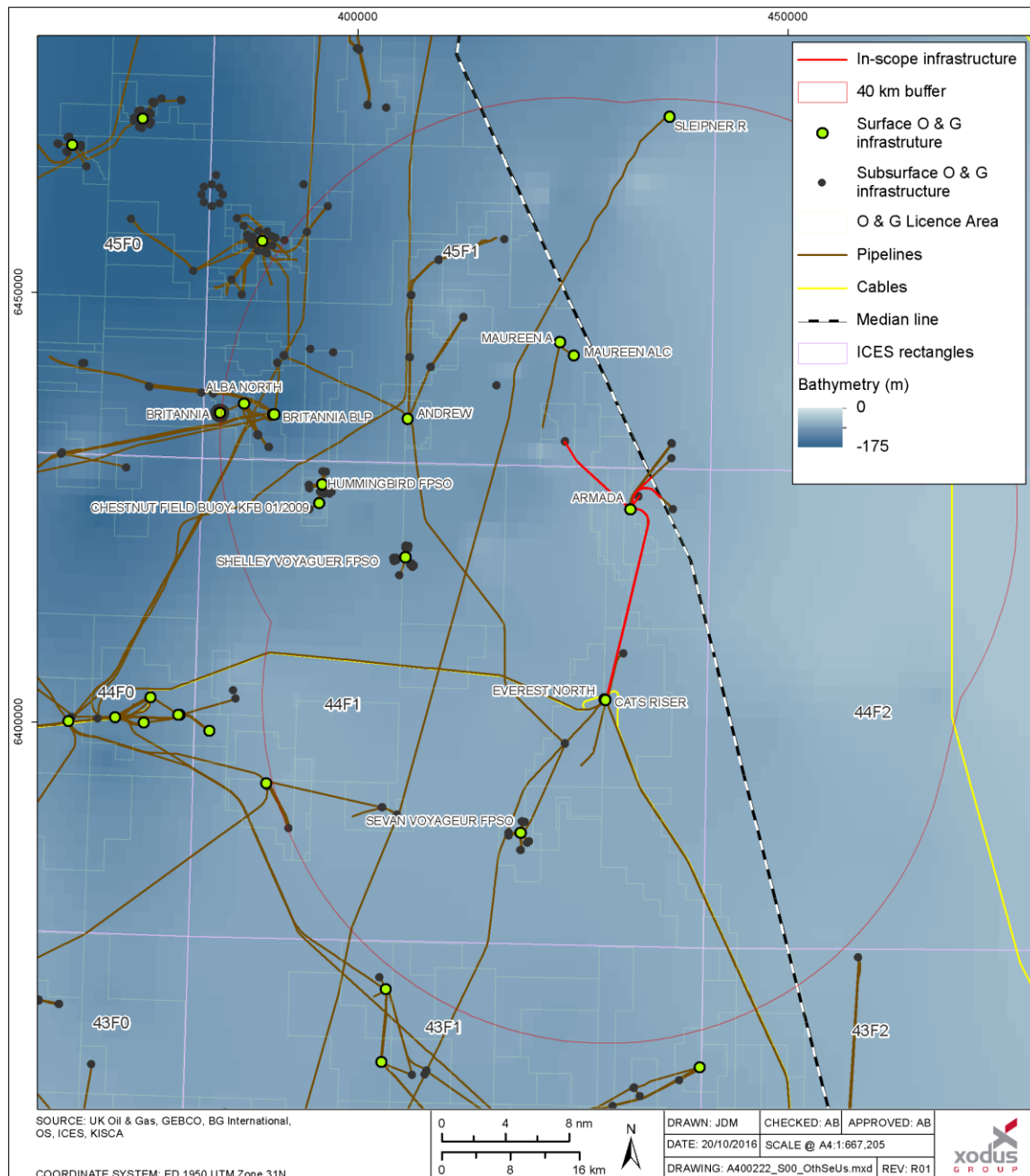
There are no existing or planned renewable energy developments close to the Gaupe area. The Armada Hub pre-decommissioning survey did not identify any wrecks or archaeology on the seabed and there are no protected wrecks or Historic Marine Protected Areas in the Armada Hub area (NMPi, 2016, Historic Environment Scotland, 2016).

2.6.2. Oil and gas activities

The Central North Sea has extensive mature oil and gas developments (UKOilAndGasData, 2016). There are a number of production facilities and a network of subsea flowlines, export pipelines and cables on the seabed in the wider area (Figure 2-12), but no flowlines or export pipelines are located in vicinity of Gaupe infrastructure



Figure 2-12 Oil infrastructure within the vicinity of the Armada Complex



2.6.3. Commercial fish

Demersal and pelagic fish stocks and shellfish stocks in the Central North Sea are fished by UK and international fishing fleets. Poseidon Aquatic Resource Management Ltd was commissioned by the Armada Hub decommissioning project to undertake a 'Socio-economic Study of Armada Hub Decommissioning Options on Commercial Fisheries' (Poseidon, 2016). Vessel Monitoring System (VMS) data allows the location of vessels to be mapped. UK registered vessels using mobile gear within International Council for the Exploration of the Sea (ICES) statistical rectangles 44F1 and 45F1 show low levels of activity compared to the Fladen Ground ICES rectangles (44F0, 45F0 and 46F0) north and west of the Armada Hub, where the highest



intensity of activity is recorded (Poseidon, 2016). The areas of peak activity and highest landings value correlate with extensive areas of sublittoral mud that is prime Nephrops habitat (Poseidon, 2016); these areas are predominantly to the north west of the Armada Hub area.

Poseidon (2016) report that the five-year average value of commercial fisheries within 2 km of the Armada platform, the Maria field and the subsea pipelines in the Armada Hub area is just under £4,500 per year, relating to approximately 250 hours fishing per year. This indicates that the area is not significantly important to commercial fisheries, and this is consistently reflected in data from the past five years. Fishing that has taken place is likely to be of exploratory nature, rather than the consistent targeting of known fishing grounds, as can be seen elsewhere in the region. To provide context, the value from the area 2 km around the Armada Hub equates to 0.13% of the total value landed from ICES rectangles 44F1 and 45F1 (based on a five-year average). This is detailed in Table 2-2

The 500m radius safety zones around Maria, Armada platform and NW Seymour each have a surface area of 0.8 km² so 2.4 km² will be open to fishing upon completion of decommissioning works. However, no options are associated with the decommissioning activity of removing structures; so, this positive impact of opening safety zones is not of relevance for future assessments. For the purpose of the Poseidon assessment, the Armada Decommissioning Area has been defined as a c.2km zone around the decommissioning elements.

Table 2-2 Live weight and value of fish and shellfish landed by UK vessels from ICES rectangles 44F1 and 45F1 for 2010 – 2015 (Poseidon, 2016, Scottish Government, 2016)

Year	Armada Hub area including 2 km buffer (Poseidon, 2016)		ICES rectangles 44F1 and 45F1 (Scottish Government, 2016)	
	Value	Effort hours	Value	Effort hours
2010	£7,321	197	4,536,272	37,138
2011	£9,801	296	£4,114,450	27,703
2012	£1,330	103	£1,430,224	10,515
2013	£2,131	427	£3,038,664	9,046
2014	£1,513	262	£3,911,256	20,112
5-year average reported by Poseidon (2016)	£4,419	257	£3,406,173	20,903 (derived from Scottish Government, 2016)
2015	Poseidon (2016) report up to the end of 2015 only		£3,577,072	19,848
2016	Poseidon (2016) report up to the end of 2015 only		£3,771,779	22,056



Poseidon (2016) report discussions with the Scottish Fishermen's Federation (SFF) who estimate that the following vessels operate across rectangles 44F1 and 45F1:

- 20 – 30 twin rigged demersal otter trawlers;
- 10 vessels or five pair teams of pair demersal otter trawlers;
- Two to four demersal seiners; and
- Five to seven pelagic vessels.

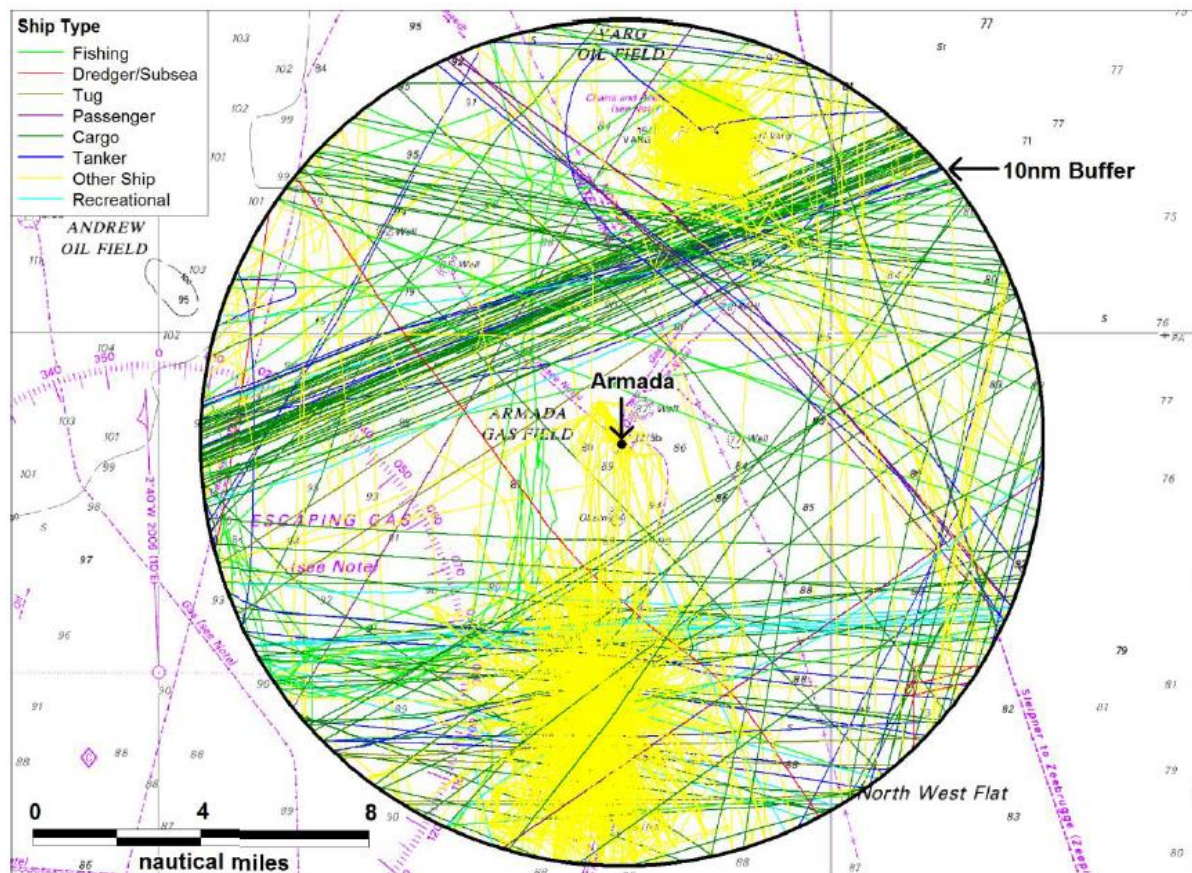
The majority of UK vessels fishing in ICES rectangles 44F1 and 45F1 are Scottish with 90% of landings (by value) made by Scottish registered vessels, although there is some evidence of fishing by Dutch vessels targeting pout (*Trisopterus luscus*) and shrimp (*Pandalus borealis*) and Norwegian vessels fishing for herring (although the mobile and annually variable nature of herring fisheries means effort is likely to be sporadic) (Poseidon, 2016).

2.6.4. Commercial Shipping

Although, the North Sea has substantial traffic of commercial ships trading between North Sea and Baltic ports, the density of shipping in the Armada Hub area is low, with approximately 0.2 – 0.5 vessels passing each week (DECC, 2016b). Anatec identified 21 shipping routes within 10 nm of the Armada platform (Figure 2-13), and estimated vessel traffic to be 1,109 ships per year, corresponding to three vessels per day. The majority of the vessels are cargo vessels of 1,500 to 5,000 tonnes, but there is also some tanker traffic (Anatec, 2015).



Figure 2-13 Shipping tracks recorded within 10 nm of the Armada platform, July-August 2014
(Anatec, 2015)



Note: Yellow tracks are offshore oil and gas vessels, including those supporting Armada

2.7. Nearshore and Onshore

At this stage of the project, the onshore dismantling and disposal sites are unknown, and therefore it is not possible to describe the specific locations where activity may take place.



3. Identification of Impacts

3.1. ENVID

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

3.1.1. ENVID Approach

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

The severity of each impact is scored through a qualitative risk-based approach utilising matrices which consider the sensitivity of the receptor, the scale of the activity and magnitude of impact. For unplanned or accidental aspects, the likelihood of the event occurring is also incorporated into the overall impact evaluation. The impact ratings were determined on the basis that standard mitigation measures required to meet regulatory permitting requirements, RDS Group practices, Industry best practice and regulatory guidance were implemented.

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



4. Environmental Appraisal

4.1. Gaupe specific information

As previously described, the UK Gaupe infrastructure will now be subject to separate decommissioning applications. Some of the items are however also taken from the Armada Impact assessment where noted.

4.2. Identification of environmental issues

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

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

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

- Physical presence – Seabed Disturbance
- Physical Presence - Underwater Sound
- Physical Presence - Other Users of the Sea
- Discharges to Sea
- Energy Use and Atmospheric Emissions
- Accidental Events
- Onshore
- Waste Management

4.3. Physical presence – Seabed Disturbance

4.3.1. Impact Overview

Direct interaction by physical disturbance can cause mortality or displacement of benthic species in the potential impact zone. The significance of direct habitat loss or mortality of sessile seabed organisms (those that cannot move away from the area of potential impact) depends on the footprint of the area of disturbance, the level of tolerance of the affected habitat and species to direct disturbance, the conservation value of the affected habitat or species and the uniqueness of the affected habitats or species assemblages to the area.

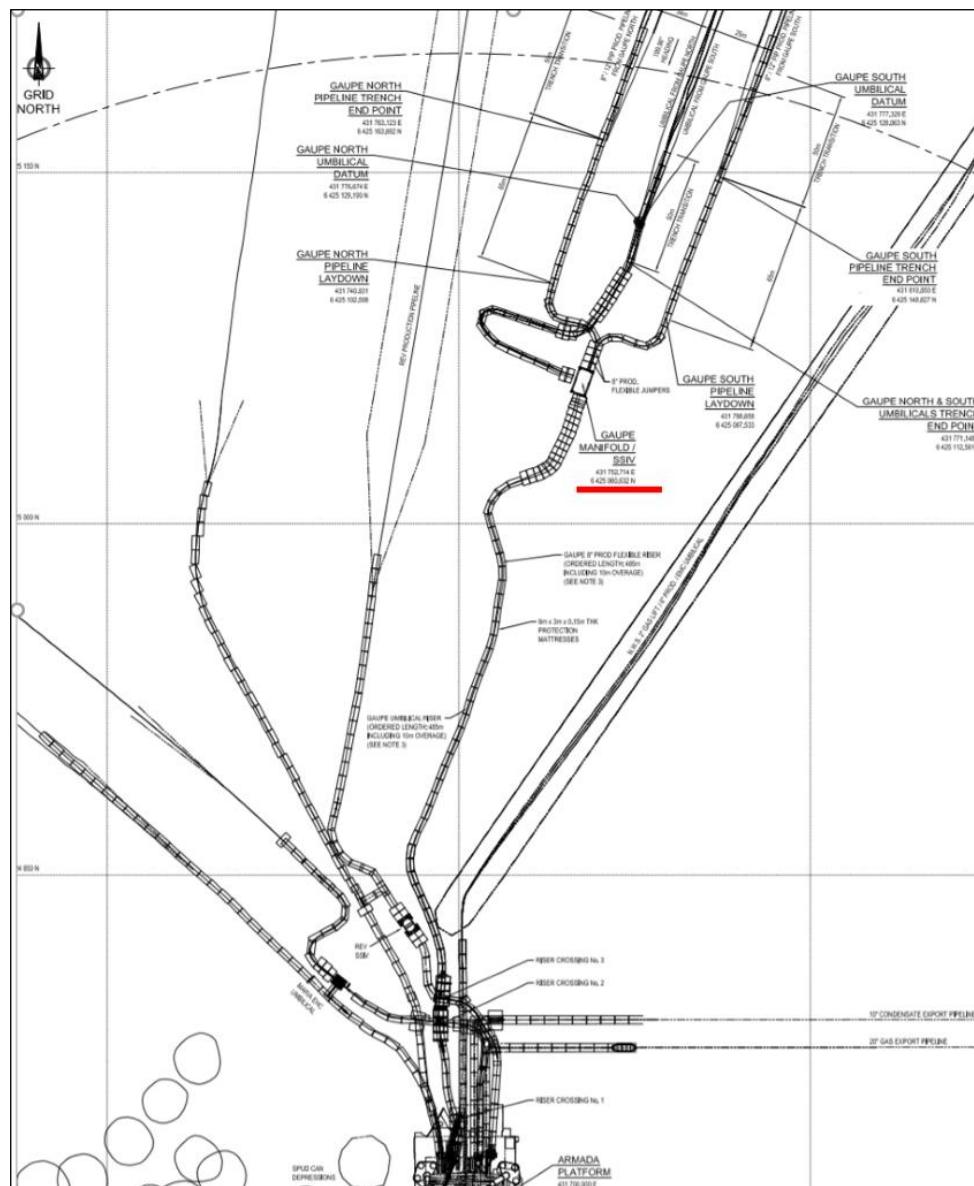
In addition to direct impacts, physical disturbance of the seabed gives rise to suspension of sediments in the water column and subsequent resettling of sediment over the adjacent seabed. This can lead to impacts to filter feeding organisms through increased sediment load and smothering of sessile organisms. The significance of the impact is dependent on the volume of material being disturbed and the sensitivity of organisms in the area of influence.



4.3.2. Sources of Impact

The majority of the exposed equipment associated with the Gaupe infrastructure on the UKCS is located within the 500m safety of the Armada Platform (see Figure 4-1). Minor number of concrete mattresses can be found outside the safety zone. Outside this range the umbilicals and pipelines are trenched and buried across Norwegian border. Pipelines and umbilicals are connected to Armada platform via the SSIV as shown. The SSIV is approx. 120m within the 500m safety zone.

Figure 4-1 Armada 500m safety zone





The base case is to remove all items that are not trenched and buried. The pipelines/umbilicals transition from surface laid to buried can be found under the last few concrete mattresses. The lines will be cut at a minimum depth of 0.6m below seabed, which will require excavation of the seabed to cut the lines, and the sections toward the SSIV will be removed. The cut ends of the pipelines and umbilicals will be covered with rock placement to ensure they are safe for fishing activity. The SSIV manifold will be removed and the sections of pipeline and umbilical running from the SSIV to the Armada platform will also be removed.

The following activities have the potential to directly and or indirectly impact the seabed:

- Pipeline and umbilical decommissioning:
 - Removal of surface laid pipelines, umbilicals, jumpers and risers;
 - Excavation of sediment in trench transition to allow pipeline / umbilical ends to be cut below seabed level;
 - Rock placement over pipeline and umbilical ends.
- Decommissioning of SSIV manifold:
 - Removal of surface laid gravity base SSIV manifold.
- Stabilisation materials:
 - Removal of mattresses and grout bags.
- Clear seabed verification:
 - Potential over trawl trials using 20m wide chain mats in specific areas along pipeline and umbilical routes in UKCS and within Armada Platform 500m safety zone.

An estimate of the direct and indirect footprint from activities related to the decommissioning of Gaupe infrastructure is given below and based on the following:

- Where structures on the seabed are removed, there is considered to be direct impact to the seabed equal to structure size, and an indirect impact due to resuspension of sediments;
- Where buried structures are removed, there is considered to be a direct impact equal to the area of seabed excavated to facilitate the removal, and an indirect impact due to resuspension and resettlement of excavated sediments;
- Ends of umbilicals and pipelines will be buried below sea floor using new rock dump material.

4.3.2.1. Removal of equipment

The SSIV manifold, surface laid production and umbilical risers (485 m in length), 292 concrete mattresses overlaying the risers and approximately 4,000 grout bags will be removed which will result in small scale, short duration disturbance of the sediments.

The removals will cause minor sediment disturbance and mortality of fauna that have colonised these features during field operation. Their removal will re-expose the natural substrate beneath them, which will be quickly recolonised by the surrounding benthic communities.

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



4.3.2.2. Excavation of pipeline ends

The Gaupe production pipelines and umbilicals will be cut where they exit their trenches within the Armada 500m zone. Three separate excavations will be required to make the cuts, the Gaupe North and South production pipelines are trenched separately and the Gaupe North and South umbilicals are laid in the same trench. A small volume of material (36 m³ in total) will be excavated to allow cuttings of the pipelines and umbilicals resulting in a total area of 47 m² of seabed being disturbed.

The excavation will potentially cause mortality of fauna at the excavation site and suspension of the sediment being excavated. These sediments will resettle within the local area and may cause smothering of benthic fauna. Excavation will result in small scale, short duration disturbance of the sediments and fauna.

4.3.2.3. Rock placement

A rock placement of approximately 36 m³ of rock covering a total surface area of 47 m² will be installed at the pipeline and umbilical ends where they transition out of their trenches (within the Armada safety zone) to ensure they remain safely buried.

Rock placement will result in permanent changes to the seabed substrate by the addition of a hard substrate, and will also cause resuspension of sediments during its installation, which will settle out within the local area.

4.3.2.4. Over trawl trials

Following recovery of subsea infrastructure and debris the seabed will be subjected to surveys to confirm that the seabed is clear and safe for fishing. Surveys may include video, side scan sonar or similar.

If the survey results identify areas where there are specific safety concerns, such as at pipeline ends, it may be necessary to supplement the surveys with over trawl trials to demonstrate that the seabed has been left in a safe state. Over trawl surveys are typically undertaken by fishermen using chain mats, and if this shows no adverse issues it is followed by trawls using standard bottom towed fishing gear.

For the purposes of estimating environmental impact, a worst-case assessment has been taken in this EA with the assumption that over-trawling may be required. Actual methods of verification will be discussed and agreed with OPRED on a case-by-case basis with an assumption that less intrusive methods of clear seabed verification are the base case.

A non-intrusive as-left survey will be undertaken once the decommissioning activities have been completed. Due to the location within the Armada 500m zone and presence of adjacent live pipelines, decommissioning of the infrastructure within the 500m zone will be undertaken following CoP of the Armada platform. Consequently the as left survey and any necessary over trawl trials of areas within the Armada safety would be performed by Armada operator Chrysaor as part of the whole 500m zone verification as one campaign, and are not further assessed here.

Parts of the trenched sections of the Gaupe North and Gaupe South production pipelines in the UKCS have been rock covered to prevent upheaval buckling. The trenched pipelines will be decommissioned in situ, however, these sections of rock cover will be surveyed to ensure they are safe for fishing activities.

During approach and turning trawl mats will also disturb sediments adjacent to the rock cover, this may result in direct mortality to benthic fauna and resuspension of local sediments.



Table 4-1 Estimate of direct and indirect seabed footprint associated with the Gaupe decommissioning activities

Project element	Details and dimensions	Duration of disturbance	Direct area (m ²)	Indirect area (m ²)
Removal of surface laid pipelines and umbilical including risers and jumpers	<p>Gaupe North production pipeline flexible jumper PL2781 (end of PiP to SSIV) – 47 m surface laid covered by mattresses</p> <p>Gaupe South production pipeline flexible jumper PL2782 (end of PiP to SSIV) – 47 m surface laid covered by mattresses</p> <p>Gaupe North and Gaupe South umbilical PLU2784, PLU2785 – 230 m from SSIV manifold to trench transition towards NCS, surface laid adjacent to each other covered by mattresses.</p> <p>Production and umbilical risers PL2783 and PLU2786 (SSIV to Armada Platform) – 485 m surface laid adjacent to each other covered by concrete mattresses</p>	Temporary	Area covered by mattress area below.	Area covered by mattress area below.
Excavation of sediment in trench transition to allow pipeline / umbilical ends to be cut below seabed level	<p>Gaupe North and South umbilicals are laid in the same trench. The cut location is 230 m from SSIV, at a depth of 1.05 m to top of umbilical. An excavation depth of 1.5 m will be required to perform the cut, resulting in excavation of up to 3.5 m³ sediment (volume of the cone). Corresponding surface area is 7 m².</p> <p>Gaupe North and South production pipelines are trenched separately and are slightly deeper than the umbilical trench. Required depth for cutting could be up to 2.5 m, a cone volume 16 m³, and surface area of 20 m² for each pipeline.</p> <p>In total the area is estimated at 47 m².</p> <p>The excavated sediment is expected to resettle over an area assumed to be within 50 m of each cut end location.</p>	Temporary	Covered by area of rock placement below.	23,562 m ²
New rock material protecting pipeline and umbilical cut ends	<p>The total area is estimated to 47 m² with a rock volume of 36 m³.</p> <p>Temporary disturbance assumes every tonne of rock causes a temporary sedimentation impact on another 1 m² area.</p>	Permanent	47 m ²	47 m ²



Project element	Details and dimensions	Duration of disturbance	Direct area (m ²)	Indirect area (m ²)
Removal of mattresses	292 mattresses. Dimensions: 3 m x 6 m = 5,256 m ² . Temporary disturbance assumes area of 1 m width around each mattress is temporarily impacted by resettling sediments.	Temporary	5,256 m ²	3,504 m ²
Removal of grout bags	4000 grout bags. Acting as free-span support at the Armada J-tube entrance, and umbilical and flowline jumper entrances to the SSIV. Bags are resting directly on seabed in three piles of 6m x 10 m. i.e. 3 x 60 m ² = 180 m ² . Temporary disturbance assumes area of 1 m width around each grout bag pile.	Temporary	180 m ²	72 m ²
Removal of SSIV	10.8 m x 6 m – 64.8 m ² . Gravity base structure. Temporary disturbance assumes area of 1 m width around the outside of the SSIV.	Temporary	64.8 m ²	24 m ²
Total			5,547.8 m² 0.0056 km²	27,209 m² 0.025 km²


Table 4-2 Estimate of potential over trawl area for Gaupe decommissioning

Project element	Details and dimensions	Area impacted by over trawl activities (km ²)
Trenched sections of production pipeline – existing rock stabilisation	<p>Gaupe North production pipeline (PL2781) has three existing areas of rock cover within the UK sector for upheaval buckling:</p> <p>KP 3.914 to KP 3.919 (5m) – requiring min. 100m trawl length.</p> <p>KP 5.961 to KP 6.045 (84m), KP 6.459 to KP 6.600 (141m) – assuming these two sections would be trawled together resulting in total length of 0.7 km trawl.</p> <p>Gaupe South production pipeline (PL2782) has five existing areas of rock cover within the UK sector for upheaval buckling:</p> <p>KP 2.289 to KP 2.293 (4m) – requiring min. 100m trawl length.</p> <p>KP 5.533 to KP 5.666 (133m), KP 5.729 to KP 5.744 (15m), KP 5.788 to KP 5.793 (5m), KP 6.048 to KP 6.148 (100m) – assuming these four sections would be trawled together resulting in total length of 0.7 km trawl.</p> <p>Assuming 400m corridor width along each pipeline and umbilical route to account for turning circles required for multiple angles of approach.</p>	0.36km ²
Trenched sections of umbilicals	<p>Gaupe North and South umbilicals (PLU2784 / PLU2785) are sufficiently buried and stable, and do not have existing rock cover. No overtrawl trials are required for these sections of the umbilical.</p>	0 km ²
Cut pipeline and umbilical ends, rock cover, and section of pipeline and umbilical from trench to SSIV.	<p>Gaupe North and South production pipeline risers (PL2781, PL2782) and Gaupe North and South umbilicals (PLU2784, PLU2785).</p> <p>A non-intrusive as-left survey will be undertaken once the rock cover has been installed over the cut pipeline and umbilical ends. Due to the location with the Armada 500m zone and presence of adjacent live pipelines, any overtrawl trials of areas within the Armada safety zone will be conducted as part of the Armada platform decommissioning. These would be performed by Armada operator Chrysaor as part of the whole 500m zone verification as one campaign, and are not double counted here.</p>	0 km ²
Surface laid infrastructure within Armada 500m zone.	<p>SSIV, Gaupe North and South production and umbilical risers. Concrete mattresses and grout bags.</p> <p>Due to the presence of adjacent live pipelines, removal of the SSIV and risers will be deferred until the Armada platform itself has been decommissioned. The seabed clearance verification surveys for both non-intrusive and over trawl, if required, would be performed as one campaign by Armada operator Chrysaor as part of the 500m zone verification, and are not double counted here.</p>	0 km ²
Total		0.36 km ²



4.3.3. Impact on Sensitive Receptors

Decommissioning the Gaupe field infrastructure will lead to both direct permanent disturbance and direct and indirect temporary disturbance to seabed sediments, primarily within the Armada 500m zone.

The receptors with the potential to be impacted by the Gaupe decommissioning activities include sediment and habitat quality, benthic communities and finfish and shellfish (including eggs/ larvae and juvenile fish).

4.3.3.1. *Permanent disturbance from rock placement*

The installation of rock placement can cause mortality or displacement of individual benthic animals. However, the rock placement for the Gaupe decommissioning will be used to fill the holes excavated to cut the pipeline/umbilical ends and to ensure the ends remain buried. Therefore the rock will be installed on previously disturbed sediment and is not expected to cause any significant additional direct seabed disturbance.

The installation of protective rock cover at the pipeline/umbilical ends may also create habitats for benthic organisms that live on hard substrates e.g. sponges, soft corals and tubeworms, sea slugs, hermit crabs and brittle stars. Considering this addition in the context of the whole Gaupe decommissioning scope, approximately 292 concrete mattresses will be removed from the Armada 500 zone as part of Gaupe decommissioning. These mattresses and grout bags currently provide 5,436m² of hard substrate that will be removed from the area, this can be compared to the new 47 m² area of hard substrate resulting from the protective rock cover. Although the seabed habitats in the Armada area are predominantly sandy sediments, numerous glacial drop stones have been recorded in the area which also provide hard substrates for benthic organisms. Therefore the additional limited rock cover is not considered to present a significant new habitat to this area.

It is possible that, over time, the natural movement of sediments across the seabed will lead to the gradual burial of the hard substrate and infilling of the spaces between the rock placement as has been observed at other developments in the North Sea (such as the Donan field in Block 15/20).

The impact is considered to be of minor significance when taking into consideration the relatively low sensitivity of the seabed habitat and the limited spatial extent and duration of impact.

The habitats and species assemblages within the area of excavation disturbance and rock placement are considered to be representative of the wider Central North Sea and generally of medium sensitivity, owing to the potential presence of the OPSAR 'sea pen and burrowing megafauna communities' habitat. The total area affected by these activities is very small (47m²) in relation to the available habitat in the Central North Sea the magnitude of impact is considered to be slight such that the effects are unlikely to be discernible due to the very localised scale. Any impacts are expected to be indistinguishable from the baseline or within the natural level of variation.

4.3.3.2. *Temporary disturbance*

Temporary disturbance from Gaupe decommissioning activities will result from removal of equipment (including the SSIV, pipeline and umbilical risers, mattresses and grout bags), sediment excavation, rock placement and over trawl trials.



Equipment removal

Areas of seabed disturbed during equipment removal will experience small scale, short duration disturbance of the sediments. The removals will cause disturbance and possible mortality of fauna that have colonised these features during field operation. Equipment removal will re-expose the natural substrate beneath them, which will be quickly recolonised by the surrounding benthic communities.

It is anticipated that sediments will have settled on the mattresses and grout bags close to the Armada platform, some of which could contain contamination from the historic drill cuttings pile. Any contaminated sediments will be resuspended during recovery of the mattresses and grout bags and, following dispersion, will resettle in the surrounding area. This may result in a minor, localised and short-term increase in contaminant levels containing elevated levels of total hydrocarbon content (THC) in the water column. It is considered unlikely to lead to increased contamination levels in surrounding sediments since these will have been subjected to the same inputs as the sediments deposited on the mattresses. The sediments are expected to resettle rapidly following removal so impacts to any filter feeding organisms or fish within the area are likely to be of very short duration and very localised.

Sediment excavation and over trawl surveys

Decommissioning activities to excavate the pipeline/umbilical ends and potential over trawl trials will result in direct disturbance to the seabed and associated fauna, and may also cause some smothering in the wider area due to the re-deposition of suspended material. While some organisms are expected to be killed by the excavation machinery and trawl mats, some will be displaced and are likely to survive. Some of the exposed organisms may not be able to re-bury before being predated upon, while others may be relocated by water movements.

The predominant sediment type within the Armada area is circalittoral sand comprising primarily fine sand (Section 2.3.6). While this biotope is listed as an Endangered habitat on European Red List, the area being disturbed by excavation and trawling has previously been subject to trenching activity when the pipelines were installed. The excavation and any potential trawl activities will be of a very short duration and limited in their extent, with resuspended sediments deposited over the adjacent area. The impacts to sediment quality are therefore considered to represent a small scale, localised and minor effect.

Smothering of species can affect their ability to feed (if they feed by filtering seawater) or to move (if the sediment drop out is high). Both the overturning of sediments and the creation of higher than normal loads of sediment suspended in the water column has the potential for negative impacts on habitats and species through burial and/or smothering. This may particularly affect epifaunal species (see Gubbay, 2003 for a review) with the degree of impact related to their ability to clear particles from their feeding and respiratory surfaces (e.g. Rogers, 1990).

In terms of epifaunal sensitivity to direct disturbance, the most commonly recorded epifaunal species during the pre-decommissioning survey (Benthic Solutions, 2016b) was *Amphiura filiformis*. Although not highly active, *Amphiura filiformis* is a crawling, burrowing, infaunal species. Following displacement individuals could crawl or burrow through sediment (Rosenberg et al., 1997) until a suitable site is found. Burrowing through sediment may take more time and energy but predation risks are decreased. Individuals can right themselves if displacement caused them to be inverted and they can rapidly burrow into the sediment. Therefore, intolerance to displacement is low and recovery is immediate (Hill and Wilson, 2008). Most mobile epifauna (e.g. starfish, hermit crabs) can move to unaffected areas.



Immobile epifauna such as seapens appear to be able to deal with increased sedimentation through mechanisms such as mucous production and retraction into the sediment (Hill and Wilson, 2000). Studies on seapen species indicate that in addition to being tolerant of temporarily raised sedimentation levels, displaced individuals that are not damaged will re-burrow and that populations subject to trawling disturbance can avoid damage through withdrawing into the sediment (Jones et al., 2000; Tuck et al., 1998). These mechanisms imply population recoverability to most types of temporary physical disturbance that is immediate or moderate (Hill and Wilson, 2000). The sea pen *Pennatula phosphorea* was observed in the Armada area during the pre-decommissioning survey, primarily along the CATS pipeline to the south. The survey concluded that the Armada area may support the OSPAR 'sea pen and burrowing megafauna communities' habitat, but the areas surveyed did not meet the definition of the OPSAR habitat. Although individual sea pens may be disturbed as a result of the excavation and trawling activities, it is expected to have minimal effect to the local population due to the limited area of disturbance and hence number of individuals impacted.

Infauna species assemblages in the area were found to be representative of the wider Central North Sea fauna. Unless physically damaged, infauna (e.g. polychaete worms) are likely to settle back to the seabed and create new burrows in the adjacent seabed or where the sand settles.

With regard to the settlement of re-suspended sediments, the infaunal communities that dominate within the sedimentary environment present are by their nature adapted to fluctuations in sedimentation levels and not likely to be particularly sensitive to temporary and localised increases. With regards to sensitivity of species recorded during the 2016 pre-decommissioning surveys (Benthic Solutions, 2016b), Ager (2005) reports that *S. Bombyx*, the second most commonly occurring species in the pre-decommissioning survey area, is tolerant to smothering. This species appears to be able to exist in areas of high physical disturbance resulting from wave and tidal action where regular resuspension and settlement of sediments will occur.

Recovery of the habitats and benthic communities is expected to commence once and potential over trawl activities are completed. Re-colonisation of the impacted areas can take place in a number of ways, including mobile species moving in from the edges of the area (immigration), juvenile recruitment from the plankton and burrowing species digging back to the surface. Hiddink et al. (2006) modelled the recovery time for benthic communities following disturbance by beam-trawling in the southern and Central North Sea, which indicated that mud habitats on average took longer to recover (approximately 4 years) than higher energy sand and gravel areas (approximately 2 years). Similar tolerance and recoverability to smothering and increased sediment load have been reported for other similar habitats such as "seapens and burrowing megafauna in circalittoral fine mud" (Hill and Tyler-Walters, 2016b), "*Virgularia mirabilis* and *Ophiura* spp. with *Pecten maximus* on circalittoral sandy or shelly mud" (Hill and Tyler-Walters, 2016c) and "*Amphiura filiformis*, *Mysella bidentata* and *Abra nitida* in circalittoral sandy mud" (De-Bastos and Hill, 2016).

The Armada area supports spawning and nursery habitats for a number of commercial fish species, which are generally lower intensity, with the exception of cod, which is thought to have higher intensity use as nursery grounds. Where avoidance by fish is not possible, their sensitivity to suspended sediments varies greatly between species and life stages, as well as depending on sediment composition (particle size and angularity), concentration and the duration of exposure (Newcombe and Jensen, 1996). Being the major organ for respiration and osmoregulation, gills are directly exposed to, and affected by, suspended solids in the water. If sediment particles are caught in or on the gills, gas exchange with the water may be reduced leading to oxygen deprivation (Essink, 1999; Clarke and Wilber 2000). This effect is greatest for juvenile fish as



they have small easily clogged gills and higher oxygen demand (FeBEC, 2010). The excavation activities would be limited to a very small area and short duration with resuspended sediment settling rapidly following completion activities, as such the potential impact to juvenile cod is considered to be minor.

Defra (2010) states that impacts to the benthic environment in general arising from sediment re-suspension are short-term (generally over a period of a few days to a few weeks). The decommissioning activities will cause the suspension of sediment, but are considered to have a short-term indirect impact on the water column due to the short time scales and wide area of the activities. These impacts on benthic habitats and species will be localised and are not expected to result in large scale changes in the benthic community in the long-term.

Rock placement

Rock placement over the excavated pipeline ends is expected to result in a small amount of sediment resuspension into the water column, which will rapidly settle out once installation has been completed. A small quantity of rock will be placed in three locations such that the duration of activities will be very short. Given the very localised and short duration of activities the resuspension and subsequent resettlement of sediment is considered to be of minor significance.

4.3.4. Mitigation measures

The indirect impacts on the seabed as a result of the proposed decommissioning activities are not expected to be significant. However, seabed interaction will occur in a controlled manner. Disturbance of the seabed will be minimised through:

- Minimising the amount and type of rock cover required while also minimising risk of snagging by careful profiling and selection of rock sizes that can be over trawled while seeking to minimise change of seabed habitat.
- OPRD's policy requirement is for clear seabed verification to be undertaken in such a way that it minimises environmental impact. Hence, any overtrawl surveys as a means to locate debris and/or verify clear seabed will be proportionate and targeted. Actual methods of verification will be discussed and agreed with OPRD on a case-by-case basis with an assumption that less intrusive methods of clear seabed verification are the base case.

However, for the purposes of estimating environmental impact, a worst-case position has been taken in this DP and supporting EA with the assumption that over-trawling may be required.

4.3.5. Cumulative impact

The main impacts identified in this section are associated with disturbance of seabed sediment; direct disturbance and indirect disturbance through re-suspension and re-settlement of disturbed sediment. DECC (2016a) specifies that impacts are considered cumulative only if:

- The physical or contamination “footprint” of a predicted project overlaps with that of adjacent activities; or
- The effects of multiple sources clearly act on a single receptor or resource (for example a fish stock or seabird population); or
- Transient effects are produced sequentially.

There are several oil and gas production facilities within the vicinity of the Armada Hub area but none are known to be scheduled for decommissioning at the same time as, or shortly before or after Gaupe Field, and none share the same physical footprint. There is considered to be low



likelihood that Gaupe decommissioning activities will act on the same benthic receptors or resources as nearby oil and gas production activity.

Commercial fishing activities cause significant physical disturbance to the seabed; “in a UKCS context, the contribution of all other sources of disturbance are minor in comparison to the direct physical effects of fishing” (DECC, 2016a). The physical footprint of the Gaupe decommissioning operations is not likely to overlap with fishing activity while decommissioning activity is ongoing, since the Armada Hub area experiences very little fishing and since vessels involved in the decommissioning activities will be required in only a few locations at any one time. Overtrawls as part of the decommissioning of the Gaupe could be considered to target the same receptors as fishing vessels, although the intent with the decommissioning overtrawls is not to remove any fauna from the seabed, and the only impact (expected to be minimal) will be direct injury or mortality from the trawl mat. Gaupe decommissioning activities are expected to be transient, as are fishing impacts (the Armada area is not heavily fished). Commercial fishing may begin immediately after decommissioning activities have finished (excluding the area around the cuttings pile, which fishing vessels are likely to avoid), and could therefore qualify as sequential transient events. The physical presence impacts associated with Gaupe decommissioning are however expected to be short-term and are on a small scale compared to the available habitat in the area. Ultimately the activities will result in additional seabed habitat becoming available through removal of infrastructure. It is therefore considered unlikely that the proposed operations will result in cumulative impacts with regards to physical impact on the seabed.

4.3.6. Transboundary Impact

The Offshore Energy SEA 3 for UKCS waters (DECC, 2016a) states that seabed impacts from oil and gas operations are unlikely to result in transboundary effects and even if they were to occur, the scale and consequences of the environmental effects in the adjacent state territories would be less than those in UK waters and would be considered unlikely to be significant. The Gaupe umbilicals and flowlines are trenched and backfilled/buried respectively and recommended to be decommissioned in situ. Work to prepare the ends of the umbilicals and flowlines will take place close to the Armada platform (approximately 4 km from the UK/Norway median line) and the limited anticipated extent of the indirect effects (e.g. sediment resuspension) will not likely result in transboundary impacts.

4.3.7. Protected sites

There are no protected sites within the direct area of works associated with the Gaupe decommissioning project, or within the zone of influence from indirect effects of sediment resuspension and re-settlement.

4.3.8. Residual impact

Taking into account the proposed mitigation measures, impacts due to seabed disturbance resulting from the decommissioning activities are expected to localised, short-term and in line with natural variability, with no cumulative or transboundary impact expected.

The receptor sensitivity is ranked as Medium recognising that some species or habitats may be of conservation importance:

- habitats were classified as biotope complex ‘Circalittoral sand’ (A5.27) which is categorised as ‘Endangered’ on the European Red List;
- the OSPAR habitat and Scottish PMF ‘sea pens and burrowing megafauna communities’ may be present in the Armada area.



Given the general uniformity of the CNS habitats, very localised scale of habitat change (47m²) and temporary nature of the majority of seabed disturbance the magnitude of impact is expected to be indiscernible and therefore Slight. Combining these rankings, the impact significance is defined as Slight and thus not significant.

Magnitude	Sensitivity	Significance
Slight	Medium	Slight and not significant

4.4. Physical presence – Underwater noise

4.4.1. Overview

Underwater sound is generated by natural sources such as rain, breaking waves and marine life, including whales, dolphins and fish (termed ambient sound). Human use of the marine environment adds additional sound from numerous sources including shipping, oil and gas exploration and production operations, aircraft and military activity. In this assessment, sound is used as a term for anything that an individual animal can hear. The term noise is used in this assessment to mean sound that may have some form of potential impact (for example, it may affect behaviour). Whilst all ‘noise’ is also ‘sound’, not all ‘sound’ is considered ‘noise’.

Many species found in the marine environment use sound to understand their surroundings, track prey and communicate with members of their own species. Some species, mostly toothed whales, dolphins and porpoise, also use sound to build up an image of their environment and to detect prey and predators through echolocation. Exposure to natural sounds in the marine environment may elicit responses in marine species; for example, harbour seals have been shown to respond to the calls of killer whales with anti-predator behaviour (Deecke et al., 2002).

In addition to responding to natural sounds, marine species such as fish and marine mammals may also respond to man-made sound. The potential impacts of industrial noise on species may include impacts to hearing, displacement of the animals themselves and potential indirect impacts which may include displacement of prey species. Whilst there is a lack of species specific information collected under controlled or well-documented conditions, enough evidence exists for fish and marine mammals to suggest that sound may have a potential biological impact and that noise from man-made sources may affect animals to varying degrees depending on the sound source, its characteristics and the susceptibility of the species present (e.g. Nowacek et al., 2007, report this specifically for cetaceans).

As well as potential behavioural impacts of noise, marine mammals and fish exposed to an adequately high sound source may experience a temporary shift in hearing ability (termed a temporary threshold shift; TTS) (e.g. Finneran et al., 2005). In some cases, the source level may be sufficiently high such that the animal exposed to the sound level might experience physical damage to the hearing apparatus and the shift may not be reversed; in this case there may be a permanent threshold shift (PTS) (Southall et al., 2007), and the animal could be considered as being injured.



4.4.2. Project activities that emit noise

There are a number of activities that will occur during the decommissioning of the Gaupe fields described that could emit noise to the marine environment:

- Use of vessels;
- Underwater cutting:
 - Once disconnected, the spools and risers will be cut into shorter sections to facilitate removal; and
 - Where pipelines, flowlines and umbilicals are to remain in situ, exposed ends of the lines will be excavated, cut and removed.
- Survey operations:
 - Post-decommissioning surveys will be required to verify depth of burial of lines decommissioned in situ. These surveys can include the use of sidescan sonar, multibeam echo-sounding and sub-bottom profile pingers.

4.4.3. Vessels and marine mammals

Noise emissions from vessels occur continuously during operation of the vessel, appearing louder as animals approach the vessels, and appearing quieter as animals move away. Such continuous noise sources are generally of less concern than intermittent sources (i.e. banging noises) where relatively high doses of noise can be received by animals over a very short period of time with little warning. As such, there is no realistic prospect of animals being instantaneously injured by any vessel noise emissions. However, if animals remained in close proximity to vessels for an extended period of time, it is possible that the noise could, cumulatively, result in injury (e.g. Southall et al., 2007). In terms of the typical noise emissions from the vessels to be deployed in the decommissioning activities, including during the post-decommissioning surveys, a review of the literature suggests that they will be in the range 178 – 191 peak sound pressure level (SPL) dB re 1 μ P @ 1 m (e.g. Austin et al., 2005, Hannay et al., 2004, MacGillivray and Racca, 2006). Published thresholds at which injury (defined as permanent shift in hearing ability) might occur for marine mammals (Southall et al., 2007) suggest that noise emissions of in excess of 200 – 230 peak SPL dB re 1 μ @ 1 m would be required for injury to occur.

Although noise emissions from vessels are not expected to cause injury, they may be sufficiently loud for marine mammals to find the noise a nuisance. Depending on the specific vessels involved, the noise may be detectable within hundreds of metres or a number of kilometres. Southall et al. (2007) note that behavioural reactions to noise by marine mammals are by no means consistent across species or individuals, and it is difficult to therefore state specific thresholds for impact. Nevertheless, considering published data on noise emissions from vessels against possible thresholds for disturbance (e.g. NMFS, 2005, Southall et al., 2007) it is clear that there is the potential for animals to be disturbed to some degree. It is important to note, however, that behavioural changes such as moving away from an area for short periods of time, reduced surfacing time, masking of communication signals or echolocation clicks, vocalisation changes and separation of mothers from offspring for short periods, do not necessarily imply that detrimental effects will result for the animals involved (JNCC, 2010a). Temporarily affecting a small proportion of a population for a limited period of time would be unlikely to result in population level effects and would be considered as trivial. In contrast, affecting a large proportion for a long period of time may be considered non-trivial.

The majority of vessels will be on site for a matter of a few weeks; even those that will remain longer will only be in the field for 2 – 3 months across the duration of the project. In the



context of low number of marine mammals likely to be found in the Armada Hub area offshore, the likelihood of significant disturbance is low. There will be vessel use in nearshore waters, temporarily as part of any requirement to place the jacket on the seabed in nearshore waters and as vessels transit to and from the offshore Armada Hub. However, the time spent in nearshore waters will be extremely limited and the likelihood of significant disturbance is low.

4.4.4. Cutting and marine mammals

A number of subsea cuts will be made during the removal of the Gaupe infrastructure. As JNCC (2010a) report, although advances in cutting technology have reduced the use of requirement to use explosives to decommissioning structures in recent years (there will be no explosives use in the Gaupe decommissioning project), the possibility of injury or disturbance occurring to marine mammals from cutting activities must still be assessed here. Although field measurements undertaken to record cutting emissions in the context of potential effects on marine life are limited, there are some records available. For example, a recent paper reported that the noise from underwater diamond wire cutting, during the severance of a 0.76 m (30 inch) diameter conductor at a platform in the North Sea, was barely discernible above background noise levels including the noise of associated vessel presence (Pangerc *et al.*, 2016). The cutting noise, an increase of 4 – 15 dB above background levels, was more discernible at higher frequencies, i.e. >5 kHz, than at low frequencies, and was identifiable in recordings made 800 m from source. Anthony *et al.* (2009) reports the peak source level for oxy arc cutters as 148 dB re 1 μ Pa @ 1 m and for cable cutters at 163 dB re 1 μ Pa @ 1 m. Injury from these noise levels is not considered likely, should animals approach the cutting activity. However, if cutting activities continued for a sustained period of time and animals remained within close proximity then there exists the potential for injury through cumulative exposure. This is not considered a likely outcome for the project, however, as cutting activities are likely to be intermittent and each cut of limited duration (approximately one hour). For Gaupe, diamond wire and hydraulic cutting disc will most likely be used with lower noise levels, hence the impact is considered to be lower.

As with vessel emissions, cutting noise could cause disturbance within the hundreds of metres or kilometres within which it may be detectable by marine mammals. The key proxy for the potential to disturb will be the length of the period over which the cutting will take place. Assuming one hour per cut, it is estimated that cutting activity will take up to 12hrs in total. In the context of the Armada Hub area being of no specific importance to marine mammals, this very short period of cutting operations is unlikely to result in disturbance that will significantly affect life functions such as breeding or nursing.

4.4.5. Survey operations and marine mammals

Side Scan Sonar and Multi-beam Echosounder

It is likely that side scan sonar (SSS) and multi-beam echo sounder (MBES) would be deployed during any survey operations. Side scan sonar typically operates at around 100 – 500 kHz, with higher frequencies outside the hearing/sonar thresholds of most marine mammals and thus not of concern with regards impact. Although the source levels are relatively high in comparison to vessels and other sound sources above (e.g. JNCC, 2010a, report emissions in the range of 200 dB re 1 μ Pa @ 1 m), the high frequency noise attenuates quickly over short distances (i.e. is not audible much beyond the activities). As such, JNCC (2010a) considers side-scan sonar systems



have a negligible risk of causing an injury to marine mammals under normal operating conditions. JNCC (2010a) state that “it is unlikely that injury would occur as an animal would need to locate in the very small zone of ensonification and stay in that zone associated with the vessel for a period of time, which is also unlikely”.

MBES use multiple transducers to send out a swath of sound covering a large, fan-shaped area of the seabed either side of the vessel track. Maximum peak source levels for the most powerful, deep-water systems are 236 – 238 dB re 1 μ Pa-m. Similar to side-scan sonar devices, the frequencies used by multi-beam echosounders are relatively high (100 – 500 kHz).

In terms of potential for disturbance, JNCC (2010a) state that noise emissions “could, in a few cases, cause localised short-term impacts on behaviour such as avoidance”. However, JNCC (2010a) also state that this is unlikely to constitute significant disturbance of a population.

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

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

Given that survey operations are likely to last for a maximum of 25 days, that the SSS or MBES would not be in use at all times, and the low density of marine mammals likely to be in the area, there is very limited potential for disturbance to marine mammals.

Sub-bottom Profiler

In addition to SSS and MBES, sub-bottom profiler (SBP) pingers may be used to survey the pipeline burial depths to ensure they are sufficiently buried to be decommissioned in situ.

Sub-bottom profiling is used to determine the stratification of soils beneath the sea floor. For pipeline burial depth surveys a Pinger type SBP provides adequate penetration at high resolution. Typical SBP Pingers used by Shell have a zero to peak SPL of 220 dB re 1 μ Pa-m, and a rms SPL of 217 dB re 1 μ Pa-m, with the sound energy generated being at a peak frequency of 3 kHz. The pulse length is approximately 50 ms and the pulse interval 0.2 s, giving a pulse frequency of 4 Hz i.e. 4 pulses will be transmitted every second. Based on the rms SPL and the pulse length, the sub-bottom profiler is estimated to have a single pulse SEL of 204 dB re 1 μ Pa²s-m, and a source SEL over a 1 second exposure of 210 dB re 1 μ Pa²s-m. The majority of sound energy from SBPs is directed vertically downwards and the pulse duration is short.

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

SBP surveys undertaken in relation to licences issued under the Petroleum Act 1998 (and the Energy Act 2008) require consent under the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001. Applications require consideration of the potential impact of noise from the SBP on the marine environment and such assessments are frequently informed by noise modelling studies. Shell frequently undertakes pipeline surveys using acoustic equipment for its assets throughout the North Sea.

Most recently, an assessment in support of application for consents for a survey using SBP pingers for pipeline inspection in autumn 2020 identified:



- Sound levels would not exceed thresholds for the onset of PTS for high-frequency hearing cetaceans and pinnipeds;
- Sound levels would decrease to below thresholds for the onset of PTS within:
 - 190 m for very high-frequency hearing cetaceans; and
 - 50 m for low-frequency hearing cetaceans;
- Behavioural responses to the sound may be exhibited by all cetacean groups and pinnipeds up to 1.8 km from the source; and
- Sound levels would decrease below the threshold for injury or potential mortality to fish, including eggs and larvae, within a maximum of 30 m from the source.

Guidelines for minimising the risk of potential impacts of sound (JNCC, 2017) include the following measures relevant for surveys of this nature:

- A qualified Marine Mammal Observer (MMO) will be aboard the vessel during the entire survey, who will be following JNCC (2017) guidelines for minimising the risk of injury to marine mammals from geophysical surveys. When the MMO observation period is ongoing, the designated MMO will not be required to undertake any other duties on the vessel.
- The designated MMO will detect marine mammals within a 500 m mitigation zone. If any cetaceans are observed within 500 m from the source array, then the start of the seismic sources will be delayed for at least 20 minutes following last sighting.
- The designated MMO will carry out a 30-minute pre-data acquisition survey of the mitigation zone and, if an animal is detected, the soft-start of the seismic sources will be delayed until their passage, or the transit of the vessel, results in the marine mammals being more than 500 metres away from the source i.e. out with the 500 m mitigation zone.
- A soft-start activation of the SBP will be employed, whereby the source power will be incrementally increased over period of at least 20 minutes. This will allow any marine mammals to move away from the sound source and reduce the likelihood of exposing the animal to sounds that could potentially cause injury. A soft start will be employed whenever the SBP is used.

If the SBP has been inactive for a period of 10 minutes or longer, the designated MMO will perform a visual inspection of the 500 m mitigation zone. If a mammal is detected within the 500 m mitigation zone, the restart of the survey will be delayed for at least 20 minutes following last sighting.

The study, in keeping with Shell's general experience of such surveys, concluded that, with the implementation of mitigation measures established by JNCC, they will not have a significant impact on marine fauna.

4.4.6. Fish

Popper et al. (2014) outline the possibility of fish being affected by various noise emitting industries, of which oil and gas is one. In the same way as marine mammals can be affected, it is possible that fish could be injured or disturbed if noise emissions are sufficiently high (e.g. De Robertis and Handegard, 2012). However, the vessels will be slow moving and fish will not experience any sudden bursts of sounds. Fish are mobile animals that would be expected to be



able to move away from a noise source that had the potential to cause them harm. If fish are disturbed by a noise, evidence suggests they will return to an area once it has ceased (Slabbekoorn *et al.*, 2010).. For cutting, the emissions could be intermittent but the sound levels are predicted to be low. Even if some fish were to be injured by the emissions, many millions of individuals make up most species populations (e.g. Mood and Brooke, 2010) and limited injury is not likely to result in significance impacts at the population level. Similarly, should the noise emissions disturb fish, the short-term movement away from the short-term activities would not constitute a large-scale movement by individuals of a species and would be highly unlikely to result in population level impacts.

4.4.7. Mitigating measures

Disturbance to marine mammals will be minimised by:

- limiting the duration of the noise emitting activities; for example, vessels will only be deployed where necessary and the number of cuts will be limited as far as is practicable, and
- following JNCC guidelines for minimising the risk of injury to marine mammals in as much as they relate to the use of SBP for geophysical surveys should this technique be required.

4.4.8. Cumulative Impact

It is possible that the various noise sources within the project (i.e. multiple vessels operating at the same time, or cutting occurring at the same time as vessels being used) to result in an impact to marine mammals and fish. However, noise levels will be sufficiently low that injury is not predicted for marine mammals and potential disturbance zones are likely to be small and, for the most part, highly limited in temporal extent. For fish, the potential for injury or disturbance to result in any detectable changes at the population is very low. Cumulative impact from sources within the project are therefore not expected. Cetacean and fish populations are free-ranging and long-distance movement is likely to be frequent, and in some cases predictable through seasonal migration (e.g. mackerel; ICES, Undated). Any animal experiencing a significant impact from one project is likely to belong to a much wider ranging population and there is the potential for that same animal to subsequently come into contact with noise from other projects. However, potential injury and disturbance impacts resulting from the decommissioning activities are not expected to be significant, and significant cumulative impact from an animal encountering noise emission from multiple projects within a short period of time is therefore considered highly unlikely.

4.4.9. Transboundary Impact

Sound emissions from proposed decommissioning activities of Gaupe infrastructure in the UK Sector could be received directly by marine mammals and fish across the median line. Also, it is possible that Gaupe infrastructure in the UK and Norwegian Sectors might be decommissioned during a single campaign. However, since injury and disturbance are not expected to result in significant impact to any population, potential transboundary impacts are also therefore considered not significant.



4.4.10. Protected sites

As described in Section 2.4.5, four species of marine mammal listed on Annex II of the Habitats Directive occur in UK waters. The Armada Hub area is well beyond the predicted foraging range for bottlenose dolphin from the Moray Firth SAC, especially since this population is restricted largely to within the 20 m depth contour around the Scottish east coast. For grey and harbour seals, foraging range is approximately 200 km and 50 km respectively, which means that the Armada Hub offshore area is also beyond the core foraging range for these species. Since there is no potential for underwater noise emissions to interact with these species in any significant manner, there is concluded to be no Likely Significant Effect (i.e. no impact) on any SAC designated for these interests and it is not necessary to consider the conservation objectives or integrity of any sites in further detail. For harbour porpoise, animals making use of the Southern North Sea candidate SAC (Section 2.5.1) may also make use of the Armada Hub; harbour porpoise within the North Sea are known to form one biogeographical population that spans the North Sea as a whole (JNCC, 2015). However, there is expected to be no injury to harbour porpoise from the project activities, and no effect of disturbance at the population level. As such, there will be no Likely Significant Effect on this protected site.

4.4.11. Residual impact

The information in the Environment Description and the definitions of magnitude and sensitivity in the EA Methodology has been used to assess the significance of the potential impact, as follows.

Considering the description of potential impact given above, including that effects are unlikely to be discernible or measurable, the magnitude of impact is ranked as Slight. On the basis that cetacean species that may be present in the project area are afforded protection at the individual level, and that the Southern North Sea candidate SAC is within the potential area of impact, the receptor sensitivity is ranked as High. Combining these rankings, the impact significance is defined as Minor and thus Not significant.

Magnitude	Sensitivity	Significance
Slight	High	Minor and not significant

4.5. Physical presence – Other users of the sea

4.5.1. Increased vessel traffic leading to temporary exclusion from sea area

The temporary physical presence of project vessels has the potential to interfere with other sea users that may be present in the area. Vessels will be required intermittently. The type of vessels



that are likely to be required for the project are detailed in Section 4.7 but are likely to include DSV, survey vessel, rock placement vessel, supply vessel and fishing vessel.

Once decommissioning activities are complete, vessel traffic associated with the Gaupe Decommissioning Project will cease in the area, except for limited vessel requirements to fulfil post-decommissioning requirements. Therefore, once the removal/decommissioning in situ activities are complete, vessel traffic will be reduced. Vessel traffic close to the Armada hub is considered to be low with 21 shipping routes identified within 10 nm of the Armada platform, and estimated vessel traffic to be 1,109 ships per year, corresponding to three vessels per day. Fishing effort is also low within the vicinity of the Armada hub (five year average of 257 hrs within 2km of Armada platform (Section 2.6.3)). Given the low shipping and fishing within the area, and the majority of the work will be conducted within the existing Armada 500m safety exclusion zone and be of very short duration the additional vessel traffic associated with decommissioning operation is considered to be minor.

4.5.2. Snagging risk from Gaupe Infrastructure and long-term exclusion from the Armada Hub

The Marine Accident Investigation Branch shows there have been 13 sinkings resulting from snagged fishing gear between 1989 and 2008, resulting in 22 fatalities (Marine Accident Investigation Branch, 2016). Once decommissioning activities have been completed at Gaupe, there will be no potential for fishing gear to snag on infrastructure that has been decommissioned in situ, as the exposed subsea structures will be removed. The rest of all pipelines, flowlines and umbilicals will not pose a snagging risk as they are either already buried to a target depth in accordance with OPRED guidelines.

It is important to note that there is a very low level of fishing activity in the Armada Hub, for both the UK demersal trawl and seine and UK pelagic trawl fleets; within 2 km of the Armada Hub, an annual average total of £4,419 value of catch and 257 hours of fishing is recorded (Poseidon, 2016). Considerably more effort is focused elsewhere within ICES rectangles 44F1 and 45F1 and across the wider Northern North Sea, specifically targeting Nephrops grounds in the Fladen Ground.

4.5.3. Mitigating measures

A number of mitigation measures will be employed to reduce the impact on other sea users:

- During decommissioning the number of vessels and length of time required on site will be reduced as far as practicable through careful planning of the decommissioning activities;
- Information on the location of vessel operations will be communicated to other sea users through the standard communication channels including Kingfisher, Notice to Mariners and Radio Navigation Warnings;
- The size and grade of any rock used will be discussed with SFF;
- Any objects dropped during decommissioning activities will be recovered and removed from the seabed as appropriate;



- Following recovery of subsea infrastructure and debris the seabed will be subjected to surveys to confirm that the seabed is clear and safe for fishing. Surveys may include video, side scan sonar or similar. If the survey results identify areas where there are specific safety concerns, such as at pipeline ends, it may be necessary to supplement the surveys with over trawl trials to demonstrate that the seabed has been left in a safe state. Once the surveys or potential overtrawls are completed, a risk-based strategy will be employed to monitor any risks that may develop in the future as in situ infrastructure degrades; and
- Details of all infrastructure decommissioned in situ will be made available for inclusion on Admiralty Charts and the FishSAFE system.

4.5.4. Cumulative Impact

Due to the low levels of shipping activity in the vicinity of the Armada Hub, the wide expanse of water available to navigate in and the limited number of vessels to be deployed for the project, it is not anticipated that there will be any significant cumulative impacts with respect to temporary use of the sea area by decommissioning vessels.

4.5.5. Transboundary Impact

As the Armada platform is beyond the UK's 12 nm limit, EU and non-EU vessels are also permitted to fish in the area, subject to management agreements including, for example, quota allocation and days at sea. Poseidon (2016) concluded that Dutch and Norwegian vessels are known to operate in ICES rectangles 44F1 and 45F1, targeting pout, shrimp and herring. VMS data for foreign vessels operating in the Armada Hub area are limited however the overall fishing effort is considered low. Therefore fishing effort from Dutch and Norwegian vessels is also considered low, meaning that there is no mechanism by which significant transboundary impacts could occur

4.5.6. Residual Impact

The information in the Environment Description and the definitions of magnitude and sensitivity in the EA Methodology has been used to assess the significance of the potential impact, as follows:

The effect of the project on other sea users will be largely short-term and localised, therefore the magnitude of effect is considered to be Minor. Receptor sensitivity is considered to be classed as Low due to the low fishing effort in the area and the opening up of areas for fishing once decommissioning is complete. Combining these rankings, the impact significance is identified as Minor and thus Not Significant

Magnitude	Sensitivity	Significance
Minor	Low	Minor and not significant



4.6. Discharges to sea

Flowlines (including spools and risers) and umbilicals will be flushed and cleaned before any decommissioning work, where possible. Some lines in the umbilicals are blocked, have a leak or no pathway to the topside and cannot be flushed (see Section 4.6.3). However, for the majority of Gaupe pipelines and umbilicals the cleaning method was selected following a concept screening workshop and an ALARP assessment of the alternative options. Based on the ALARP evaluation, the base case assumption for pipeline cleaning is to flush with viscous gel followed by at least one line volume of seawater to remove mobile hydrocarbons and loose solids. The pipelines will be flushed to a level demonstrating ALARP and from which further cleaning would provide no further environmental benefit. The target cleanliness will be agreed with the regulator before commencing execution under approved discharge permits. Therefore, as part of the decommissioning operations, small volumes of residual chemicals and/or hydrocarbons contained within the pipelines, flowlines and umbilicals on Gaupe may be discharged to sea. This may happen during the disconnection and cutting of lines in preparation for decommissioning, or over a longer period of time as the lines degrade in situ.

4.6.1. Spool and risers

Spools and risers will be recovered to shore. However, it is likely that these lines will be cut into short sections (approximately 24 m long) to facilitate recovery to shore. During this activity, their content is anticipated to be released to sea. However, the lines will have been flushed with filtered seawater before disconnection to ensure only small and acceptable levels of liquid hydrocarbons to be released to sea during cutting activity.

4.6.2. Flowlines

Based on fluid properties in Gaupe north pipeline, several shut downs and wax inhibitor injection history there is a risk that some amounts of wax have been deposited along the flowline wall during production. The modelling (Shell 2019) revealed that the wax had potentially been deposited on the entire pipeline length of the north pipeline with the bulk of wax being deposited within first 1.5 km from the wellhead on NCS. The maximum deposit thickness is around 12 mm. The deposition thickness reduced along the pipeline profile and is minimal around SSIV and riser, hence the bulk of the wax will be located on NCS. The total amount of accumulated wax in the pipeline is estimated to about 46 m³. The estimated amount of entrained liquid oil in the wax deposit is no more than 23 m³ which is distributed with the wax along the pipeline length.

Unfortunately, proper analysis (by HTGC) of characterization of the Gaupe wax never been done for Gaupe north oil, hence full wax characterization of Gaupe wax is not available. The production in the field was stopped in Q4 2018, and this made it impossible to collect a new sample. However, wax deposits similar in nature were analysed on Curlew C flowline which represent a typical wax formation and will be the basis for the discussion further in the EA (The Curlew field is located in Block 29/7 of the United Kingdom Continental Shelf (UKCS) in the central North Sea. It is situated 197 km SE of Aberdeen in a water depth of approximately 90 m).

It is therefore anticipated that the composition of the wax will be characterized as hard wax coating the Gaupe North flowline and will include hydrocarbons with a wide range of carbon numbers from C26 and above, although predominantly these will be between C38 and C60.



Biodegradation:

There is limited data available on the biodegradation of long chain alkanes such as those expected to make up the residual wax in the Gaupe North flowline on decommissioning. This is primarily due to the very low solubility of these compounds, which makes them unsuitable for use in almost all experimental tests. However, it is expected that these long chain molecules are impeding transmembrane transport and hence restrain degradation by microorganism. The biodegradation of these long chain hydrocarbons will therefore most likely be very slow.

The entrained liquid hydrocarbon is expected to have a range of carbon length, where the shorter chain will degrade faster, and the long chain will degrade slower, as indicated for the hard wax composition.

Bioaccumulation:

It is generally considered that metabolic processes prevent bioaccumulation and that the size and structure of long chain hydrocarbons sufficiently impedes transmembrane transfer so that bioaccumulation is not observed.

Ecotoxicity:

Lab tests show that hydrocarbon chains longer than C10 is too low for aquatic toxicity. It is therefore expected that the bulk of the wax in the Gaupe north pipeline is not toxic for marine organisms.

Trapped metal contaminants:

It is anticipated that there will be some traces of the heavy metal in the wax as per Gaupe oil composition. However, the predicted metals concentrations have been compared against sediment toxicity thresholds developed by the US EPA (United States Environmental Protection Agency), and endorsed under the OSPAR Co-ordinated Environmental Monitoring Programme assessment criteria.

Table 4-3 Concentration of contaminants trapped in wax versus OSPAR criteria for sediments

Substance	OSPAR criteria sediments Background/low concentration	Concentration on Gaupe wax (worst case)
Vanadium	NA	< 1 mg/kg
Nickel	30 mg/kg	< 1 mg/kg
Chromium	60 mg/kg	< 1 mg/kg
Lead	25 mg/kg	< 1 mg/kg
Mercury	50 µg/kg	7 µg/kg
Arsenic	15 000 µg/kg	5 µg/kg

The levels for all types heavy metals are well below OSPAR criteria for sediments. The metal concentrations trapped within Gaupe wax are therefore likely to have negligible environmental impact.

It will be recommended that Exposed flowlines will be removed, while trenched/buried flowlines will be flushed with filtered seawater and cut below seabed and left in-situ. When the flowlines are initially disconnected on the seabed, there will be a release of their contents. These



flowlines will be flushed with filtered seawater to a pre-agreed cleanliness level that will have negligible impact on the surrounding environment.

4.6.3. Umbilicals

Table 4-4 and Table 4-5 details the volume of each chemical expected to be in the Gaupe north and Gaupe south umbilicals respectively within the field at the time of the decommissioning activities.

Table 4-4 Chemical inventories of Gaupe North umbilical

Designation	Line(s) no.	Size	Current contents	Volume (m ³)	Flushing Method (Base Case)
Hydraulic LP	9,10	1/2"	HT2N	2.0	Leave fluid in core
Hydraulic HP	7,8	3/8"	HT2N	1.1	Leave fluid in core
Hydraulic Spare <i>Leak reported</i>	6	1/2"	HT2	1.0	Leave fluid in core
Methanol <i>Leak reported</i>	2	1.25"	MEOH	6.1	Leave fluid in core due to leak
Methanol/ Vent	1	1.25"	MEOH	6.1	Flush into pipeline pre-COP, fluid returns to Armada in process stream
Asphaltene inhibitor <i>HC based</i>	3	1/2"	MI Swaco EPT 2337	1.0	Flush into pipeline pre-COP, fluid returns to Armada in process stream
Wax inhibitor <i>HC based</i>	11	1/2"	Clariant DF3694	1.0	Flush into pipeline pre-COP, fluid returns to Armada in process stream
Foamer	4	1/2"	EC7007A + MEG/water	1.0	Flush (downhole) pre-COP (fluids returned to Armada in process stream)
Chemical spare	5	1/2"	MEG/water	1.0	Flush into pipeline pre-COP, fluid returns to Armada in process stream

Table 4-5 Chemical inventories of Gaupe South umbilical

Designation	Line(s) no.	Size	Current contents	Volume (m3)	Flushing Method (Base Case)
Hydraulic LP	9,10	1/2"	HT2N	2.0	Leave fluid in core
Hydraulic HP	7,8	3/8"	HT2N	1.1	Leave fluid in core
Hydraulic Spare	6	1/2"	HT2	1.0	Leave fluid in core
Methanol	2	1.25"	MEOH	6.1	Flush into pipeline pre-COP, fluid returns to Armada in process stream
Methanol/Vent	1	1.25"	MEOH	6.1	Flush into pipeline pre-COP, fluid returns to Armada in process stream
Asphaltene inhibitor <i>HC based; Blocked</i>	3	1/2"	MI Swaco EPT 2337	1.0	Leave fluid in core due to blockage
Wax inhibitor <i>HC based; Blocked</i>	11	1/2"	Clariant DF3694	1.0	Leave fluid in core due to blockage
Foamer	4	1/2"	EC7007A + MEG/water	1.0	Flush (downhole) pre-COP (fluids returned to Armada in process stream)
Chemical spare	5	1/2"	MEG/water	1.0	Flush into pipeline pre-COP, fluid returns to Armada in process stream



Chemicals may be present in a small number of umbilical cores as some of the cores are blocked, have a leak or no pathway to the topside, and therefore flushing back to Armada is not directly feasible. Opportunities has been looked at, but not endorsed further due to low ability of displacement of the chemicals in the narrow lines. This is applicable for the hydraulic, asphaltene and wax inhibitor lines. Fluids contained in these cores will be released to sea when cuts are made to the end of the umbilicals and while the lines disintegrate with time. Shell together with a 3rd party completed a risk assessment ('Osborne-Adams calculation') to understand the potential environmental impact of an instantaneous release of these chemicals (Table 4-6; Shell, 2017b). The assessment concluded that the time taken for the no observable effect concentration (NOEC) to be exceeded (T1) is significantly greater than the refreshment rate of the water column (T2), such that the refreshment rate will prevent the discharge from reaching a concentration at which it could have an adverse environmental effect (i.e. $T1 > T2$). On this basis, it is expected that an instantaneous release of a reduced volume of these chemicals (since cutting of the ends of lines would not be likely to result in the release of the entire inventory) or a release of the entire inventory over the period of time over which the umbilicals will degrade will not result in an adverse environmental effect.

Table 4-6: Osborne Adams calculations for Gaupe North and South umbilicals

Chemical	Discharge Rate (m ³ /hr)	Discharge volume (m ³)	Time for NOEC to be exceeded - T1 Value (hr)	Refreshment rate - T2 Value (hr)
Gaupe North Umbilical				
Castrol Transaqua HT2-N	0.0558	3.46	551	2.78
Castrol Transaqua HT2-N	0.0278	1.24	927	2.78
Gaupe South Umbilical				
Castrol Transaqua HT2-N	0.02650	3.1	1,160	2.78
Castrol Transaqua HT2-N	0.03100	1.0	829	2.78
Waxtreat DF 3694	0.00105	1.6	1,340,000	2.78
EPT-2337	0.00375	1.06	4,920	2.78
Note: Gaupe North volumes also include volume of the two chemicals in the Gaupe riser (0.36m ³ of TH2-N, and 0.24m ³ of HT2) for the OA analysis.				
Note: Gaupe South volumes above also include volumes of the Wax Inhibitor (0.6m ³) and asphaltene inhibitor (0.06m ³) present in the Gaupe riser for the OA analysis.				

Hydraulic line will contain most of the volume left in-situ. Originally when Gaupe started up, the hydraulic line was filled with Castrol Transaqua HT2. This chemical is categorized as red based on OSPAR requirements. Castrol Transaqua HT2 was substituted with Castrol Transaqua HT2-N in 2017 which is categorized as yellow. Due to low consumption of hydraulic fluids on Gaupe, it assumed that most of the hydraulic line is filled with Castrol Transaqua HT2. However, Castrol Transaqua HT2 contains 99,99% green- (environmental friendly) and yellow components (environmentally acceptable), hence the amount of red components in Castrol Transaqua HT2 is very low. The low levels of red components do not degrade readily and has some degree of toxicity to some types of marine organisms. One of the red components does bioaccumulate, the rest does not bioaccumulate. The total volume of these red components that may be discharged to sea is therefore considered to have a low impact on the marine environment.

4.6.4. Mitigating measures

The relevant permits and consents will be in place for the discharge of chemicals and residual hydrocarbons from the removal of subsea infrastructure. These will include a robust chemical risk assessment and justifications (where applicable) for any discharges associated with these



activities. These activities are expected to take place over the course of a number of months. Therefore, the release of these chemicals and any residual hydrocarbons will not take place at the same time lessening the environmental impact further compared to an instantaneous release of the total discharge volumes for all lines.

4.6.5. Cumulative impact

It is possible that the various chemical and hydrocarbon discharges within the execution of the decommissioning activities, and from other assets in the area (during both ongoing production operations and other planned decommissioning activities), could act cumulatively to result in some negative impact to the surrounding environment. However, as a result of the water depth and the operations occurring over a period of weeks and months, any discharge of chemicals and/or residual hydrocarbons is expected to disperse and dilute in the water column relatively rapidly and have a negligible environmental impact.

4.6.6. Transboundary impact

The decommissioning activities of the Gaupe infrastructure in the UK Sector will be undertaken immediately adjacent to the median line. There is the possibility that discharges to sea could therefore cross median lines. However, despite the relatively low seabed currents in the Armada Hub area, the limited discharge of chemicals and/or residual hydrocarbons is expected to dissipate sufficiently rapidly and thus have a negligible impact. Consequently, none or negligible transboundary impacts are expected.

4.6.7. Protected sites

All discharges will occur sufficiently far from the NCMPA to mean that there is no mechanism of impact.

4.6.8. Residual impact

Considering the above description of potential impact, the magnitude of impact for discharges to sea is ranked as Slight. On the basis that no discharges will occur within the protected site (i.e. the Norwegian Boundary Sediment Plain NCMPA), the receptor sensitivity is ranked as Low. Combining these rankings, the impact significance is defined as Slight and thus Not significant.

Magnitude	Sensitivity	Significance
Slight	Low	Slight

4.7. Energy use and atmospheric emissions

4.7.1. Description and quantification of potential impact

The use of fuel to execute the decommissioning project will result in emissions of gases to air that could potentially result in impacts at a local, regional, transboundary and global scale. Local, regional and transboundary issues include the potential generation of acid rain from nitrogen and sulphur oxides (NO_x and SO_x) released from combustion, and the human health impacts of ground level nitrogen dioxide (NO₂), sulphur dioxide (SO₂), both of which will be released from



combustion) and ozone (O₃), generated via the action of sunlight on NO_x and volatile organic compounds (VOCs). On a global scale, concern with regard to atmospheric emissions is largely focused on global climate change. The Intergovernmental Panel on Climate Change (IPCC) in its fifth assessment report states that the dominant cause of observed warming is anthropogenic greenhouse gas (GHG) emissions (IPCC, 2014). GHGs include water vapour, carbon dioxide (CO₂), methane (CH₄), NO_x, O₃ and chlorofluorocarbons. The most abundant GHG is water vapour, followed by CO₂. IPCC (2007) states that the combustion of fossil fuels is the primary contributor to CO₂ emissions

Atmospheric emissions from the Gaupe decommissioning project will occur as a result of:

- Fuel consumption by vessels (offshore and nearshore);
- Movement and treatment of materials brought to shore (onshore); and
- Replacement of anthropogenic materials decommissioned in situ offshore (onshore).

Table 4-7 and Table 4-8 provides assumptions based on which energy use and atmospheric emissions, shown in Table 4-9 have been calculated. The estimates include vessel use and the replacement of any materials decommissioned in situ (materials decommissioned in situ will not be available for reuse or recycling and this is accounted for in the assessment by considering the energy and emissions associated with creating that material).

The majority of the decommissioning activities are too remote from other human receptors (including other offshore oil and gas activity) for there to be any impact on local air quality (the dispersive offshore environment will limit the potential further). For onshore activities, including recycling and movement of material returned to shore, appropriate management plans will be in place for facilities to ensure that no local air quality issues occur.

Table 4-7 Vessel days

VESSEL TYPE	MOBILIS ^N & TRANSIT	OPERAT ^N	INTERIM MOBILIS ^N	WEATHER DISRUP ^N	TRANSIT & DEMOB ^N	TOTAL
Light Construction Vessel flushing	2.25	6.75		2.1	1.5	12.6
Light Construction Vessel Infrastructure	4.75	17.25	1.75	5.5	4.75	34
MRV	3.00	12.75	4	4.15	3.5	27.4
MSV	2.75	3		3.5	2.5	11.75
Rock placement vessel	1.75	1		0.75	1	4.5

Emissions and emission balance during recycling

The actual deconstruction and recycling are estimated to emit in the order of 230 tonnes CO₂, while savings compared to new production represents about 700 tonnes. The overall balance gives about 475 tonnes of CO₂ saved by material recycling. Figures for NO_x and SO_x are also provided in below table, results being negative and generally low, however with some more uncertainty to the numbers. These emissions will generally be marginal from these activities.

Table 4-8 Emissions balance Gaupe materials to shore.

Activity	CO ₂ (tonnes)	NO _x (tonnes)	SO _x (tonnes)
Deconstruction, recycling and disposal	230	1,3	0,8
New production	-704	-0,8	-0,2
Emissions balance	-474	0,5	0,6

Total emissions:

Table 4-9 Total energy use and emissions

Project Activity	Energy use (Gigajoules)	CO ₂ (tonnes)	NO _x (tonnes)	SO ₂ (tonnes)
Removal of subsea structures, including wellhead protection structures, pipelines, flowlines, umbilicals and mattresses	43500	3205	74	4
Post-decommissioning survey and overtrawls	964	71	2	0,1
Onshore recycling and replacement of material decommissioned in situ	7550	230	1,3	0,8
TOTAL	52 014	3506	77,3	4,9

4.7.2. Mitigating measures

The appropriate management procedures will be in place to ensure the following:

- Use of low sulphur diesel;
- Operations planned to reduce vessel numbers and the duration of operations;
- All vessels comply with the Merchant Shipping (Prevention of Air Pollution from Ships) (Amendment) Regulations 2014;
- All combustion equipment subject to regular monitoring and inspections to ensure an effective maintenance regime is in place, ensuring all combustion equipment runs as efficiently as possible;
- All vessels have the appropriate UK Air Pollution Prevention or International Air Pollution Prevention certificates in place as required;
- Onshore facilities have appropriate management procedures in place to ensure that atmospheric emissions, including those from movement, storage, treatment and disposal of materials, are below levels that could affect local air quality.

4.7.3. Cumulative impact

Local air quality

The majority of the decommissioning activities are too remote 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. Whilst there may be an increase in emissions onshore, the additional potential emissions are sufficiently low that no cumulative impact on local air quality is expected.



Global climate

The issue of atmospheric emissions in terms of global climate is a specifically cumulative one. To understand the potential impact from the atmospheric emissions associated with the project, it is useful to set the emissions in the context of wider UK emissions. Whilst, an exact figure for offshore emissions in UK waters does not exist, the contribution of emissions from shipping activities can be summed with oil and gas industry emissions to provide a benchmark against which the project can be considered. The latest available total annual CO₂ emissions from oil and gas activity on the UKCS is estimated at 13,232,726 tonnes (for 2015, OGUK, 2016) and the latest total annual CO₂ emissions estimate for UK shipping is approximately 11,000,000 tonnes (for 2013, DECC, 2015, cited in Committee on Climate Change, 2015), giving a total of 24,232,726 tonnes of CO₂. The total CO₂ emissions from the Gaupe decommissioning activities are estimated to be approximately 3,502 tonnes, which will contribute approximately 0.014% of the atmospheric emissions associated with UK offshore shipping and oil and gas activities. The emissions from the project will thus likely have a limited cumulative effect in the context of the release of GHGs into the environment and their contribution to global climate change.

4.7.4. Transboundary impact

With regards to air quality, due to the lack of human receptors in the offshore Norwegian sector means that there will be no significant transboundary impacts in this respect.

With regards transboundary impacts, the impact assessment presented above for cumulative impact demonstrates that the Gaupe Hub Decommissioning activities will make no significant contribution to UK emissions to the global atmosphere. As such, there will be no significant transboundary impacts.

4.7.5. Residual impact

Considering all of the above, including that the anticipated emissions from the Gaupe decommissioning activities are very small, effects are unlikely to be discernible or measurable and the magnitude of impact is ranked as Slight. On the basis that the atmosphere has the capacity to accept the emissions without change, the receptor sensitivity is ranked as Low. Combining these rankings, the impact significance is defined as Slight.

Magnitude	Sensitivity	Significance
Slight	Low	Slight



4.8. Accidental events

The potential impact of any accidental hydrocarbon and chemical release will be determined by the characteristics of such release, its weathering properties, the direction of travel and whether environmental sensitivities lie in its path. These environmental sensitivities will have spatial and temporal variations. Therefore, the likelihood of any accidental release having a potential impact on the environment must consider the likelihood of the release occurring against the probability of that hydrocarbon or chemical reaching a sensitive area and the environmental sensitivities present in that area at the time of hydrocarbon or chemical release. The probability definitions presented in Table 4-9 have been developed to take account of this.

Table 4-9 Likelihood criteria for unplanned events

Definition	Environmental impact
A – Extremely remote	Never heard of in the industry; $<10^{-5}$ per year; Has never occurred within the industry or similar industry but theoretically possible.
B – Remote	Heard of in the industry; $10^{-5} - 10^{-3}$ per year; Similar event has occurred somewhere in the industry or similar industry but not likely to occur with current practices and procedures.
C – Unlikely	Has happened within the company or more than once per year in the industry; $10^{-3} - 10^{-2}$ per year; Event could occur within lifetime of similar facilities. Has occurred at similar facilities.
D – Possible	Has happened at the location or more than once per year in the company; $10^{-2} - 10^{-1}$ per year; Could occur within the lifetime of the project.
E – Likely	Has happened more than once per year at the location; $10^{-1} - >1$ per year; Event likely to occur more than once at the facility.

4.8.1. Sources and likelihood of occurrence

Accidental release from a vessel

Potential sources of accidental release from vessel operations include:

- Release of fuel inventory as a result of damage sustained during a collision, grounding or fire;
- Storage tank failure resulting in a release of chemicals; and
- Accidental release during decommissioning activities.



Dropped objects causing pipeline rupture.

There is the potential for the loss of objects during the decommissioning process. Dropped objects can vary in size from tools to large sections of topsides, the entire jacket, infrastructure or the loss of a vessel. Depending on size, the dropped object may cause a rupture to subsea infrastructure including pipelines and umbilicals. It is likely that vessels will transit to shore and cross live pipelines, but the time spent above such lines would be very limited and the structures would have been secured onto the vessels by that point (i.e. there would be no lifting or transfer of structures above any live lines). Therefore, the only plausible event resulting from a dropped object event is the release of chemicals and hydrocarbons remaining in the Gaupe lines. Information on specific chemical use and associated environmental impact assessment will be provided in the relevant permit (e.g. Master Application Template/Subsidiary Application Template) prior to the commencement of activity. Lines will be cleaned to a pre-agreed cleanliness level that will have negligible impact on the surrounding environment. For these reasons, combined with the likelihood of this event occurring being remote, this impact has not been assessed further.

Accidental releases onshore

Once infrastructure has been transported to an onshore dismantling site there is the potential for accidental hydrocarbon and chemical releases to occur, which may lead to contamination of land and groundwater of the surrounding environment. Hydrocarbon releases onshore are anticipated to be minimal in quantity as all infrastructure will be flushed and as hydrocarbon free as possible before it reaches the dismantling site for full decontamination and cleaning. Although the site has not been chosen yet, audits will be carried out to ensure relevant procedures are in place to prevent accidental chemical releases. The volume of any chemical release is likely to be extremely limited as a result of the limited scope and the likelihood, as defined in (table 5-9), is 'unlikely'. For these reasons, accidental onshore releases are not assessed further.

Behaviour of hydrocarbons at sea

The potential environmental impact of an accidental hydrocarbon release depends on a wide variety of factors, which include:

- Accidental release volume;
- Type of hydrocarbon released;
- Direction of travel of the slick;
- Weathering properties of the hydrocarbon;
- Any environmental sensitivities present in the path of the slick (these may change with time); and
- Sensitivity of the sea and beaching locations.

Accidental hydrocarbon release modelling for a vessel collision scenario has been undertaken as part of previous assessment work for the Armada Hub (BG Group, 2008). The scenario parameters are presented in table 4-10.

Table 4-10 Accidental hydrocarbon release modelling parameters

Source	Initiating event	Quantity	Oil type	Model type
Diesel storage	Collision	167.4 m ³	Diesel	Single trajectory (deterministic)



The model predicted there to be no shoreline impact from a release in the Armada Hub, with the diesel rapidly dispersing and evaporating. It persisted for 22 hours and travelled a total distance of 71.2 km from the release location (but note that this is a worst-case scenario). It should be noted that there will be a requirement for very limited use of vessels nearshore, and therefore the likelihood of beaching should there be an accidental release is low.

Environmental vulnerability to accidental releases

Environmental vulnerability is a function of both the likelihood of impact (as considered in previous sections) and the sensitivity of the environment. Offshore and coastal vulnerabilities need to be considered separately as different parameters will apply.

There can be impacts on plankton in the immediate area of the release for the duration of the release due to the dissolution of aromatic fractions into the water column. Such effects will be greater during a period of plankton bloom and during fish spawning periods. Contamination of marine prey including plankton and small fish species may then lead to aromatic hydrocarbons accumulating in the food chain. These could have long-term chronic effects such as breeding failure in fish, bird and cetacean populations. This may affect fish stocks of commercially fished species. A major release could also have a localised effect on the fishing industry, should certain areas be temporarily closed to fishing.

Juvenile fish and eggs are potentially the most sensitive life-stage to hydrocarbon discharges. As outlined earlier in the EA, a number of commercially important pelagic and demersal fish species are found in the vicinity of the project.

The JNCC has stated in a memorandum to the UK Parliament that the greatest risks to nature conservation of oil on the offshore sea surface are to seabirds (JNCC, 2011). The seasonal vulnerability of seabirds to surface pollutants in the immediate vicinity of the decommissioning activities, derived from JNCC block-specific data, suggest that seabirds in this area have an overall medium to high vulnerability to surface pollution, although some of the blocks exhibit very high vulnerability at certain times of the year. The magnitude of any impact will depend on the number of birds present, the percentage of the population present, their vulnerability to hydrocarbons and their recovery rates from oil pollution. The physical impact is one of plumage damage leading to loss of insulation and waterproofing.

Cetaceans are also present in the vicinity of the Armada Hub. In the event of an accidental release, the potential impact, will depend on the species and their feeding habits; the overall health of individuals before exposure; and the characteristics of the hydrocarbons. It is thought unlikely that a population of cetaceans in the open sea would be affected in the long-term (Aubin, 1990). Baleen whales are particularly vulnerable whilst feeding, as oil may stick to the baleen if the whales "filter feed" near surface slicks. Cetaceans are pelagic (move freely in the oceans) and migrate. Their strong attraction to specific areas for breeding or feeding may override any tendency cetaceans have to avoid hydrocarbon contaminated areas.

The likelihood of a hydrocarbon release impacting the coastal environment is a function of the likelihood of such an event occurring and the probability of the hydrocarbon beaching. The level of impact is also directly related to the volume of the hydrocarbons released, the volume of hydrocarbon beaching, the composition of the beached hydrocarbons, and the type of beach and receptors present on the oiled shore at the time of beaching. The hydrocarbons associated with the decommissioning activities that may beach in the event of an accidental release are marine diesel from a vessel, this diesel is particularly light with a relatively high API gravity and modelling has shown shoreline oiling is not predicted to occur (should a spill occur in the Armada Hub offshore area). Should an accidental release occur nearshore then beaching is more likely.



4.8.2. Mitigating measures

The following provides an overview of proposed measures that either reduce the probability of an accidental release, or reduce the consequences in the event of a release:

- Decommissioning and supply vessel personnel will be given full training in release prevention and actions to be taken in the event of an accidental release;
- Shipboard Oil Pollution Emergency Plans, mandatory under Marine Pollution (MARPOL) Convention 73/78 for ships above 400 gross tonnage, including modelling and appropriate response planning will be in place where relevant;
- A standby vessel will be present during decommissioning activities of the Gaupe Fields, as appropriate;
- Simultaneous operations will be actively identified and managed;
- Vessels will be selected which comply with International Maritime Organisation/Maritime and Coastguard Agency codes for prevention of hydrocarbon pollution;
- Operational procedures to be in place on board vessels including use of drip trays under valves, use of pumps to decant lubricating oils, use of lockable valves on storage tanks and drums;
- Chemical storage areas will be contained to prevent accidental release of chemicals;
- Vessels will be subject to an audit which will cover oil spill response, procedural controls, bunkering and storage arrangements;
- Visual inspection of hoses and connections prior to use;
- Test certification of loading hoses and valves; and
- Tool box talks will highlight the importance of minimising the likelihood of an accidental release occurring.

4.8.3. Cumulative effects

Existing hydrocarbon spill risks in the North Sea are associated primarily with oil and gas industry activities as well as other marine industries such as merchant shipping and fishing. However, as indicated by historical data, the likelihood of a major accidental release occurring is remote, and there will be no cumulative impact between the Gaupe decommissioning activities and associated activities in this respect.

4.8.4. Transboundary Impact

There is a high probability that an accidental hydrocarbon or chemical release would cross into the Norwegian sector. Despite the likelihood of a transboundary impact should such a release occur, the volumes would generally be expected to be small with limited scope for environmental impact. In the event of an accidental hydrocarbon release entering Norwegian waters, it may be necessary to implement the NORBRIT Agreement (the Norway-UK Joint Contingency Plan), which agreement sets out command and control procedures for pollution incidents likely to affect both parties, as well as channels of communication and available resources. The Maritime and Coastguard Agency Counter Pollution and Response Branch also have agreements with equivalent organisations in other North Sea coastal states, under the Bonn Agreement 1983. These measures aim to reduce the impacts associated with such events.



4.8.5. Protected sites

Direct interaction with coastal sites from an offshore or nearshore release

This section considers the potential for events related from the decommissioning activities to impact upon the conservation objectives (and ultimately site integrity) of important protected sites, specifically SPAs, SACs, NCMPAs and MCZs. The output of the accidental hydrocarbon release modelling described earlier has been compared against the location of SPAs, SAC, NCMPA and MCZ to determine where there is considered to be the potential for interaction. As outlined earlier in this section, shoreline oiling is not predicted to occur from the offshore operations. Although there will be some limited requirement for vessels to transit nearshore as material is recovered to shore, this represents a very small percentage of overall vessel requirements. As such, combined with the remote likelihood of an event occurring, direct interaction with any coastal or onshore protected sites is not expected to occur.

Direct interaction between an offshore release and receptors from coastal sites found offshore

In addition to direct interaction with a site (i.e. hydrocarbon crossing the boundary of a site), it is necessary to consider the potential that some qualifying features of some sites are mobile (e.g. seabirds, marine mammals) and that some individuals may forage or move through the area within which an accidental release has occurred. In terms of marine mammals for which sites are designated, bottlenose dolphins associated with the Moray Firth SAC are generally restricted to the 20 m depth contour in the Moray Firth and the Scottish east coast and are thus unlikely to be found in the vicinity of any potential hydrocarbon release that occurs offshore. Given that any such release would not reach the UK coast and that harbour seals usually forage within 40 – 50 km of their haul-out sites (SCOS, 2014), there is unlikely to be any interaction with harbour seals from SACs on the east Scottish coast. Grey seals may forage up to 200 km from haul-outs (e.g. McConnell et al., 1999) and mainly on the seabed at depths of up to 100 m (SCOS, 2014). However, after breeding, most grey seals at a SAC disperse away from the site, making it very difficult to assign an individual to a particular SAC outside of the breeding season. Grey seal usage of an SAC is therefore very time and space-specific. On this basis, and reviewing available data on grey seal movements (e.g. Cronin et al., 2011, SMRU, 2011), it is considered that a 20 km radius around SACs may be used as a guide to the potential for interactions with projects. Given this distance, there is unlikely to be any interaction with grey seals from SACs on the east Scottish coast in the event of an offshore accidental hydrocarbon release.

In terms of seabirds that may move offshore from SPAs into the area of potential offshore hydrocarbon release, it is very difficult to apportion these birds to specific SPAs, as discussed by Furness (2014), which defines biological appropriate, species-specific, geographic non-breeding season population estimates for seabirds. Furness (2014) used existing data and literature in order to determine biologically defined minimum population scales for key seabird species. For many seabirds, once breeding is complete, individuals are no longer restricted to foraging within certain distances (i.e. foraging ranges) from their breeding colony as there is no longer any requirement to return to eggs or chicks. For a number of key species there is strong evidence that once birds leave the breeding colony they become widely dispersed over large distances, often intermingling with birds from other breeding colonies (typically of the same species) and in some cases birds that have migrated from overseas breeding colonies (Furness, 2014). Consequently, given that individuals from an SPA population become so widely dispersed, the potential for an accidental release from the project to impact any of these birds becomes significantly diluted as it is not possible to know which SPA birds present belong to. Potential impacts from an offshore release



on birds during the non-breeding season (i.e. when they are offshore) are therefore expected to be negligible.

Direct interaction with offshore sites

For direct interaction with offshore sites without a land component, surface occurrence of released hydrocarbon within the site is taken as an indication that the site has the potential to be impacted. A hydrocarbon release encountering a site (offshore or coastal) has been considered for inclusion in this assessment where the probability of the encounter occurring (in the event of a very low probability accidental hydrocarbon release) is equal to or greater than 5%. On this basis, interaction between a vessel release and the following offshore sites may occur (and hence the potential for Likely Significant Affect has been investigated):

- Scanner Pockmark SAC;
- Norwegian Boundary Sediment Plain NCMPS; and
- East of Gannet and Montrose Fields NCMPS.

Marine diesel has a gravity of approximately 36.4°API and therefore floats on water. Once the lighter fractions of the hydrocarbon have evaporated, the remaining fraction is expected to form a stable water-in-oil emulsion. Therefore, given that the offshore sites located closest to the project are in water depths ranging from a minimum of 80 m to a maximum of approximately 120 m, it is very unlikely that hydrocarbons would be redistributed to these depths in sufficient quantities or thickness to affect the protected seabed features. For these reasons, there is predicted to be no Likely Significant Affect on sites designated for seabed features.

4.8.6. Cumulative impact

It is important to consider the potential for cumulative impacts to arise from the project acting upon the environment along with other developments. In terms of the potential for accidental releases from multiple projects to act together, the small potential releases outlined earlier in this assessment are of little concern due to their spatially and temporally restricted nature. Therefore, cumulative effects on protected sites are expected to be negligible.

4.8.7. Residual impact

The magnitude of the effect is predicted to be Moderate. A vessel collision risk assessment identified 21 shipping routes trafficked by an estimated 1,109 ships per year passing within 10 nm of the Armada platform, corresponding to an average of 3 vessels per day (Anatec, 2015). The majority of vessels were cargo vessels of 1,500 to 5,000 deadweight tonnage with 4% being tankers. Considering this and the mitigation measures outlined above, the likelihood of accidental release is Remote. On the basis that some of the habitats and species which an unplanned event could affect are afforded protection but that any potential release is not expected to interact with protected sites, the receptor sensitivity is ranked as Medium. Combining these rankings, the impact significance is defined as Minor and thus Not Significant.

Magnitude	Sensitivity	Likelihood	Significance
Moderate	Medium	Remote	Minor and not significant

4.9. Onshore

There is the potential for the onshore phase of decommissioning to interact with communities in the vicinity of the dismantling yard. Nearshore activities, such as movement of vessels between



the dismantling yard and the offshore Armada Hub area may interact with other users of the nearshore environment. The onshore (and associated nearshore) location has yet to be confirmed, but locations in both the UK and continental Europe are currently being considered. Whether in the UK or continental Europe, recycling of recovered material will be carried out at existing sites which will have in place site management plans and the correct licences for the proposed dismantling operations and as such will limit potential impacts to the environment and to local communities. Although no site has yet been confirmed, this assessment considers the potential onshore impacts and describes how these issues will be managed. Management of waste is considered separately in section 5.5, and air quality issues have already been addressed in section 5.6.

Light:

There will be no additional light above and beyond what is already emitted regularly from the selected dismantling yard. There will be limited light emissions from any nearshore laydown activity, but this will occur adjacent to the selected dismantling yard (i.e. in an area that already experiences ongoing light emissions).

Noise:

It might be necessary to dismantle the Gaupe subsea infrastructure that is brought onshore into suitably sized sections for transportation to the relevant recycling and disposal sites. The cutting action itself, which may also occur in the dedicated laydown area, will not be particularly noisy and will occur as part of current operation of the dismantling yard and dedicated laydown area. Noise will be managed as part of the yard's management practices.

Odour:

Although not large volumes are anticipated to be brought onshore, marine growth on the Gaupe infrastructure may produce an unpleasant odour which, when ashore, may be detectable by communities local to the dismantling yard. Environmental conditions such as prevailing wind direction and temperature will also determine the severity and area impacted by any such odour. Based on the small quantities, odour may be detectable for a number of weeks and it will be managed as part of the existing odour control procedures that will be part of any selected dismantling yard's management practices.

Road transport:

Although the dismantling yard has not yet been identified, there will likely be increased traffic, particularly resulting from the transportation of the segregated waste streams to their relevant end locations. Such increased transport in proximity to the yard will be managed as yard's traffic management practices.

4.9.1. Mitigating measures

The site chosen for decommissioning activities will have in place correct and up to date licences for operation and relevant site management plans. These will ensure operations on site minimise any potential environmental and social impacts. For specific issues detailed above:



- Site-specific socio-economic and environmental risks will be assessed while the dismantling yard location is selected;
- Noise will be managed as part of the onshore dismantling contract and as part of the selection process for the dismantling yard, noise management will be taken into consideration. Noise emitting activities should not occur at particularly sensitive times such as early morning and late night;
- In order to mitigate odour from marine growth, a dismantling yard will be selected that has procedures in place to remove and dispose of marine growth in a manner that will avoid odour nuisance occurring. This could take the form of an odour management plan being in place within the dismantling yard, management measures could include rapid removal of marine growth and spraying of odour suppressants; and
- The transportation routes of the materials will be assessed when the onshore location is selected and a road transport minimisation plan considered.

4.9.2. Cumulative Impact

Any cumulative impacts will be dependent on the exact location of the recycling yard as different locations will have different industries and communities in the vicinity, which could contribute cumulatively to the potential impacts identified. However, given the onshore Gaupe infrastructure decommissioning activities are not anticipated to significantly change the impacts occurring at any particular yard, cumulative impacts are not expected to occur.

4.9.3. Transboundary impact

The extent of the potential for transboundary impacts to occur is dependent on the location of the onshore recycling yard. However regardless of whether a UK or continental Europe location is selected, any transboundary impacts will be managed in the same manner under site management plans and relevant licensing.

4.9.4. Residual impact

The sensitivity of the receptor for potential impacts from onshore dismantling activities is considered to be Medium as it involves the local community. The proposed recycling activities associated with the Gaupe Infrastructure decommissioning are not anticipated to significantly increase any potential impacts above and beyond what already occurs at the chosen dismantling yard. Taken this into account and the proposed mitigation measures, the magnitude of the potential impacts is considered to be Slight and the significance is considered Slight and Not significant.

Magnitude	Sensitivity	Significance
Slight	Medium	Slight



4.10. Waste management

Approximately 260 tonnes of steel will be removed from the field from riser pipelines and umbilicals, spools and SSIV. Approximately 844 tonnes of concrete from mattresses and 100 tonnes of grout bags will be removed.

4.10.1. Routine Vessel Waste

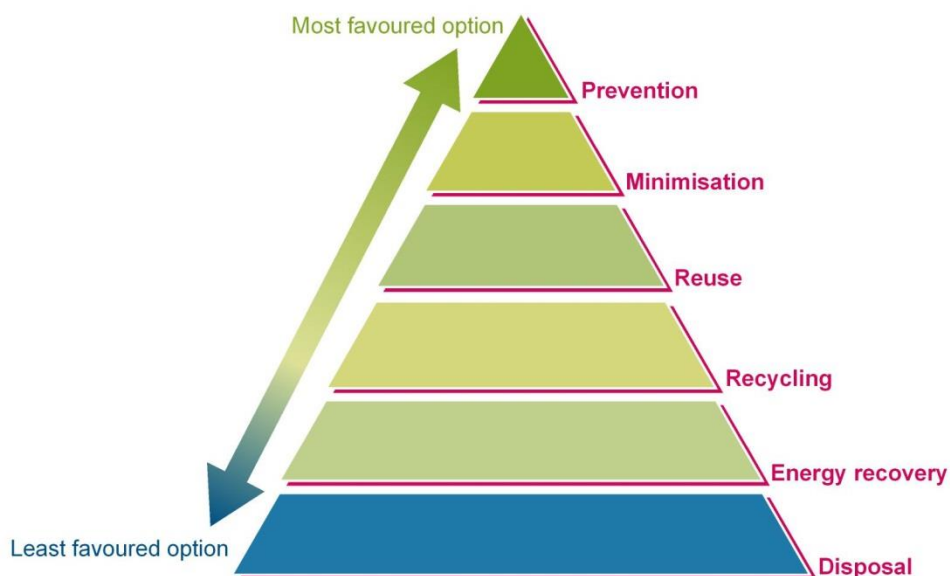
The discharge of food waste, bilge water and grey water (water and chemicals from washing and laundry facilities) from vessels to sea during the decommissioning operations has the potential to cause short-term, localised organic enrichment of the water column and an increase in biological oxygen demand. This could contribute to a minor increase in plankton and attract fish to the area. However, food waste is typically macerated to increase the rate of dispersion and biodegradation at sea and waste water will be treated appropriately before being discharged to sea, in accordance with the requirements of the MARPOL convention.

4.10.2. Waste from onshore dismantling

The anticipated waste streams include steel, copper and aluminium, as well as marine growth. It is estimated that approximately 1 tonne of dry weight marine growth is present on the Gaupe infrastructure. Most of the marine growth is soft marine growth (e.g. anemones and the soft coral *Alcyonium digitatum*), but the hard marine growth includes tube worms, barnacles and mussels. It is expected that very small portion will be brought ashore for processing and disposal (since it will be jet off offshore or it will dry and drop off during transport). The receiving recycling yard will strip the installation into its components before they undergo further processing. It is proposed that marine growth be either disposed of to landfill or composted. An additional option is to send some of the marine growth to be disposed of at an anaerobic digestion facility for use as a fertiliser on land.

4.10.3. Management measures

The project is committed to reducing waste production and to effectively managing all produced waste by applying approved and practical methods. The Gaupe decommissioning project will utilise a waste management approach supported by the waste hierarchy shown in Figure 4-2. The waste management hierarchy is based on the principle of waste disposal only where re-using, recycling and waste prevention cannot be undertaken. The decommissioning of the Gaupe infrastructure will be compliant with the Shell Control Framework Waste Manual.

**Figure 4-2 Decommissioning waste management hierarchy**

A Waste Management Plan will be developed for the Gaupe decommissioning project to further identify the types of waste and the management procedures for each waste stream. The Waste Management Plan will detail the measures in place to ensure that the principles of the Waste Management Hierarchy are followed during the decommissioning (as described above). For example, transfer notes will accompany all non-hazardous waste to shore and consignment notes will be in place for any hazardous waste. Furthermore, radioactive waste will be processed by a licensed facility capable of taking contaminated material under appropriate licences and disposing accordingly. The Waste Management Plan will detail the checks that will be undertaken on the selected dismantling yard and any onward disposal facilities to ensure all permits and licenses are in place for the handling and disposal of the waste types identified. The project will ensure that waste is transferred by an appropriately licensed carrier who should have a Waste Carrier Registration, Waste Management Licence or Exemption, as appropriate for the type of waste. The contractor(s) that are assigned to the work will be required to maintain a waste audit trail through to recycling or disposal facility.

4.11. Environmental and social performance management

Beyond the main period of preparation for decommissioning in situ and removal of components of the Gaupe infrastructure, the Gaupe decommissioning project has limited activity associated with it (beyond post-decommissioning monitoring). The focus of environmental and social performance management for the project is therefore to ensure that the activities that will take place during the limited period of decommissioning happen in a manner acceptable to the project. It will also be important to ensure that any lessons learned during the decommissioning of the Gaupe infrastructure are shared within the company. The following sections detail the procedures in place that will ensure this occurs.



4.11.1. Environmental management system (EMS)

Shell ensures that it meets its environmental commitments through its EMS, which is in accordance with ISO 14001, meaning it meets the requirements of OSPAR Recommendation 2003/5 on the requirements of an EMS. The EMS is embedded in the Corporate Management System (CMS), a set of controls that help Shell comply with laws and regulations and which facilitate the implementation of the company's Health, Security, Safety, the Environment and Social Performance (HSSE-SP) policy. The HSSE-SP Policy (Figure 4-3) details Shell's commitment to protect the environment and demonstrates Shell's systematic approach to environmental management.

4.11.2. Ensuring decommissioning activities meet Shell expectation

The Gaupe Project Manager is responsible for ensuring that the CMS described above, containing within the EMS and HSSE-SP policies, is applied to all activities. A Gaupe decommissioning project HSSE-SP Plan will be developed which outlines how HSSE-SP issues will be managed and how Shell's HSSE-SP policies and CMS will be implemented effectively throughout the project. The HSSE-SP Plan will apply to all work carried out on the Gaupe decommissioning project be it onshore or offshore. Performance will be measured to satisfy both regulatory requirements including compliance with environmental consents, as well to identify progress on fulfilment of project objectives and commitments.

The Gaupe decommissioning project will use contractors in the execution of the decommissioning work scope. All companies contracted to Shell are required to work to similar, consistently high standards and to achieve comparable levels of performance adopted by Shell. Project and Contractor employees, on their part, have a clear responsibility to exercise discipline, maintain a high level of awareness, prevent injury to themselves and others, protect the environment and comply with all statutory and contractual obligations between Shell and the relevant Contracting counterparty. Contactor competency is reviewed at the tendering stage where checks are made as to whether contactors have received the level of training required and have the relevant qualifications.



Figure 4-3 Norske Shell HSSE-SP Policy

**SHELL COMMITMENT AND POLICY ON
HEALTH, SECURITY, SAFETY, THE
ENVIRONMENT AND SOCIAL PERFORMANCE**

COMMITMENT

In Shell we are all committed to:

- Pursue the goal of no harm to people;
- Protect the environment;
- Use material and energy efficiently to provide our products and services;
- Respect our neighbours and contribute to the societies in which we operate;
- Develop energy resources, products and services consistent with these aims;
- Publicly report on our performance;
- Play a leading role in promoting best practice in our industries;
- Manage HSSE & SP matters as any other critical business activity; and
- Promote a culture in which all Shell employees share this commitment.

In this way we aim to have an HSSE & SP performance we can be proud of, to earn the confidence of customers, shareholders and society at large, to be a good neighbour and to contribute to sustainable development.

POLICY

Every Shell Company:

- Has a systematic approach to HSSE & SP management designed to ensure compliance with the law and to achieve continuous performance improvement;
- Sets targets for improvement and measures, appraises and reports performance;
- Requires contractors to manage HSSE & SP in line with this policy;
- Requires joint ventures under its operational control to apply this policy, and uses its influence to promote it in its other ventures;
- Engages effectively with neighbours and impacted communities; and
- Includes HSSE & SP performance in the appraisal of staff and rewards accordingly.


Ben van Beurden
Chief Executive Officer


Agnete Johnsgaard-Lewis
Country Chair
A/S Norske Shell

Originally published in March 1997 and updated by the Executive Committee December 2009.

General Disclaimer: The companies in which Royal Dutch Shell plc directly and indirectly owns investments are separate entities. In this Policy the expression "Shell" is sometimes used for convenience where references are made to companies within the Shell group or to the group in general. Likewise, the words "we", "us" and "our" are also used to refer to Shell companies in general or those who work for them. These expressions are also used where no useful purpose is served by identifying specific companies.





Once contactors have been identified, HSSE-SP interface documents will be set up between Shell and its contractors to ensure that Shell's HSSE-SP policy is effectively communicated and implemented. These interface documents agreed by all parties and periodically reviewed, will be held by the relevant HSE managers. An assurance programme, including a comprehensive plan of environmental audits will be put in place to monitor contractor competences and standards with regards to HSSE-SP management and effective delivery of Shell's HSSE-SP policy objectives.

Shell has an extensive assurance programme which includes a comprehensive programme of environmental audits. These will be important in confirming that the onshore dismantling yards will operate with due regard to onshore communities. As a requirement of ISO 14001, environmental considerations are integrated into audit programmes that address all aspects of Shell's business. The leadership teams throughout Shell carry out regular reviews of the CMS, taking into account any relevant matters including the findings of audits, non-conformances and environmental performance.

4.11.3. Learning for future projects

Shell promotes compliance and continuous improvement in performance by establishing appropriate environmental objectives and targets within an annual HSSE-SP plan. Environmental specialists are available to provide advice to management on environmental matters. Communication with the authorities and interested parties is also an important part of Shell's approach to environmental management.

As Shell has a number of assets that will require decommissioning in the future, a key outcome of the Gaupe decommissioning project will be a record of lessons learned that can benefit future similar projects.

4.11.4. Scottish National Marine Plan

In addition to considering environmental and social performance in the execution of the decommissioning activities, it is considered that the Gaupe decommissioning project is in broad alignment with the objectives and policies of the Scottish National Marine Plan published by the Scottish Government. The extent to which the Gaupe decommissioning project is aligned with the published Scottish National Marine Plan oil and gas objectives and policies that are relevant to decommissioning is summarised in table 4-11.



Figure 4-11 Oil and Gas objective policies

Objective/policy	Project details
Maximise the recovery of reserves through a focus on industry-led innovation, enhancing the skills base and supply chain growth.	The Gaupe has extracted hydrocarbons to the point that maximum economic recovery has been achieved. The decommissioning activities will provide high-skilled work in an emerging industry.
An industry which delivers high-level risk management across all its operations and that it is especially vigilant in more testing current and future environments.	Extensive mitigation measures and response strategies have been developed for identified risks.
Where possible, to work with emerging sectors to transfer the experience, skills and knowledge built up in the oil and gas industry to allow other sectors to benefit and reduce their environmental impact.	The project will draw on experienced engineers, environmental specialists and other groups that are not necessarily limited to oil and gas experience.
Where reuse of oil and gas infrastructure is not practicable, either as part of oil and gas activity or by other sectors such as carbon capture and storage, decommissioning must take place in line with standard practice, and as allowed by international obligations. Reuse or removal of decommissioned assets from the seabed will be fully supported where practicable and adhering to relevant regulatory process.	Full consideration has been given to all available decommissioning options, including reuse and removal, as part of the development of the project.
Consenting and licensing authorities should have regard to the potential risks, both now and under future climates, to oil and gas operations in Scottish waters, and be satisfied that installations are appropriately sited and designed to take account of current and future conditions.	The proposed activities have been developed in a way that there will not be a significant impact on the physical, biological and socio-economic environment, now or in the longer-term.
Consenting and licensing authorities should be satisfied that adequate risk reduction measures are in place, and that operators should have sufficient emergency response and contingency strategies in place that are compatible with the National Contingency Plan and the Offshore Safety Directive.	Potential environmental impacts have been reviewed as part of this EA and relevant mitigation measures developed.



5. Conclusions

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

The development of the decommissioning programmes for the Gaupe infrastructure has been informed by ongoing appraisal of the environmental impacts and risks posed by options under consideration. The EA has been based on an understanding of the baseline environment established from multiple web-based sources and seabed surveys.

5.1 Protected sites and species

This Environmental Appraisal has concluded that there will be no significant impact on any Annex I habitat (of the Habitats Directive). There are a number of offshore and coastal conservation areas on the Scottish mainland that have been designated under the Habitats Directive as SACs, under the EU Birds Directive as SPAs and under the Marine Scotland Act 2010 and Marine and Coastal Access Act 2009 as NCMPAs and MCZs. The potential for significant impacts on any such site has been considered within each impact assessment, with particular focus given to the Norwegian Boundary Sediment Plain NCMPA as the Gaupe field is located approximately 5 km away. Given the short-term duration of the decommissioning activities, the mitigation measures to be executed and the expected swift recovery from the approved decommissioning activities, the Gaupe decommissioning project is confident that the conservation objectives or site integrity of any SAC, SPA, NCMPA or MCZ is unlikely to have any significant or mid to long lasting impact.

The majority of species protected under Annex I of the Birds Directive that are present within the North Sea will generally be found much closer to shore and may only encounter the project with any regularity during the limited period of the vessel activity. Given such vessel use will result in limited interaction with individuals of those protected species, the Gaupe decommissioning project will not likely result in significant impacts to those populations.

The presence within the Gaupe area of species protected under Annex II of the Habitats Directive is limited to marine mammals. Marine mammal species that may be present in the Gaupe area occur in relatively low densities, or occur only occasionally, or as casual visitors. The EA has assessed whether the noise emitting operations associated with the project have the potential to result in injury or disturbance to any marine mammal species. This assessment concluded that there is a very low likelihood of injury (such as temporary or permanent hearing loss), or disturbance as a result of the activities associated with the project and that potentially environmental impacts would not result in population level impacts.

Considering the above, no significant impacts are expected upon protected species and habitats.

5.2 Cumulative and Transboundary impacts

A review of each of the potential environmental impacts associated with the Gaupe decommissioning project, and the proposed mitigation measures against the range of other activities in the region, indicates that no significant cumulative impacts are expected.

A review of each of the potential environmental impacts associated with the Gaupe decommissioning project and the mitigation measures proposed, indicate that no significant transboundary impacts are expected.

The residual environmental impacts for the Gaupe decommissioning project (i.e. following application of any mitigation) are summarised in table 5-12.

Table 5-12 Summary of residual environmental impacts

Impact	Key potential impacts assessed	Mitigation identified?	Residual risk	Environmental Impact / Significance
Seabed disturbance	Effects of disturbance of seabed on habitats and species.	Yes	Slight	Not significant/low impact
Underwater noise	Vessel use, survey operations and cutting noise on marine mammals and fish	Yes	Minor	Not significant/low impact
Other sea users	Short and longer-term effects on fisheries use of the Armada Hub	Yes	Minor	Not significant/low impact
Discharges to sea	Short and longer-term release from lines decommissioned <i>in situ</i>	Yes	Slight	Not significant/low impact
Energy use and atmospheric emissions	Emissions resulting from vessel use and recycling/replacement of materials	Yes	Slight	Not significant/low impact
Accidental events	Vessel-vessel collision	Yes	Minor	Not significant/low impact
Onshore	Disturbance to onshore communities from dismantling activities	Yes	Slight	Not significant/low impact

5.3 Legacy

Once decommissioning activities have been completed, all subsea structures (such as manifolds) has been removed in accordance to the approved schedule. Whilst some of the pipelines, flowlines and umbilicals will remain in place, they will be buried in trenches and protected by rocks where necessary. The rock profiles will be made suitable for overtrawling by fishing gear, and the trenches will be as near to flat with the seabed as can be achieved in order to permit overtrawling by fishing gear. Prior to the decommissioning activities being formally closed out, chain mats will be trawled over the Gaupe pipelines and umbilicals to confirm the lack of snagging risks.

Once these overtrawls are completed, a risk-based strategy will be developed and agreed with BEIS to monitor (and remediate if necessary) any snag risks that may develop in the future as infrastructure decommissioned in situ degrades. Given that there will be low snag risk at the point of decommissioning close-out and given that appropriate monitoring and remediation will



be undertaken beyond close-out, there is expected to be no exclusion of fishing from the area (either due to the presence of physical infrastructure or due to perceived snag risk)

5.4 Final remarks

The EA presented in this document has been informed, in part, by extensive stakeholder engagement, the Comparative Assessment process and by specialist environment studies (such as the environmental baseline surveys). This has facilitated the development of a robust environmental baseline and a comprehensive environmental assessment, which has considered the resultant environmental impact. An integral part of the EA has been the development of appropriate mitigation measures (detailed within each of the relevant impact assessment sections) to ensure that environmental impact is minimised as far as is reasonably practicable. The implementation of mitigation measures will be tracked as part of the Gaupe decommissioning project HSSE-SP Plan.

Taking into account the environmental sensitivities of the area, the proposed decommissioning activities, and the mitigation measures that will be deployed, it is concluded that the Gaupe decommissioning project will result in low environmental impact.



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Appendix A: ENVID Methodology

The purpose of the ENVID was to identify potential environmental hazards, or 'aspects', associated with the different operations involved in the decommissioning of the Gaupe field.

Prior to the ENVID a Terms of Reference was issued describing the ENVID process, an overview of the project and an overview of the environmental sensitivities in the area.

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

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

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

Impact Identification and Aspects

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

Table B- 1: Shell Environmental Impact Assessment Aspects

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

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

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

Assessment of Impact Significance

The significance of environmental impacts were assessed in terms of:

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

Magnitude

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

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

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

Table B- 2: Definitions of Impact Magnitude

LEVEL	DEFINITION	ENVIRONMENTAL IMPACT
0	No effect	<ul style="list-style-type: none"> • No environmental damage or effects.
1	Slight effect	<ul style="list-style-type: none"> • Slight environmental damage contained within the premises. Example: Small spill in process area or tank farm area that readily evaporates; • Effects unlikely to be discernible or measurable; • No contribution to transboundary or cumulative effects; • Short-term or localised decrease in the availability or quality of a resource, not effecting usage.
2	Minor effect	<ul style="list-style-type: none"> • Minor environmental damage, but no lasting effects; • Change in habitats or species which can be seen and measured but is at same scale as natural variability; • Unlikely to contribute to trans-boundary or cumulative effects;



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

* To be used for unplanned events only

Receptor Sensitivity

Receptors were categorised into different groups:

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

Receptor sensitivity criteria were based on the following key factors:

- **Importance of the receptor at local, national or international level:** for instance, a receptor will be of high importance at international level if it is categorised as a designated protected area (such as Ramsar site or Special Area of Conservation (SAC). Areas that may potentially contain e.g. Annex I Habitats are of medium importance if their presence/extent has not yet been confirmed.
- **Sensitivity/vulnerability of a receptor and its ability to recovery:** for instance, certain species could adapt to changes easily or recover from an impact within a short period of time. Thus, as part of the receptor sensitivity criteria (Table B- 3), experts considered immediate or long term recovery of a receptor from identified impacts.
- **Sensitivity of the receptor to certain impacts:** for instance, vessel emissions will potentially cause air quality impacts and do not affect other receptors such as seabed.

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

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

Evaluation of Significance

Planned Events

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

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

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

Unplanned Events

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

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

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

Table B- 5: Likelihood criteria.

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

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

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



Appendix B: ENVID Output

Aspect	Activity										Mitigation	Consider in the EIA?	Actions/Comments
	Reverse construction/ prep work	Subsea structure, pipeline/ umbilical and spools removal/ prep for leave in situ	Remove Amada platform topsides and transfer to shore	Remove Amada jacket and template and transfer to shore	Spud can remediation	Nearshore jacket transfer/ dismantling	Onshore dismantling	Offshore debris clearance and overtrawl trials	Legacy	Planned/ Unplanned			
Emissions to air													
Gaseous emissions													
- Vessels and machinery, onshore transport	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	P	- Low sulphur diesel - Maintenance programme - MARPOL - Campaign, logistics, sharing vessels to minimise use	Yes	- Action: Clarify which activities are required to be in the scope of the EIA.
- Flaring	No	No	No	No	No	No	No	No	No	P		No	- Flaring will occur at CATS when the pigs in the export pipelines slow down and the pressure drops to below that which could be re-compressed to meet export specifications. This is out of scope, however.
- Power generation on offshore or onshore facilities (vessels covered above)	Yes	No	No	No	No	No	Yes	No	No	P	- Maintenance programme - Demonstration of BAT/ energy optimisation - Fuel gas use will cease at CoP, with the turbines moving over to diesel. They will then be replaced with a single smaller diesel turbine.	Yes	- Onshore power generation from the dismantling yard is excluded from the scope at this point, with emissions captured under the recycling and replacement calculations
- Material recycling and replacement	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	P		Yes	- Note that not all material returned to shore need be destined for the same location/yard. - There is assumed to be no materials returned to shore or added offshore during legacy activities (i.e. monitoring only).
Discharges to water													
Fluids and other materials into water													
- Routine vessel (e.g. greywater, blackwater, ballast) and/or facilities discharges	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	P	- IMO Ballast Water Management Convention, including Ballast water plan and log book - Treatment to IMO standards - Compliance with company's marine assurance standards	No	
- Chemicals/hydrocarbon discharges	No	Yes	No	No	No	No	Yes	No	Yes	P	- Selection of chemicals with less potential for environmental impact, or already at that level - Environmental risk assessment through the MATs/SATs system - Decom yard management plans, selection, auditing - Target cleanliness of gas export of 30 mg/l, but certainly less than 100 mg/l	Yes	- Some of the umbilical cores are blocked, which may cause contents to be released when outs are made - Corrosion/scale/asphaltene inhibitors are OCNS Group E or CHARM Gold categories - Seepage in cores of any umbilicals left in place would occur very gradually over a long period of time - Methanol may be left in the cores of umbilicals as it is problematic to displace without being released to sea through the produced water system - Action: Discuss further with BEIS the requirement for any additional flushing/cleaning of umbilical cores.
- Accidental chemical/hydrocarbon release (inc. export pipelines, vessels, both offshore and nearshore)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	UP	- SOPEP, including modelling and appropriate response planning (for vessels over 400 gross register tonnage) - Maintenance procedures - SIMOPs - Bulk handling procedures and personnel training - Vessels will be selected which comply with IMO/MCA codes for prevention of oil pollution - Preferred operational procedures to be in place onboard Vessels including use of drip trays under valves, use of pumps to decant lubricating oils, use of lockable valves on storage tanks and drums - Chemical storage areas contained to prevent accidental release of chemicals - Maintenance procedures - Pre-mobilisation audits will be carried out including a comprehensive review of spill prevention procedures - Arrangements in place to track spill	Yes	- Some potential for accidental events when recovering the pigs following the export pipeline flushing and cleaning
Effects on land including groundwater													
Fluids into soil and groundwater - discharge	No	No	No	No	No	No	No	No	No	P		No	



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Aspect	Activity										Mitigation	Consider in the EIA?	Actions/Comments
	Reverse construction prep work	Subsea structure, pipeline umbilical and spools removal/ prep for leave in situ	Remove Armada platform topsides and transfer to shore	Remove Armada Jacket and template and transfer to shore	Spud can remediation	Nearshore jacket transfer/ dismantling	Onshore dismantling	Offshore debris clearance and overtrawl trials	Legacy	Planned/ Unplanned			
Fluids into soil and groundwater - accidental release	No	No	No	No	No	No	Yes	No	No	UP	- Audits will be carried out of onshore yards including a comprehensive review of spill prevention procedures - Chemical storage areas contained to prevent accidental release of chemicals - Maintenance procedures	Yes	
Waste materials	See sub-categories												
- Non-hazardous waste	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	P	- Project waste management plan, use of licensed waste contractors/sites, waste transfer notes - Develop WMP prioritising reuse and recycling - Contractor to maintain a waste audit trail through to recycling or disposal facility - Contractor to report waste inventories - Audit of yard's waste management	Yes	- Possible scale/wear on the export pipeline returned during piggings - Temporary steel lift points may be required on the topsides/jacket/template - May also require lifting loops on subsea structures - Mattresses are capable of being lifted - SEPA don't advocate leaving offshore but point out the issues associated with bringing potentially large numbers to shore - Plan to clean topsides offshore
- Hazardous waste (including F-gases)	Yes	No	Yes	Yes	No	No	Yes	No	No	P	- Project waste management plan, use of licensed waste contractors/sites, waste transfer notes - Contractor to maintain a waste audit trail through to recycling or disposal facility - Contractor to report waste inventories - Audit of yard's waste management - Responsible for material to be recycled continues up to the point it is in a form that can be used for other purposes	Yes	- Note: this item refers to hazardous waste that is identified as such offshore and then returned to shore for treatment/disposal (e.g. passive fire protection) - Solid waste from piggings may be hazardous
- Radioactive waste (including naturally occurring radioactive material)	Yes	No	Yes	Yes	No	Yes	Yes	No	No	P	- Project waste management plan, use of licensed waste contractors/sites, waste transfer notes - Contractor to maintain a waste audit trail through to recycling or disposal facility - Contractor to report waste inventories - Audit of yard's waste management - Licensed facility capable of taking contaminated material under appropriate licence and disposing appropriately (e.g. incineration) - Company procedures during preparation to return radioactive material to shore	Yes	
- Marine growth	No	Yes	No	Yes	No	Yes	Yes	Yes	No	P	- Project waste management plan, use of licensed waste contractors/sites, waste transfer notes - Develop WMP - Contractor to maintain a waste audit trail through to recycling or disposal facility - Audit of yard's waste management - Consider jetting offshore	Yes	- Primarily an issue for the jacket, but there is some growth on other metal structures. Very little on the mattresses - Not cost effective to jet the mattresses clean - May jet off material on the barges whilst structures are being brought to shore - SEPA has advised of 3 sites capable of handling marine growth, but none are near disposal yards - Consideration will be given to local land farm use - Experience that marine growth falls off during transit to shore but dies off and may emit odour for in excess of one month
Disturbance of soil/subsoil (earth tremors, water table)	Not relevant												
Extraction and consumption of resources	Not relevant												
Use of raw materials and additives (including chemicals, rock cover)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	P	- Planning of activities will minimise use of materials (there is also a financial driver for this)	No	
Water consumption (including seawater)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	P		No	
Energy consumption (fuel use and power consumption)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	P	- Scheduling/design to optimise opportunities to use resources more efficiently (e.g. at same time) - Move from gas -> diesel -> smaller diesel turbines on Armada as demand reduces	No	- Energy use will be noted as part of the emissions to air assessment but not specifically considered.

Aspect	Activity										Mitigation	Consider in the EIA?	Actions/Comments
	Reverse construction prep work	Subsea structure, pipeline umbilical and spools removal/ prep for leave in situ	Remove Armada platform topsides and transfer to shore	Remove Armada Jacket and template and transfer to shore	Spud can remediation	Nearshore jacket transfer/ dismantling	Onshore dismantling	Offshore debris clearance and overtrawl trials	Legacy	Planned/ Unplanned			
Use of space (physical presence)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	P	- Campaign planning to limit vessel days to minimum required - Collision risk assessment - Notice to mariners	Yes	
Hydrocarbon extraction (depletion of resource)	Not relevant												
Others	Not relevant												
Radiation - heat and ionising	Yes	No	Yes	Yes	No	Yes	Yes	No	No	P	- Comply with ionising radiation requirements - Comply with any local procedures	No	- Heat from welding activities - Heat source of the platform being removed
Noise and vibration	See sub-categories												
- Underwater noise from vessels (injury/disturbance to marine species)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	P	- Campaign planning to limit vessel days to minimum required - Require evidence from bidders in tendering that they have considered environmental sensitivities in nearshore handling locations	Yes	- No explosives required
- Underwater noise from cutting (injury/disturbance to marine species)	No	Yes	No	Yes	No	No	No	No	No	P	- Limit the duration of the noise emitting activities - Suitable technology for cutting will be selected to ensure the effectiveness of the cutting, minimising the duration, disturbance and risk of requiring the activity to be repeated - No underwater cutting in nearshore areas	Yes	- Diamond wire cutting to be used. HSE document presents source level of 120 - 170 dB - No MMCs required - Nearshore cutting will occur above the waterline
- Airborne noise, including traffic movements at onshore sites	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	P	- Limit the duration of the noise emitting activities - Environmental audit of dismantling yard (including site visit) - Yard to engage with local communities - Review records of engagement with communities and close out of issues - Contract award should include recognition of social issues including noise	Yes	
Odour (onshore) (e.g. from marine growth)	No	No	No	No	No	Yes	Yes	No	No	P	- Environmental audit of dismantling yard - Selection of a yard that has procedures in place to dispose of marine growth in a manner that will avoid odour nuisance	Yes	- Welding emits a gaseous smell - Offshore odour is out of scope as it is considered an HSE issue rather than a societal one for the EIA
Light	See sub-categories												
- Offshore (particularly seabirds)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	P	- Lighting directed below the horizontal plane unless required for technical or safety reasons	No	
- Onshore	No	No	No	No	No	Yes	Yes	No	No	P	- Environmental audit of dismantling yard - Yard to engage with local communities - Review records of engagement with communities and close out of issues	Yes	
Dust	No	No	No	No	No	No	Yes	No	No	P	- Environmental audit of dismantling yard - Yard to engage with local communities - Review records of engagement with communities and close out of issues - Bid evaluation for onshore activities should consider economic, environment and social issues	Yes	- Scopes of EIA excludes mining of rock. - Action: For consistency of documents, the EIA Report is to make use of the terms 'rock placement' for the activity and 'rock cover' to describe the material
Materials to subsurface/disturbance to the soil or subsoil (applies to deep earth layers only)	Not relevant												Note: some chemicals may be disposed of within the wells at Gaupe, but these wells are outwith the scope of this EIA.
Aesthetics (visual amenity)	See sub-categories												
- Offshore	No	No	Yes	Yes	No	Yes	No	No	No	P	- Campaign planning to limit vessel days to minimum required	Yes	
- Onshore	No	No	No	No	No	No	No	No	No	P	- Environmental audit of dismantling yard - Yard to engage with local communities - Review records of engagement with communities and close out of issues	No	- Could be limited number of visitors should the jacket be brought nearshore for dismantling
Biodiversity	See sub-categories												



Aspect	Activity										Mitigation	Consider in the EIA?	Actions/Comments
	Reverse construction/ prep work	Subsea structure, pipeline/ umbilical and spuds removal/ prep for leave in situ	Remove Amada platform topsides and transfer to shore	Remove Amada Jacket and template and transfer to shore	Spud can remediation	Nearshore jacket transfer/ dismantling	Onshore dismantling	Offshore debris clearance and overtrawl trials	Legacy	Planned/ Unplanned			
- Interaction with seabed habitats/species (no test excavations around jacket legs, trenching, backfill, rolling (sediment stirred up by ROV), anchored barge if selected)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	P	<ul style="list-style-type: none"> - Limit the footprint of the activities - Anchoring plan for barge (if anchored barge selected) - Optimise rock placement (e.g. FFPV, bags, grade etc.) - Review of survey data for distribution of sensitivities - No anchoring in the NCMPA - Discussion of rock grading with SFF 	Yes	<ul style="list-style-type: none"> - Overtrawability trials likely to cover 100 m either side of a potential obstacle, and have turning circles at either end - Action: Test excavations to be added to the EIA - Report project description - Spud can remediation may include 1) placement of grout bags and mattresses with a rock cover 2) Mass Flow Excavation (MFE) to make overtrawable 3) rock cover 4) do nothing - Action: Discuss further with BEIS the remediation options for the spud can inlets - There are sediments with elevated hydrocarbon content underneath the platform. They are considered not to be oil-based mud cuttings as they were deposited subsequent to the prohibition on CBM being discharged directly to the seabed - Not possible for laydown to occur close to some potential dismantling yards, such as Seifast where seabed protections exist
Drill cuttings disturbance	Yes	No	No	Yes	No	No	No	Yes	No	P	<ul style="list-style-type: none"> - Cutting piles internally to minimise seabed disturbance - Selection of test excavation site away from drill cuttings - Stakeholder engagement - Disturbance included on relevant Marine Licence, if proposed in the future - Debris in the cuttings will be recovered with an ROV and not by overtrawl 	Yes	<ul style="list-style-type: none"> - Action: Further discussion between Nodas and BG required on the need for modelling of disturbance to drill cuttings - Total volume of cuttings in the main pile under the helideck is limited, but it is possible that spotting on the surface could occur should there be any disturbance - Action: Require consideration of cumulative impact of drill cuttings presence/disturbance in the EIA
Livelihood / employment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	P		No	<ul style="list-style-type: none"> - Although some positives onshore, the loss of jobs offshore from cessation of production is likely to balance any positive effect.
Collision risk	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	UP	<ul style="list-style-type: none"> - UKHO standard communication channels including Kingfisher, Notice to Mariners and radio navigation warnings - Consultation will be undertaken with relevant authorities and organisations - Guard vessels - Logistics plan 	Yes	
Snagging of fishing gear	No	No	No	No	No	No	No	Yes	Yes	UP		Yes	<ul style="list-style-type: none"> - Both the long and short section of the 20" gas export pipeline is to be left in situ - The Maria umbilical will be re-trenched as there are exposed sections - Where rock is required to cover cut ends, 1 to 5 tonnes of rock will be used per end
Dropped objects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	UP	<ul style="list-style-type: none"> - Overtrawability trials following activities 	Yes	<ul style="list-style-type: none"> - Procedures will be in place to reduce the potential for dropped objects - Subsea structures will not be removed until after the flowlines and pipelines have been flushed and cleaned - Training and awareness will be required of contractors - Lift planning will be undertaken to manage risks during lifting activities, including the consideration of prevailing environmental conditions and the use of specialist equipment where appropriate - All lifting equipment will be tested and certified - Procedures will be put in place to make sure that the location of any lost material is recorded and that significant objects are recovered where practicable - Debris clearance surveys will be carried out

Legacy includes monitoring activities but no remediation



ABBREVIATIONS

A&C	Atlantic and Cromarty
ACOPS	Advisory Committee On Protection of the Sea
BAP	Biodiversity Action Plan
BEIS	Department for Business, Energy and Industrial Strategy
CA	(Gaupe) Comparative Assessment
CATS	Central Area Transmission System
CCS	Carbon Capture and Storage
CH ₄	Methane
CNS	Central North Sea
CoP	Cessation of Production
CO ₂	Carbon Dioxide
dB	Decibel
DECC	Department of Energy and Climate Change
DoB	Depth of Burial
DP	(Gaupe) Decommissioning Programmes
DSV	Dive Support Vessel
EA	(Gaupe) Environmental Appraisal
EC	European Commission
EIA	Environmental Impact Assessment
ENVID	ENVironmental Impact iDentification
EPS	European Protected Species
ESAS	European Seabirds At Sea
EUNIS	European Nature Information System
F-gas	Fluorinated Greenhouse Gas
FPS	Forties Pipeline System
FPSO	Floating Production, Storage and Offloading
GHG	Greenhouse Gases
GIS	Geographical Information Systems
GMAS	(Shell's) Global Marine Assurance System
HLV	Heavy Lift Vessel
HTGC	High Temperature Gas Chromatograph



HSSE	Health, Safety, Security and Environment
Hz	Hertz
ICES	International Council for the Exploration of the Sea
IMO	International Maritime Organization
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
Kg	Kilograms
kHz	Kilo Hertz
km	Kilometres
KP	Kilometre Point
LAT	Lowest Astronomical Tide
m	Metres
MARPOL	International Convention for the Prevention of Pollution from Ships
MBES	Multi Beam Echo Sounder
MDAC	Methane Derived Authigenic Carbonate
MEG	MonoEthylene Glycol
MLWS	Mean Low Water Springs
MMS	Minerals Management Service
MPA	Marine Protected Area
MS	Marine Scotland
NCES	Natural Capital and Ecosystem Services
NCMPA	Nature Conservation MPA
NCS	Norwegian Continental Shelf
nm	Nautical Miles
NNS	Northern North Sea
NOAA	National Oceanic and Atmospheric Administration
NO _x	Nitrogen Oxides
NORM	Naturally Occurring Radioactive Material
NS	North Sea
NUI	Normally Unattended Installation
OBM	Oil Based Mud
OCIMF	Oil Companies International Marine Forum
OGA	Oil and Gas Authority



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



SSS	Side Scan Sonar
te	tonnes
THC	Total Hydrocarbon
TTS	Temporary Threshold Shift
UK	United Kingdom
UKCS	UK Continental Shelf
UKHAP	UK Habitats Action Plan
UKOOA	UK Offshore Operators Association
VMS	Vessel Monitoring System
VOC	Volatile Organic Compounds
WBM	Water Based Mud
WMP	Waste Management Plan
WONS	Well Operations Notification System
μPa	Micro Pascal
μg	microgram