SEPTEMBER 2023
WINTERSHALL NOORDZEE B.V.

RAVN DECOMMISSIONING ENVIRONMENTAL IMPACT ASSESSMENT

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CONTENTS

1 Abbreviations

The following abbreviations are used in the document:

BAT	**Best Available Technique**
BEP	Best Environmental Practice
CO2	Carbon Dioxides
DEA	Danish Energy Agency
DEPA	Danish Environmental Protection Agency
DSV	Diving Support Vessel
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EU	European Union
GES	Good Environmental Status
HLV	Heavy Lift Vessel
HOCNF	Harmonised Offshore Chemical Notification Form
IMO	International Maritime Organization
LAT	Lowest Astronomical Tide
LDPE	Low-Density PolyEthylene
MCV	Mono-hull Crane Vessel
MSFD	Marine Strategy Framework Directive
NORM	Naturally Occurring Radioactive Materials
NOx	Nitrogen Oxides
NUI	Normally Unmanned Installation
OSPAR	OSlo PARis convention
P&A	Plug & Abandonment
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Poly Chlorinated Biphenyls
PLONOR	Pose Little Or NO Risk
PP	PolyPropylene
PTS	Permanent Threshold Shift (permanent hearing damage)
ROV	Remotely Operated Vehicle
SAC	Special Areas of Conservation
SCANS	Small Cetacean Abundance in the North Sea
SLV	Sheerleg Vessel
SO2	Sulphur Dioxide
SPA	Special Protection Areas
SVO	Særlig Verdifulle Områder (special vulnerable and valuable areas)
TTS	Temporal Threshold Shift (temporal hearing damage)
VOC	Volatile Organic Compounds

2 Non-technical summary

Wintershall Noordzee B.V. has started the planning of the decommissioning of the Ravn field located in the Danish part of the North Sea.

This report includes an Environmental Impact Assessment (EIA) of the decommissioning of the Ravn platform and pipelines and focus on the environmental impacts related to the offshore activities related to this.

The platform will either be sent onshore for dismantling or for temporary storage for reuse. These two options will only be described briefly as these activities will be covered by the environmental permits and other permits for the specific disposal yard/location of storage.

The cleaning of the topside, the pipelines and umbilical has been carried out prior to the decommissioning and there is no further cleaning needed for the topside, pipelines and umbilical. The cleaning scope includes;

- Removal of tanks etc. from topside
- Flushing, purging and cleaning of the topside, pipelines and umbilical

Thus, these processes are not a part of the decommissioning and are not included in the present EIA. Any cumulative effects are covered in chapter 14.

The plug and abandonment program of the wells in relation to the Ravn field has been included in EIA screenings and/or EIAs and are subject to an independent approval process and for that reason are not included in the present EIA. The EIA screenings have been sent to the Danish Energy Agency (DEA) on 8th of July 2022. The plug and abandonment of the wells will take place before the actual decommissioning and thus no cumulative effects are expected, and this activity will not be assessed further in this EIA. Thus, the EIA will not contain information on discharges from chemicals used for plug and abandonment, underwater noise and emissions from rig and vessel activities, unplanned discharges, and spills in relation to wells.

2.1 The project

The Ravn field is developed as an unmanned oil production offshore platform, tied-back to the German A6-A platform. Production export is through subsea infrastructure to the German platform and no processing takes place at Ravn.

The platform is located in the Greater Ravn area in license 5/06, Block 5504, approximately 245 km from the Danish west coast and 11.3 km northeast of the border between Germany and Denmark.

The platform is located at position 55°52'50.2" N, 4°14'5.4" E (ETRS89), see Figure 2-1. The water depths around the site are consistently between 48 and 50 m LAT.

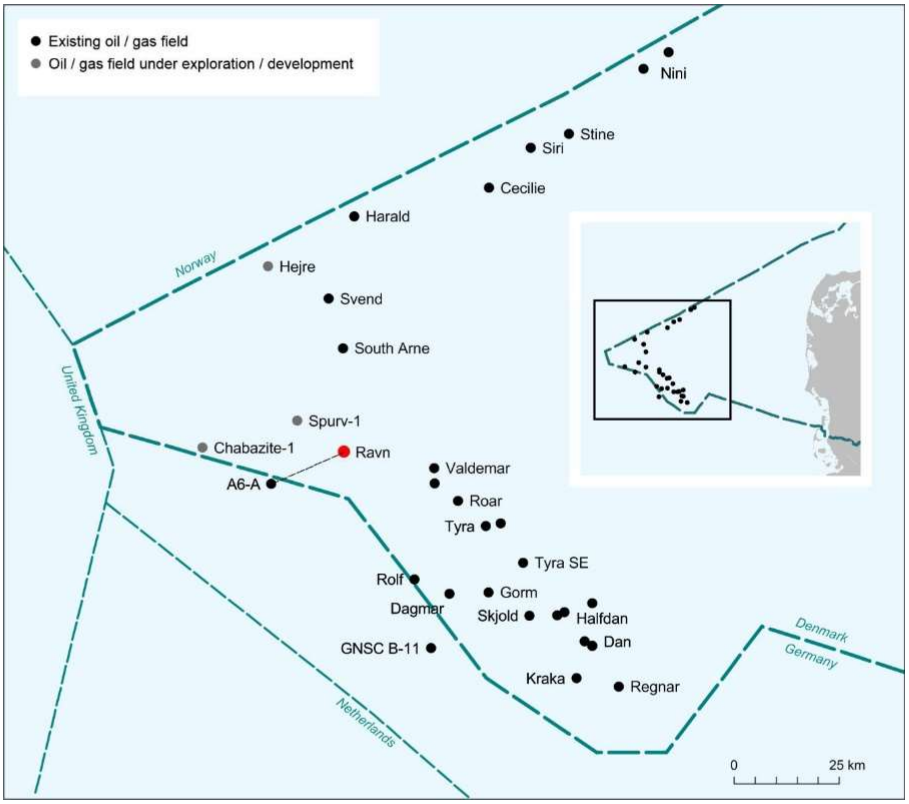


Figure 2-1 Location of the Ravn field in the North Sea.

The offshore facilities consist of a minimum facility platform with 2 wells no longer in operation and 2 pipelines (an 8" multiphase production pipeline, a 3" gas lift pipeline, piggy-backed to the 8" pipeline) and an umbilical tied back to the A6-A platform (5.7" umbilical providing chemicals, fiberoptics and electricity to the Ravn platform).

The Danish Ravn platform is located about 15 km from the border with Germany; consequently, the pipelines run through the German North Sea over approx. 3 km and through the Danish waters for the remaining 15 km. At the Danish shelf the pipeline bundle crosses the 40” Europipe I.

The decommissioning project covers:

- Disconnection of pipelines and umbilical at the ends and removal of the spool piece and umbilical sections that have been cut.
- Removal of topside and jacket
- Decommissioning of pipelines. 4 alternatives included:
  - Leaving in situ
  - Removal of materials above seabed
  - Removal by reversed installation or
  - Removal by cut and lift
- Post decommissioning site surveys

The platform will either be sent onshore for dismantling or for temporary storage for reuse. These two options will only be described briefly as these activities will be covered by the environmental permits and other permits for the specific disposal yard/location of storage.

2.2 Alternatives

The 0-alternative is a situation in which the present project is not carried out. However, as decommissioning is required as per OSPAR 98/3 the 0-alternative is not possible, and therefore not further assessed.

Different technical scenarios for decommissioning have been assessed throughout the EIA.

2.3 Existing environment

The Ravn field is located centrally in the North Sea at the northeast border of the Dogger Bank, in a water depth of around 48 m. This is an area with a relatively low biological production. However, the shallow Dogger Bank has been identified as an area which exhibits high primary production throughout the year.

The water is dominated by Atlantic water with a relatively stable salinity of 35-38 ppm and an average temperature of 10-11 °C. Based on an integrated assessment of the chemical status, most of the Danish part of the North Sea is classified as "problem areas" due to a combination of input of contaminants from sources on both land and sea and input from atmospheric deposition.

The sediment around Ravn consists of mud to muddy sand. The benthic fauna includes infauna that lives within the sediments of the seabed and epifauna that lives on the surface of the seabed. The abundance of infauna at the Ravn field is relatively high, whereas the abundance of epifauna species is relatively low compared to other areas in the North Sea. Herring, sprat, and mackerel are the dominating pelagic fish species at the Ravn field. The dominating demersal fish species include whiting, haddock, dab, long rough dab, plaice, and grey gurnard. Cod, plaice, lemon sole and mackerel spawn in the project area.

The waters around Ravn are not important for sea birds. During winter, some seabirds may however be encountered in the area, not because the area is of importance for these species, but because they are distributed over the entire North Sea during winter.

Harbour porpoise is the most common species of cetacean in the North Sea and is regularly encountered in the waters around the Ravn field, although the area is not a core area for the species. Harbour seals and Grey seals are also regularly sighted around oil and gas fields in the North Sea although they tend to be coastal species. 15 km south of the Ravn field is the Dogger Bank, a designated Natura 2000 area in Germany (SAC DE 1003-301 Doggerbank), Netherlands (SAC NL 2008-001 Doggerbank) and the UK (SAC UK003,352). Dogger Bank is designated to protect the habitat type Sandbanks (1110) and the species Harbour porpoise (1356) and Harbour seal (1365).

Valuable and vulnerable areas (SVO-areas) have been designated as marine protected areas in Norway. The closest SVO to Ravn is the Sandeel field South bordering the Danish Exclusive Economic Zone (EEZ).

2.4 Assessment of impacts and environmental risks

Impacts that have been assessed

Below is an overview of the potential impacts related to the decommissioning of Ravn and conditions that potentially may affect organisms and other environmental features that have been assessed in the EIA.

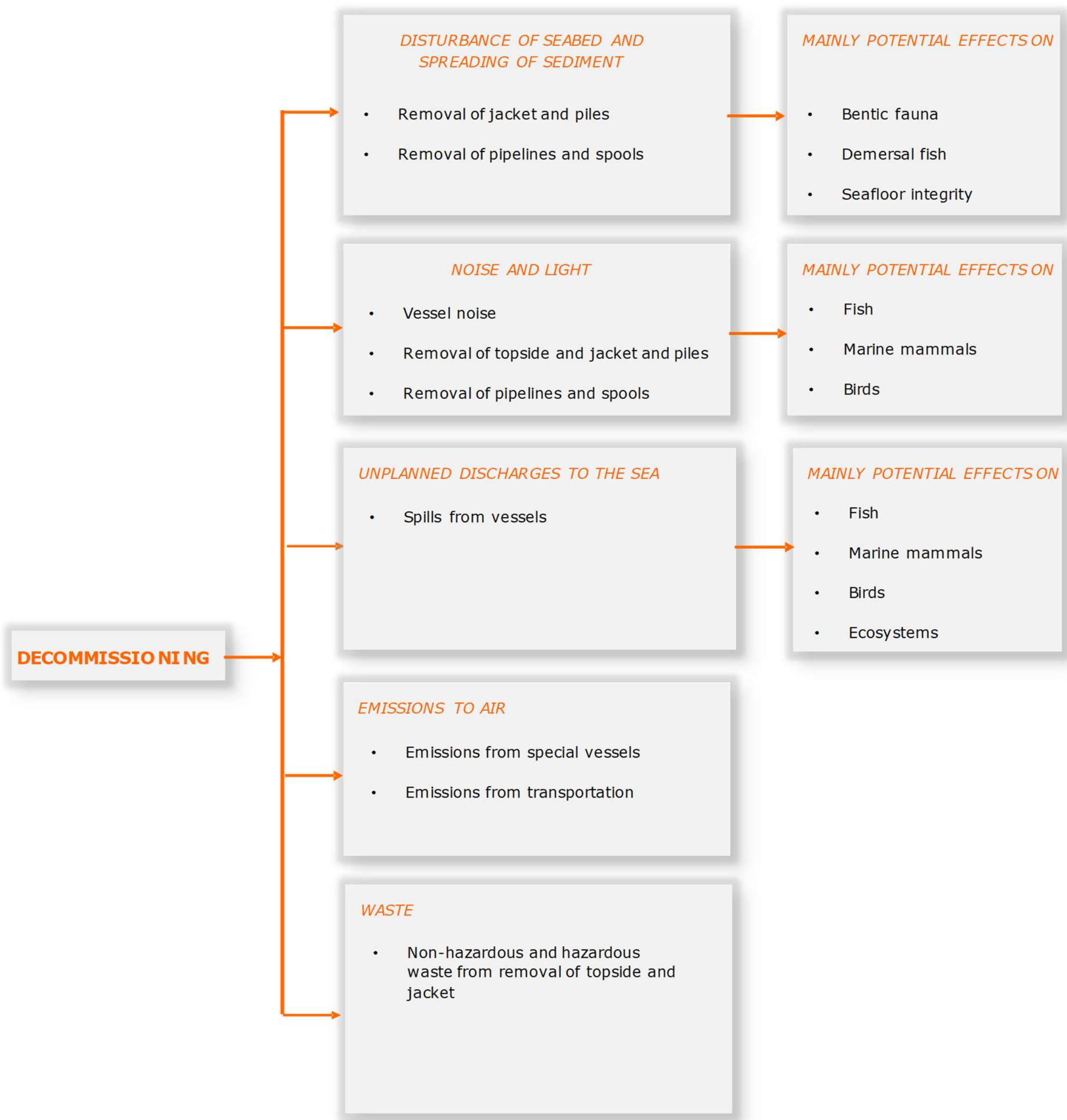


Figure 2-2 Overview of potential environmental impacts from Ravn decommissioning and effects on environmental components.

Severity and risk of impacts

Environmental severity and risks of different project activities and incidences have been assessed. Environmental risk is defined as the combination of the severity and impact of an activity/incidence and the probability that the impact will occur.

The severity of an impact has been defined by combining criteria for:

- The nature of the impact (Positive or negative)
- Extension of the impact (Local, regional, national, or international)
- Duration of the impact (Short-term, medium-term, or long-term)
- Magnitude of the impact (Small, medium, or large)
- Reversibility (whether an impact is permanent, reversible or irreversible)

By combining these criteria in a predefined manner, the following severity categories have been used: Positive impact, no impact, minor impact, moderate impact, or major impact.

The probability that an impact will occur has been defined as very low, low, probable, highly probable, or definite.

Impacts during decommissioning of pipelines

Before the decommissioning of the pipelines and umbilical the cleaning and disconnection of the pipeline and umbilical ends will be conducted. The disconnection will be done by installing a hydraulic isolation plug and disconnecting the subsea pipeline flange and cutting of the spools. The ends have been covered with gravel to protect the ends against fishing activities. In compliance with regulations, the pipeline cleaning programme has been designed to ensure the hydrocarbon content and any deposits within the pipelines are sufficiently cleaned.

Four methods are assessed for decommissioning of pipelines in the Danish part of the North Sea:

- Leaving in situ, where the pipelines and the umbilical are left in situ
- Removal of materials above seabed and pipelines and umbilical are left in situ (stabilization of pipeline ends and at crossing with rocks)
- Removal of pipelines by reverse installation
- Removal of pipelines by cut and lifting

Leaving the pipelines in situ will result in gradual dissolvement of the pipeline coating buried under the sediment). However, the impact on benthic flora and fauna is expected to be negligible. There will be no or very limited impact on benthic fauna and seabed integrity from physical disturbance of the seabed if the pipelines are not removed. Removal of the pipelines will on the other hand result in physical disturbance and loss of benthic fauna both within the footprint of the pipelines but also as they are buried under settled material.

In addition, removal of pipelines will result in dispersion of sediments in the water column. Physical disturbance and sediment dispersal are assessed not to impact spawning fish stocks. The seabed integrity and marine fauna is expected to recover within 2 years after removal and backfilling of the trench.

Underwater noise is related to vessels used during the removal activities in addition to noise created by the potential removal of the pipelines. The underwater noise is expected not to cause hearing damage of mammals. The mammals may however exhibit avoidance behavior during the decommissioning activities, but it's expected that they will return to the area. Fish may flee from noisy areas, but this will not affect fish populations.

Waste related to pipelines consists mainly of the steel pipes, concrete mattresses at the ends and the pipeline coating. Depending on the selected decommissioning method, the amounts of waste can range from minor (left *in situ*) to substantial (complete removal).

During decommissioning of pipelines there will be emissions to air in relation to vessel activities. The emissions are assessed for the four different decommissioning methods for pipelines, as the activities will include different types of offshore vessels such as offshore construction vessels, rock placement vessels, pipe trench vessels etc. and also result in different length of the offshore work-scope. The worst-case decommissioning scenario for the pipelines in relation to emissions to air, is the cut and lift scenario. The CO_2 emissions related to the removal of pipelines by cut and lift are comparable to the yearly emissions from approx. 1,400 Danes or 0.03% of the total Danish emissions for 2020. The impacts related to air quality are assessed to be negligible and relatively low for the impacts related to global warming potential.

Impacts during decommissioning of the platform

Two methods are assessed for removal of the topside and jacket:

- Single-lift removal, where the topside and jacket are lifted in a single lift each
- Piece-small removal, where the jacket is cut into smaller pieces and the topside and jacket are lifted in several lifts

The removal of the platform structures and to some extent disconnection of pipelines cf. the section above will cause disturbance of the seabed and result in removal of hard substrate and associated flora and fauna from the area. Since the fauna living on the platform structures do not represent high biodiversity value, the environmental impact from loss of fauna attached to the physical structures is assessed to be small and local. Because the disturbance will be temporary, short-term, and confined to a small area compared to the potential available living space, measurable impacts on the fish population are not anticipated. The impacts are assessed to be negligible.

Underwater noise is related to the vessels used for removal of the platform in addition to noise generated by the cutting of underwater structures, including disconnection of pipelines and jacket structures. Noisy activities will not exceed the threshold for triggering temporary or permanent hearing damage of mammals or result in impacts on fishes and are thus expected to be negligible.

Light and noise from vessels can potentially impact birds. Lights from the vessels may thus create additional foraging opportunities for gulls that normally forage by daylight, thus supplementing their diets and, potentially, increasing their survival and reproductive success. However, illumination of the vessels may also attract and disorient migratory birds. Since the impacts of light from the vessels is temporary and the magnitude small, it is assessed that the environmental risk is negligible and in no way will affect bird populations. Some loud noise will be generated during decommissioning of platform that will temporarily disturb seabirds locally. This will in no way impact seabird population. Thus, the impacts are assessed to be negligible.

Removal of artificial lights from the platform can cause both positive and negative impacts. There are examples that illumination from offshore platforms under such circumstances can attract and disorient the birds and have a trapping effect that leads birds to circle around the light source. Removal of the artificial light will hereby have a positive effect on especially migratory birds. Removal of night lights from platform may have negative impact on foraging gulls because light attract prey to the surface waters (zooplankton and/or small fishes). All together the impact is assessed to be negligible.

Emissions to air related to removal of the platform by cutting and lifting is assessed. The CO_2 emissions related to removal of the platform are comparable to the yearly emissions from approx. 140 Danes or 0.003% of the total Danish emissions for 2020. The impacts related to air quality are assessed to be negligible and relatively low for the impacts related to global warming potential. Also, the transport of the platform to shore will generate emissions. The disposal yard is not decided upon yet, but it is expected that the Ravn platform will be decommissioned in the northern part of Europe and thus an estimate of the emissions related to the transport shows that this will only comprise approx. 7% of the emissions related to the removal activities, and thus the impacts are expected to be negligible.

Environmental assessment of an accidental oil spill

Accidental spill of oil can be spilled from the vessels. The risk of a large oil spill (>1 m^3) from a vessel is comparable to the risk related to spills from other offshore vessels operating and is thus very small and the extent will be limited.

Summary of environmental impacts

Below a summary of the environmental risk assessment can be seen related to decommissioning pipeline activities and removal of the platform (Table 2-1, Table 2-2, Table 2-3 and Table 2-4).

For the pipeline activities also the comparative assessment between the decommission methods is summarized, as the overall risk assessment does not capture the short-term effects and thus does not capture the differences between the methods.

Table 2-1 Environmental risk for activities for leaving pipelines in situ.

Impact related to leaving pipeline *in situ*	Severity of impact	Probability of impact	Environmental risk
Impact on benthic fauna from rock placement			N/A
Impact from pipeline corrosion and decomposition	Insignificant impact	Highly probable	Negligible
Impact on sea floor integrity			N/A
Impacts of underwater noise on mammals	Insignificant impact	Probable	Negligible
Impacts of underwater noise on fish	Insignificant impact	Probable	Negligible
Impacts of waste	Minor impact	Probable	Negligible
Impacts of air emissions (NO_X, SO_X)	Minor impact	Probable	Negligible
Impacts of air emissions (CO_2-eq.)	Minor impact	Highly probable	Low

Table 2-2 Environmental risk for activities for disconnect of pipelines and removal of material above seabed.

Impact related to removal of material above seabed	Severity of impact	Probability of impact	Environmental risk
Impact on benthic fauna from rock placement	Insignificant Impact (positive)	Probable	Negligible
Impact from pipeline corrosion and decomposition	Insignificant impact	Highly probable	Negligible
Impact on sea floor integrity	Insignificant	Low	Negligible
Impacts of underwater noise on mammals	Insignificant impact	Probable	Negligible
Impacts of underwater noise on fish	Insignificant impact	Probable	Negligible
Impacts of waste	Minor impact	Probable	Negligible
Impacts of air emissions (NO_X, SO_X)	Minor impact	Probable	Negligible
Impacts of air emissions (CO_2-eq.)	Minor impact	Highly probable	Low

Table 2-3 Environmental risk for activities for removal of the pipelines.

Impact related to removal of pipelines by reverse installation or cut and lift	Severity of impact	Probability of impact	Environmental risk
Impact on benthic fauna from physical disturbance and sediment dispersal	Insignificant impact	Highly probable	Negligible
Impact on sea floor integrity	Minor	Highly probable	Low
Impacts of sediment dispersal on fish stocks	Insignificant impact	Highly probable	Negligible
Impacts of underwater noise on mammals	Insignificant impact	Probable	Negligible
Impacts of underwater noise on fish	Insignificant impact	Probable	Negligible
Impacts of waste	Minor impact	Probable	Negligible
Impacts of air emissions (NO_X, SO_X)	Minor impact	Probable	Negligible
Impacts of air emissions (CO_2-eq.)	Minor impact	Highly probable	Low

Table 2-4 Environmental risk for activities for removal of platform.

Impact of decommissioning activities for platform	Severity of impact	Probability of impact	Environmental Risk
Impacts of disturbance of seabed and benthic fauna	Insignificant impact	Highly probable	Negligible
Impacts of underwater noise on marine mammals	Insignificant impact	Highly probable	Negligible
Impacts of underwater noise on fish	Insignificant impact	Highly probable	Negligible
Impacts of artificial light from vessels	Insignificant impact	Highly probable	Negligible
Impact of noise (airborne) from vessels	Insignificant impact	Highly probable	Negligible
Impacts of removal of artificial light from platform	Insignificant impact	Highly probable	Negligible
Impacts of air emissions (NO_X, SO_X)	Minor impact	Probable	Negligible
Impacts of air emissions (CO_2-eq.)	Minor impact	Highly probable	Low
Impacts of non-indigenous species	Major impact	Very low	Low

From the comparative assessment of the pipeline decommissioning methods both the short-term and long-term impacts can be seen (Table 2-5). From this comparative assessment it can be seen, that leaving the pipelines *in situ* mostly will have an impact on the sea floor integrity due to leaving the pipelines which are not a natural part of the seabed and also the materials from the pipelines will not be recycled. However, looking at the two removal methods these will have larger impact on the benthic fauna, marine growth, and fishes by the physical disturbances and generate larger emissions to air.

Table 2-5: Comparison of the environmental impacts related to the four decommissioning methods for pipelines. The three shadings are used to indicate the difference between the three methods and not the severity of the impact.

Comparative impacts assessed	Left *in situ*	Removal of material above seabed	Removal by reverse installation	Removal by cut and lift
Environment	Least impact on benthic fauna, marine growth, and fish.	Least impact on benthic fauna, marine growth, and fish, but slightly higher than for left *in situ.*	Medium impact on benthic fauna, marine growth and fish.	Medium impact on benthic fauna, marine growth, and fish.
	Least impact on physical disturbance and disturbance on water column.	Least impact on physical disturbance and disturbance on water column, but slightly higher than for left *in situ*.	Medium impact on physical disturbance and disturbance on water column.	Medium impact on physical disturbance and disturbance on water column.
	Least impact on sea floor integrity.	Least impact on sea floor integrity, but slightly higher than for left *in situ*.	Medium impact on sea floor integrity.	Medium impact on sea floor integrity.
Pipeline corrosion and decomposition	Larger impact on the aquatic environment.	Larger impact on the aquatic environment.	No impact as pipelines are removed.	No impact as pipelines are removed.
Underwater noise	Least underwater noise levels with no impacts on mammals and fish.	Least underwater noise levels with no impacts on mammals and fish, but slightly higher than for left *in situ*.	Medium underwater noise levels with no impact on mammals and fishes.	Medium underwater noise levels with no impact on mammals and fishes.
Emissions to air (NO_X, SO_X)	Least amount of emissions due to vessel activities.	Least amount of emissions due to vessel activities, but slightly higher than for left *in situ*.	Medium amount of emissions due to vessel activities.	Larger amount of emissions due to vessel activities.
Emissions to air (CO_2-eq.)	Least amount of short-term emissions due to vessel activities.	Least amount of short-term emissions due to vessel activities, but slightly higher than for left *in situ*.	Medium amount of short-term emissions due to vessel activities.	Larger amount of short-term emissions due to vessel activities.
	Larger amount of long-term emissions due to no recycling potential for the pipeline materials	Larger amount of long-term emissions due to no recycling potential for the pipeline materials and thus an indirect	Least amount of long-term emissions due to recycling potential of materials from	Least amount of long-term emissions due to recycling potential of materials from pipelines and thus

Comparative impacts assessed	Left *in situ*	Removal of material above seabed	Removal by reverse installation	Removal by cut and lift
	and thus an indirect energy use for production of primary materials.	energy use for production of primary materials.	pipelines and thus substitution of primary materials and saved energy related to production.	substitution of primary materials and saved energy related to production.
Waste	Least amounts of waste shipped to shore.	Medium amounts of waste shipped to shore.	Larger amounts of waste shipped to shore.	Larger amounts of waste shipped to shore.
	Least amounts of materials to be recycled and thus no substitution of primary materials/resources. Risk of gradual corrosion and leachate of chemicals in the coating over time.	Medium amounts of materials to be recycled and thus no substitution of primary materials/resources. Risk of gradual corrosion and leachate of chemicals in the coating over time.	Larger amounts of materials to be recycled and thus substitution of primary materials/resources.	Larger amounts of materials to be recycled and thus substitution of primary materials/resources.

2.5 Socio-economic impacts

The platform and pipelines are surrounded by fisheries safety zones to prevent ship collision with the platform and pipeline rupture. After decommissioning of the platform and pipelines, the safety zones can either be removed or extended. The removal of safety zones impact a relatively small area and will not affect fish landings from the area. Ravn is situated far from major shipping lanes and removal of safety zones around the platform will only have a minor positive impact on marine traffic.

2.6 Cumulative effects

The potential cumulative effects of activities in the area around Ravn field have been assessed. There are no significant cumulative impacts in relation to the project. As the effects are considered minor and the removal would happen in a consecutive order (in one process) no cumulative effects are expected. It is expected that the potential impacts will be local in extent. Further, they take place in an area where there is already a significant natural physical disturbance. With the expected local extent for a relatively short period of time, for an activity that will not take place simultaneously, no cumulative effects are expected from removal of the pipelines with reverse installation or cut and lifting.

2.7 Cross border impacts

The only potential cross boarder impact resulting from the decommissioning activities are the release of a maximum of approx. 20,000 tons CO_2 and the activities. Compared to national CO_2 emissions, the release is however insignificant (the total CO_2 emissions for the project are comparable to the yearly emissions from ca. 1,600 Danes corresponding to 0,03% of the Danish Emissions (2020 numbers)). The CO_2 emissions related to the decommissioning are lower than the yearly emissions from producing platforms, and thus the CO_2 emissions will be reduced from the first year of decommissioning. The activities in regard to disconnection of the pipelines between Ravn and the A6-A in the German sector could result in temporary disturbance of the seabed from spool removal but no cross-boundary effects are expected. If the pipelines were to be removed a larger area of the seabed would be affected but the sedimentation would be local and the potential effects of physical disturbance would be minor. Based on the assessment in section 16.4, the decommissioning activities are expected to be in compliance with the specific protection measures in the Dogger Bank.

2.8 Natura 2000

Underwater noise caused by topside/jacket removal and pipeline disconnecting activities, accidental spills, and the removal of the pipelines (if applicable) may potentially affect designated species and habitats of Natura 2000 areas. There will however be no impacts in the Danish Natura 2000-areas due to the distance between these and the Ravn field.

The nearest Natura 2000-site is the German DE 1003-301 Dogger Bank area located approximately 15 km from the Ravn field. In general, the potential impacts from underwater noise and accidental spills are expected to be local and for a relatively short period of time.

Decommissioning of the topside and jacket at the Ravn field is therefore not expected to negatively impact the conservation status of habitats and species in this Natura 2000-area. The same accounts for the disconnect scope that needs to be executed prior topside and jacket removal.

There are 18 km of pipelines between the Ravn field and the A6-A platform, where the 3 km of pipelines are located directly in the German DE 1003-301 Doggerbank area. The decommissioning of the pipelines within the Danish waters has been assessed and it has been concluded that neither leaving the pipelines in situ nor removing the pipelines will significantly influence the conservation objectives within the Dogger Bank area negatively. However, leaving the pipelines in situ will cause less disturbance to the seabed.

2.9 Marine strategy Framework Directive (MSFD)

The EU has a marine strategy that aims to maintain or establish a 'Good Environmental Status' (GES) in all European marine areas by 2020. The strategy is implemented in Denmark by the Danish Marine Strategy II. The Marine Strategy II defines what is regarded as 'Good Environmental Status' of the marine environment using 11 different descriptors. For each descriptor a set of qualitative environmental targets and preliminary indicators are set. The impact of the project on relevant descriptors is assessed.

The potential impacts from the Ravn decommissioning project activities are compared with the targets for the 11 descriptors as described in chapter 18. These impacts are summarized in Table 2-6 below.

Based on the assessment it is concluded that the Ravn decommissioning activities will not prevent or delay the achievements of good environmental status for each descriptor as defined in the Danish Marine Strategy II.

Table 2-6 Potential impacts on the environmental targets in the Danish Marine Strategy II which implements EU's Marine Strategy Framework Directive (MSFD).

Descriptor	Assessment of potential impact
D1 Biodiversity	Birds may potentially be impacted by light and noise disturbances although impacts are assessed to be negligible. The project area is not considered important for seabirds. Marine mammals may potentially be impacted by underwater noise and disturbance. The noise levels are not expected to cause any hearing damage, but the mammals may exhibit avoidance behaviour. The project area is not assessed to be a core area for marine mammals. The impacts will be temporary and not expected to affect the marine mammal populations.
D2 Non-indigenous species	Vessels may potentially introduce non-indigenous species by growth on the hull or discharge by ballast water, however it is assessed that there is a low risk. Non-indigenous species may use platforms in the North Sea as steppingstones for dispersal, however this risk for the Ravn platform is taken away after the decommissioning.
D3 Commercially exploited fish stocks	The diversity of fish in the Ravn field area is low, as is the fishing intensity. Decommissioning of the Ravn platform may open up more commercial fishing in the area. Decommissioning of Ravn is not expected to impact fish mortality or spawning biomass. There may however be local impacts caused by an unplanned oil spill.
D4 Marine Food webs	The decommissioning of Ravn is not expected to impact the marine food webs in the area.
D5 Eutrophication	The decommissioning of Ravn is not expected to impact the level of eutrophication in the area.
D6 Sea floor integrity	The decommissioning of Ravn may cause physical disturbance of the seabed under the footprint (directly) and increased sedimentation (indirectly) during the removal of the platform and pipelines (if applicable). The physical disturbance is expected to be temporary. The extent of physical disturbance for each habitat type is expected to be reported. The decommissioning of Ravn will decrease the footprint from oil and gas installations in the North Sea.
D7 Hydrographical changes	The decommissioning of the Ravn platform will not cause physical loss of the seabed. There will only be very limited and local temporary impacts.
D8 Contaminants	According to the Danish Marine Strategy Directive II threshold values are decided for PFOS, PBDE, Benz(A)pyrene and mercury. None of these substances are expected to be discharged during decommissioning. Acute pollution events are extremely rare events.
D9 Contaminants in seafood for human consumption	No major discharges of contaminants are expected from the decommissioning activities. Measurable contaminants in fish and other seafood are assessed to only occur because of a major oil spill.

Descriptor	Assessment of potential impact
D10 Marine litter	All general waste is transported to shore. All topside material will be transported to a suitable shipyard on land for decommissioning or storage for reuse. If the pipelines are left *in situ* it can be argued that some waste is left as marine litter, leachates of compounds from degradation and corrosion of the pipelines may potentially introduce plastic, although it is assessed that this risk is negligible as the pipelines are buried within the seabed.
D11 Underwater noise	Very limited (if any) impulse noise is expected during the decommissioning activities. The low frequency noise will not cause hearing damage to the marine mammals but may cause disturbance so the mammals may exhibit temporary avoidance behaviour. This is not expected to impact the populations.

In addition, the Ravn decommissioning project is assessed not to impact any of the monitoring activities described in the monitoring programme under the Marine Strategy Framework Directive, or any of the measures described in the programme of measures.

2.10 Monitoring programme

A post decommissioning monitoring programme will be set up for the Ravn field.

2.11 Mitigating measures

The main structures of the field will be taken to shore for further dismantling or storage for reuse, thereby limiting the work offshore and no waste production is foreseen offshore. Onshore, the dismantling of platform structures and waste sorting will be performed on a regulated site approved for this type of work.

The risk of introducing non-indigenous species from vessels can be mitigated by exchange of ballast water in open waters, by implementing a ballast water treatment system or by regular removal of marine fouling from the vessels sides prior to departure.

3 Introduction

Wintershall Noordzee B.V. has started the planning of the decommissioning of the Ravn field located in the Danish part of the North Sea.

The partners in the Ravn license are:

- Wintershall Noordzee B.V. (operator)
- The Danish North Sea Fund (Nordsøfonden)

Wintershall Noordzee B.V. has commissioned COWI to carry out an environmental impact assessment (EIA) for the Ravn decommissioning project.

The present EIA report documents the process, findings and conclusions. The EIA has been carried out in compliance with the Danish EIA regulations (Consolidated Act No. 1976 of 27/10/2021) and (Executive Order No. 1050 of 27/06/2022).

3.1 The Ravn field

Wintershall is operator for license 5/06. The Ravn platform is located in the Block 5504 within the Greater Ravn field, in the Danish sector of the North Sea, approximately 245 km from the Danish west coast and 11.3 km northeast of the border between Germany and Denmark, see Figure 3-1 and Figure 3-2.

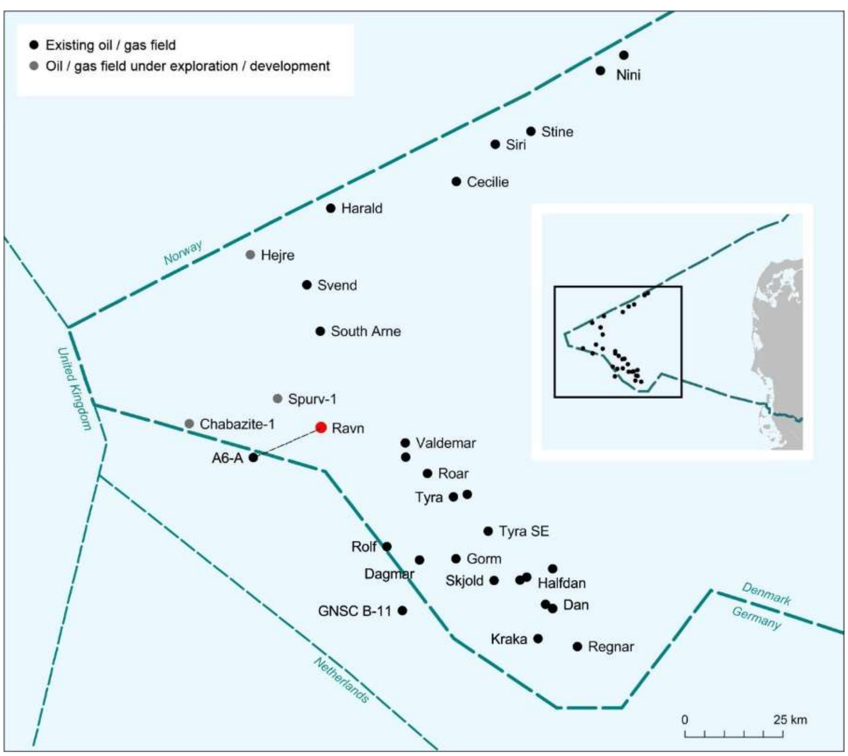


Figure 3-1 Location of the Ravn field and other oil and gas installations in the North Sea. Ravn is marked with red color.

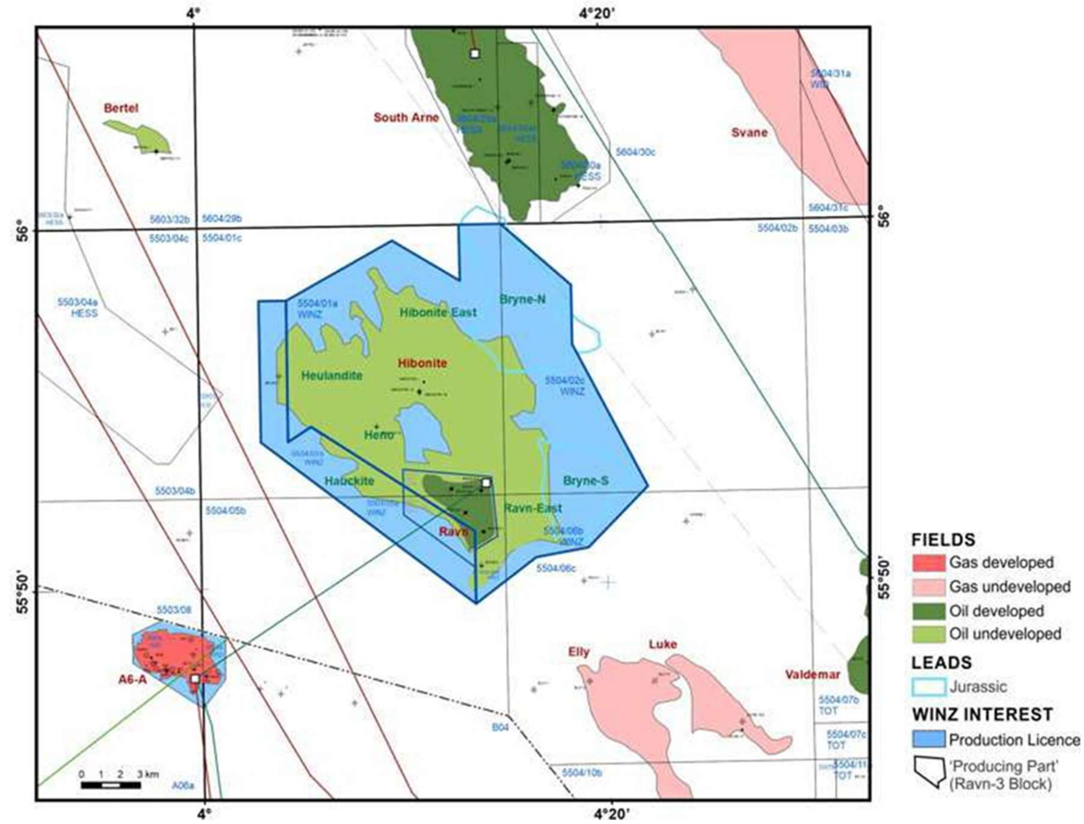


Figure 3-2 Location of the Ravn field and the A6-A field.

The offshore facilities consist of a minimum facility platform with 2 wells no longer in operation and 2 pipelines (an 8" multiphase production pipeline, a 3" gas lift pipeline, piggy-backed to the 8" pipeline) and an umbilical tied back to the A6-A platform (5.7" umbilical providing chemicals, fiberoptics and electricity to the Ravn platform).

The A6-A platform and sections of the pipelines are located in the German EEZ in the area known as the *Entenschnabel* (= Duck's Bill) and thus in the "*Doggerbank*" FFH site. The Danish Ravn platform is located about 15 km from the border with Germany; consequently, the pipelines run through the German North Sea for a distance of approx. 3 km and through the Danish waters for the remaining 15 km. At the Danish shelf the pipeline bundle crosses the 40" Europipe I.

The Ravn platform was installed in 2015 as a topside minimum facility structure supported by a jacket structure. The water depths around the site are consistently between 48 to 50 m LAT.

The platform is located at position 55°52'50.2" N, 4°14'5.4" E (ETRS89).

There are two inactive oil producer wells on Ravn (A1 and A2). All wells have been suspended and are no longer producing. The well Ravn A1 was in service until 2020, when the well was suspended. The suspension is documented in an environmental note, which has been sent to DEA in 2020. The well Ravn A2 was already temporarily plugged and abandoned in 2018.

In July 2022 the EIA screenings for the plug and abandonment (P&A) of the wells were sent to DEA and are subject to an independent approval process. The wells will be P&A'd before the decommissioning of the platform.

The Ravn platform produced oil and small amounts of associated gas and water, which were transferred through the 8" multiphase production pipeline to the A6-A platform for processing and storage. There is no processing equipment on the Ravn topside.

The gas lift is supplied from the A6-A platform through a 3" gas lift pipeline.

Electrical power, chemicals and fiberoptics are supplied to Ravn via an umbilical from the A6-A platform.

In the below the decommissioning scope for Ravn is outlined.

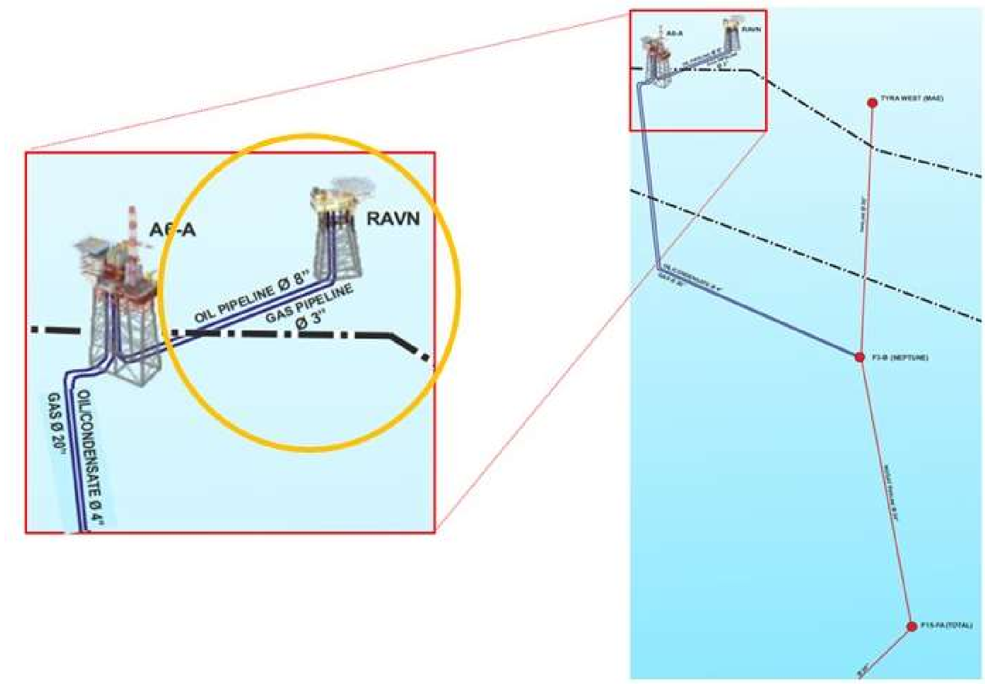


Figure 3-3 Overview of the field layout. The decommissioning scope for Ravn is outlined in orange.

3.2 Scope of EIA

The EIA covers the following processes:

- Disconnection of pipelines and umbilical at the ends and removal of the spool piece and umbilical sections that have been cut.
- Removal of topside and jacket
- Decommissioning of pipelines. 4 alternatives included:
  - Leaving *in situ*
  - Removal of materials above seabed

  - Removal by reversed installation or
  - Removal by cut and lift
- Post decommissioning site surveys

The platform will either be sent onshore for dismantling or for temporary storage for reuse. These two options will only be described briefly as these activities will be covered by the environmental permits and other permits for the specific disposal yard/location of storage.

The cleaning of the topside, the pipelines and umbilical has been carried out prior to the decommissioning and there is no further cleaning needed for the topside, pipelines and umbilical. The cleaning scope includes;

- Removal of tanks etc. from topside
- Flushing, purging and cleaning of the topside, pipelines and umbilical

Thus, these processes are not a part of the decommissioning and are not included in the present EIA.

The plug and abandonment program of the wells has been included in EIA report and are subject to an independent approval process and for that reason are not included in the present EIA. The plug and abandonment of the wells will take place before the actual decommissioning and thus this activity will not be assessed further in this EIA, see further detail in chapter 14. Thus, the EIA will not contain information on discharges from chemicals used for plug and abandonment, underwater noise and emissions from rig and vessel activities, unplanned discharges and spills in relation to wells since this is covered by the EIA for P&A of well A1 and A2.

4 National and international legislation

4.1 Decommissioning programme

In accordance with the Danish Subsoil Act, Section 32A the license holders of the Ravn installation/field (see section 3) shall apply to the Danish Energy Agency to obtain approval of the final decommissioning plan latest two years prior to commencement of decommissioning. The first decommissioning plan was submitted to DEA in 2018.

The final decommissioning plan is submitted in compliance with national and international regulations and DEA guidelines. Execution is planned in 2023 but not later than 2025 in case of unexpected (market) developments.

The decommissioning programme is described in detail in section 6 hereafter.

4.2 Environmental impact assessment

An EIA is required to obtain approval for changes to activities concerning offshore exploration and production of oil and gas and certain industrial plants. This requirement is set forth in Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment. The directive is implemented in Danish legislation through the:

- Subsoil act (Consolidation act no. 1533 of 16/12/2019)
- The EIA act (Consolidation act no. 1976 of 27/10/2021)
- Regulation on EIA, impact assessment regarding international nature conservation areas and protection of certain species during offshore exploration and production of hydrocarbons, subsoil storage, pipelines, etc. (Executive Order no. 1050 of 27/06/2022).
- Subsoil act (Consolidation act no. 1533 of 16/12/2019)

The present EIA is compliant with the above-mentioned legislation.

4.3 Protection of the marine environment

The Marine Environment Act (Consolidation act no. 1165 of 25/11/2019) regulates discharges and emissions from platforms.

Discharges to sea

The associated regulation on discharges to the sea of compounds and materials from certain marine facilities (Executive order no. 394 of 17/7/1984) defines the information needed to obtain permission for discharges.

Danish Environmental Protection Agency (DEPA) is the permitting authority.

The discharge permit regulates planned discharge of oil and chemicals to the sea and, among others, define requirements on:

Classification of offshore chemicals

Use and discharge of offshore chemicals depending on classification (explained below).

Chemicals are classified according to the DEPA colour coding system, which follows the OSPAR classification (substitution, ranking and PLONOR) and relates to the environmental hazard of offshore chemicals. The codes are:

Black chemicals are the most critical and not acceptable to be used offshore.

Red chemicals are environmentally hazardous to such an extent that they should generally be avoided and be substituted where possible. Substances that meet two of three criteria of low biodegradation (<60% in 28 days), high bioaccumulation (logPow ≥3) or toxicity (EC/LC50 <10 mg/l) are classified as red.

Green chemicals are considered not to be of environmental concern (so-called PLONOR-substances that ''Pose Little Or NO Risk'' to the environment) and organic substances with toxicity EC/LC50 > 1mg/l. The PLONOR-substances are included in a PLONOR list approved by the Danish Environmental Protection Agency (DEPA).

Yellow chemicals are those that do not fall into any of the above categories, i.e. substances exhibiting some degree of environmental hazard, which in case of significant discharges can give rise to concern. Substances that meet one of three criteria of low biodegradation (<60% in 28 days), high bioaccumulation (logPow ≥3) or toxicity (EC/LC50 <10 mg/l) are classified as yellow.

Emissions

Air emissions from platforms, drilling rigs and ships are regulated in the in the regulation on prevention of air pollution from ships (Notification no. 9840 of 12/04/2007).

Ballast Water Management Convention

The term non-indigenous species means that the species is introduced outside its natural, past or present range (Ministry of Environment and Food, 2019). The vessels used for the decommissioning activities can potentially introduce non-indigenous species to the North Sea area through marine fouling on vessels or through discharge of ballast water from the vessels.

The international convention for control and management of ships' ballast water and sediments (Ballast Water Management Convention) entered into force on 8th September 2017 and the scope of the convention is to help prevent the introduction and spread of invasive species as well as potential harmful pathogens.

The Ballast Water Management Convention implemented in Danish law through the Consolidation Act on Protection of the Marine Environment (LBK 1165 of 25/11/2019) and regulated through the Executive Order on treatment of ballast water and sediments from ships' ballast water tanks (BEK 733 of 19/05/2022) stipulate the requirements for the vessels management of their ballast water. Vessels solely operating in the Danish sea-territory and exclusive economic zone are exempted from the requirements in the Ballast Water Management Convention. Smaller vessels (<400GT) are until 8 September 2024 also exempted.

If the vessel must fulfil the requirements in the Ballast Water Management Convention, it will either be by exchange of their ballast water (D1 exchange standard) or discharge of treated ballast water (D2 discharge standard). Whether the vessel must comply with the D1 or D2 standard depends on the vessels' renewal date of the IOPP certificate. These vessels must comply with the D2 standard on 8th September 2024 at the latest.

In general, the convention requires all ships engaged in international traffic to have:

- Ballast water management plan.
- Ballast water record book.
- International ballast water management certificate.

Dumping of waste

Dumping of waste and other matters are covered by the IMO's Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter (known as the London Convention 1972).

4.4 Offshore safety

To prevent and mitigate pollution from major accidents, the Offshore Safety Act (Consolidation act no. 125 of 06/02/2018) requires response contingency plans for offshore platforms carrying out exploration, production, and transport of petroleum hydrocarbons. The required content of such plans is specified in the associated regulation on contingency plans in case of pollution of the marine environment from oil and gas pipelines and other platforms (Executive order no. 909 of 10/07/2015).

4.5 Protective zones and safety zones

To minimize the risk of damage to submarine cables and pipelines a *protective zone* of 200 meter has been established along and on each side of the cable or pipeline (Executive order no. 939 of 27/11/1992). A set of provisions have been laid on activities in the protective zones as for example ships may not anchor without urgent necessity, suction dredging, fishing for stones and other use of tools and gear that are dragged on the seabed are prohibited.

A safety zone of 500 meter is established around an oil and gas installation (Executive order no. 125 of 06/02/2018). Vessels are not allowed to access the safety zone unless the purpose of access is related to the operation and maintenance of the installation or related infrastructure or for emergency reasons.

Protective zones and safety zones are marked on charts.

After removal of the oil and gas installation and after the pipelines are emptied and cleaned it is expected that the protective zones and safety zones can be terminated. However, Wintershall intends to seek extension of the prohibition to protect the site and thereby limit the risk of damage to the remaining pipeline from e.g. new developments.

4.6 Naturally Occurring Radioactive Material (NORM)

Offshore oil production in the North Sea is associated with contamination of certain parts of the processing equipment by low-level radioactivity substances, known as NORM (Naturally Occurring Radioactive Material).

NORM naturally occurs in the reservoirs in the North Sea. The radioactive elements occur in chemical compounds in the produced water (formation water) either dissolved in the water or as small particles in the multiphase flow from the wells. NORM also occurs in systems where formation water and sea water are mixed. The radioactive particles or NORM can be accumulated and concentrated in separators (sludge) or deposited as scale in pipes and process equipment due to changes in pressure and temperature. NORM can also occur in the production liner of the wells. As the Ravn platform does not contain any processing equipment and no occurrence of NORM has been detected during operation, NORM is not expected in any materials from the platform.

The use (handling, storage, discharge, and disposal etc.) of radioactive substances such as NORM is regulated through The Radiation Protection Act (Act no. 23 from 23 of January 2018 on Ionizing Radiation and Radiation Protection No. 23 of 15/01/2018) and its underlying orders:

- Executive Order No. 669 of 1 July 2019 on ionizing Radiation and Radiation Protection.
- Executive Order No. 670 of 1 July 2019 on Use of Radioactive Substances.

The above legislation also regulates the use of sealed radioactive sources.

4.7 Natura 2000 areas

Natura 2000 is a network of nature protection areas established under the EU Habitats Directive and the Birds Directive. The network consists of Special Areas of Conservation (SACs) designated by the member states under the Habitats Directive 92/43/EEC of the Council of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. The network also consists of Special Protection Areas (SPAs) designated under the Birds Directive 2009/147/EC of the European Parliament and by the Council of 30 November 2009 on the conservation of wild birds. The aim of the network is to ensure the long-term survival of Europe's most valuable and threatened species and habitats.

The directives are implemented in Danish legislation through:

- The Environmental Goal act: Consolidation Act no. 119 of 26/01/2017
- The Subsoil Act: Consolidation act no. 1400 of 05/12/2017
- The EIA Act: Consolidation act no. 973 of 25/06/2020
- The Habitat Act: Executive order no. 1595 of 06/12 2018
- Executive order no. 434 of 02/05 2017 on impact assessment regarding international nature conservation areas and the protection of certain species in connection with

offshore exploration and production of hydrocarbons, storage in the subsoil, pipelines, etc.

Prior to any decision on projects with potential impact on a Natura 2000 area, documentation must be presented that the activity will not lead to significant effects on the favorable conservation status of species or habitats that are part of the selection basis or affect the integrity of the area significantly.

4.8 Protected species (Annex IV species)

The EU Habitats Directive (Council Directive 92/43/EEC of 21 May 1992) specifies wild fauna and flora for which the member states must ensure protection. The species to be protected are specified in the Annexes of the directive. Annex IV lists species of animals and plants in need of particularly strict protection. Of the marine mammals encountered in the North Sea, all species of cetaceans are listed in Annex IV.

4.9 Espoo Convention

Convention on Environmental Impact Assessment in a Cross-border Context, the Espoo Convention from 1991, sets out obligations of parties to assess the environmental impact of certain activities at an early stage of the planning. The convention also lays down a general obligation on the Member states to notify and consult each other on all major projects that are likely to have a significant adverse environmental impact across boundaries.

The Danish Environmental Protection Agency is the Danish Point of Contact for notifications regarding the Espoo Convention and thus also takes care of the notifications and consultation of other countries according to the Espoo convention for projects where the Danish Energy Agency is the competent authority.

4.10 OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic or OSPAR Convention is the main legislative instrument regulating international cooperation regarding the marine environment in the North Sea. The Convention regulates international cooperation in the North-East Atlantic and sets European standards for the offshore oil and gas industry, marine biodiversity, and baseline monitoring of environmental conditions. The focus of the convention is on BAT, BEP and clean technologies.

The OSPAR Convention has implemented several strategies on environmental issues such as hazardous substances, biodiversity, and radioactive compounds. The strategies include prohibition of the discharge of oil-based mud (OBM), and how drill cuttings are managed in the construction phase. In addition, hazardous substances are regulated after principles of substitution, where less hazardous substances or preferably non-hazardous substances substitute these substances if possible. The Convention requires a HOCNF (Harmonised Offshore Chemical Notification Format) and a pre-screening of substances in relation to their toxicity, persistence, and biodegradability. Compounds that cannot be substituted must be ranked if not listed on the PLONOR (Pose Little Or No Risk) list, which contains the substances with no or little environmental effect.

OSPAR agreement 2017-02 recommends procedures for monitoring of environmental impacts of discharges from offshore installations including monitoring of sediment and water column characteristics. The monitoring programmes should comprise both baseline surveys prior to any petroleum development and follow-up surveys during exploration, production, and decommissioning.

In OSPAR decision 98/3 on the disposal of disused offshore installations, OSPAR sets up the rules for leaving disused installations offshore. A disused offshore installation is defined as an offshore installation that no longer serves the purpose it was originally placed in the area for, or not serving another legitimate purpose. Offshore pipelines are not covered by the decision. The general rule is that offshore installations are not allowed to be left in a maritime area. Derogation from decision 98/3 may be considered for parts of an installation if certain conditions are met.

4.11 Marine Strategy Act

The EU has a marine strategy that aims to maintain or establish a 'Good Environmental Status' (GES) in all European marine areas. This strategy is set forth in Directive of the European Parliament and by the Council of 17 June 2008 on establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive - MSFD). The directive is implemented in Danish legislation through Marine Strategy Act (Consolidation act no. 1161 of 25/11/2019).

The marine strategy act sets up the content of a marine strategy to include:

1. Basis analysis
2. Description of good environmental status
3. Stipulate environmental targets and indicators
4. Monitoring programme
5. Programme of measures

Danish Marine Strategy II

The Danish Ministry of Environment defines what is regarded as 'Good Environmental Status' of the marine environment using 11 different descriptors. For each descriptor a set of qualitative environmental targets and preliminary indicators are set in the Danish Marine Strategy II – part 1. The 11 descriptors are listed below:

D1 Biodiversity

D2 Non-indigenous species

D3 Commercially exploited fish stocks

D4 Marine food webs

D5 Eutrophication

D6 Sea floor integrity

D7 Alteration of hydrographical conditions

D8 Contaminants

D9 Contaminants in fish and other seafood for human consumption

D10 Marine litter

D11 Underwater noise

OSPAR is currently working on a common framework of indicators and assessment values to be used in the Northeast Atlantic. In this EIA, the targets and indicators from the Danish Marine Strategy II has been used to assess the impact of the project on the objectives of the Marine Strategy. The Danish strategy has been prepared based on the 2017 EU criteria for good environmental status (GES).

It should be noted that environmental targets are not defined for all descriptors. The remaining targets are defined as trends that describe a development or descriptive target.

Eight areas in the North Sea have been appointed as marine protected areas according to the Marine Strategy Framework Directive. Activities within these areas are strictly regulated, however the Ravn field is not located within one of these areas.

Marine Strategy – Monitoring programme

The Danish Environmental Protection Agency under the Ministry of Environment has prepared a monitoring programme as part of the Danish Marine Strategy II covering the period 2021-2026. The monitoring programme includes activities related to all the 11 descriptors and covers both existing monitoring programmes and new initiatives. The monitoring programme serves as input to the programme of measures planned to be finalized in 2022.

4.12 Regulation of decommissioning

Decommissioning is regulated through Danish legislation in the Subsoil Act (Consolidation act no. 1533 of 16/12/2019) and the Marine Environment Act (Consolidation act no. 1165 of 25/11/2019).

According to the subsoil act, decommissioning plans for offshore oil and gas installations shall be prepared, submitted, and approved by the DEA before the installations can be removed. DEA has prepared a guideline for these decommissioning plans "Guideline on decommissioning plans for offshore oil and gas facilities or installations" dated August 2018. The guideline explains the legal framework and the required contents of the plans.

In addition, decommissioning is regulated through the following international conventions and declarations:

- IMO's Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter (known as the London Convention 1972) including the 1996 Protocol which became effective in 2006. The London Convention is a global convention that aims at protecting the marine environment from human activities by promoting control of sources of marine pollution and by taking steps to prevent pollution of the ocean. Under the convention all dumping of waste is prohibited except certain types of waste listed on the convention's 'reverse list'.

- Ministerial Declaration of the Ninth Trilateral Governmental Conference on the Protection of the Wadden Sea (known as the Esbjerg Declaration 2001).

- OSPAR Commission's OSPAR Convention (1992 and 1998), Annex III on Prevention and elimination of pollution from offshore sources, Decision 98/3 on Disposal of disused offshore installations, and recommendation 77/1 on Disposal of pipes, metal shavings and other material resulting from offshore petroleum hydrocarbon exploration and exploration operations.

- Regarding decommissioning, the Esbjerg Declaration states that more environmentally acceptable and controllable land-based solutions are preferred, and that decommissioned offshore installations therefore shall either be reused or be disposed on land.

The OSPAR Commission establishes the framework for decommissioning including guidelines and procedures. Recommendation 77/1 states that dumping of bulky waste is prohibited without special permission excluding inter-field pipelines. All dumping or leaving wholly or partly in place of offshore installations in the North Sea is prohibited according to Decision 98/3. However, derogation from this regulation is possible when there are significant reasons why an alternative disposal is preferred. Decision 98/3 does not include decommissioning of pipelines.

DEA Drilling guidelines (DEA, 2009) state how wells should be plugged before abandonment according to approved procedures. The P&A procedures secure that wells site will be re-established in accordance with the original state and that the well site shall be verified before abandonment.

4.13 Waste

Waste is regulated through the EU Directive 2008/98/EU which establishes a framework for waste management and put forward the waste hierarchy to reduce generation of waste and increase reuse and recycling. The directive is implemented in Danish legislation through the Executive Order no. 2512 of 10/12/2021 on waste.

The cross-border transfer of waste is regulated by the EU-Parliament and the Council Regulation (EF) 1309/2006. The regulation establishes procedures for transport of waste.

5 Alternative concepts

5.1 0-alternative

The 0-alternative is a situation in which the present project is not carried out. However, as decommissioning is required as per OSPAR 98/3 the 0-alternative is not possible, and therefore not further assessed.

5.2 Alternative decommissioning concepts

Selection of the decommissioning and removal method for the Ravn platform will generally be based on the removal contractors' proposals although operators should determine a removal strategy for the facility to eliminate unnecessary work in other elements.

The principal methods considered for decommissioning and removal of the Ravn facility are summarized and shown in below Table 5-1 including reference to relevant section for detailed description.

Table 5-1 Alternative decommissioning methods considered.

Method	Description	Section:
Removal of topside		6.2.2
Single lift removal by HLV / SLV / MCV	Removal of topside as complete unit and transportation to shore for re-use of selected equipment, recycling, break up, and / or disposal.	
Modular removal and reuse/recycle by HLV / SLV /MCV	Removal of parts/modules of topside for transportation and re-use in alternative locations and/or recycling/disposal.	
Offshore removal 'piece small' for onshore reuse/disposal	Removal of topside by breaking up offshore and transporting to shore using work barges. Items will then be sorted for re-use, recycling, or disposal.	
Proposed removal method and disposal route for Ravn	Removal of topside in a single lift by heavy-lift vessel (HLV). Transportation to Dutch shore to execute the dismantlement, disposal and recycling or alternatively for storage before reuse. Trans-frontier shipment of waste will be addressed during the commercial tendering and permitting process.	
Removal of jacket		6.2.3
Removal and re-use	Jacket piles cut 3 meters below seabed. Removal of jacket for transportation to alternative site (via onshore for overhaul).	
Offshore removal with single lift, onshore disposal	Jacket piles cut 3 meters below seabed. Removal of jacket as complete unit and transport to shore for break up and/or recycle.	

Method	Description	Section:
Offshore removal using 'piece small' for onshore disposal	Removal of jacket in several pieces using attendant work barge and transport to shore yard. Jacket piles cut 3 meters below seabed.	
Proposed removal method and disposal route	Jacket piles cut 3 meters below seabed. Removal of jacket with single lift. Transport to Dutch shore to execute the dismantlement and recycling. Trans-frontier shipment of waste will be addressed during the commercial tendering and permitting process.	
Decommissioning of pipelines		6.2.5
Proposed removal method and disposal route	Decommissioning Options Considered: 1) Leaving *in situ* 2) Removal of materials above seabed 3) Remove by reverse installation 4) Remove by cut and lift The pipeline is currently stable and buried below seafloor (except at crossings) and leaving *in situ* represents the least impact to the seabed, see comparative assessment in section16. The preferred option by Wintershall Noordzee B.V. based on a comprehensive comparative assessment: Leaving *in situ* the pipelines and umbilical along with the concrete mattresses. The crossing at the Europipe I is left *in situ*.	

A final decision on the decommissioning method will be made following a commercial tendering process. Once the methodology for removal is confirmed the facility can be prepared for lifting and removal.

6 The Ravn decommissioning project

6.1 Technical description of the Ravn decommissioning project

The following section includes a description of the Ravn platform and related infrastructure and how they will be decommissioned.

Location

The Ravn platform is located in the Block 5504 within the Greater Ravn field, in the Danish sector of the North Sea, approximately 245 km from the Danish west coast and 11.3 km northeast of the border between Germany and Denmark, see Figure 3-1 and Figure 3-2.

The platform was installed during 2015 and production commenced in 2017.

The water depths around the site are consistently between 48 and 50 m LAT.

Specific location coordinates for the Ravn platform are shown in Table 6-1.

Table 6-1 Coordinates for the Ravn platform.

Name	Facility Type	Location	
Ravn	Fixed Platform (NUI)	ERTS89	55°52'50.2" N 4°14'5.4" E

The Ravn installation

The offshore facilities consist of a Normally Unmanned Installation (NUI) platform, see Figure 6-2, including two wells (not producing), and 2 pipelines (3” gas lift and 8” multiphase) and a 5.7” umbilical tied-back to the A6-A platform (18 km long).

The platform was developed with two oil producing wells, which were in service until 2020, where the well Ravn A1 was suspended. The well Ravn A2 was already temporarily plugged and abandoned in 2018. Previously the oil and gas were transferred by the multiphase pipeline to the A6-A platform for processing and further export, see Figure 6-1.

The Ravn platform has been cleaned and flushed from hydrocarbons and solar panels have been installed to generate sufficient power for navigation lights and remote well monitoring, independent from its host platform A6-A. This new status allows for reduced maintenance and the platform is only visited once per year by means of a Walk to work-vessel.

There is no processing equipment installed on the Ravn topside. Access to the platform is possible via the crew transfer boat-landing facilities or by means of a Walk to Work vessel, following the mothball status in September 2020. The helideck is taken out of service.

The platform remains connected via the two 18 km long pipelines and the umbilical to the Wintershall Noordzee B.V. operated A6-A host platform in German waters. The two pipelines have been flushed and preserved with Nitrogen to allow for potential future use. Before the decommissioning the pipelines and umbilical will be flushed and cleaned.

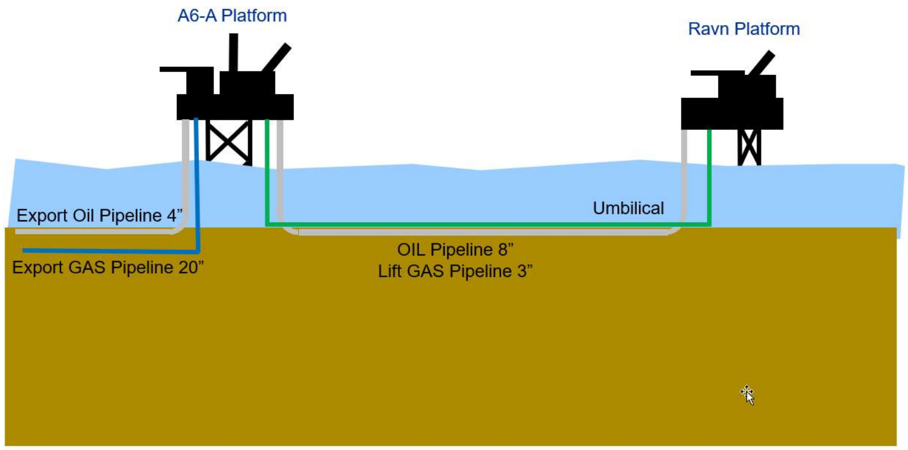


Figure 6-1 Overview of the pipeline connection of Ravn and the A6-A platform.

Figure 6-2 Photo of the Ravn platform.

Ravn topside and jacket

The Ravn platform is a 711 mT topside minimum facility structure.

The overall specifications for items at the surface facilities of the platform to be decommissioned (topside/jacket/piles) are summarized in Table 6-2.

Table 6-2 Specifications of topside and jacket.

Surface Facilities Information									
Name	Facility Type	Location		Topside/ Facilities		Jacket			
				Weight [mT]	No of Modules	Weight [mT]	No. of Legs	No. of Piles	Weight of Piles [mT]
Ravn	Small, fixed type (NUI)	ERTS89	55°52'50.2" N 4°14'5.4" E	718[1)]	1	1,177[(2)]	4	4	952[(3)]

[(1)] Including 12-17mT temporary equipment (as generators/diesel tank etc.) & including 7mT from P/L spools from the deck
[(2)] Excluding the piles and the grout in the skirt piles
[(3)] Assuming 20 meters of each pile included in the jacket skirts (cut 3m below seabed), then the total weight is 316 mT (A1/B1 ~65 mT and A2/B2 ~93 mT)

It is noted that the topside weight is 711 mT and combined with the weight of the spools the total weight is 718 mT.

Ravn topside structure

The topside has five levels/decks (spider-, cellar-, mezzanine-, main- and helideck) as shown in Figure 6-3 and Figure 6-4.

1 Spider deck

2 Cellar deck: Emergency crew shelter, lifeboat, life raft and various other equipment

3 Mezzanine deck: Control and high-voltage room

4 Main deck: The vent stack, platform crane and tanks / containers

5 Helideck: The helideck is designed for a 10.6 mT helicopter weight

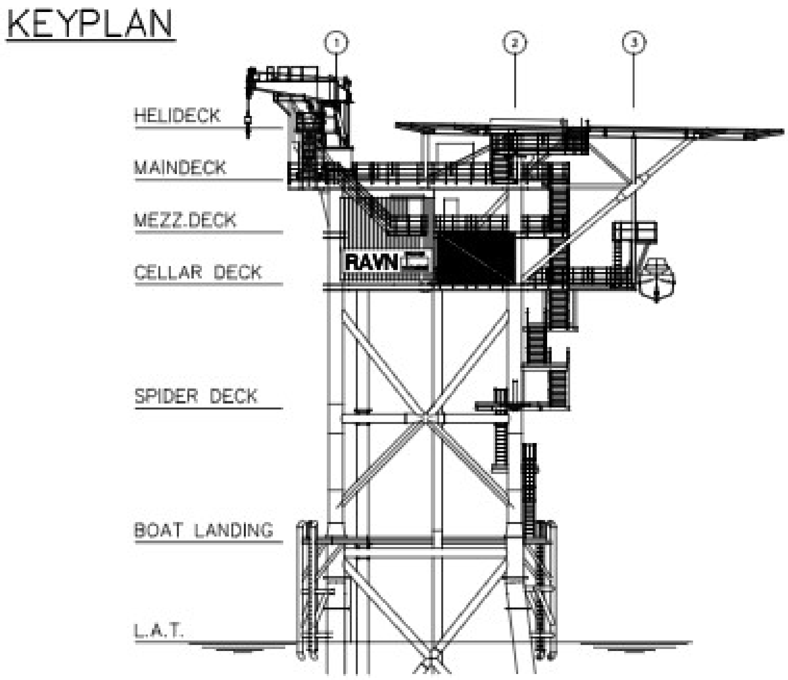


Figure 6-3 Keyplan of the topside.

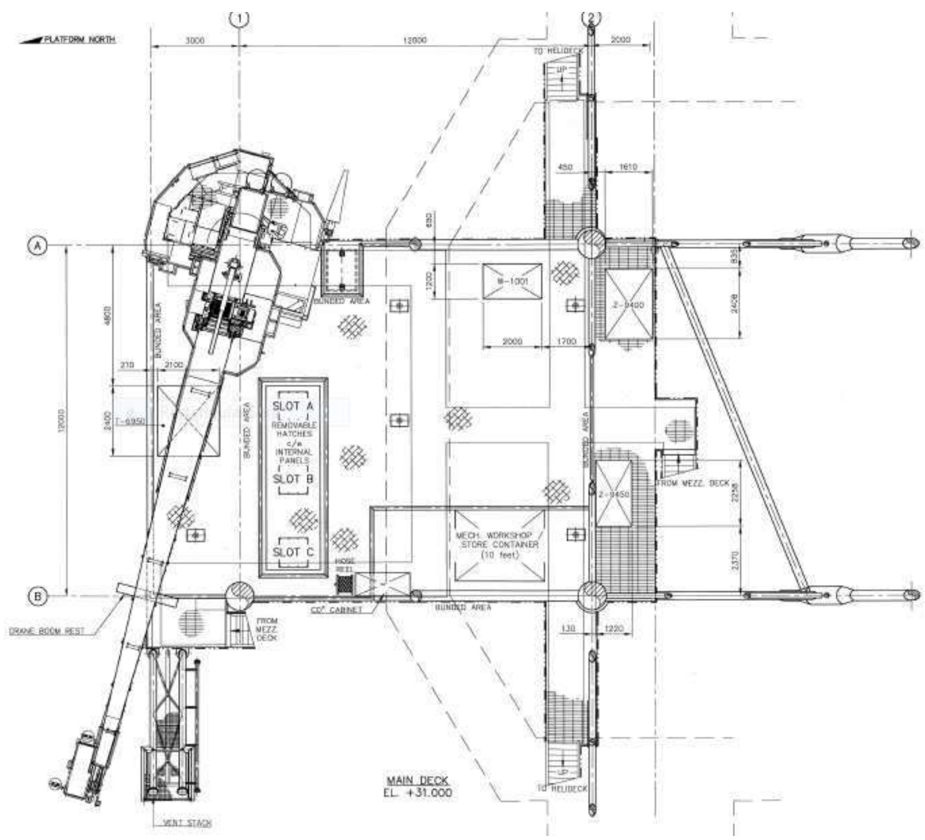


Figure 6-4 Keyplan of the topside main deck level.

The components and estimated dry weight of the topside, including the 22 m X 22 m helideck and the temporary equipment of up to 17 tons, are shown in Table 6-3.

Table 6-3 Topside components and weights.

Satellite	Ravn	
Discipline load summary	Dry weight [Tons]	Fraction [%]
Main structure (Steel)	228	32
Secondary structure (Steel)	270	37
Mechanical	43	6
Piping	121	17
Elec. & Control Equipment	28	4
Electrical	21	3
Total	**711**	**100%**

Ravn jacket structure

The Ravn NUI is supported by a fixed four-legged jacket steel structure (leg A1, B1, A2 and B2), see Figure 6-5 to Figure 6-7. The jacket weights 1,177 mT and is fastened to the seabed with four piles with a total weight of 817 mT incl. grout. The water depth at the location is 49.0 m LAT.

Furthermore, the jacket structure has four subsea elevations, two risers, one J-Tube, one umbilical and two pipelines, one caisson and two conductors.

The structure is protected with Cathodic Protection against external corrosion by sacrificial anodes. All anodes inspected in 2020 appeared to be in a satisfactory condition with no apparent signs of damage, defects or significant debris being noted.

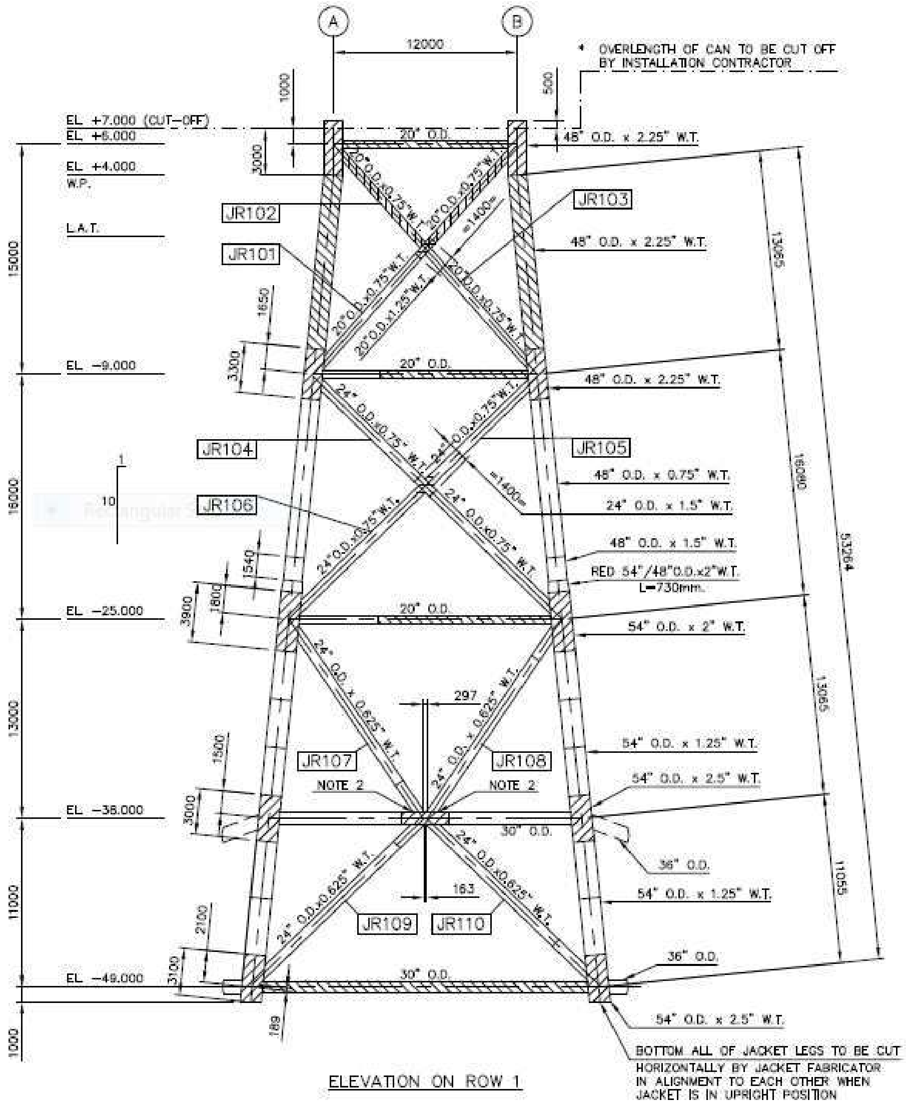


Figure 6-5 Jacket elevation.

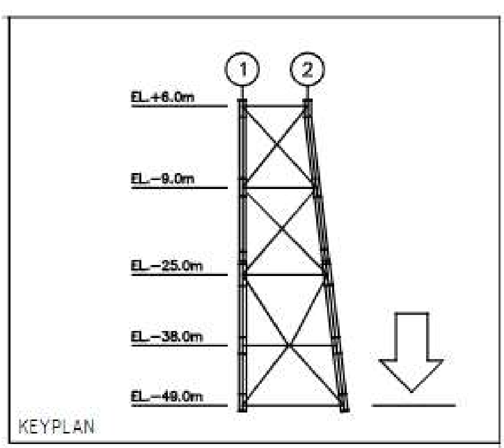


Figure 6-6 Keyplan of the jacket.

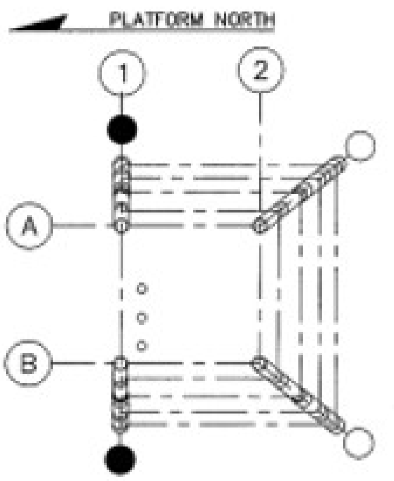


Figure 6-7 Horizontal keyplan of the jacket.

The components and estimated dry weight of the jacket excl. piles are shown in Table 6-4.

Table 6-4 Jacket components and weights (excl. piles).

Jacket (steel structures)	Dry weight [Tons]	Fraction [%]
Anodes (Aluminum)	82	7
Jacket structure (Steel)	1,095	91.5
Spools	7	0.5
Pipeline sections from seabed to topside	20	1
Total	**1204**	**100%**

The pile weights can be seen below (numbers referring to the leg):

- A1 = 65 tons (cut 3 m below seabed)
- A2 = 93 tons (cut 3 m below seabed)
- B1 = 65 tons (cut 3 m below seabed)
- B2 = 93 tons (cut 3 m below seabed)

Assuming 20 meters of each pile included in the jacket skirts, this totaling 316 tons.

Pipelines

There are two pipelines and an umbilical connecting the Ravn platform with the A6-A platform, one 8" multiphase pipeline with a 3" gas lift pipeline piggy-backed to the multiphase pipeline (connected by piggyback blocks and steel straps). The umbilical is 5.7".

The pipelines are laid in tandem. These pipelines as well as the umbilical are buried in the seabed. The pipeline bundle and the umbilical have been trenched separately over the entire length except at the crossing with the Europipe I at the Danish shelf and the Norpipe at the German shelf. The A6-A platform and sections of the pipelines are located in the German EEZ in the area known as the Entenschnabel (= Duck's Bill) and thus in the "*Doggerbank*" FFH site. The Danish Ravn platform is located about 15 km from the border with Germany; consequently, the pipelines run through the German North Sea for a distance of approx. 3 km and through the Danish waters for the remaining 15 km.

The pipeline bundle and the umbilical both cross the 40" Europipe I owned by Gassled at the Danish shelf. As the pipeline bundle and the umbilical is trenched separately in parallel, they cross the Europipe I in separate crosses. As the Europipe I is exposed, approx. 0.3 m above seabed, concrete mattresses are placed on top of the Europipe I and the pipeline bundle are placed above the concrete mattresses within a layer of rock, which is further protected with an amour- and sprinkle layer consisting of smaller gravel. The umbilical located parallel to the pipeline bundle is placed in the same type of section, see Figure 6-8 to Figure 6-10.

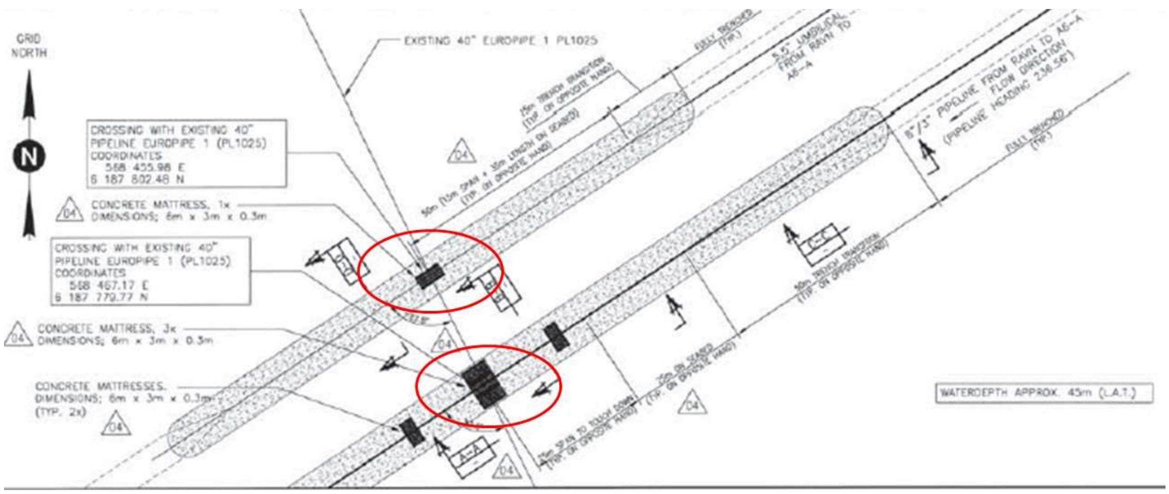


Figure 6-8 *Plan view of the crossings between the Europipe I and the pipeline bundle (marked with the lower red circle) and the umbilical (marked with the upper red circle).*

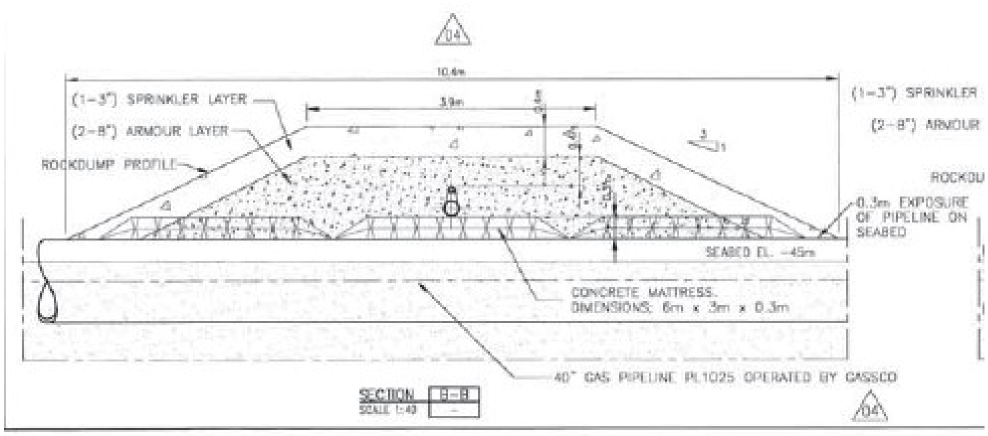


Figure 6-9 *Cross section of the crossing between the Europipe I and the pipeline bundle.*

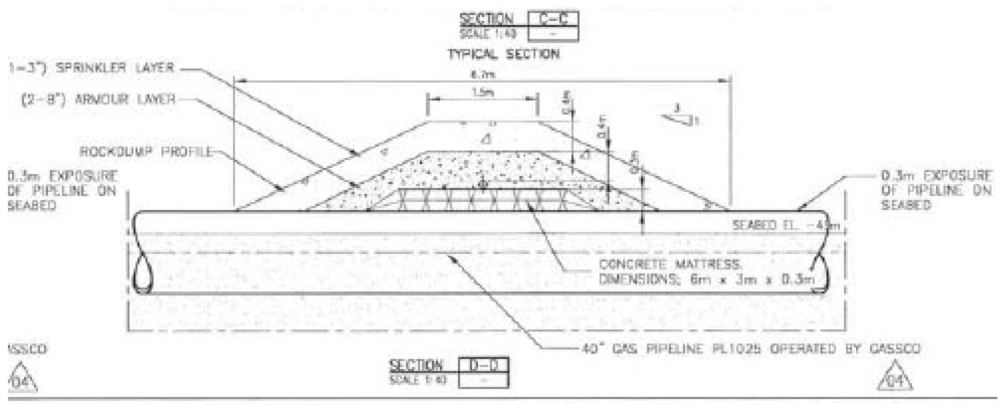


Figure 6-10 Cross section of the crossing between the Europipe I and the umbilical.

In 2020 Wintershall Noordzee B.V. decided to suspend the Ravn oil and associated gas production. The multiphase content was removed out of the 8" pipeline. The 3" gas lift pipeline was de-gassed. Both lines were conservated with 3 bar nitrogen pressure. End 2021 Wintershall Noordzee B.V. and DNSF decided not to pursue any (re)development of the (greater) Ravn area because this was found not to be financially attractive.

To ensure safe decommissioning of the A6-A and Ravn platform in the future the pipeline bundle and umbilical needs to be cleaned and disconnected subsea from the A6-A and the Ravn platform.

Because the Ravn platform is a satellite platform, Ravn does not have sufficient space to accommodate a cleaning spread to receive the pipeline content during the cleaning operation. This means the cleaning operation needs to be executed from Ravn to A6-A. The cleaning will be conducted before decommissioning. In compliance with regulations, a pipeline cleaning programme has been designed to ensure the hydrocarbon content and any deposits within the pipelines are sufficiently cleaned.

The diameter of the multiphase pipeline is 8” (equivalent to approx. 22 cm). The pipeline itself is made of steel and is protected from corrosion by three layers of polypropylene (PP). The layer is 2.8 mm thick. In addition, sacrificial anodes are installed at regular intervals, approximately +/- 300 m, for cathodic protection. These consist of a zinc-aluminum alloy, weigh about 25 kg and have a functional life of about 30 years. Additional weighting was not necessarily due to the high dead or true specific weight.

In addition, a 3” lift gas line was installed. This is mounted directly on the pipeline in what is known as “piggyback style” with a protective coating layer of 2.1 mm PP.

Parallel to the pipelines, a supply line referred to as an umbilical was laid 25 m away. This includes a power supply cable and a fiberoptics cable, as well as several pipes for transporting chemicals, see Figure 6-11. The umbilical was used to transport methanol, corrosion inhibitors and asphaltene inhibitors from A6-A to Ravn. It connects the A6-A and Ravn platforms, has a diameter of 5.7” and is encased in a 5.3 mm thick low-density polyethylene (LDPE) layer.

Like the pipelines, the umbilical was placed inside the sediment. In the vicinity of the platforms, where burial is not possible, the pipeline was secured using concrete mattresses.

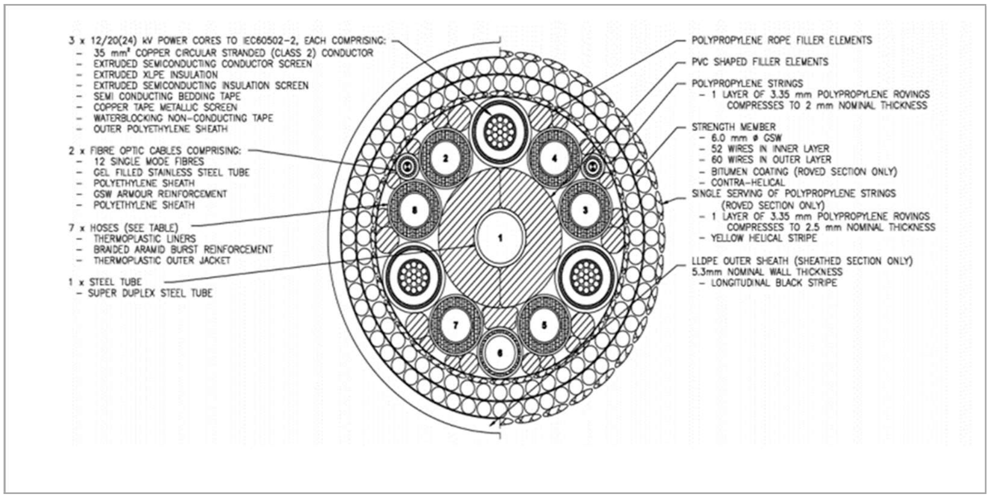


Figure 6-11 Cross section through the umbilical.

In Table 6-5 an overview of the applicable design information and status on the two pipelines and umbilical between the Ravn and the A6-A platform can be seen.

Table 6-5 Information on the pipelines and umbilical.

Information	8" multiphase pipeline	3" gas lift pipeline	Umbilical
Type:	Rigid API-5L-X52	Rigid API-5L-X52	Umbilical
Outer diameter:	8.625" (219.1 mm)	3" (88.9 mm)	145 mm
Tubes:	-	-	1 ea super duplex tube ¾" NB 7 ea thermoplastic tube ½"' NB
Wall thickness:	12.7 mm	6.4 mm	-
Coating:	2.8 mm PP	2.1 mm PP	Outer layer 5.3 mm LDPE
Water depth:	49 m Ravn Platform (47 m A6-A Platform)	49 m Ravn Platform (47 m A6-A Platform)	49 m Ravn Platform (47 m A6-A Platform)
Length:	18,295 m	18,295 m	18,295 m
Current Pipeline pressure (N2):	3 barg	3 barg	0 barg (ambient)
Product:	Crude Oil/associated gas/water	Dry gas	Methanol/Corrosion Inhibitor/Asphaltene inhibitor
Status:	De-oiled and filled with 3 bar Nitrogen	De-gassed and filled with 3 bar Nitrogen	Filled
Burial:	Trenched over the entire length of the	Piggybacked to the 8" multi-phase line and trenched over	Trenched over the entire length of the umbilical except at crossings

Information	8” multiphase pipeline	3” gas lift pipeline	Umbilical
	pipeline except at crossings	the entire length of the pipeline except at crossings	
Spool piece/ Umbilical 500m zone:	Not piggy backed. Covered by concrete mattresses at Ravn and a rock berm at A6-A	Running parallel to 8". Covered by concrete mattresses at Ravn and a rock berm at A6-A	Covered by concrete mattresses at Ravn and a rock berm at A6-A

In total approx. 40 concrete mattresses have been placed at the pipelines and the umbilical ends near the Ravn platform and 8 mattresses have been placed at the crossing with the Europipe I. Furthermore, there have been placed approx. 1,885 tons rock as amour layer and 2,157 tons sprinkle layer at the crossing.

6.2 The Ravn decommissioning programme

In the following section the decommissioning programme is described including the proposed methods and processes herein.

The general Scope of Work for the decommissioning process can be seen below:

Phase I : Removal and Disposal Plan & Removal Engineering (onshore)

Phase II : Offshore preparations and pipeline disconnect

Phase III : Platform removal

Phase IV : Seabed cleaning & survey

Phase V : Disposal of all materials

Removal of topside

The topside was installed by a Heavy Lift Vessel (HLV) in a single crane lift.

There are two principal methods for topside removal as shown in Table 6-6, including single lift by using a large lift vessel to remove the topside as a single unit and transport onshore for dismantling. Piece small removal by breaking up the topside offshore and transport it to shore by work barge. The decision of method is also related to the availability of various vessels and offered by contractors.

A final decision on the decommissioning method will be made following a commercial tendering process. Once the methodology for removal is confirmed the topside can be prepared for lifting.

Various vessels used for commissioning and installation of platforms are also used for decommissioning and removal of platforms, including HLV / SLV / MCV and so forth (please refer to the Abbreviations in section 1). The options for removal of the topside by use of different vessels are described in Table 6-6.

Table 6-6 Topside removal methods.

Method	Description
Single lift removal by HLV / SLV / MCV	Removal of topside as complete unit and transportation to shore for re-use of selected equipment, recycling, break up, and / or disposal.
Offshore removal 'piece small' for onshore reuse/disposal	Removal of topside by breaking up offshore and transporting to shore using work barges. Items will then be sorted for re-use, recycling, or disposal.
Proposed removal method and disposal route for Ravn	Removal of topside in a single lift by heavy-lift vessel (HLV). Transportation to Dutch shore to execute the dismantlement, disposal and recycling. Trans-frontier shipment of waste will be addressed during the commercial tendering and permitting process.

The proposed removal method is topside removal by single lift and is thus the method assessed.

To separate the topside from the jacket, cutting work need to be executed. It is anticipated that the cutting works above water will be executed with oxygen and gas torch cutting and that the cutting below seabed will be executed with an internal abrasive cutting tool. Other options could also be investigated and/or executed. The removal of the platforms will be executed by first removing the topside (incl. leg extensions) followed by the jacket.

The topside will be lifted off the jacket and transported, to the proposed port with the appropriate decommissioning yard, see Figure 6-12 and Figure 6-13.

Below the general process is described:

1 Inspection (Non-Destructive Testing) of existing pad eyes (4)

2 Interface removal of topside/jacket

3 Installation of slings

4 Cutting legs, lift and sea fasten on barge or transport in crane hook to shore

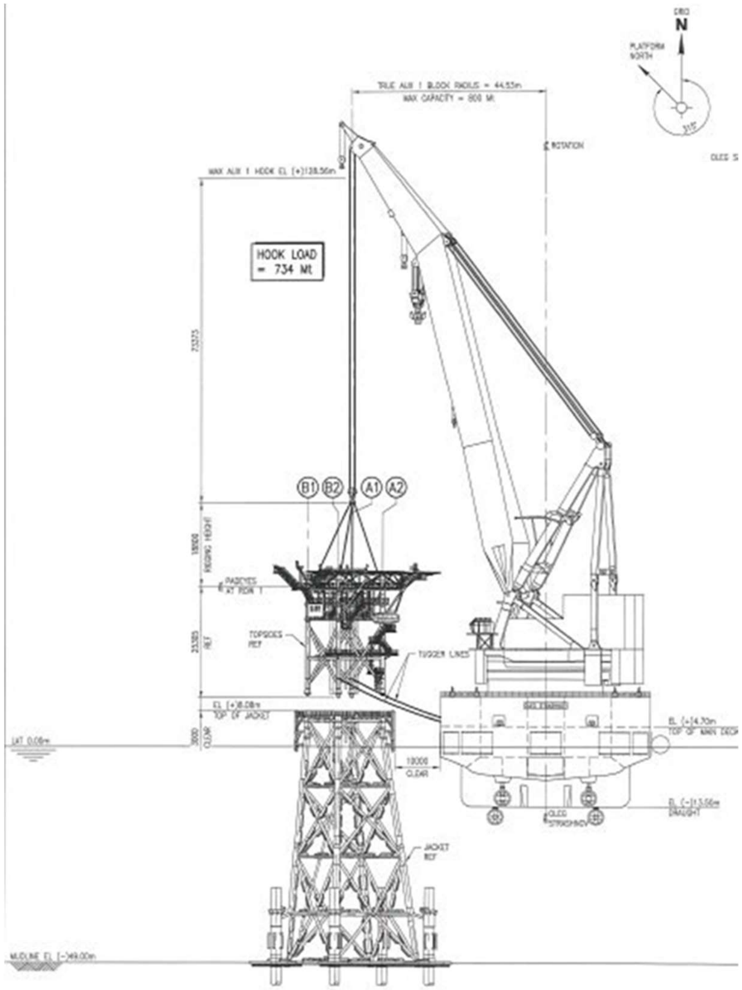


Figure 6-12 Lifting of Topside (example).

Figure 6-13 Lifting of Topside (example from erecting).

Removal of Jacket

There are three principal methods for jacket removal as shown in Table 6-7. The methods includes;

- Single lift by using a large lift vessel to remove the jacket as a single unit and transported to shore for dismantling.
- Removal of jacket and transport to an alternative site to reuse via onshore stop for overhaul.
- Piece-small removal by breaking the jacket into small pieces offshore and transporting the waste to shore.

The principal methods including the various types of vessels available for removal of jacket are described in Table 6-7. A final decision on the decommissioning method will be made following a commercial tendering process.

Table 6-7 Jacket removal methods.

Method	Description
Removal and re-use	Jacket piles cut 3 meters below seabed. Removal of jacket for transportation to alternative site (via onshore for overhaul).
Offshore removal with single lift, onshore disposal	Jacket piles cut 3 meters below seabed. Removal of jacket as complete unit and transport to shore for break up and/or recycle.
Offshore removal using ‘piece small’ for onshore disposal	Removal of jacket in several pieces using attendant work barge and transport to shore yard. Jacket piles cut 3 meters below seabed.
Proposed removal method and disposal route	Jacket piles cut 3 meters below seabed. Removal of jacket with single lift. Transport to Dutch shore to execute the dismantlement and recycling. Trans-frontier shipment of waste will be addressed during the commercial tendering and permitting process.

The proposed removal method is jacket removal by single lift and is thus the method assessed.

The jacket will be disconnected from the seabed by cutting the foundation/skirt piles at the required level below the seabed. The jacket will be lifted with the crane(s) and transported to the proposed port while suspended in the crane hooks or by barge, see Figure 6-14. The cutting below seabed will be executed with an internal abrasive cutting tool.

Prior to cutting the jacket foundation/skirt piles, the piles need to be dredged till a required depth to allow positioning of the abrasive cutting tool at the appropriate location/depth. As the cutline of the piles is below the general seabed level, the soil plug in the pile needs to be removed until 3 m under the general seabed level.

To remove the sediment (soil plug) inside the pile, it is proposed to use an airlift tool. The type of tool can differ depending on the soil type (clay/sand) within the pile. The tool will be deployed inside the pile to the required depth and once in position, the power to the system will be supplied and the sediment will be removed.

After dredging the soil in the (skirt) piles, the cutting operation can take place. Initially the cutting will include all four piles 3 meters below the seabed. Cutting of the piles will be executed by an abrasive cutting tool lowered into the jacket piles to the required depth.

Below the general process is described:

1 Installation of access (rigging platform/scaffolding)

2 Inspection (Non-Destructive Testing) of existing pad eyes

3 Installation of slings

4 Internal pile dredging (4x), (soil plug removal)

5 Internal pile cutting (abrasive water jet cutting)

6 Lifting and sea fasten on barge or transport in crane hook

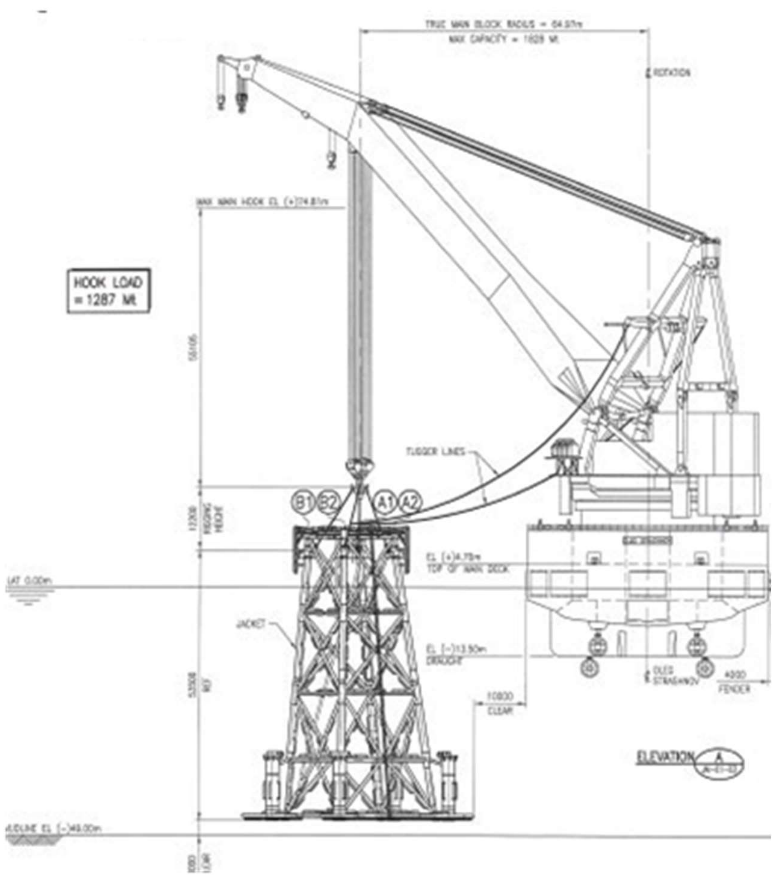


Figure 6-14 Lifting and jacket (example).

It shall be decided whether the jacket shall be cleaned for marine growth prior to the removal or if it shall be performed onshore, Figure 6-15. Projects with jackets, which have been previously removed with the marine growth, have reported odour problems on disposal yards near residential areas. It should be determined whether the disposal yards have such problems and if cleaning the jacket offshore should be taken into consideration.

A marine growth survey was conducted (visual inspection) in 2020. The structural elements, conductors and caissons were covered with a combination of both hard and soft type marine growth. Table 6-8 and Table 6-9 summarize the average and maximum marine growth percentages and values at structural component in an uncompressed state. It was found that the extent of the marine growth coverage obscures underlying component details at times.

Table 6-8 Marine growth – average percentages/values.

Inspection item	LAT to -12.0m				-12.0m to Seabed			
	AVG HARD		AVG SOFT		AVG HARD		AVG SOFT	
	%	mm	%	mm	%	mm	%	mm
Rows & Elevations	51%	78	49%	88	57%	32	43%	59
Conductors	90%	50	10%	90	50%	34	50%	40
Caissons	60%	40	40%	90	50%	40	40%	40

Table 6-9 Marine growth – maximum percentages/values.

Inspection item	LAT to -12.0m				-12.0m to Seabed			
	MAX HARD		MAX SOFT		MAX HARD		MAX SOFT	
	%	mm	%	mm	%	mm	%	mm
Rows & Elevations	60%	100	50%	90	80%	70	80%	70
Conductors	90%	50	10%	90	80%	40	80%	40
Caissons	60%	40	40%	90	50%	40	40%	40

Figure 6-15 Example of marine growth on jacket.

A marine growth density of 1,325 kg/m³ is common according to a review carried out by Science Direct based on studies from 2005-2017 (Science Direct, 2008-2017). A study from 2019, carried out by a group of scientists from Wageningen University in collaboration with an operator in the Danish sector, shows a much lower density of marine growth and a big difference in density at different water depths and locations in the North Sea. To improve the model, a detailed survey was carried out at two Dutch platforms in 2018 (Coolen et al., 2019). Samples were weighted as wet weight immediately after collection, and the density from the surface to low water depths was 311 kg/m³ and at deeper water 945 kg/m³ with an average density of 612 kg/m³. We have used the average density of 612 kg/m³.

With an estimated surface area of roughly 2,400 m² of the Ravn jacket structure below the water line and an average marine growth thickness of 57 mm, the volume of the marine growth can be estimated to approximately 137 m³ or approximately 84 tons of organic material.

Emissions to air during removal of topside and jacket

Emissions to air in relation to the removal of topside and jacket are related to:

Operation of different offshore special vessels (e.g. heavy lift vessels, survey vessels etc.)

In Table 6-10 the expected transport related to decommissioning activities can be seen.

Table 6-10 Type of transport related to removal of topside and jacket.

Vessel	Numbers	Days	Fuel consumption [m³/day]
Removal of topside and jacket by single lift with Heavy Lift Vessel			
Heavy Lift Vessel (HLV)	1	14.5	28
150t Anchor-Handling-Tug	1	14.5	11

The assumptions are:

All estimated days include contingency for weather delays and unforeseen events.

The emissions to air have been calculated for the proposed removal methods for the topside and jacket, see Table 6-11.

Table 6-11 Total emission to air for removal of topside and jacket.

Emissions related to removal of topside and jacket	CO_2 [ton]	NO_x [ton]	SO_x [ton]	CH_4 [ton]	nmVOC [ton]
Heavy Lift Vessel (HLV)	1,094	18	0.3	0.05	2
150t Anchor-Handling-Tug	430	7	0.1	0.02	1
Total	**1,524**	**25**	**0.5**	**0.1**	**2.4**

Disconnection of pipelines and umbilical

Prior to disconnection of the pipeline and umbilical these have been cleaned. The cleaning activities are not further assessed in this EIA. Emissions from activities are described in section in 9.1.5 and 9.2.5.

After the two pipelines (8-inch multiphase and 3-inch gas lift) and the umbilical have been cleaned, the pipeline will be disconnected at the Ravn Platform. This will be executed by divers and a DSV DP2 class in air dive mode and on deck saturation to improve workability. The air dive spread comes with a redundant LARS (Launch and recovery system) capable to dive to 50 m water depth. The DSV will have cutting equipment on board and a small work class ROV (Tiger) to perform surveys and observe the divers while working. The ROV will perform an as found survey.

Divers will cut the exposed pipeline and umbilical section by either using oxy arc cutting equipment or a Spitznas hydraulic reciprocating saw. 20 m of the 8-inch/3-inch piggybacked pipeline will be removed, as well as 6 m of the umbilical. In total 6 cuts will be made on the pipeline spool sections and two cuts on the umbilical section to create lengths that can be lifted aboard the DSV. Duration for cutting and removing the exposed spool piece and umbilical sections including surveys and diving preparations will take approximately 24 hours. The spool piece and umbilical sections that have been cut are lifted aboard the DSV and transported to shore. The exposed pipeline bundle and umbilical end are covered by gravel to protect the ends against fishing activities. The gravel berm on each pipeline and umbilical end will have a footprint of approximately 6 m^2.

The Figure 6-16 below shows an overview of the subsea spool pieces at the Ravn platform to be removed.

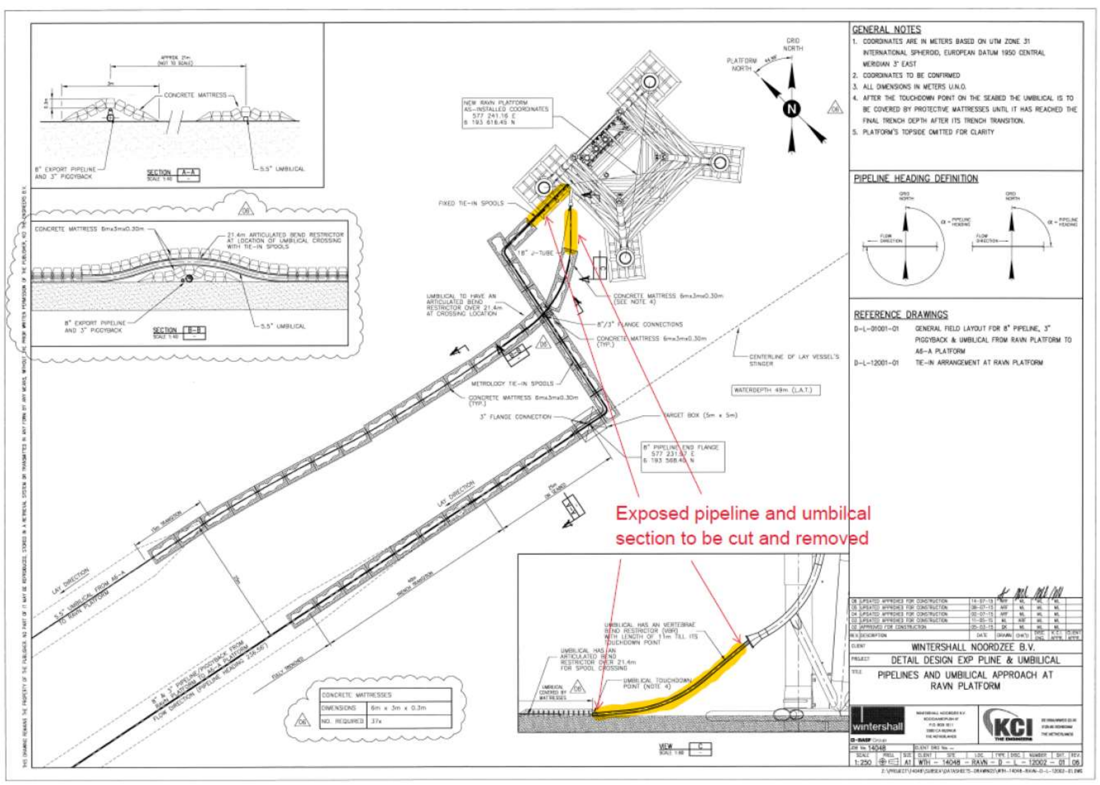


Figure 6-16 8-inch/3-inch pipeline bundle and umbilical sections to be cut and removed at Ravn Platform.

Decommissioning of pipelines and umbilical and pipeline stabilization features

Before the decommissioning of the pipelines and umbilical the cleaning and disconnection of the pipeline and umbilical ends has been conducted cf. section 6.2.4 above. The ends have been covered with gravel to protect the ends against fishing activities. In compliance with regulations, the pipeline cleaning programme has been designed to ensure the hydrocarbon content and any deposits within the pipelines are sufficiently cleaned.

In Table 6-12 the assessed decommissioning options for the pipelines and the umbilical are presented.

Table 6-12 Pipeline decommissioning options assessed.

Pipeline or Pipeline Groups Decommissioning options assessed			
Pipelines and umbilical	Condition of line/group (Surface laid/Trenched/ Buried/ Spanning)	Whole or part of pipeline/group	Decommissioning options assessed
8”, 3”, 5.7”	Trenched, buried	Whole of pipelines except at crossings	1) Leaving *in situ* 2) Removal of materials above seabed 3) Remove by reverse installation 4) Remove by cut and lift

The decommissioning options considered for the pipelines and the umbilical located in the Danish area include the following:

Leaving in situ: The pipelines and umbilical are left in place with no further action. There will be no further rock placement at the ends of the pipeline and umbilical as this has been conducted in relation to the cleaning and disconnection scope.

Removal of materials above seabed: The first 150 m of the pipeline bundle and the umbilical and the crossing sections are removed as these are above the seabed, while the remaining pipeline bundle and the umbilical is left in situ below seabed. The rock amour- and sprinkle layer around the crossing will be displaced on the seabed and the concrete mattresses will be removed and taken to shore. Exposed pipeline ends will be secured with rock berm.

Remove by reverse installation: The process by which the pipeline bundle will be recovered from the seabed by reverse S-lay and the umbilical will be recovered by reverse reeling. The pipeline and umbilical corridor need to be excavated. The reverse S-lay includes recovering the pipeline bundle from the seabed and cutting it on the deck of the S-lay vessel. The reverse reeling recovers the umbilical using a specialist reel vessel. These vessels are usually engaged in installation activities but can be adapted to recover pipelines as part of a decommissioning project.

Remove by cut and lift: The pipelines and umbilical are cut down in appropriate length pieces on the seabed and lifted to vessel for transport to shore. Require removal of rock cover and opening of the trench where the pipeline and umbilical are buried.

The decommissioning of the pipelines is described in Table 6-13.

Table 6-13 Decommissioning of pipelines.

Method	Description
Proposed removal method and disposal route	Decommissioning Options Considered: 1) Leaving *in situ* 2) Removal of materials above seabed 3) Removal by reverse installation 4) Removal by cut and lift The pipeline is currently stable and buried below seafloor (except at crossings) and leaving *in situ* represents the least impact to the seabed, see comparative assessment in section16. The preferred option by Wintershall Noordzee B.V. based on a comprehensive comparative assessment: Leaving *in situ* the pipelines and umbilical along with the concrete mattresses. The crossing at the Europipe I is left *in situ*.

Summary of the preferred option by Wintershall Noordzee B.V. for pipeline decommissioning:

- Spool pieces exposed above seabed will be removed and returned to shore during the preparational phase (clean and disconnect).
- Spool pieces and umbilical sections already covered by concrete mattresses and/or rock berm will be left in situ.
- Pipeline will be left in situ and stabilized by rock placement if needed during the preparational phase (clean and disconnect).
- Previously installed rocks will be left in situ, this will also cover removed rocks during and excavating of pipelines ends and spools during the preparational phase (clean and disconnect).
- Crossing will be left in situ regarding pipeline bundle, umbilical, concrete mattresses, rock amour- and sprinkle layer.
- Regular surveys will be performed by Wintershall Noordzee B.V. to ensure no parts of the pipelines become exposed.

The pipeline is considered stable and buried, and no negative impact is expected to fisheries. Therefore, at this stage in planning of the decommissioning it is the intention to remove tie-in spools and bury pipeline ends with rocks during the preparational phase (clean and disconnect) and leave the pipeline in situ.

Emissions to air in relation to decommissioning of pipelines

The different work scopes for the four decommissioning options for the pipeline require different types and numbers of work vessels and the activities will have different time scopes. Thus, this will impact the emissions related to the decommissioning of the pipelines.

For the option to leave the pipeline in situ, the disconnection of the pipelines and the umbilical as well as the rock placement of the ends has already been conducted as a part of the cleaning and disconnection scope and thus only inspection surveys need to be performed on a regular basis. This will require a survey vessel approx. 24 hours on a yearly basis. However, the frequency of surveys will, based on a risk-based assessment, be agreed with the authorities. The emissions from the survey vessel related to these inspection activities are estimated for a single survey as the frequency is not agreed upon yet. However, it is expected that the related emissions will be negligible as it is one vessel and for a limited time period for example every fourth year.

The option to remove all material above seabed, will require work at site for approx. four weeks with special vessels such as DSV/trenching vessel, rock placement vessel and supply vessels. If all three types of vessels are used for 28 days this will result in emissions to air. An estimate of the level of related emissions can be seen in Table 6-14.

The option to remove the pipelines and umbilical by reverse installation, will require work at site for approx. 55 days with special vessels such as DSV/trenching vessel, reel vessel, S-lay vessel, guard vessel and supply vessels. If all vessels are used for 55 days this will result in emissions to air. An estimate of the level of related emissions can be seen in Table 6-14.

The option to remove the pipelines and umbilical by cut and lift, will require work at site for approx. 100 days with special vessels such as DSV/trenching vessel, offshore construction vessels and supply vessels. If all vessels are used for 100 days this will result in emissions to air. An estimate of the level of related emissions can be seen in Table 6-14.

All workdays and types of vessels are estimated, as it is not yet known which types of vessels will be used as this will depend on the commercial tendering process.

Table 6-14 Approximations of emissions to air from the different decommissioning option for the pipelines.

Decommissioning options	CO_2 [ton]	NO_X [ton]	SO_X [ton]	CH_4 [ton]	nmVOC [ton]
Leaving in situ[1)]	10-15	0.5-1	0.005-0.01-	0.0005-0.001	0.01-0.05
Removal of materials above seabed[2)]	6,000-8,000	100-150	2-4	0.5-1	10-15
Removal by reverse installation[3)]	8,000-10,000	150-200	3-5	0.5-1	15-20
Removal by cut and lift[4)]	15,000-20,000	250-300	5-7	1-2	25-30

1) Estimate for one survey. Assumed 24 hours of survey vessel per survey. The exact survey frequency will be determined in agreement with the authorities.
2) Assumed 28 days of DSV (fuel consumption 30 m³/day), rock placement vessel (fuel consumption 27 m³/day) and supply vessel (7 m³/day).
3) Assumed 55 days of reel vessel (fuel consumption 10 m³/day), DSV vessel (fuel consumption 30 m³/day), S-lay vessel (fuel consumption 10 m³/day), guard vessel (fuel consumption 0.5) and supply vessel (7 m³/day).
4) Assumed 100 days of DSV (fuel consumption 30 m³/day), offshore construction vessel (fuel consumption 20 m³/day) and supply vessel (7 m³/day).

Post decommissioning site survey

After the completion of the abandonment work, a survey of the former platform site (500 m safey zone) will be performed to verify that the removal has been performed in accordance with the agreed plans, both in terms of the environmental aspects and the baseline survey for the in situ decommissioned pipelines.

After removal of spools, an as-left survey will be performed in the area, where the activities have taken place (500 m safety zone) to prove that the pipeline and umbilical ends are covered with rocks/mattresses.

During the annual pipeline surveys any debris within the 50 m wide corridor at each side along each pipeline route will be detected.

Based on the information from these surveys a monitoring program will be set up to follow the development of any findings from the baseline. The post decommissioning survey should be agreed with the Authorities.

Transport to shore

The amount of waste and waste fractions to be removed to onshore disposal yard is given in section 10 below. It is expected to be transported to Dutch shore.

During transportation from the location in the North Sea and until arrival at the disposal yard, Wintershall Noordzee B.V. will be responsible for the platform. The platform will be handed over to the disposal yard upon arrival at the port.

Wintershall Noordzee B.V. will ensure that the transportation of the platform will be in accordance with legislation and provide required data.

Examples of transport in crane hook or on a barge (with tugs) can be seen in Figure 6-17 and Figure 6-18.

Figure 6-17 Examples on transport of Topside and Jacket in crane hook.

Figure 6-18 Example of transport on barge.

Items to remain in place

Wintershall Noordzee B.V. recognizes that it will continue to retain ownership of, and residual liability for, all decommissioned items allowed to remain in place through acceptance of the results of the comparative assessment process of the pipelines.

Materials to remain in situ after decommissioning include skirt piles and pipeline cover materials as well as the pipelines from Ravn to A6-A. This is based on the left in situ decommissioning method for the pipelines and umbilical.

The amount of materials to be left in situ at the Ravn site is estimated as follows:

- The four piles, totaling 636 tons, cut and buried 3 m below seabed.
- Pipelines (8" multiphase pipeline; 3" gas lift pipeline; 5.7” umbilical) 15 km between Ravn and the German border buried in trench below seabed.
- Approx. 1500 m^2 rock berm around crossing with Europipe I.
- Approx. 8 concrete mattresses at the crossing with Europipe I.
- Approx. 40 concrete mattresses above the pipeline and umbilical ends.
- Approx. 2000 m^2 rock berm at the pipeline and umbilical ends.

6.3 Onshore dismantling and disposal

The disposal yard has not yet been selected. However, below is an overview of the considered sites in the selection process. The final decision will be made based on the selection and auditing process.

For the topside/module the proposed subcontractors are in NL (Vlissingen or Amsterdam area). The disposal yard in Vlissingen is well known to Wintershall Noordzee B.V. as 8 Wintershall Noordzee B.V. decommissioning projects have already taken place here. The Amsterdam yard is new and shows high potential. At present, an auditing process is being conducted by HLV contractors (and partially Wintershall Noordzee B.V.)

For the jacket disposal the proposed subcontractors could be in Norway. These disposal yards are well experienced with international decom projects. A large advantage is the deep-water quay and low hazardous waste content of the jackets.

The onshore disposal yard will have access to sea, offloading facilities and sample area for handling and demolition of structures, including warehouse and office facilities. The harbor area must be surrounded by sheltered waters, for various inshore marine activities. The quayside must be constructed to support skidding or trailing operations or from flat top barges.

The open land area must have facilities for environmental protection from liquid spillage, area for scrap handling, waste segregation and storage, lifting/crane support and safe driveways for transport and logistic operations. The area must be securely fenced in and protected from unwanted traffic and personnel movement.

The operator must hold relevant environmental permits and comply with any licenses from local and governmental authorities, to execute onshore demolition work at the dedicated area, licenses for any sort of waste treatment, storage, handling and transporting, including scrap handling.

The process of the onshore decommissioning work - dismantling and waste management - includes the following main steps (principal for both topside and jacket):

- Removal of hazardous components and materials
- Striping of non-bearing/structural components (e.g., piping and ladders)
- Dismantling and cutting of structures by various cutting tools
- Sorting of material fractions
- Reuse, recycling, and disposal in accordance with regulations

Waste management

In line with the waste hierarchy, the re-use of an installation (or parts thereof) is first in the order of preferred waste management options. Options for the reuse of installations or pipelines (or parts thereof) are currently under investigation.

Waste generated during decommissioning will be segregated by type and periodically transported to shore in an auditable manner through licensed waste contractors. Steel and other recyclable metals are estimated to account for the greatest proportion of the material inventory.

As much as possible of the material recovered to shore will be recycled. Experience shows that typically recycling of at least 95% (weight) of all materials combined[1] is possible.

[1] Target set for similar projects e.g. the decommissioning of the Anglia field (Ithaca Energy, 2020).

Time estimate

It is currently envisaged that the decommissioning activities at Ravn will commence in 2023 but not later than 2025 in case of unexpected (market) developments.

		2023												2024											
Activity on A6-A and Ravn	**Info on execution**	**jan**	**feb**	**mar**	**apr**	**may**	**jun**	**jul**	**aug**	**sep**	**oct**	**nov**	**dec**	**jan**	**feb**	**mar**	**apr**	**may**	**jun**	**jul**	**aug**	**sep**	**oct**	**nov**	**dec**
P&A Ravn-A2 and Ravn-A3 platform wells	Noble Resilient rig, 60 days																								
P&A Ravn-3 MLS well	MV Island Valiant DP2 vessel, 5 days																								
P&A A6-1x and A6-3x MLS wells	Swift 10 rig, 30 days																								
Cleaning pipelines Ravn-A6A with rig on Ravn	7 days, A6-A and Ravn both manned (4" oil pipeline)																								
Cleaning pipeline A6A - F3-FB	14 days, crew on A6A and F3-FB (8" oil pipeline and 3" liftgas pipeline)																								
Disconnect scope Ravn	Disconnect 2 risers + umbilical at Ravn, 3 days Work will not be executed simultaniously with A6-A or F3-FB disconnect scope																								
Disconnect scope A6A	Disconnect 4 risers and umbilical at A6A: 3 weeks Work will not be executed simultaniously with Ravn or F3-FB disconnect scope																								
Disconnect scope F3-FB	*Disconnect 2 risers: 3 days* *Work will not be executed simultaniously with A6-A or Ravn disconnect scope*																								
Ravn platform removal	Scaldis, ~2,5 weeks offshore operations																								
A6-A platform removal	HLV tender ongoing, ~2,5 weeks offshore operations Potentially after mid-2024 onwards																								

Base case
Optional
Potential opportunity (unlikely)

7 Description of existing environment

This chapter describes the physical, biological, ecological and social use conditions and characteristics in the North Sea, which are relevant for the assessment of impacts during the decommissioning phases of the Ravn Field.

The chapter includes general descriptions for the North Sea and specific project site descriptions. The specific project site descriptions are based on the full descriptions on the existing environment included within the approved EIA for the Ravn Field (Wintershall Noordzee B.V., 2014) in addition to updated information, hereunder the description in the "Stilllegung der Pipelines zwischen A6-A und Ravn - Umweltfachlicher Vergleich zwischen dem In Situ-Belassen der Pipelines und dem Rückbau" (ARSU, 2022). Table 7-1 provides a list of the environmental and social aspects (receptors) described in this chapter.

Table 7-1 Relevant environmental and social receptors for the assessment of potential impacts during decommissioning of the Ravn Field

Environment	Social
Bathymetry Hydrography Water quality Primary production Plankton Sediment composition and quality Benthic fauna Fish Seabirds Marine mammals Protected areas (Natura 2000)	Oil and gas production Maritime traffic (shipping) Wind power Fishery Cultural heritage

7.1 Bathymetry

The Ravn field is located centrally in the North Sea around 245 km from the west coast of Jutland. The North Sea is a shelf sea placed between the Northwestern continental Europe and Great Britain. The water is relatively shallow with a maximum depth of 800 m in the north down to 20 m at the Dutch and German coasts (average depth 80 m). The Ravn field located at the northeast border of the Dogger Bank in a water depth of around 48 m.

7.2 Hydrography

The North Sea is a semi-enclosed sea. The currents are mainly driven by the topography and determined by the water inflow from the North Atlantic through the English Channel, river outflow and the out-going currents from the Baltic Sea. The general circulation of the tidal currents in the North Sea are characterized by a strong north going current along the continental coast and an east going current in the central North Sea (Otto et al. 1990). The prevailing currents at the Ravn field are east going (Figure 7-1).

Hydrographical fronts are created where the different water masses meet and include upwelling, tidal fronts and saline fronts:

- "**Tidal fronts**", which are found in areas between stratified water masses and water, which is fully mixed due to tidal currents. Such fronts are developing in the western and southern parts of the North Sea during the summer;

- "**Upwelling fronts**" which may be encountered in areas along the coast where the water masses are stratified. The front develops when the wind blows surface water away from the coast and thereby forcing bottom water to the surface. Such fronts are frequently developing in Kattegat, Skagerrak and along the Norwegian coast;

- "**Salinity fronts**" are found in areas where high salinity water masses meet water masses with lower salinity.

Hydrographical fronts are generally high productive areas since nutrients are brought from the seabed to the surface waters. The Ravn field is located outside areas with the potential to develop hydrographical fronts and is consequently a low productive area (Edelvang et al., 2017; OSPAR, 2000). Areas with hydrographical fonts are shown on Figure 7-1.

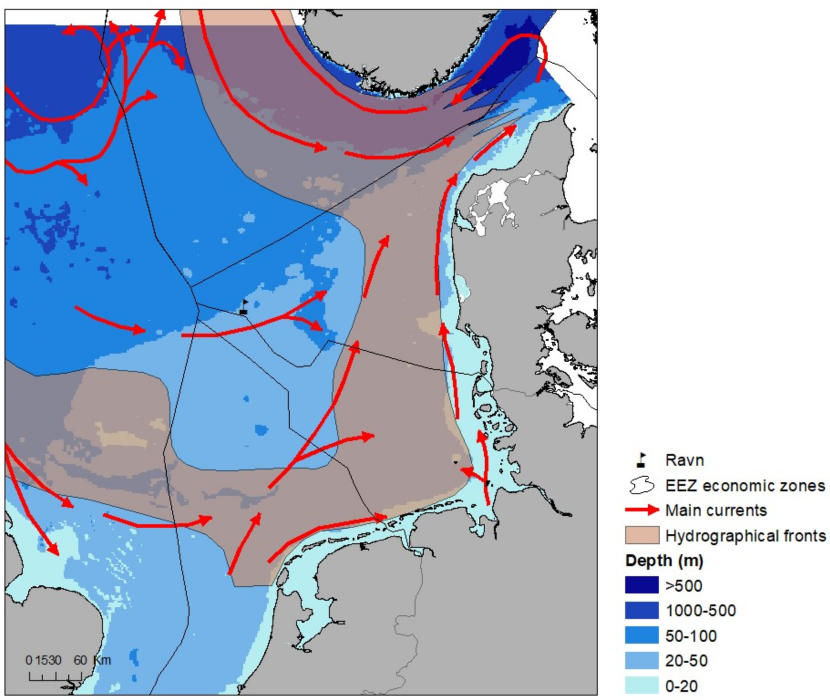


Figure 7-1 General circulation of surface currents in the North Sea and the location of areas in the North Sea where hydrographical fronts may develop (OSPAR, 2000).

The water masses around the Ravn field are fully mixed during winter (OSPAR, 2000). During the summer period, the sun heats up the upper water layers in the central and northern North Sea including the area of Ravn field. A thermocline is developed, which separates the upper and lower water masses (van Leeuwen et al., 2015). The separation is due to differences in density and prevents exchange of nutrients and oxygen between the water masses. During the autumn, storms and cooling of the surface waters breaks down the thermocline and the water masses are mixed again.

In more shallow waters of the southern and eastern parts of the North Sea, the water masses remain mixed during the summer due to strong currents (van Leeuwen et al., 2015).

7.3 Water quality

The water at the Ravn field is dominated by Atlantic water with a relatively stable salinity of 35-38 ppm. The temperature of the surface water varies from 10-11 ^{o}C (Ministry of Environment and Food, 2019). The concentration of nutrients in the North Sea is highest in the coastal waters near river runoffs.

The implementation of EUs Marine Strategy Framework Directive requires an assessment of the environmental status in the North Sea (among others). An integrated assessment of the chemical status in Europe's seas has been published (EEA, 2018) and it is concluded that most assessment units in the Danish part are classified as "problem areas" and thereby not fulfilling the objective of a good environmental status according to the EUs Marine Strategy Framework Directive. This impaired state is caused by a combination of input of contaminants from sources on both land and sea, in addition to input from atmospheric deposition.

For contaminants the objective of achieving a good environmental status is currently not achieved due to an exceedance of the threshold levels in fish for PBDE and mercury (Ministry of Environment and Food, 2019).

7.4 Primary production

The Ravn field is situated in an area with low primary production (Figure 7-2). This is due to the lack of hydrographical fronts and strong stratification of the water column in the productive summer season, which result in quick depletion of nutrients in the surface waters (Peeters & Peperzak, 1990).

In the coastal areas of the North Sea, fronts may develop creating high productive areas (OSPAR, 2000; Edelvang et al., 2017). In addition, runoff of nutrient rich water from land supports high primary production in the coastal areas.

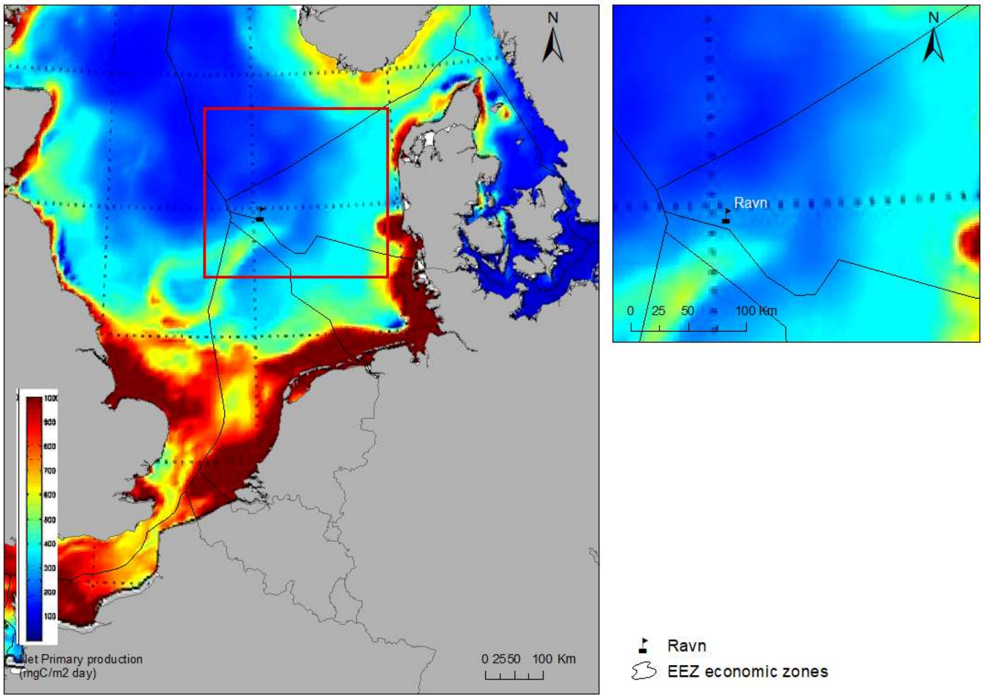


Figure 7-2 Net primary Production (mg m^{-2}d^{-1}), modelled yearly average for a representative year (OSPAR, 2000).

Dogger Bank, which is the largest sandbank in the North Sea, can be recognized as the area southwest of the Ravn field (Figure 7-2). Dogger Bank is shallower than the surrounding area and due its central location and the convergence of different water masses, the area has a relatively high production (ARSU, 2022).

7.5 Plankton

Plankton constitutes the base of the trophic food web and includes phytoplankton (pelagic microscopic algae) and zooplankton (pelagic microscopic animals) drifting passively with currents. Zooplankton includes both organisms that stay planktonic during the entire life cycle (holoplankton) and organisms that are only planktonic in the earliest life stages (meroplankton) such as larvae of fish, sea urchins, starfish, mussels, bristle worms, shrimps, crabs and lobsters.

Phytoplankton blooms occur during spring in the entire North Sea as the light returns and the water masses become stratified. Diatoms and autotrophic dinoflagellates dominate the phytoplankton in the North Sea. During summer, the biomass of plankton decreases due to stratification of water columns and the depletion of nutrients in the surface waters. A minor bloom is often observed during the autumn, when the waters are mixed again, and nutrients are again available in the surface waters.

Copepods dominate the zooplankton in the North Sea. Copepods are food for fish and other organisms, including larvae, juveniles and mature individuals of many commercially important fish species such as herring and sprat. The composition of the copepod populations in the North Sea is dominated by *Calanus finmarchicus* and *C. helgolandicus.*

The composition of the copepod populations in the North Sea has changed markedly. The biomass of the previously dominant "cold-water" copepod *Calanus finmarchicus* has declined by 70% since the 1960s and is now primarily encountered in colder waters north and north-west of the North Sea. On the other hand, species with warmer water affinities e.g., *C. helgolandicus* has moved northwards into the North Sea from the south to replace C. finmarchicus. The displacement of cold- and warm water species to the north has been related to global warming and the observed increase in the water temperature in the North Sea (ICES, 2016; Planque and Fromentin, 1996).

7.6 Sediment composition and quality

The Danish sector of the North Sea is characterized by a sandy or sandy to muddy sediment. A few areas have silt or coarse sediment. The substrate type at the Ravn field is categorized as "mud to muddy sand" (Figure 7-3). This is confirmed by an investigation at the A6-A platform within the German Exclusive Economic Zone (EEZ), which found that silty sands had been found around the Ravn platform and that the organic content decreased towards the sandy Dogger Bank (ARSU, 2022).

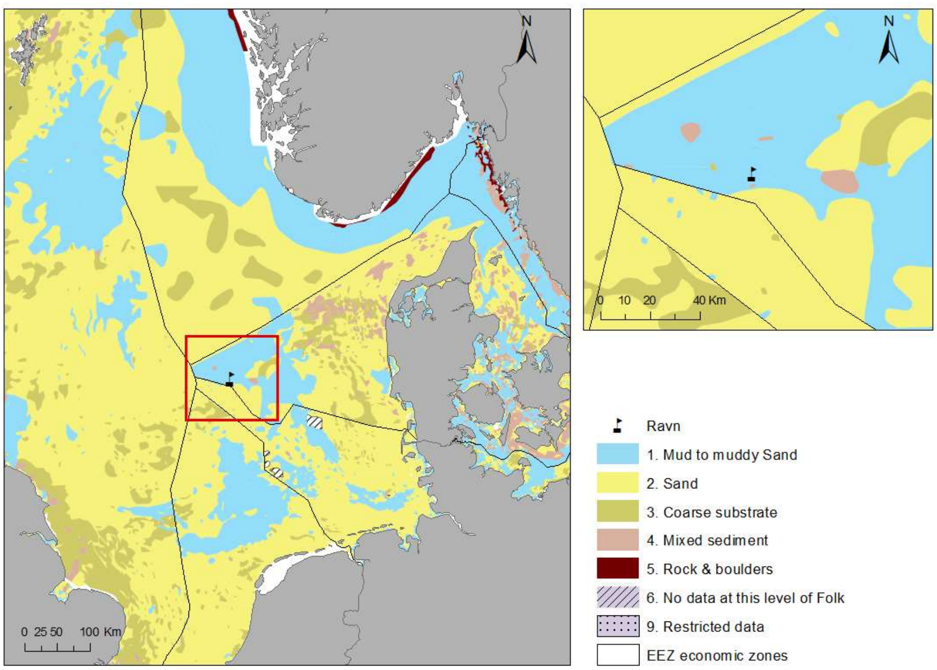


Figure 7-3 Substrates in the North Sea with indication of the project area. EMODnet reclassification substrate (GEUS, 2019). Note that classification of substrate may vary between national borders.

The composition and quality of the sediments around the Ravn field have not been monitored.

7.7 Benthic fauna

Benthic fauna includes a wide variety of invertebrate species such as species of bristle worms, mussels, snails and crustaceans. The benthic fauna can be grouped into infauna and epifauna. Infauna includes benthic fauna that live within the sediments of the seabed while epifauna live on the surface of the bottom substratum. The abundance of infauna at the Ravn field is relatively high whereas the abundance of epifauna species is relatively low compared to other areas in the North Sea (Reiss et al., 2010). The composition of the benthic fauna in an area is dependent on a complex interaction between environmental factors (the type of sediment, oxygen levels, currents, stratification or mixing of water column, salinity, pollutants etc.). This is because the species differ in terms of tolerance and preference of specific environmental factors. Biological interactions (predation, competition symbiosis, parasitism etc.) and random variation also play a role.

The benthic fauna can be grouped in fauna communities consisting of species that are adapted to (or can tolerate) specific environmental conditions. Reiss et al. (2010) carried out multivariate statistical analysis of a large number of fauna data from all over the North Sea. The analysis showed that:

- The infauna community in the Ravn field area is characterised by the occurrence of the bristle worms *Spiophanes bombyx* and *Magelona filiformis*, the brittle star *Amphiura filiformis* and the bivalve *Mysella bidentata*.

- The epifauna community is characterised by the occurrence of Common starfish *Asterias rubens*, Sand star *Astropecten irregularis* and the crustaceans *Pagurus bernhardus*, and *Corystes cassivelaunus*.

The analysis also showed that the most influential environmental variables that determine the composition of the benthic fauna communities in the North Sea appear to be hydrographical variables such as bottom water temperature, bottom water salinity and tidal stress. Previous investigations indicate that the sediment conditions (section 7.6) are homogeneous, and it is therefore also assumed that the area as a whole can be classified as homogeneous based on the species composition (ARSU, 2022).

In general, it has been found that the benthic fauna is not affected beyond 1,500 meters from the platforms and that the local reference stations have good environmental status according to the MSFD (Oil & Gas Denmark, 2017).

7.8 Fish

Approximately 230 fish species are found in the North Sea. Compared to other areas in the North Sea, the diversity is low, but increases westwards towards the coast. The fish species in the North Sea can be grouped in pelagic species (species living in the free water masses) and demersal (bottom dwelling) species. Biology and distribution patterns of common species are described below.

Pelagic species encountered in the project area

Pelagic species commonly found in the Danish sector of the North Sea include Herring (*Clupea harengus*), sprat (*Sprattus sprattus*) and mackerel (*Scomber scombrus*). The biology of these species is described in Table 7-2.

Table 7-2 Biology of the dominating pelagic fish species that may be encountered at the Ravn field.

Species	Distribution and biology	References
Herring *(Clupea harengus)* 	Herring is numerically one of the most important pelagic schooling species in the North Sea and is an important commercial species. Herring may be found all over the North Sea. They form large shoals, which tend to remain close to the seabed during the day. At dusk, the herring follow their prey (zooplankton), move towards the surface, and disperse over a wider area during the night. There are several different stocks of herring in the North Sea of which, the Orkney-Shetland, Bucan, Bank and Downs stocks represent the bulk of the stocks. During the spawning season the different stocks migrate to specific spawning grounds. Peak: December-January). Herring deposits its sticky eggs on coarse sand, gravel, shells, rocks or stones on the seabed. After hatching larvae drift with the currents south and eastwards towards nursery areas in the Skagerrak and along the Danish coast to Southern Bight.	ICES, 2019a; Sundby et al., 2017; Warnar et al, 2012; Schmidt et al., 2010; Worsøe et al., 2002
Sprat *(Sprattus sprattus)* 	Sprat is a small-bodied pelagic schooling species that is mainly landed for industrial processing. Sprat is most abundant in the eastern part of the central North Sea, in the southern North Sea and in the Kattegat. Sprat spawning areas extent through the southern North Sea, the German Bight, the west coast of Jutland and in Kattegat. Spawning also occurs northwards along the English and Scottish coast. The main spawning areas are found in the German Bight, in the Southern Bight and in the English Channel. Spawning occurs during spring and late summer, with peak spawning during the period May - August. Sprats are multiple batch spawners with females spawning repeatedly throughout the spawning season (up to 10 times in some areas). The eggs and larvae are pelagic.	ICES, 2019a; Sundby et al., 2017.
Mackerel (*Scomber scombrus*) 	Mackerel are widespread throughout the North Sea. During winter, both immature and mature mackerel tend to be more abundant along the edges of the continental shelf and the Norwegian Deeps, as well as the central parts of the North Sea. Abundance increases during the summer, when mackerel enter the Southern Bight through the Channel and the northern North Sea around Scotland. Mackerel make extensive annual migrations between feeding, wintering and spawning areas. Spawning occurs in the central and northern North Sea between May and July with peak spawning in June. The Ravn field is located in a spawning area for mackerel (Figure 7-5). Eggs and larvae are pelagic.	ICES, 2019a; Sundby et al., 2017 and Worsøe et al., 2002.

Demersal species encountered at the project area

The abundance of demersal (bottom dwelling) fish species in the project area is relatively low compared to other areas in the North Sea (ICES International Bottom Survey database, Reiss et al. 2010). The typical demersal fish species found at 50-100 m depth in the central North Sea include whiting (*Merlangius merlangus*), haddock (*Melanogrammus aeglefinus*), dab (*Limanda*

limanda), long rough dab (*Hippoglossus platessoides*), plaice (*Pleuronectes platessa*) and grey gurnard (*Eutrigla gurnardus*). It should, however, be noted that the abundance of haddock is larger in the northern North Sea, compared to the central North Sea. Cod (*Gadus morhua*), lemon sole (*Microstomus kitt*) and sandeel (*Ammodytes/Hyperoplus* sp.) are also relatively common.

The basic biology of these species is described in Table 7-3, Table 7-4 and Table 7-5.

Table 7-3 Biology of demersal cod fish species that may be encountered at the Ravn field.

Species	Distribution and biology	Reference
Cod *(Gadus morhua)* 	Cod may be encountered within the project area although the area is not a core area for cod. The Ravn field is situated in a spawning area for cod (Figure 7-6). The spawning season is from the beginning of January to May and peaking in January – February. After spawning, the eggs are found floating near the water surface over large areas. The eggs hatch within 2-3 weeks, depending on water temperature. The pelagic eggs drift with the prevailing east, northeast and north going currents to nursery areas for larvae, which are mainly found in German Bight, north of German Bight, Jutland Bank, Great- and Little Fishing Bank and along the Norwegian Trench into Skagerrak. These areas are characterised by the formation of hydrographical fronts with high concentrations of zooplankton on which the larvae feed.	ICES, 2019a; Sundby et al., 2017; Knutsen et al., 2004; Munk et al., 1999; Munk et al., 1995.
Haddock *(Melanogrammus aeglefinus)* 	Haddock is widespread throughout the deeper waters of the temperate northern Atlantic, shoaling loosely at depths from around 40 to 300 m with a preference for depths between 75 and 125 m. In the Norths Sea the bulk of haddock is found in the northern parts. Haddock may be encountered at the Ravn field, but the area is not a core area for the species. Spawning takes place, at depths of 100 to 150 m in the northern part of the North Sea. Spawning period is from February to May, with peak spawning in March – April. Eggs and larvae are pelagic.	ICES, 2019a; Sundby et al., 2017; Worsøe et al., 2002.
Whiting *(Merlangius merlangus)* 	Whiting is widely distributed throughout the North Sea, Skagerrak and Kattegat. High densities of whiting are found along the UK east coast, the southern and central North Sea (except the Dogger Bank) and Kattegat Skagerrak The spawning areas of whiting are wide ranging and are distributed over much of the North Sea from Viking Bank-Shetland in the North to the English Channel in the south. The Ravn field is not located in a spawning area for whiting. However, as spawning areas for fish are not static and fixed delimited areas, it is very likely that whiting in fact spawns at the Ravn field. Spawning takes place from March to June. Eggs and larvae are pelagic.	ICES, 2019a; Sundby et al., 2017.

Table 7-4 Biology of flatfish species that may be encountered at the Ravn field.

Species	Distribution and biology	Reference
Plaice (*Pleuronectes platessa*) 	Plaice generally inhabits relatively soft substrata and are most abundant on water depths between 10 and 50 m. In the North Sea plaice is most abundant in the central and southern parts. The Ravn field is situated in a plaice spawning area (Figure 7-7). Spawning takes place from December until March (peak: January and February). The pelagic eggs and larvae are transported by the currents, mainly in the eastern and north-eastern directions. During the transport larvae gradually metamorphose and obtain the typical flatfish form. The juveniles settle on the seabed in in nursery areas in shallow inshore waters. The nursery areas in the Wadden Sea are of especially importance.	ICES, 2019a; Sundby et al, 2017 and Bromley, 2000.
Dab *(Limanda limanda)* 	Dab is the most abundant flatfish species in the North Sea and is distributed over the whole of the North Sea in waters down to a depth of about 100 m. Dab spawn in the Central and Southern North Sea. As spawning areas for fish are not static and fixed delimited areas, it is likely that dab also spawns at the Ravn field. The spawning takes place from April to June.	ICES, 2019a; Sundby et al, 2017.
Long rough dab *(Hippoglossus platessoides)* 	Long rough dab lives over clean, muddy and sandy bottoms usually at deeper waters. It is not of commercial value. The Ravn field is not located within the mapped spawning area for long rough dab. However, as spawning areas for fish are not static and fixed delimited areas, it is very likely that long rough dab in fact spawns at the Ravn field. Spawning takes place from February to May (Peak: April).	ICES, 2019a; Sundby et al, 2017.
Lemon sole (*Microstomus kitt*) 	Lemon sole is a medium sized flatfish. It mostly occurs on rocky or sandy bottoms at depths between 20 to 150 m. The Ravn field is situated in a spawning area for lemon sole (Figure 7-4). Spawning takes place from January to October.	ICES, 2019a; Sundby et al 2017.

Table 7-5 Biology of sandeel and grey gurnard that may be encountered at the Ravn field

Species	Distribution and biology	Reference
Sandeel (*Ammodytes/Hyperoplus* sp.) 	Four different species of sandeels are encountered in the North Sea. They are an important food source for many predatory species, including other fish, marine mammals and seabirds. Sandeels are burrowing species that spend most of their time in sandy sediments, although during the spring and summer they enter the water column to feed. The Ravn field is located outside the spawning areas for sandeel (Figure 7-8). After hatching the juveniles, spend approximately 3-4 months in the plankton before settling on a suitable sandy substrate.	ICES, 2019a.
Grey gurnard *(Eutrigla gurnardus)* 	Grey gurnard is one of the main demersal species in the North Sea. It occurs throughout the North Sea but there is a marked seasonal northwest-southeast migration pattern. During winter the population is concentrated in the central western North Sea to the northwest of the Dogger Bank at depths of 50-100 m. During spring there is a mass migration to the south-east. Spawning takes place in this area from April to August. The eggs are pelagic.	ICES, 2019a.

The state of fish stocks

Most of the commercially exploited Norths Sea stocks of the typical fish species encountered in the project area are in good condition and are fished at a sustainable level.

However, the cod stock in the North Sea is in a poor condition. Spawning stock biomass is below the sustainable level and the fishing mortality is too high (

Table *7-6*).

Table 7-6 State of the North Sea stocks of the commercially exploited typical fish species encountered in the Ravn field area.

Species	State of stock
Herring	The condition of the herring stock is good. The stock is fished at a sustainable level and the spawning stock biomass has shown a fluctuating but increasing trend since 1987 (ICES, 2019b).
Sprat	The spawning stock of sprat has full reproductive capacity (ICES, 2019c)
Mackerel	The condition of the mackerel stock is good. The spawning biomass is estimated to have increased in the late 2000s, reaching a maximum in 2014. It has declined since but has still full reproductive capacity. The Fishing mortality has declined from high levels in the mid-2000s and the stock is harvested sustainably (ICES, 2019d)
Cod	The cod stock in the North Sea is in a poor condition. However, the state of the stock is gradually improving. Spawning stock biomass has increased from

Species	State of stock
	the historic low in 2006 but is still below sustainable level and the fishing mortality is still too high (ICES, 2019e).
Haddock	The condition of the haddock stock is good. Spawning stock biomass has full reproductive capacity and the stock is harvested sustainably ICES (2019f)
Whiting	The condition of the whiting stock is good. Spawning stock biomass has full reproductive capacity and the stock is harvested sustainably ICES (2019g)
Plaice	The plaice stock is in excellent condition. The spawning stock biomass is at a record high and has increased almost fivefold during the last 15 years. The stock is harvested in a sustainable manner (ICES, 2019h).
Dab	Sustainable levels for dab have not been defined. The ICES assessment of the dab stock is indicative only. The spawning stock biomass has been increasing since 2006 and total mortality has decreased since 2009. ICES (2019i).
Sandeel	The condition of the sandeel stock is good (Ministry of Environment and Food, 2019). However, the spawning stock biomass has a reduced reproductive capacity (ICES, 2019j).

Fish spawning at Ravn

There are two main ways fish spawn: demersal and pelagic spawning. Demersal spawners lay their eggs on the seabed, pelagic spawners lay their eggs in the free water masses where they remain free flowing for fertilization.

Cod, plaice, dab, long rough dab, lemon sole, mackerel and whiting are pelagic spawners. All are encountered at the Ravn field (Sundby et al., 2017; Warnar et al., 2012). Sandeel is demersal spawner (lay egg on the seabed) and is dependent on sandbanks. However, sandeel banks are not identified at the Ravn field area (Figure 7-8).

The locations of spawning areas in the North Sea for lemon sole, mackerel, cod and plaice are shown in Figure 7-4, Figure 7-5, Figure 7-6 and Figure 7-7. It can be seen that the Ravn field is located inside the spawning area for all these four species. The Ravn field may not be in spawning areas for sprat, long rough dab and whiting, however as spawning areas for fish are not static and fixed delimited areas, these species may spawn at the Ravn Field.

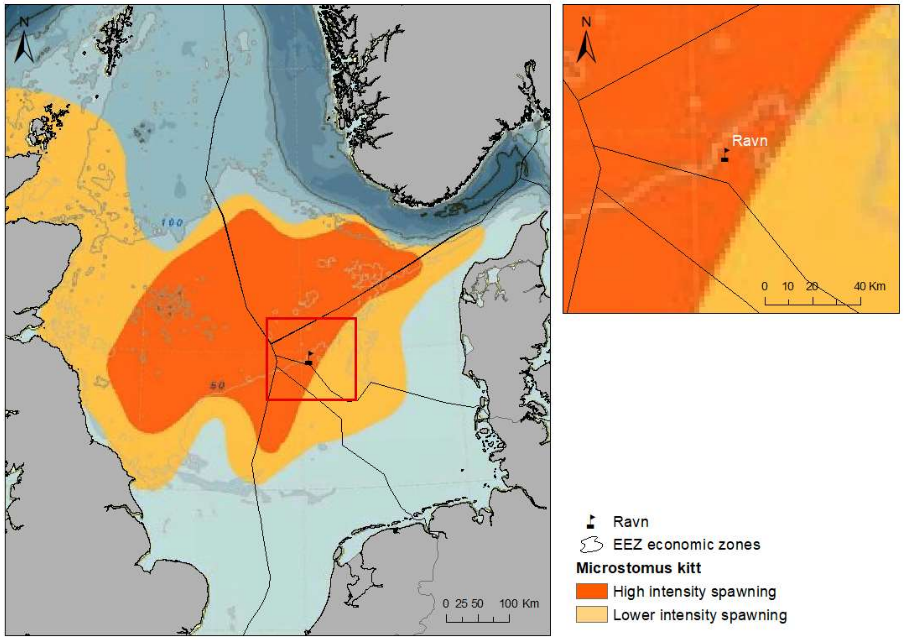


Figure 7-4 *Spawning areas for lemon sole (Solea solea) in the North Sea. The blue areas indicate the bathymetry. (Based on Sundby et al., 2017).*

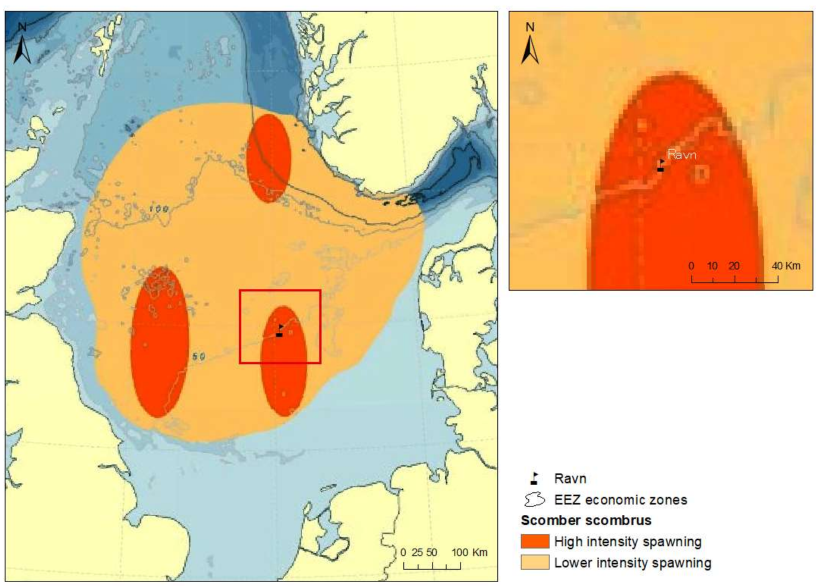


Figure 7-5 *Spawning areas for mackerel (Scomber scombrus) in the North Sea (Based on Sundby et al., 2017). The blue areas indicate the bathymetry.*

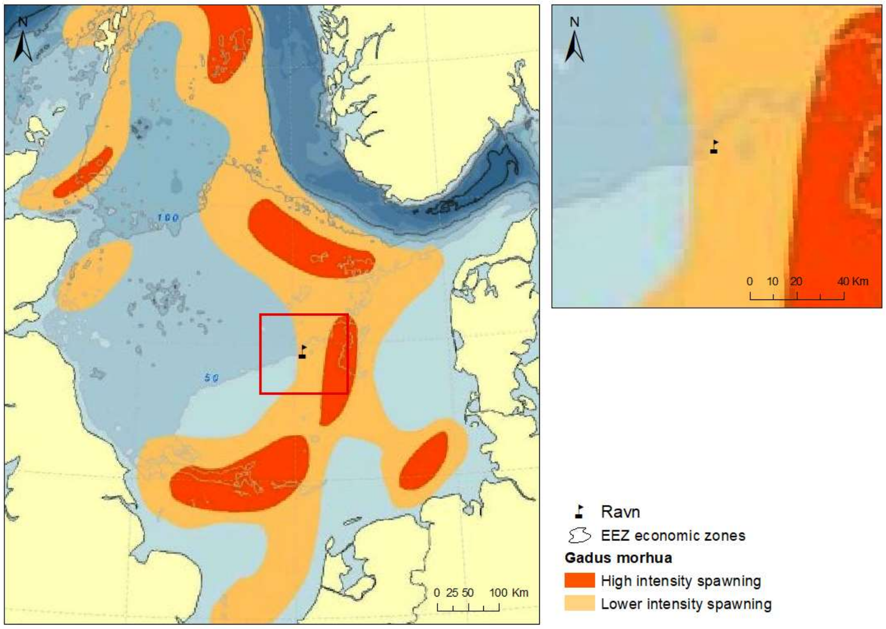


Figure 7-6 *Spawning areas for cod in the North Sea. The blue areas indicate the bathymetry (Based on Sundby et al., 2017).*

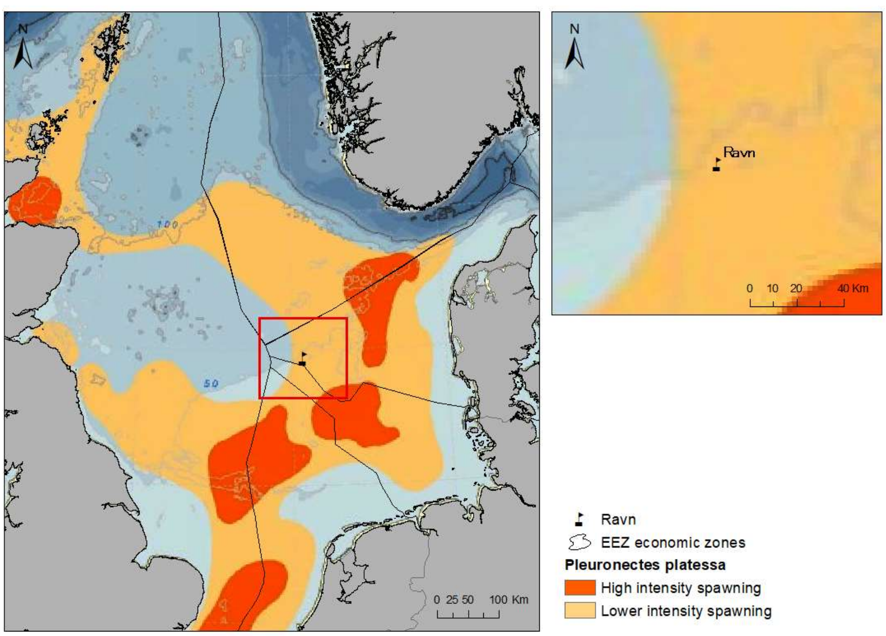


Figure 7-7 Spawning areas for plaice (Pleuronectes platessa) in the North Sea. The blue areas indicate the bathymetry (Based on Sundby et al., 2017)

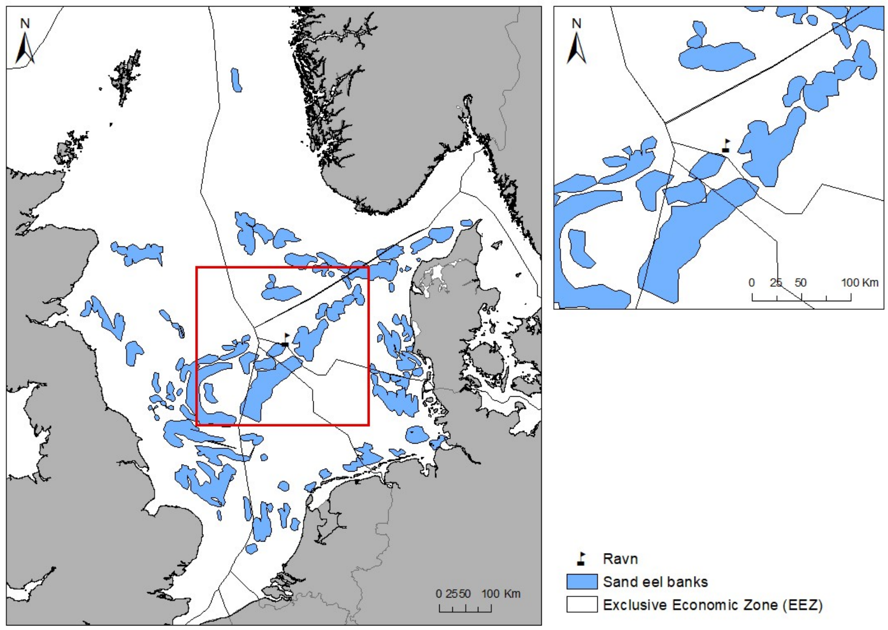


Figure 7-8 Spawning areas (banks) for sand eel (Ammodytes spp.) in the North Sea. (van Deurs, 2019).

The spawning seasons for the species that are likely to spawn are shown in Table 7-7. It is seen that most spawning takes place during winter, spring and early summer.

Table 7-7 Spawning seasons for fish that may spawn at Ravn (Sundby et al., 2017). Light grey: Total spawning period. Dark grey: Peak spawning.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cod												
Whiting												
Plaice												
Dab												
Long rough dab												
Lemon sole												
Mackerel												
Sandeel												

Eggs and larvae are carried with the prevailing east, north-east and north going currents to the front areas close to the coasts of the eastern North Sea and Skagerrak, where they can benefit from the high plankton production at the hydrographical fronts. Several field surveys have demonstrated that high concentrations of larvae of cod, whiting and sandeel are encountered in the front areas of Skagerrak and north-eastern North Sea south of Norway. Other surveys have shown that the front area along the Danish west coast and in the German Bight houses large concentrations of larvae of sandeel, plaice, cod and whiting (Knutsen et al., 2004; Munk et al., 2002; Munk et al., 1999; Munk et al., 1995).

7.9 Birds

The North Sea is an important area for seabirds. This is primarily caused by the high productive hydrographical front areas which are important feeding areas for birds. It is estimated that more than 10 million birds make use of the North Sea for breeding, feeding, or migratory stopovers every year. Furthermore, important breeding colonies fringe the coastlines (Skov et al., 1995). The Ravn field is located far from important bird areas (Figure 7-9).

The important bird areas in the North Sea coincide with the highly productive areas where hydrographic fronts can be formed, producing an abundance of food for seabirds (Figure 7-9).

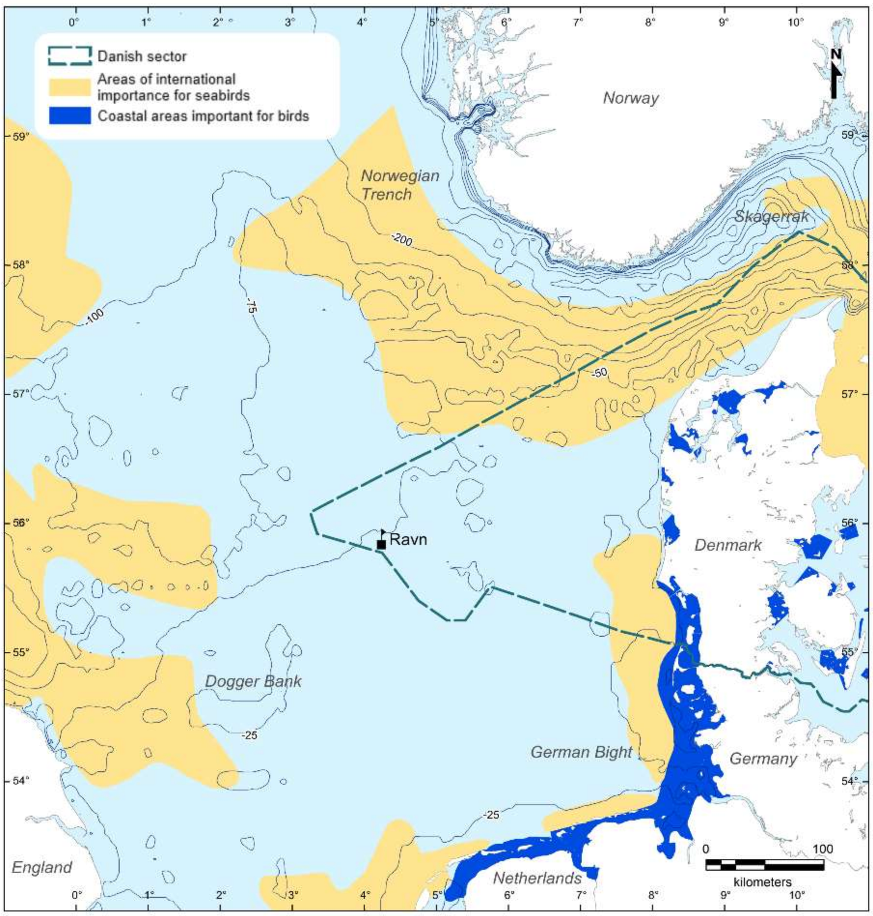


Figure 7-9 Areas of international importance for seabirds (light brown shading) and coastal areas important for birds (blue shading). (Data: Skov et al., 1995; Falk & Brøgger Jensen, 1995).

Seabirds at the Ravn field

During winter some seabirds may be encountered at the Ravn field since these species are distributed over the entire North Sea during winter. The predominant species are fulmar (*Fulmarus glacialis*) and kittiwake (*Rissa tridactyla*). Additionally, Gannet (*Sula bassanus*), razorbill (*Alca torda*) and common guillemot (*Uria aalge*) occur in low densities. These species are mainly associated with cliffs and offshore islands and only occur in the open sea outside the breeding season. They occur in larger densities in other areas of the North Sea with more favourable feeding opportunities that the central parts (COWI 2006, Skov et al., 1995). The biology of these species is described in Table 7-8.

Table 7-8 Biology of birds that may be encountered at the Ravn field during winter (Source: Birdlife International, 2014). Images from www.rsbp.org

Species	Biology
 Fulmar (*Fulmarus glacialis*)	The fulmar typically breeds on cliffs and rock faces, occasionally on flatter ground and up to 1km inland, nesting within colonies on narrow ledges or in hollows. The most important breeding colonies in the North Sea are found in Scotland, the Orkneys, and the Shetlands and at Flamborough head. Fulmars have a potentially large offshore foraging range from their colonies, as birds regularly depart for more than 4-5 days on foraging trips, both before egg-laying and during incubation. Fulmars prey on a wide variety of fish such as, sandeels, sprat, and small gadoids. Large zooplankton species (especially amphipods and copepods) and squid are also important food items. They will also scavenge offal including fishery waste, entrails, and whole fish discarded by fishing vessels.
Kittiwake  (*Rissa tridactyla*)	The kittiwake breeds from mid-May to mid-June in very large single- or mixed-species colonies. The most important breeding colonies in the North Sea are found in Scotland, the Orkneys, Shetlands and at Flamborough head. The kittiwake nest on high, steep coastal cliffs with narrow ledges. The nest is a compacted mass of mud, grass and feathers. During the breeding season, it generally feeds within 50 km of the breeding colony. After breeding, it disperses from coastal areas to the open ocean. The species begins to disperse from the breeding colonies between July and August, often moulting in large flocks of several thousand individuals on beaches between the breeding grounds and the open sea. During the winter, the species is highly pelagic, usually remaining on the wing out of sight of land. Its diet mainly consists of small pelagic shoaling fish such as sandeel, sprat and young herring, but squid shrimps or other invertebrates may also be included in the diet
Gannet  (*Sula bassanus*)	The gannet is strictly marine, with movements largely confined to the continental shelf. Individuals nest on cliffs and offshore islands and occasionally on the mainland. Its diet consists primarily of shoaling pelagic fish, mostly caught by plunge diving. Birds can also be seen attending trawlers in large numbers. This is a ground nesting species, usually within large colonies. The nest is built with seaweed, grass and earth stuck together with excreta.
Guillemot (*Uria aalge*) 	The guillemot breeds in colonies primarily on steep cliff faces or low, flat islands. The most important breeding colonies in the North Sea are found in Scotland, the Orkneys, Shetlands and at Flamborough head It does not construct a nest but lays on broad or narrow cliff ledges and low, flat islands. Individuals mostly occur offshore during winter usually within the breeding range, but the species may be encountered in low to moderate density all over the North Sea. Most individuals return to the colony in March-April. Its diet consists mostly of schooling pelagic fish, mostly sandeel, herring and sprat with small gadoids important at some colonies. Crustaceans can also be the dominant food source. The food is usually obtained within 10-20 km of the colony (Bird Life International, 2014)

Migrating land birds

Large numbers of land birds migrate across the North Sea between the UK and Western Europe including waders and species of thrushes, chats, warblers and finches (Baptist, 2000; Lack, 1959, 1960, 1963). Several of these species may sporadically be encountered at the Ravn field.

7.10 Marine mammals

Seals

Harbour seals (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) are regularly sighted around oil and gas fields in the Danish sector of the North Sea (Delefosse et al. 2018). However, the Ravn field area is not in any way a core area for these species (Tougaard et al., 2008). Seals are generally coastal which is seen from Figure 7-10. Their basic biology is described in

Table 7-9.

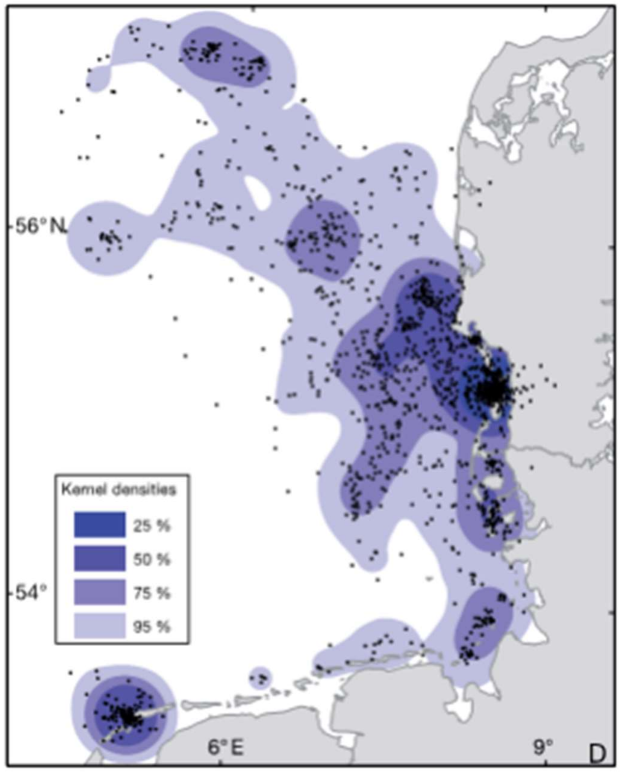


Figure 7-10 Modelled distribution of seals by satellite marking (Tougaard et al., 2008).

Harbour seal is included in the basis for the designation of the German, Dutch and UK Nature 2000 areas DE 1003-301 *Doggerbank*, NL 2008-001 *Doggerbank* and UK0030352 Dogger Bank. Grey seal is also listed in the basis for the designation of NL 2008-001 *Doggerbank* and UK0030352 Dogger Bank areas (see section 7.11 below).

Table 7-9 Biology of seal species that may be encountered at the Ravn field.

Species	Biology
Harbour seal (*Phoca vitulina*) 	Harbour seal (*Phoca vitulina*) is the only seal species that is observed regularly in the Danish sector of the central part of the North Sea. Harbour seals are primarily coastal, depending on isolated and undisturbed land areas for resting, breeding and moulting (such as undisturbed islands, islets sandy beaches, reefs, skerries and sandbanks). They are gregarious animals and when not actively feeding, they will haul onto a terrestrial resting site. The harbour seal does not generally venture more than 20 kilometres offshore. However, radio-tagging experiments using satellite tracing have indicated that harbour seals may undertake foraging migrations far out into the North Sea from their core areas along the coast (Tougaard et al. 2003, Tougaard 2007). They are known to prey primarily on fish such as herring, mackerel, cod, whiting and flatfish, and occasionally upon shrimp, crabs, molluscs and squid. Females give birth once a year, with a gestation period of approximately nine months. Harbour seal breed in large numbers in the Wadden Sea. It is less common along the British coast.
Grey seal (*Halichoerus grypus*) 	The grey seal (*Halichoerus grypus*) breeds in several colonies on islands on the east coasts of Great Britain. Notably large colonies are at Donna Nook (Lincolnshire), the Farne Islands off the Northumberland Coast Orkney and North Rona off the north coast of Scotland. In the German Bight, colonies exist off the islands Sylt and Amrum and on Helgoland. The pups are born in the period September-November. Within a month or so, they shed the pup fur and grow the dense waterproof adult fur, and soon leave for the sea to learn to fish for themselves. Tagging experiments have indicated that grey seals breeding in Great Britain migrate long distances into the North Sea from their breeding colonies (McConnell et al. 1999) but they have not actually been observed in the offshore parts of the Danish sector of the North Sea (Tougaard 2007). The grey seal feeds on a wide variety of fish including sandeels, cod and other gadoids, flatfish, herring and skates. They may also take octopus and lobster.

Cetaceans (Annex IV species)

All species of cetaceans (whales, dolphins and porpoise) are listed in Annex IV in the Habitats Directive and are therefore strictly protected. In addition, harbour porpoises are included in the basis for the designation of the German, Dutch and UK Nature 2000 areas DE 1003-301 *Doggerbank* and NL 2008-001 *Doggerbank*, UK0030352 Dogger Bank.

Sightings around oil and gas installations in the Danish sector of the North Sea has confirmed the presence of 7 marine mammal species, of these five cetaceans: harbour porpoise (*Phocoena phocoena*), minke whale (*Balaenoptera acutorostrata*), white-beaked dolphin (*Lagenorhynchus albirostris*), killer whale (*Orcinus orca*), pilot whales (*Globicephala spp.*) (Delefosse et al. 2018). Only harbour porpoise, white-beaked dolphin and minke whale are encountered regularly in the western part of the Danish sector of the North Sea (Sveegaard et al., 2018; SCANS II; Kinze, 2007; Reid et al., 2003).

The biology of the three cetacean species is briefly described in Table 7-10. Other cetacean species are rare and do only occasionally migrate into in the North Sea from the Atlantic. Harbour porpoise is the most common cetacean in the North Sea. The population characteristics of harbour porpoises is described in more detail below.

Table 7-10 Biology of species of cetaceans that may be encountered at the Ravn field.

Species	Biology
Harbour porpoise (*Phocoena phocoena*) 	The harbour porpoise (*Phocoena phocoena*) is the most abundant whale species in the North Sea and occur regularly in the Ravn field area. The population in the North Sea has been estimated to 300.000-350.000 (Sveegaard et al. 2018, Gilles et al. 2016). Harbour porpoises feed mostly on fish such as cod, whiting, mackerel, herring and sprat. Harbour porpoises tend to be solitary foragers, but they do sometimes hunt in packs. The mating season is July-August. The gestation period typically lasts 10–11 months and most births occur in late spring and summer. Calves are weaned after 8–12 months.
White-beaked dolphin (*Lagenorhynchus albirostris*) 	White beaked dolphin (*Lagenorhynchus albirostris*) is relatively common in the northern part of the North Sea and may be encountered in the Ravn field area (Geelhoed et al 2014, Hammond et al 2013, Reid, et al. 2003). White beaked dolphin is much less abundant than harbour porpoise. The total population in the North Sea is only about 16,500 individuals (Hammond et al. 2013). White-beaked dolphins are acrobatic and social animals that are typically found in pods of 4-6 animals. They will frequently ride on the bow wave of fast-moving vessels and jump clear of the sea's surface. White beaked dolphin mates from May to August and the delivery occur the following summer after a gestation period of 11 months. They primarily feed on fish such as herring, cod, haddock, whiting and hake but may also prey on squid, octopus and benthic crustaceans
Minke whale (*Balaenoptera acutorostrata*) 	Minke whale (*Balaenoptera acutorostrata*) may be observed at the Ravn field area (Geelhoed et al. 2014, Hammond et al. 2013, Kinze 2007, Reid et al. 2003). Minke whale is the only species of baleen whale that occurs regularly in the North Sea. The population in the North Sea has been estimated to about 19.000 individuals (Hammond et al. 2013). Mating and delivery take place from late winter to early spring. The female minke whale gives birth to a calf every year or every second year. The gestation period is 10 months and nursing of the calf takes place for 3-6 months. Minke whales primarily feed on pelagic fish such as herring and sprat and small crustaceans.

Harbour porpoises

The harbour porpoise is the most abundant whale species in the North Sea. It is regularly encountered in the waters around the Ravn field although the area is not a core area for the species. Harbour porpoises in the project area belong to the North Sea population. Through its migration and feeding pattern the species reaches into the Northern Kattegat and Skagerrak. The North Sea population has been estimated during international projects called SCANS (Small Cetacean Abundance in the North Sea) which took place in the period 1995 to 2016 (a total of three SCANS). The population was estimated to include 300.000 to 350.000 individuals indicating a stable population (Sveegaard et al., 2018).

Waggit et al. (2019) has modelled the distribution of harbour porpoises in the North Sea. The model shows that harbour porpoise is concentrated in the most Eastern part of the North Sea during winter and distributed over a larger area during summer (Figure 7-11). The most important area for harbour porpoise in the North Sea is the waters between the western part of the Dogger Bank and the UK. The waters along the Danish, German and Dutch coasts, especially the German Bight/Horns Rev areas, are also important (Waggit et al., 2019; Gilles et al., 2016 and Sveegaard et al., 2018). It appears from the model that the Ravn field area is located within an area of some importance for harbour porpoises.

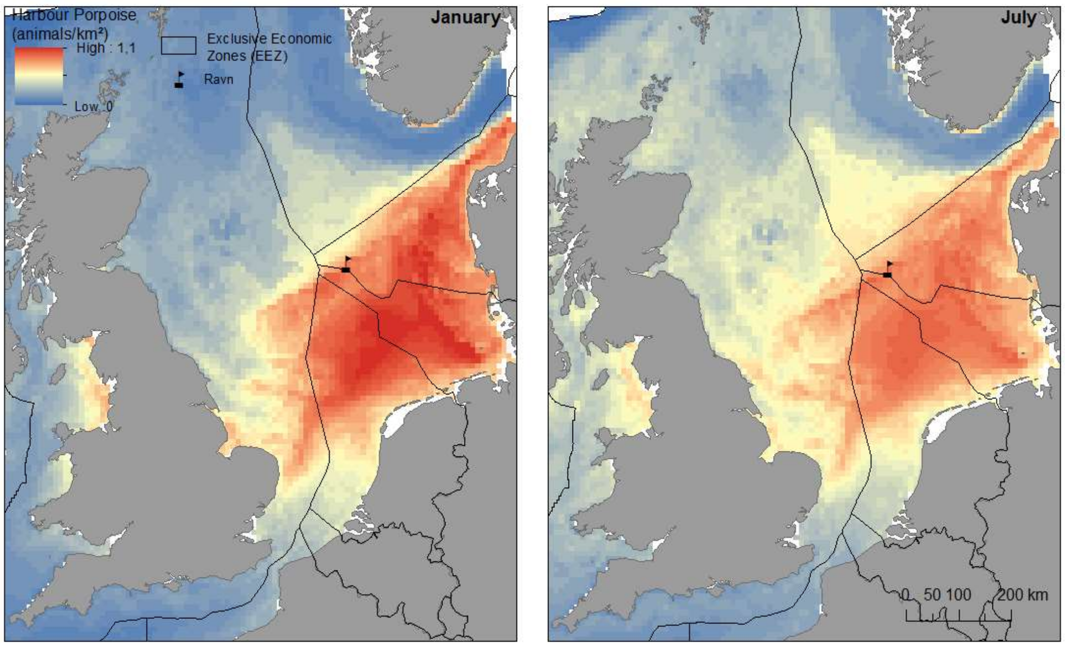


Figure 7-11 Distribution of harbour porpoise (Phocoena phocoena) in the North Sea Waggit et al., 2019).

7.11 Protected areas

Natura 2000 and annex IV species

The EU Habitats Directive (Council Directive 92/43/EEC of 21 May 1992) specifies natural habitats and wild fauna and flora for which the member states must ensure protection. The species and nature habitats to be protected are specified in the Annexes of the directive:

- Annexes I and II to the Directive contain the types of habitats (Annex I) and species (Annex II) whose conservation requires the designation of Special Areas of Conservation (SACs). For birds, Special Protected Areas (SPAs) are designated. Together SACs and SPAs make up Natura 2000 areas.

- Annex IV lists species of animals and plants in need of particularly strict protection. Of the marine mammals encountered in the North Sea, all species of cetaceans are listed in Annex IV.

The Ravn field is situated far from Danish designated Natura 2000 areas. However, around 15 km south of the field is a German designated Natura 2000 area: DE 1003-301 *Doggerbank*. As an extension of this area is the Dutch NL 2008-001 *Doggerbank* and the UK0030352 Dogger Bank in the UK sector (Figure 7-12).

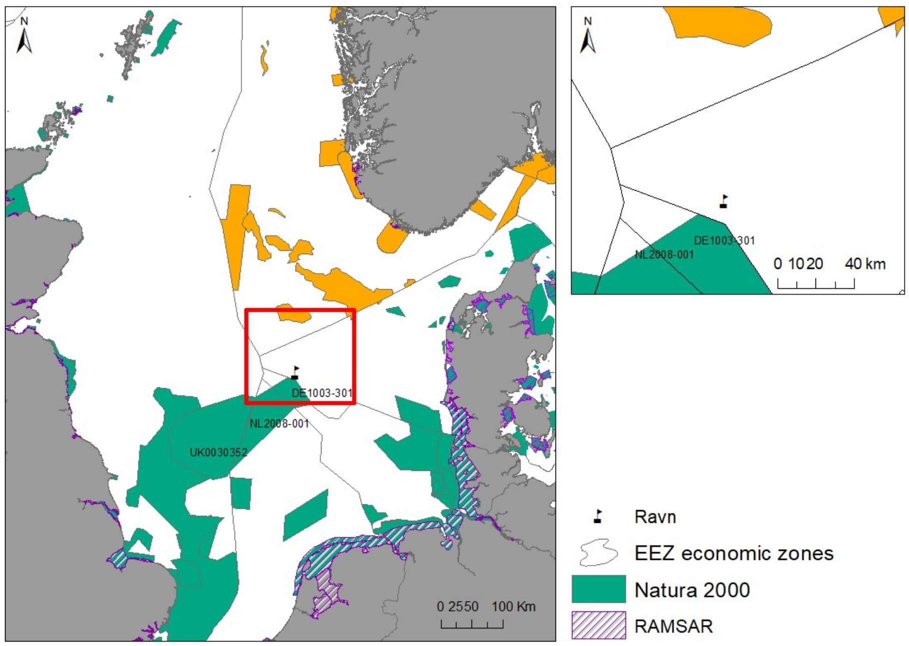


Figure 7-12 Location of Natura 2000-areas (SAC) in the North Sea.

The basis for the designation of these three SACs is listed in Table 7-11:

Table 7-11 Basis for the designation of the closest Natura 2000 areas.

Natura 2000 areas (SACs)	Basis for the designation
DE 1003-301 Doggerbank	Annex I habitat type 1110 Sandbanks which are slightly covered by sea water all the time and Annex II species 1351 Harbour porpoise and 1365 Harbour seal.
NL 2008-001 Doggerbank	Annex I habitat type 1110 Sandbanks which are slightly covered by sea water all the time and The Annex II species 1351 Harbour porpoise, 1365 Harbour seal and 1364 Grey seal
UK0030352 Dogger Bank	Annex I habitat type 1110 Sandbanks which are slightly covered by sea water all the time and The Annex II species 1351 Harbour porpoise, 1365 Harbour seal and 1364 Grey seal

The general protective purpose of DE 1003-301 is "*The protection of the marine area as a nature reserve serves to achieve the conservation objectives of the Natura 2000 site by permanently preserving the marine area and the diversity of its biotic communities and species of relevance to* *this area, as well as the function of the Dogger Bank as a separating geological structure between the northern and southern North Sea*" (ARSU, 2022).

Valuable and vulnerable areas (SVO-areas)

Valuable and vulnerable areas (SVO-areas) is the management framework for marine protected areas in Norway. The SVO-areas include protected areas for red listed species and bird protection areas such as RAMSAR-sites (international conservation of wetlands). The SVO-areas have integrated management plans with criteria for protection.

The closest SVO's are in the Norwegian sector of the North Sea an include the Sandeel field North (Vikingebanken) and South (Table 7-12). The Sandeel field North and South are designated as SVO to protect valuable spawning areas for sandeel. The area is also designated to protect the two seabird species common guillemot (*Uria aalge)* and northern fulmar (*Fulmaris glacialis*).

Northwest of the Sandeel field South is the Mackerel field SVO, designated as important spawning area for mackerel. There are existing oil and gas activities in the SVO. The basis for the designation of the Sandeel fields SVO and the Mackerel field SVO area listed in Table 7-12.

Table 7-12 Basis for the designation of the closest SVO areas.

SVO	Basis for the designation
Sandeel field north (Vikingebanken) and sandeel field south	The sandeel fields north and south are spawning and foraging area for eel. Furthermore, the sandeel fields are a valuable habitat for common guillemot (*Uria aalge)* and northern fulmar (*Fulmaris glacialis*) from April to December. Common guillemot overwinters in the North-western part of the area from December to March.
Mackerel field (Makrellfeltet)	The SVO is a spawning area for mackerel from May to July. The mackerel is monitored in the area through the international mackerel cruise (IESSNS)

RAMSAR

RAMSAR sites are designated through the RAMSAR convention. It is an intergovernmental treaty that provides the framework for national action and international management of wetlands. RAMSAR sites are of importance for birds. In Denmark they overlap with SPA (Natura 2000-areas) for birds.

Protected areas under the Marine Strategy Framework Directive (MSFD)

Eight protected areas under the Marine Strategy Framework Directive have been designated in the North Sea. The closest area H is located in the far western part of the Danish EEZ, that is immediately west of the Ravn field area (Figure 7-13). This protection regulates activities within the area itself but not activities outside the protected area (Miljøministeriet, 2021).

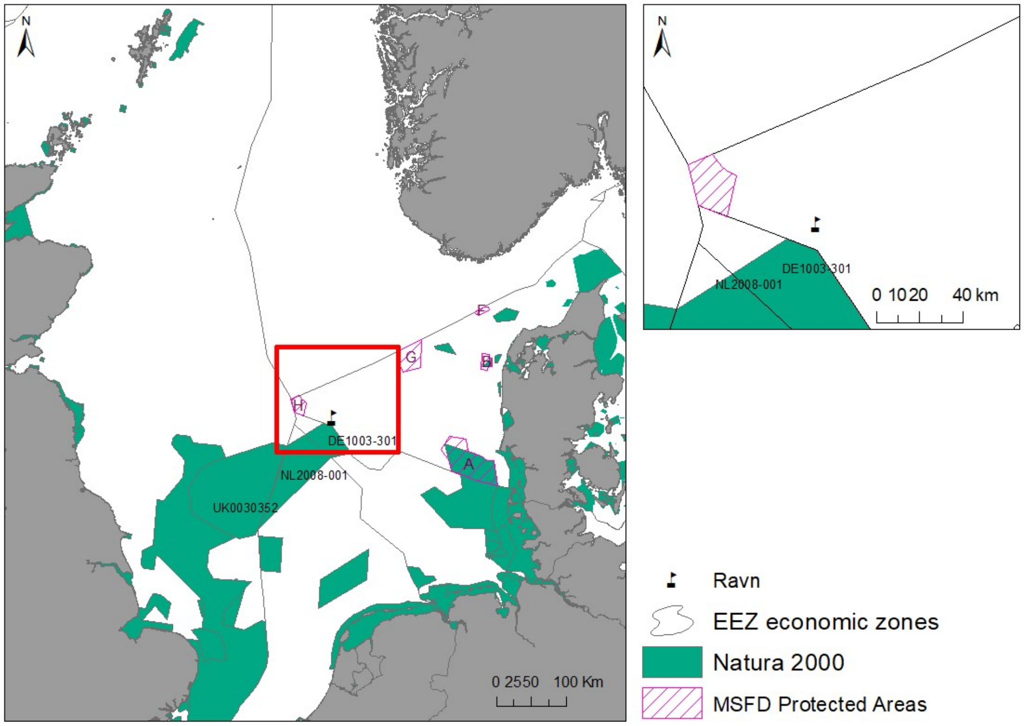


Figure 7-13 Protected areas in the North Sea including Natura 2000-areas and areas protected according to the Marine Strategy Framework Directive (MSFD). Note that area F has been located manually as no public source is available for this particular area.

7.12 Non-indigenous species

The term non-indigenous species means that the species is introduced outside its natural, past or present range (Ministry of Environment and Food, 2019).

Distribution of non-indigenous (NIS) related to oil and gas installations in the Danish North Sea is described in Oil and Gas Denmark's report from February 2017 "Descriptor-based review of 25 years of seabed monitoring data collected around Danish offshore oil and gas platforms". The inventory of the benthic species was compared with catalogues of NIS (AquaNIS; Olenin et al., 2014). The trend in abundance, the temporal occurrence and spatial distribution were evaluated. Four of the more than hundreds of NIS reported in the North Sea were identified in the benthic samples collected at platforms and reference stations from 1989-2015. NIS were typically found in low numbers with an average of 1.2 +/- 0.3 individuals per 0.1 m². The rare occurrence and low abundance reported is not indicative of a well-established population considering that the four benthic NIS observed have been present in the North Sea coastal areas for several decades.

7.13 Human environment

Commercial and cultural interests in the western part of the Danish sector of the North Sea include:

- Oil and gas extraction
- Shipping
- Wind power
- Fisheries
- Cultural heritage

Oil and gas extraction

The Ravn field is located in a part of the central North Sea with other oil and gas activities. The closest existing Danish oil and gas facilities in operation to Ravn is the INEOS Oil & Gas Denmark operated South Arne and the Total Energies operated Valdemar approximately 22 km to the southeast. (Figure 7-14). The closest by facility is the A6 in German waters 18 km to the southwest.

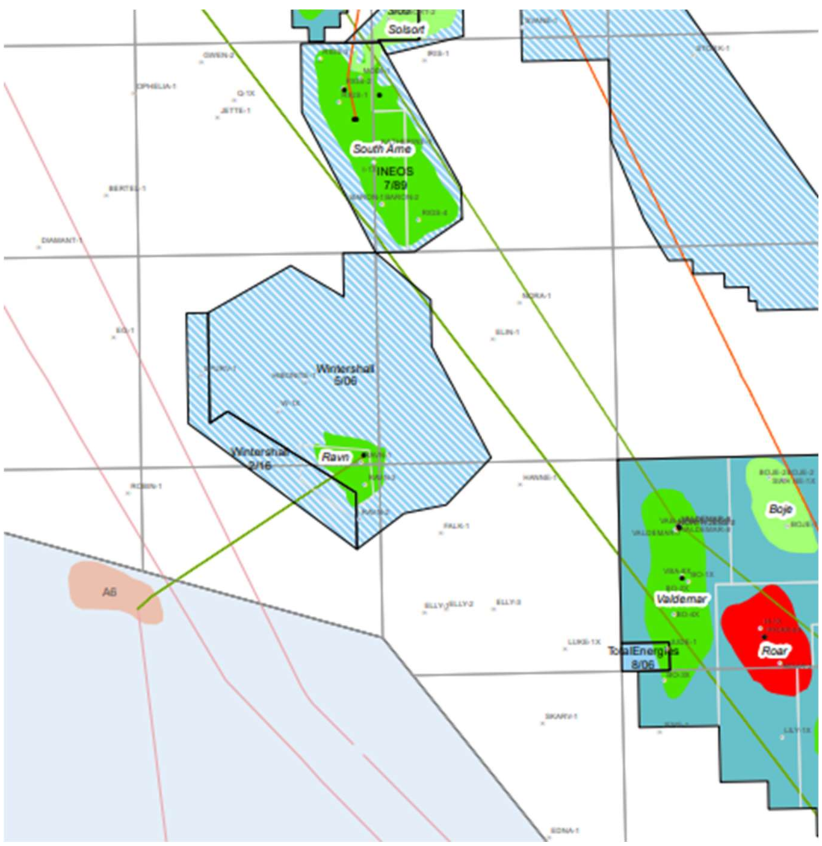


Figure 7-14 The Ravn field location and surrounding infrastructure in the Danish sector of the North Sea. (https://ens.dk/sites/ens.dk/files/OlieGas/oliegaskort2021-10-13.pdf)

Shipping

Data from the AIS system (Automatic Identification System) shows the intensity of merchant vessels in the central North Sea of the year 2018 (Figure 7-15).

It is seen that the Ravn field is situated far from major shipping lanes. It is noted that appropriate measures are already implemented to minimize the risk of ship collision with the Ravn facility. This includes a safety zone around the platform in the form of a circle with a radius of 500 m. In addition, there is a safety zone of 200 m on either side of the pipeline to the host platform.

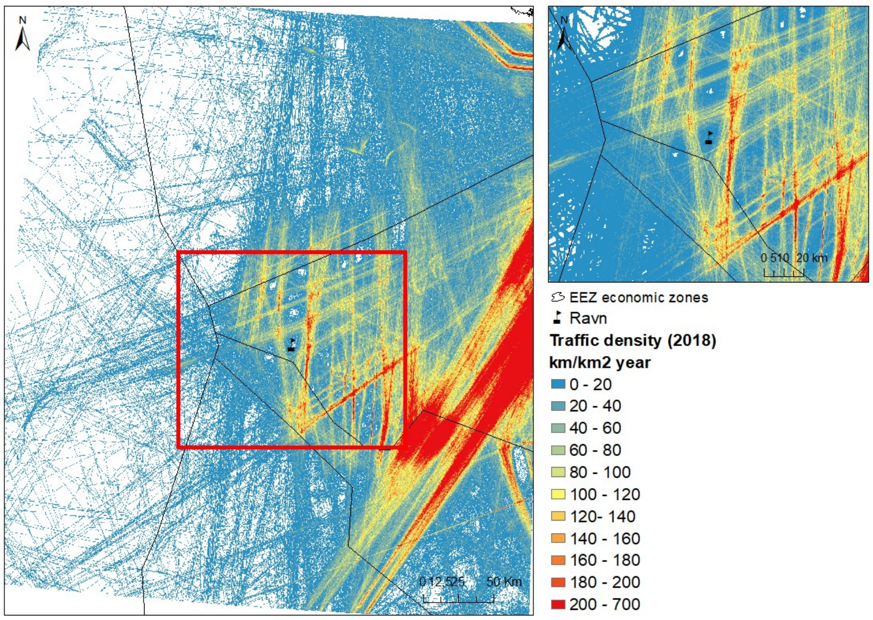


Figure 7-15 Ship traffic in the North Sea based in AIS data from all ships in 2018. Offshore service-related traffic is not included.

Wind power

The closest windfarm is located more than 200 km from the Ravn field at Horns Rev. The offshore windfarms at Horns Rev include Horns Rev I, Horns Rev II and Horns Rev III with a total of 200 wind turbines. In addition, there is planned one offshore wind farms (Sørlige Nordsjø II) the Norwegian sector of the North Sea bordering the Danish sector of the North Sea (ca. 40 km from the Ravn field).

Fisheries

Figure 7-16 shows the fishing effort of Danish vessels using active gear (dredgers, beam trawl, pelagic trawl, otter trawl or demersal seiners) in the eastern North Sea during the period 2007-2015. Figure 7-17 shows the fishing effort using passive gear (i.e. mainly gill nets) in the same area during the same period.

It is seen that the Ravn field is situated in an area with low fishery intensity. The fishery intensity is concentrated in the following areas:

- Along the edge of the Norwegian trench and the Skagerrak
- Along the Danish west coast.

The main fishing, which takes place in the Danish sector of the North Sea (COWI, 2015) are:

- Fishery for Norway lobster, using otter trawls;
- Industrial fishery for sandeel by trawlers using small meshed demersal trawl in industrial fisheries (i.e. for fishmeal);
- Industrial fisheries for sprat for fish oil and fish meal using small meshed trawls; and
- Mixed fishery for flatfish using primarily otter trawl and gill nets.

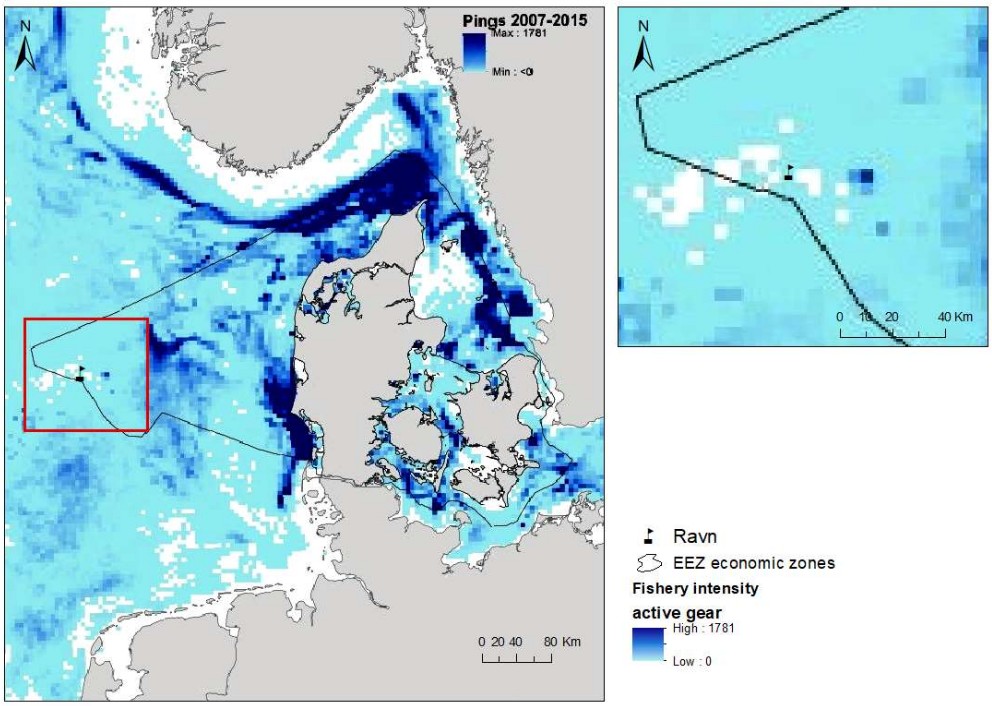


Figure 7-16 The distribution of active fishing intensity based on VMS and AIS data from the period 2007-2015 (Based on Egekvist et al., 2018). Active fishing includes the use of dredgers, beam trawl, pelagic trawl, otter trawl or demersal seiners.

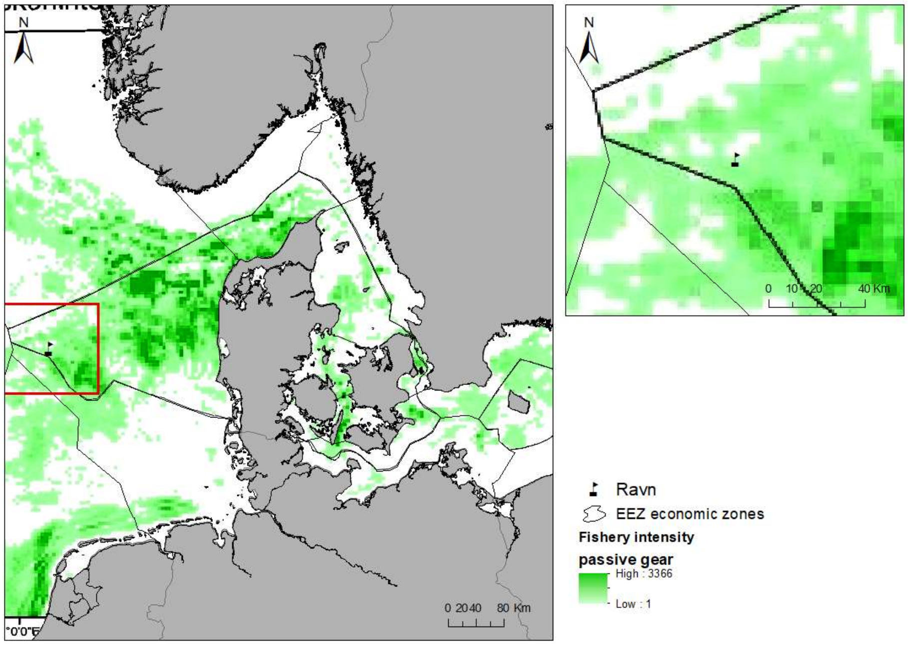


Figure 7-17 The distribution of passive fishing intensity based on VMS and AIS data from the period 2007-2015 (Based on Egekvist et al., 2018). In the area passive gear used is primarily gill nets.

Cultural heritage

The only cultural heritage that potentially could exist in the project area is ship and plane wrecks. There are no registered wrecks in the project area (Figure 7-18). The closest registered wreck is located ca. 25 km east of the Ravn field. The wreck is not protected.

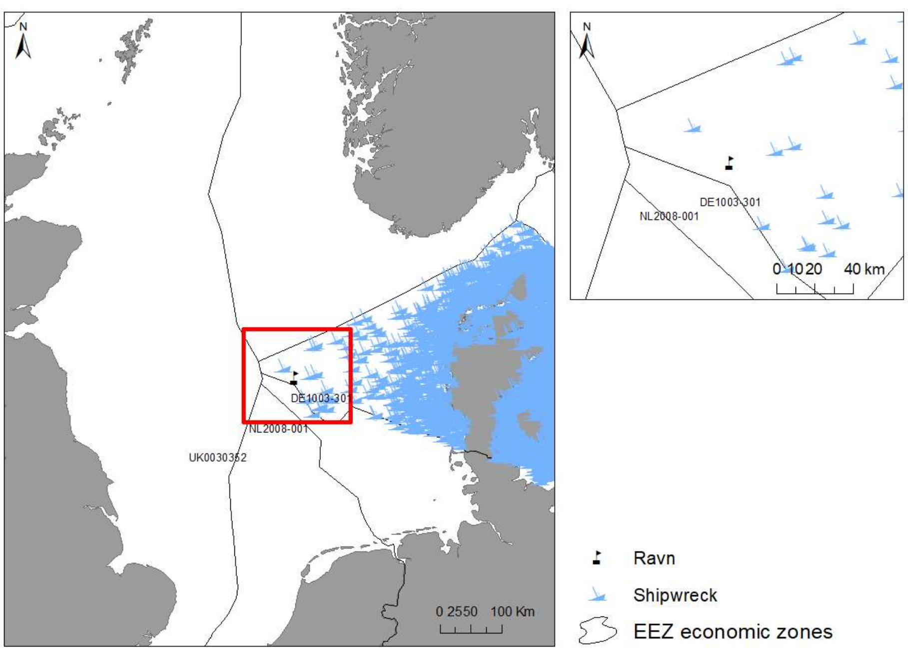


Figure 7-18 Registered wrecks in the project area (Palace and Culture Agency, 2022)

8 Methodology

8.1 Methodology for evaluation of environmental severity and risk

The environmental significance (severity) and risk of impacts of the project on environmental and socioeconomic receptors has been evaluated using the methodology described in section 0.

However, for the onshore dismantling of the platform the potential impacts will be described qualitatively and will not be assessed according to the below method as the site is not a part of the project evaluated in the present EIA. The environmental impacts related to the onshore dismantling are handled as a part of the environmental permit for the specific disposal yard and the specific conditions in the environmental approval required for the specific disposal yard. It will be ensured that the chosen disposal yard holds an adequate environmental approval covering the relevant activities.

Procedure for risk assessment

Environmental risk is the combination of the significance (severity) of an impact and the probability that an impact may arise. This implies for instance that an incidence that may cause severe impacts but is not very likely to occur has a low environmental risk.

For each operation or incidence, the assessment of environmental risk includes three steps:

- Assessment of environmental significance (severity) of an impact
- Assessment of the probability that an impact will occur.
- Assessment of risk by combining severity and probability

Assessment of environmental significance (severity) of an impact

Qualitative assessments of environmental severity of impacts of different operations and events will be carried out for both the EIA and the Natura 2000 screening. The assessment of severity includes the following steps:

- Assessments of nature, extent, duration and magnitude of impacts using the criteria shown in

- Table 8-1 including whether the impact is positive or negative, temporary or permanent.
- Assessment of the severity of impacts combining the assessments of extent, duration and magnitude of the impacts using the criteria shown in Table 8-2.

Table 8-1 Criteria for assessment of nature, extent, duration and magnitude of impacts.

Criterion	Description
Nature	***Nature of the environmental change***
Positive	Beneficial environmental change
Negative	Adverse environmental change
Extent	***The geographical area that may be affected by the impact***
Local	Only the place where the activities directly related to construction may occur
Regional	Effects may occur in the Central North Sea
National	Effects may occur in Danish waters
International	Effects may occur in the entire North Sea
Duration	***Period along which the impact is expected to occur***
Short-term	Less than 8 (eight) months
Medium-term	Between 8 (eight) months and 5 (five) years
Long-term	More than 5 (five) years
Magnitude	***The magnitude of impacts on environmental and social processes***
Small Medium Large	If possible, the magnitude of an effect is assessed from results of environmental modelling. Otherwise, the magnitude of an effect is based on an expert assessment based on previous experience from other projects. The following factors are taken into consideration: • The extent to which potentially affected habitats and organisms are unaffected by human activity • The numbers/areas of an environmental feature that will be potentially affected • The uniqueness/rarity of potentially affected organism and habitats • The conservation status of habitats or organism (Natura 2000 areas, Annex IV species etc.) • The sensitivity of the habitat/organism • The robustness of the organism/habitats against impacts, i.e., and evaluation of the ability to adapt to the impact without affecting the conservation status, uniqueness or rarity • The potential for replacement i.e., an assessment of to what extent the loss of habitats or populations of organisms can be replaced by others.
Frequency	***How often the impact will occur***
Low	The impact occurs rarely or as a single event
Medium	The impact happens regularly
High	The impact happens often or continuously
Reversibility	***Whether or not an impact is permanent***
Reversible	The impact is not permanent
Irreversible	The impact is permanent

Table 8-2 Criteria for assessment of severity of potential impacts of the project.

Severity rating	Relation with the criteria on nature, extent, duration, and magnitude that describe the impact
Positive impact	The assessed ecological or socioeconomic feature or issue is improved compared to existing conditions
No impact	The assessed ecological or socioeconomic feature or issue is not affected
Insignificant impact	Small magnitude, with local extent and short-term duration
Minor impact	1) Small magnitude, with any combination of other criteria (except for local extent and short-term duration, and long-term duration and national or international extent) or 2) Medium magnitude, with local extent and short-term duration 3) Reversible impact
Moderate impact	1) Small magnitude, with national or international extent and long-term duration; or 2) Medium magnitude, with any combination of other criteria (except for local extent and short-term duration; and national extent and long-term duration 3) Large magnitude, with local extent and short-term duration 4) Some irreversible impact but at a local scale
Major impact	1) Medium magnitude, with national or international extent and long-term duration. 2) Large magnitude, with any combination of other criteria (except for local extent and short-term duration) 3) No reversibility of impact (irreversible)

Assessment of the probability that an impact will occur

The probability that an impact will occur will be assessed using the criteria shown in Table 8-3.

Table 8-3 Criteria for assessment of the probability of that an impact will occur.

Probability criterion	Degree of possibility of impact occurrence
Very low	The possibility of occurrence is very low, either due to the project design or due to the project nature, or due to the characteristics of the project area
Low	The possibility of occurrence is low, either due to the project design or due to the project nature, or due to the characteristics of the project area
Probable	There is possibility of impact occurrence
Highly Probable	Possibility of impact occurrence is almost certain
Definite	There is certainty that the impact will occur

Risk assessment

The environmental risk of different operations and incidences will be assessed combining significance (severity) and probability of an impact according to a risk matrix as outlined below (Table 8-4).

Table 8-4 Qualitative risk assessment matrix.

	Significance (severity) of impact			
Probability	**Insignificant Impact**	**Minor impact**	**Moderate impact**	**Major impact**
Definite	Negligible risk	Low risk	Significant risk	High risk
Highly probable	Negligible risk	Low risk	Significant risk	High risk
Probable	Negligible risk	Negligible risk	Low risk	Significant risk
Low	Negligible risk	Negligible risk	Low risk	Low risk
Very low	Negligible risk	Negligible risk	Negligible risk	Low risk

9 Environmental impacts of planned activities

Generally, environmental impacts from decommissioning operations are expected to be of the same nature, extent, and order of magnitude as the impacts related to construction of the facilities. Long-term environmental impacts from the decommissioning operations are expected to be negligible. In addition, incremental cumulative impacts and transboundary effects associated with the planned decommissioning operations are expected to be negligible.

Based on the project description, the potential impact mechanisms of the Ravn include the following:

- Disconnect of pipelines and removal of underwater structures such as jacket, piles, pipelines and spools
- Physical disturbance of the seabed
- Sediment dispersal
- Solid waste
- Emissions to air
- Emission to water from leaving pipelines in place
- Underwater noise and light disturbance
- Oil- and gas dependency
- Unplanned/accidental discharge

Figure 9-1 at the next page provides an overview of the potential impacts of the Ravn decommissioning project and the relevant receptors. The specific operations and associated impacts are listed in Table 9-1.

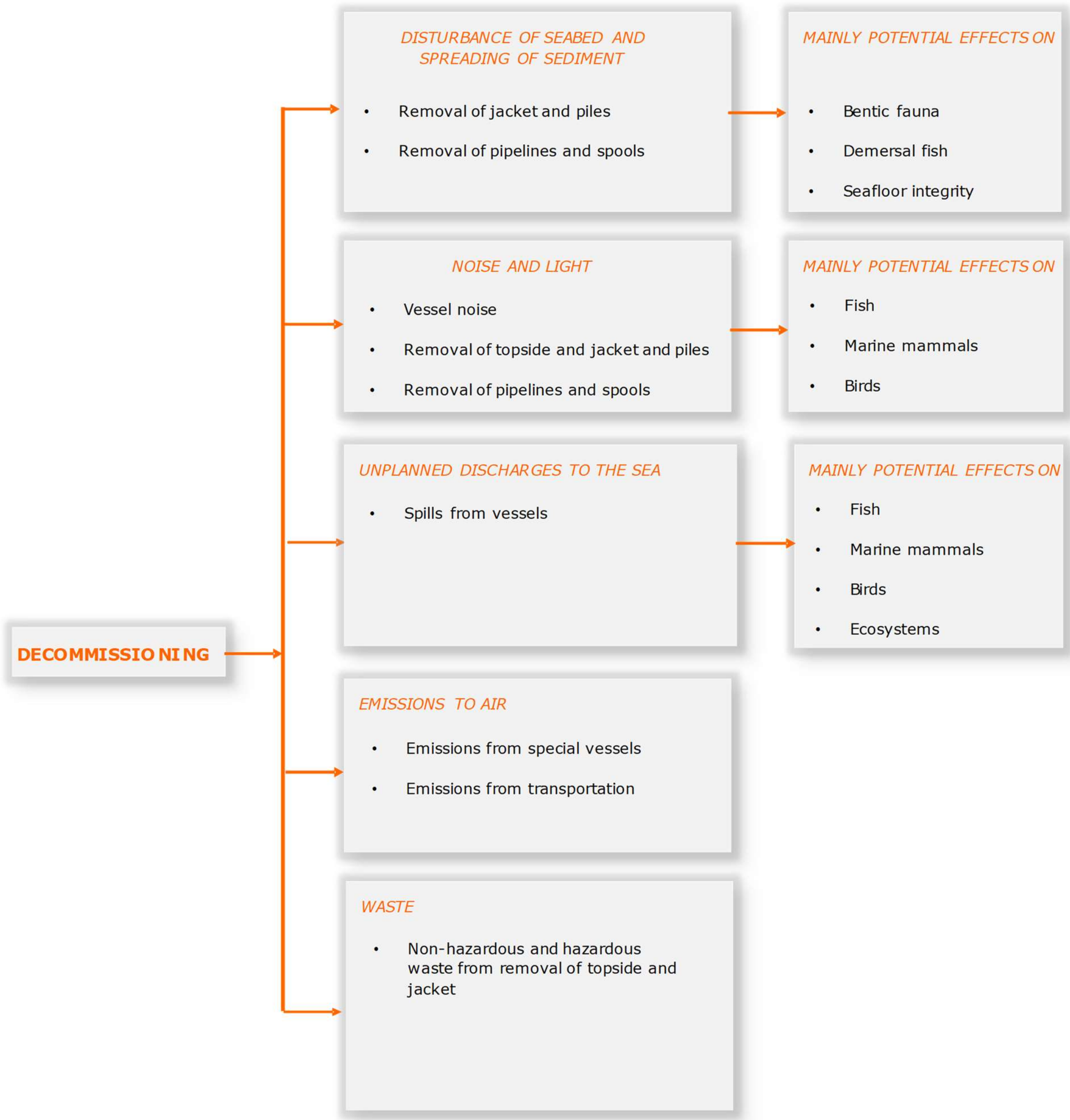


Figure 9-1 Overview of potential environmental impacts from Ravn decommissioning and effects on marine receptors.

Table 9-1 Operations and their potential impacts on environmental receptors.

Operations	Potential Impacts
› **Decommissioning of pipelines**	
Decommissioning of pipelines (leave in place or remove)	› Physical disturbance of seabed and benthic fauna (if removed) › Removal of marine growth on rock placement (if removed) › Noise disturbance to marine mammals resulting in behavioural avoidance (if removed) › Waste from pipelines, i.e. microplastic and pipelines structures (if left in place)
Decommissioning of structures	
Removal of topside and jacket including spools	› Physical disturbance of seabed and benthic fauna › Disturbance to marine mammals and fish from underwater noise › Release of particles (PM_{10}) and gaseous emissions (SOx, NOx, VOC, CO, CO_2, CH_4) from vessels › Waste from topside, jacket, and other structures › Disturbance of birds due to noise and artificial light from vessels › Disturbance to birds from loss of artificial light on platform
› **Onshore decommissioning activities**	
Dismantling of the platform	› Noise disturbance to humans from onsite transport and dismantling processes. › Release of particles (PM10) and gaseous emissions (SOx, NOx, VOC, CO, CO_2, CH_4) from dust, transport, dismantling processes, and smell from aerosols etc. › Pollution of surfaces, groundwater, recipients, and surface water. › Waste (non-hazardous and hazardous), NORM, oil and hydraulic fluids, wastewater etc.
Accidental oil spills	
Accidental oil spills	› Impact on birds, marine mammals, fish, coastal ecosystems, aquaculture, and tourism

9.1 Environmental impacts of planned activities for pipelines

Four decommissioning methods are assessed for the decommissioning of pipelines in the Danish part. The methods include:

- Leaving in situ, where the pipelines and umbilical are left in situ
- Pipeline disconnect and removal of materials above seabed (ends, spools and crossing will be removed and the remaining pipeline bundle and umbilical will be left in situ)

› Removal of pipelines by reverse installation (the pipeline is removed by reverse S-lay and the umbilical is rolled up onto a spool, the anodes must be removed prior to the reverse installation)

› Removal of pipelines by cut and lifting (generally cut under water in 30 m pieces and then lifted onto the deck of a vessel)

There are a total of two pipelines and an umbilical tied back to the host platform, an 8" multiphase production line, a 3"gas lift pipeline piggy-backed to the 8" pipeline and a 5,7" umbilical providing chemicals, fibreoptics and electricity to the Ravn field platform. The pipelines and umbilical are buried below the seabed. The multiphase production line and the gas lift pipeline is buried approximately with a distance of 25 m to the umbilical. The total length of the pipelines is 18 km, 3 km within the German EEZ and 15 km in the Danish EEZ. The pipeline bundle and the umbilical cross the Europipe I at the Danish shelf.

The pipelines are made of steel and is protected from corrosion by three layers of polypropylene and the umbilical by layers of low-density polyethylene (LDPE). In addition, sacrificial anodes are installed at regular intervals, approximately +/- 300 m, for cathodic protection. These consist of an aluminum alloy, weigh about 25 kg. and have a functional life of about 30 years.

The potential environmental impacts have been assessed below for the options of:

- Leaving the pipelines and umbilical in situ (spools included in section 9.2)
- Removal of the material above seabed
- and for removal of pipelines collectively for both methods, that is removal of pipelines by reverse installation by cut and lift

The expected impact related to the four decommissioning methods are assessed separately, and the impact related to the four methods are summarized in chapter 16.

Leaving pipelines and umbilical in situ

Leaving the pipelines and umbilical in situ will not be associated with any physical disturbance of the seabed or dispersal of sediment to the surrounding environment as there will be no activities post the cleaning and disconnection scope except for inspection of the seabed with a survey vessel, which will occur on an annual basis or less frequently. This inspection will cause underwater noise from the survey vessel as low frequency noise, although this is expected to cause only negligible impacts on the marine environment. Gradual decomposition of corrosion protection layers of the pipelines is described below.

Decomposition of pipeline corrosion

Prior to be left in situ, the pipelines will be cleaned (pigging and seawater flushing). They will be left open ended, filled with seawater. Because the pipelines are buried, they have been protected against water, salt, microbes and soil stress and corrosion. In addition, they have been protected against degradation by corrosion resistant coating materials.

The pipelines corrosion protection includes a 3-layer polypropylene (for the pipelines) and low-density polyethylene (for the umbilical) corrosion protection layer. This material is generally viewed as relatively non soluble in water and is fairly inert and does not break down or decompose easily. This coating is therefore expected to remain relatively inert and unchanged (Francis 2015).

The fate of the buried pipeline coatings has been assessed using leachate rates determined by leachate studies in the literature (Alben et al, 1982). Degradation of the pipelines and the protective has taken place since the pipelines were buried in 2015. Consequently, the lower molecular weight, water soluble, easily leachable components have probably all been removed some time ago.

The major leachable chemicals from epoxy pipeline coatings include primarily the solvents methyl isobutyl ketone, and ortho-, meta- and para-xylene. These solvents may be present in the epoxy from the manufacturing process but are quickly leached from the coating and their content may be reduced by 77 % after 30 days in water (Alben *et al*, 1989). It is therefore expected that all the potential toxic chemicals have already been removed from the pipeline long before decommissioning will take place.

The plastic particles, which could be formed when polypropylene is slipping from the steel pipes requires a different approach when assessing environmental impact. We are talking about number of particles. First of all, the pipelines are buried under the seabed, it is expected that sedimentation has taken place and that marine activity has started on top of the sand. The corrosion rate of the pipelines is slower than during operation. The degradation of the pipeline is expected to be slow as there are no significant fluids being transported through the pipeline. Also, the plastic particles are buried under sediment, meaning only a negligible number of plastic particles will be available to any organisms due to for example limited bioturbation, and the impact is therefore expected to be negligible.

Removal of material above seabed

Removal of the material above seabed and leaving the pipelines and umbilical in situ will not be associated with any significant physical disturbance of the seabed or dispersal of sediment to the surrounding environment. The seafloor integrity will similarly not be affected besides at the pipeline ends and the crossings, where rocks will be placed to stabilize pipeline ends. Gradual decomposition of corrosion protection layers of the pipelines is described below.

Although this scenario includes leaving the pipelines and umbilical in situ, there will be some decommissioning of pipeline stabilization features e.g. approx. 150 m of the pipelines and umbilical will be removed at the ends and the crossings will be removed and thus the pipelines and the umbilical will be cut at the crossings and the concrete mattresses will be removed from the seabed and shipped to shore. This will among others increase the vessel traffic in the area and thus increase the underwater noise, with a subsequent potential impact on marine mammals and fish. However, based on the expected increase in continuous noise and the threshold levels for hearing damage presented below (section 0), it is assessed that it will be a local, short-term and a very small magnitude, i.e., a negligible environmental risk.

Impact on benthic fauna from rock placement

If the parts of the pipelines and umbilical will be removed and the remaining left in situ, the pipeline ends, and the crossing will be stabilized with rocks. Fauna may be killed in the rocks footprint and rock placement will slightly increase the area where the seafloor integrity is affected. However, the rocks functions as substrate for other types of fauna such as hydroids and crustaceans and may gradually serve as an artificial reef comparable to the existing rocks on the pipelines. This will have a positive but insignificant impact on the benthic fauna.

Decomposition of pipeline corrosion

As described above the leaving pipelines and umbilical in situ will result in decomposition of the pipeline corrosion. However, the impact is expected to be negligible, see section 0.

Removal of pipelines

Both methods considered for removal will result in physical disturbance in the pipeline trench and dispersion of sediments. The sediment dispersion is expected to be of similar magnitude as for laying of the pipelines as assessed in the approved EIA for the Ravn Field (Wintershall Noordzee B.V., 2014), i.e. temporal and local. The pipelines were trenched (except at the crossings) and left in the open trench on the seabed. Subsequently the pipelines were buried as a result of natural sediment transport and deposition of sediments in the trench. It was expected based on Norwegian experience, that the pipelines were completely buried within half a year after the laying (Nøland et al., 1999).

As the pipes are currently buried, they must be excavated prior to removal. It is generally not possible to lift the pipelines directly from the seabed as it would put too much pressure on the pipeline and the equipment. The first step will therefore be to create a trench with sufficient working width. Techniques for this excavation include a mechanical trencher, which potentially can damage the pipeline, or by water jetting, which can liquefy the seabed causing the pipeline to sink. An alternative method is by the mass flow excavator, which generates a downward water current over the pipeline which exposes the pipeline.

It is expected that the excavation and subsequent removal of pipelines will create suspension of sediment to the water column which will gradually settle on the seabed again. Coarser particles will settle on the seabed in the vicinity of the pipeline footprint while finer particles will disperse further downstream before they settle. The excavation will impact a relatively wide corridor on each side of the pipelines in order for the walls to have a sufficient slope for not collapsing, in addition this is required for both the multiphase production line/gas lift pipeline and the umbilical. However, the disturbance period from dispersion of sediment is assessed to be relatively short with a local impact.

Calculations made in the Baltic Pipe EIA for the part of the 30” gas pipeline located in the North Sea indicated that most of the sediment suspended after jetting of the pipeline would settle close to the trench in a 75 mm thick layer. Hereafter the sediment layer would gradually decrease within a distance of 50 meters from the trench (Niras 2019). Finer particles such as silt would disperse to a larger area (up to 500 meters from the trench), but settle in a very thin layer of max 0,6 mm.

Noisy activities during decommissioning of the pipelines will include noise from machinery/propellers of offshore vessels in addition to handling the pipelines, e.g., handling the pipeline and remove the cathodes for reverse installation or cutting the pipelines for cut and lift.

Impacts on benthic fauna

Removal of the buried pipelines by reverse installation or cut and lifting will result in loss of marine flora and fauna living in the sediment. Most of the benthic epifauna will be killed when removing the approximately 15 km long pipeline trench in the Danish EEZ, either through direct contact with the removal device and due to burial. In addition, settled dispersed sediment suspended during removal of pipelines may bury and kill benthic fauna locally.

Benthic fauna communities living in the sediment of the North Sea are relatively robust to disturbance and shortly after the removal of pipelines and natural backfilling, benthic fauna will recolonize the affected areas. The organisms will immigrate from undisturbed areas and from larvae settlement (COWI/DHI Joint Venture, 2001; Kiørboe & Møhlenberg, 1982). The community will usually be re-established within 0.5-2 years after the disturbance (Kiørboe & Møhlenberg, 1982). Recovery of the echinoderms including *Amphiura filiformis* may take longer time, due to slow growth and late maturity.

The pipeline ends are covered with rock. Removal of the spools will result in killings of epifauna attached to the rocks. However, it is not expected that the epifauna associates with the rocks represent high biodiversity value. Since the rocks will be left in situ, benthic fauna community will recover after a few years. The environmental impact from loss of fauna living in and on the seabed as well as on the rocks is assessed to be small, short-term, and local.

Impact on sea floor integrity

Both methods for removal of pipelines will have a local and temporal impact on the sea floor integrity (D6 of the Marine Strategy) in the form of physical disturbance. The extent of the physical disturbance will include the footprint in addition to the area impacted by the sedimentation of the suspended sediment. Since the seabed is composed of sandy substrate and since the trench will be naturally backfilled, the sea floor will be brought back to natural conditions shortly after backfilling.

Impacts on fish from physical disturbance and sediment dispersal

The area near the Ravn field is a spawning area for cod, plaice, lemon sole and mackerel and potentially also for whiting, dab and long rough dab (section 7.8). If the removal of pipelines takes place during the spawning season, eggs and larvae of these species may potentially be affected due to physical disturbance and dispersal of sediment. However, it is argued that any such impact will be insignificant and will in no way affect the population size of these fish species. Firstly, the duration of elevated concentration particles above effect concentrations is limited to few hours at any site. Secondly, fish species produce vast numbers of eggs and larvae and have extensive spawning grounds, impacts on eggs and larvae around the Ravn field will not affect the adult populations. This should also be seen in the light of the vast natural fluctuations in e.g. food availability for the larvae and amount of predation which typically can have a big impact on recruitment.

Common fish species for the area such as haddock, dab, and rough dabs, which stay on the seabed or within the bottom 1-2 m of the water column may temporarily avoid the area. Because the disturbance will be temporary, short-term, and confined to a small area compared to the potential available living space, measurable impacts on the fish population are not anticipated.

Impact on marine mammals from underwater noise

Noisy activities related to removal of pipelines are not expected to exceed the threshold for triggering temporary or permanent hearing damage of cetaceans (harbour porpoises, minke whale or white beaked dolphin) or seals (for further details see 0). The marine mammals may exhibit avoidance behavior during the decommissioning activities but is expected to return to the area.

Impact on fish from underwater noise

Fish may flee from noisy areas, but this will not affect fish populations (for further details see 0).

Risk assessment

Based on the above and using the criteria described in chapter 8, it is assessed that the environmental risks on benthic fauna, fish and marine mammals are **low** when leaving the pipelines *in situ* (Table 9-2) as well as when removing material above seabed (Table 9-3). In comparison, the environmental risk related to the planned activities for removal of pipelines (regardless of method) is **negligible** for benthic fauna, marine mammals and fish and **low** for sea floor integrity (Table 9-4).

Table 9-2 Environmental severity and risk of impacts of activities related to ***leaving the pipelines in situ (but including disconnect of pipelines)****.*

Impact	Extent of impact	Duration of impact	Magnitude of impact	Severity of impact	Probability of impact	Environ-mental risk
Impact on benthic fauna from rock placement						N/A
Impact from pipeline corrosion and decomposition to aquatic environment	Local	Long-term	Small	minor	Highly probable	Low
Impacts of physical disturbance on sea floor integrity						N/A
Impact of underwater noise on marine mammals	Local	Short-term	Very small	Insignificant impact	Probable	Negligible
Impact of underwater noise on fish	Local	Short-term	Very small	Insignificant impact	Probable	Negligible

Table 9-3: Environmental severity and risk of impacts of activities related to ***removal of material above seabed including disconnect of pipelines****.*

Impact	Extent of impact	Duration of impact	Magnitude of impact	Severity of impact	Probability of impact	Environ-mental risk
Impact on benthic fauna from rock placement	Local	Short-term / reversible	Small (positive)	Insignificant impact	Probable	Negligible
Impact from pipeline corrosion and decomposition to aquatic environment	Local	Long-term / reversible	Small	Insignificant impact	Highly probable	Negligible
Impacts of physical disturbance on sea floor integrity	Local	Short-term / reversible	Small	Insignificant impact	Low	Negligible
Impact of underwater noise on marine mammals	Local	Short-term / reversible	Very small	Insignificant impact	Probable	Negligible
Impact of underwater noise on fish	Local	Short-term / reversible	Very small	Insignificant impact	Probable	Negligible

Table 9-4 Environmental severity and risk of impacts of activities related to ***removal of pipelines****.*

Impact	Extent of impact	Duration of impact	Magnitude of impact	Severity of impact	Probability of impact	Environ-mental risk
Impacts of physical disturbance and sediment dispersal on benthic fauna	Local	Short-term / reversible	Small	Insignificant	Highly probable	Negligible
Impacts of physical disturbance on sea floor integrity	Local	Short-term / reversible	Small	Minor	Highly probable	Low
Impacts of sediment dispersal on fish stocks	Local	Short-term/ reversible	Small	Insignificant impact	Highly probable	Negligible
Impact of underwater noise on marine mammals	Local	Short-term/ reversible	Very small	Insignificant impact	Probable	Negligible
Impact of underwater noise on fish	Local	Short-term/ reversible	Very small	Insignificant impact	Probable	Negligible

Waste from pipeline activities

Leaving the pipelines in place, means the pipelines will be filled with seawater and that a gradual corrosion and leachate of pipeline material and chemicals in the coating will take place. The major constituent of the pipelines is steel, and the leachates of iron (Fe) over time is not considered an environmental challenge and is therefore not included in the EIA.

The corrosion protection coating consists of polypropylene (PP) and low-density polyethylene (LDPE). Plastics particles in the sea have become a priority pollutant to consider carefully. Careful handling of plastic materials will be in focus during decommissioning, and focus will be on waste collection of plastic materials. PP and LDPE have been used as the primary coating material for corrosion protection of the Ravn pipelines planned left in place after decommissioning. The fate of the leachates from the pipeline coatings and their degradation has been assessed based on experiences reported in chapter 0.

Approximately 7 tons of steel are transported to shore from the cut spool pieces.

Risk assessment

Based on the above and using the criteria described in chapter 8, it is assessed that the environmental risks from waste are **negligible** when leaving the pipelines *in situ* (Table 9-5).

Table 9-5 Environmental severity and risk of impacts from pipeline leachates and degradation

Impact	Extent of impact	Duration of impact	Magnitude of impact	Severity of impact	Probability of impact	Environmental risk
Impacts of waste	Local	Short-term / reversible	Small	Minor impact	Probable	Negligible

Emissions to air from decommissioning of pipelines

The emissions to air related to the different decommissioning scenarios for pipelines are related to:

- Supply vessels
- Survey vessels
- Special vessels for pipeline activities (e.g. pipe trench vessel, rock placement vessel, pipe reel vessel, DSV)

The standard emission factors for vessels are from Norwegian Oil & Gas and are assumed to be diesel oil burned in motors (OLF, 2019). These are similar to emission factors for marine diesel oil/marine gas oil used for ships in the EMEP/EEAs Inventory Guidebook, 2019.

The emissions to air have been calculated for the four decommissioning methods for pipelines and are given in Table 9-6.

Table 9-6 Emission to air for different decommissioning scenarios for pipelines.

Decommissioning options	CO_2 [ton]	NO_X [ton]	SO_X [ton]	CH_4 [ton]	nmVOC [ton]
Leaving in situ[1)]	10-15	0.5-1	0.005-0.01-	0.0005-0.001	0.01-0.05
Removal of materials above seabed[2)]	6,000-8,000	100-150	2-4	0.5-1	10-15
Removal by reverse installation[3)]	8,000-10,000	150-200	3-5	0.5-1	15-20
Removal by cut and lift[4)]	15,000-20,000	250-300	5-7	1-2	25-30

1) Estimate for one survey. Assumed 24 hours of survey vessel per survey. The exact survey frequency will be determined in agreement with the authorities.
2) Assumed 28 days of DSV (fuel consumption 30 m^3/day), rock placement vessel (fuel consumption 27 m^3/day) and supply vessel (7 m^3/day).
3) Assumed 55 days of reel vessel (fuel consumption 10 m^3/day), DSV vessel (fuel consumption 30 m^3/day), S-lay vessel (fuel consumption 10 m^3/day), guard vessel (fuel consumption 0.5) and supply vessel (7 m^3/day).
4) Assumed 100 days of DSV (fuel consumption 30 m^3/day), offshore construction vessel (fuel consumption 20 m^3/day) and supply vessel (7 m^3/day).

The worst-case decommissioning activities for pipelines correspond to 0.03% of the total annual CO_2-eq. emissions in DK or to the emissions from approx. 1,400 Danes in 2020.

Based on the relative limited emission, small magnitude and thus the minor impact the impacts related to emissions to air are assessed to be **negligible** and **low**, as can be seen below in Table 9-7. Due to the characteristics of the greenhouse gases, they will contribute to global warming if emitted, and thus the probability of the impact is assessed to be highly probable. The impacts related to NO_X and SO_X are determined by the surrounding environment and thus are assessed to be probable.

Table 9-7 Environmental severity and risk of impacts of activities related decommissioning of pipelines.

Impact	Extension of impact	Duration of impact	Magnitude of impact	Severity of impact	Probability of impact	Environ-mental risk
Impacts of air emissions (NO_X, SO_X)	Regional	Short-term / irreversible	Small	Minor impact	Probable	Negligible
Impacts of air emissions (CO_2-eq.)	International	Short-term / irreversible	Small	Minor impact	Highly probable	Low

Summary of impacts related to pipeline activities

The impacts are assessed based on leaving the pipelines and umbilical in situ, removal of material above seabed or removal of the pipelines. In the below Table 9-8, Table 9-9 and Table 9-10 the environmental risks for the different impact categories are summarized for the pipeline activities. For a thorough comparison between the four methodologies of leaving the pipelines in situ, removal of material above seabed, removal by reverse installation or removal by cut and lift, please see chapter 16, where a comparative assessment is performed.

It is noted that these assessed impacts are not dependent on certain activities taking place during certain times of the year or seasons. The assessments are thus valid for the entire year and the project activities can based on this be performed throughout the year.

Table 9-8 Environmental risk for activities for pipelines left in situ.

Impact related to pipelines left *in situ*	Severity of impact	Probability of impact	Environmental risk
Impact on benthic fauna from rock placement			N/A
Impact from pipeline corrosion and decomposition	Insignificant impact	Highly probable	Negligible
Impact on sea floor integrity			N/A
Impacts of underwater noise on mammals	Insignificant impact	Probable	Negligible
Impacts of underwater noise on fish	Insignificant impact	Probable	Negligible
Impacts of waste	Minor impact	Probable	Negligible
Impacts of air emissions (NO_X, SO_X)	Minor impact	Probable	Negligible
Impacts of air emissions (CO_2-eq.)	Minor impact	Highly probable	Low

Table 9-9 Environmental risk for activities for removal of material above seabed.

Impact related to removal of materials above seabed	Severity of impact	Probability of impact	Environmental risk
Impact on benthic fauna from rock placement	Insignificant (positive)	Probable	Negligible
Impact from pipeline corrosion and decomposition	Insignificant	Highly probable	Negligible
Impact on sea floor integrity	Insignificant	Low	Negligible
Impacts of underwater noise on mammals	Insignificant impact	Probable	Negligible
Impacts of underwater noise on fish	Insignificant impact	Probable	Negligible
Impacts of waste	Minor impact	Probable	Negligible
Impacts of air emissions (NO_X, SO_X)	Minor impact	Probable	Negligible

Impacts of air emissions (CO_2-eq.)	Minor impact	Highly probable	Low

Table 9-10 Environmental risk for activities for removal of the pipelines.

Impact related to pipeline removal by reverse installation or cut and lift	Severity of impact	Probability of impact	Environmental risk
Impact on benthic fauna from physical disturbance and sediment dispersal	Insignificant impact	Highly probable	Negligible
Impact on sea floor integrity	Minor	Highly probable	Low
Impacts of sediment dispersal on fish stocks	Insignificant impact	Highly probable	Negligible
Impacts of underwater noise on mammals	Insignificant impact	Probable	Negligible
Impacts of underwater noise on fish	Insignificant impact	Probable	Negligible
Impacts of waste	Minor impact	Probable	Negligible
Impacts of air emissions (NO_X, SO_X)	Minor impact	Probable	Negligible
Impacts of air emissions (CO_2-eq.)	Minor impact	Highly probable	Low

9.2 Environmental impacts of planned activities for decommissioning of platform

The decommissioning of the platform includes removal of the topside and jacket, in addition to 'associated' structures like spools. Different removal methods are assessed for the decommissioning of the platform (topside and jacket). The methods include:

- Single lift removal
- Piece-small removal

The expected impact related to the two removal methods are assessed below.

Disturbance of seabed and benthic fauna

Decommissioning of platform will lead to physical disturbance of seabed and benthic fauna due to removal of subsea structures with marine growth.

Two methods are considered for removal of platform. The two methods will result in the same nature and magnitude of the impact.

Removal of platform structures

Removal of platform structures and other physical structures like spools will result in loss of marine flora and fauna attached to the subsea structures. Inspections from platforms indicate that the attached marine life generally is composed of mussels and macro algae.

Impacts on benthic fauna and fish

Flora and fauna, primary mussels, hydroids, and algae, attached to the platform will be lost permanently since the soft seabed in the Ravn field area is not suitable habitat for these species. Since the fauna living on the platform structures do not represent high biodiversity value, the environmental impact from loss of fauna attached to the physical structures is assessed to be small and local.

The Ravn field area a is spawning area for cod, plaice, lemon sole and mackerel (section 7.8). If the removal of the platform structures takes place during the spawning season, eggs and larvae of these species may be affected. However, it is argued that any such impact will be insignificant and will in no way affect the environmental status of the fish stocks which is considered stable. Firstly, because the affected area is relatively small. Secondly, fish species produce vast numbers of eggs and larvae and have extensive spawning grounds.

Common fish species for the area such as haddock, dab, and rough dabs, which stay on the seabed or within the bottom 1-2 m of the water column may temporarily avoid the area. Because the disturbance will be temporary, short-term, and confined to a small area compared to the potential available living space, measurable impacts on the fish population are not anticipated.

Risk assessment

Based on the above and using the criteria described in chapter 8, it is assessed that the environmental risks related to planned activities for removal of platform on benthic flora and fauna and fish is **Negligible.**

Table 9-11 Environmental severity and risk of impacts of activities removal of platform.

Impact	Extent of impact	Duration of impact	Magnitude of impact	Severity of impact	Probability of impact	Environ-mental risk
Impacts of removal of platform structures on benthic fauna	Local	Short-term / reversible	Small	Insignificant impact	Highly probable	Negligible
Impacts of removal of platform structures on fish	Local	Short-term / reversible	Small	Insignificant impact	Highly probable	Negligible

Underwater noise

Noisy activities during decommissioning of the platform include noise from cuttings and machinery/propellers of offshore vessels.

Source of underwater noise

During the decommissioning of the Ravn platform, there will be underwater noise generated by vessels and cutting of underwater structures.

The cutting of structures, for example the jackets, will be performed by using an internal abrasive cutting tool, as for example an abrasive water jet, which is a technology that does not involve metal-to-metal contact during the process. No underwater noise measurements for water jet cutting could be found in the literature, and the following is based on general expectations.

The primary source of noise from water jet is the turbulence caused by the steep velocity changes between the high-speed jet and the surrounding medium. For industrial cutters in workshops it is known that submerging the cutting in water dramatically reduces this noise, and one supplier reports (airborne) noise levels in the order of 75 dB(A). The jet noise is continuous, with a broadband character and with expected maximum in the lower kHz frequency range. The present scenario the jet noise propagates from the localised cutting point through the structure wall and subsequently passes through to the water column. Due to the attenuation by the structure wall, it seems likely that the resulting noise contribution from the jet itself will be reduced.

A secondary noise source from the cutting concerns acoustic radiation of the structure due to induced vibration. The vibration is introduced in radial direction at the cutting point 3 m down of the structure. On that background significant attenuation is expected before the vibration reaches the water-loaded part. When radiated into the water, this noise is expected to attenuate at 15·Log distance dependence, which is a reduction of approximately 5 dB per doubling of distance. Hence, it seems likely that the noise contribution from the structure is minor.

Prior to removal of spools, the pipelines will be disconnected at the A6-A and Ravn Platform. It is expected that the cutting will be performed by divers using either oxy arc cutting equipment or a Spitznas hydraulic reciprocating saw. In total 6 cuts will be made on the pipeline spool sections and two cuts on the umbilical section (Method Statement Ravn to A6-A pipeline & umbilical decommissioning, Wintershall, 2022). The oxy arc cutting use high temperatures and oxygen to cut metals, i.e. does not involve metal-to-metal contact during the process. The Spitznas hydraulic reciprocating saw uses a blade and thus will involve metal-to-metal contact during the process.

No underwater noise measurements for utilization of the two different pieces of cutting equipment could be found in the literature, and the general considerations for the internal abrasive cutting tool as presented above is expected to be valid for the oxy arc cutting equipment and the Spitznas hydraulic reciprocating saw. Although, for the Spitznas hydraulic reciprocating saw, which involves metal-to-metal contact during the process, the expected maximum noise will be within the higher kHz range.

Underwater noise may affect marine organisms in different ways. As cetaceans (i.e. whales, porpoises and dolphins) depend on the underwater acoustic environment for orientation and communication, they are believed to be the marine organisms that are most sensitive to underwater noise (NOAA, 2018). Seals and fish may, however, also be affected by underwater noise.

Possible effects of underwater noise on marine mammals include:

- **Hearing damage**. Intense underwater noise may damage hearing of cetaceans and seals. There are two levels of damage. Temporary threshold shift (TTS), which is a reversible hearing loss, from which the animal subsequently will recover. Permanent threshold shift (PTS) which is an irreversible hearing loss. Generally, PTS will occur only after repeated TTS episodes or exposure to higher levels of sound than causing TTS (Southall et al., 2019).

- **Behavioural reactions**. Underwater noise may cause avoidance reactions and other behavioural effects of cetaceans and seals, such as changes in surfacing, breathing and diving behaviour, cessation of feeding, aggression, aversion and panic (e.g. Dähne et al., 2013; Southall et al., 2008; Thompson et al., 2010). Behavioural impacts to acoustic exposure are generally more variable, context-dependent, and less predictable than the effects of noise exposure on hearing.

- **Masking.** Because cetaceans depend on the underwater acoustic environment for orientation (echo location) and communication an emitted cetacean sound can be obscured or interfered with (masked) by manmade underwater noise (Tougaard, 2014). There are examples of whales changing their vocalisation because of underwater noise (Weilgart, 2007).

The most commonly used predictor for TTS and PTS is the sound exposure level (SEL), cumulated over a period of at least two hours. Guiding threshold values of sound exposure levels that may cause TTS or PTS or behavioural/avoidance reactions for harbour porpoise, white-beaked dolphin, minke whale and seals are presented in Table 9-12.

Table 9-12 Sound exposure levels, that are harmful to cetaceans and seals. I-type sounds are impulsive sounds characterised by a very fast onset, often, but not always, followed by a slower decay, short in duration as a fraction of a second and with a large bandwidth. Other sounds are defined as sounds not defined as I-type sounds. Based on "Guideline for underwater noise" (DEA, 2022). 1) SPL $L_{p,rms,125ms}$

Impact	I-type sounds SEL (cum) $L_{E,p,xx,24h}$ (dB re 1μPa²s)[3]	Other sounds SEL (cum) $L_{E,p,xx,24h}$ (dB re 1μPa²s)[3]
Harbour porpoise (very high frequency cetacean)		
Sound exposure level causing permanent threshold shift (PTS)	155	173
Sound exposure level causing temporary threshold shift (TTS)	140	153
Behavioural reactions	103[1]	103[1]
White beaked dolphin (high frequency cetacean)		
Sound exposure level causing permanent threshold shift (PTS)	185	198
Sound exposure level causing temporary threshold shift (TTS)	170	178

Minke whale (low frequency cetacean)		
Sound exposure level causing permanent threshold shift (PTS)	183	199
Sound exposure level causing temporary threshold shift (TTS)	168	179
Seals (phocid carnivores in water)		
Sound exposure level causing permanent threshold shift (PTS)	185	201
Sound exposure level causing temporary threshold shift (TTS)	170	181

It is expected that the general underwater noise generated by the activities for the decommissioning of the Ravn field will be "other sounds" and only very limited if any "I-type sounds".

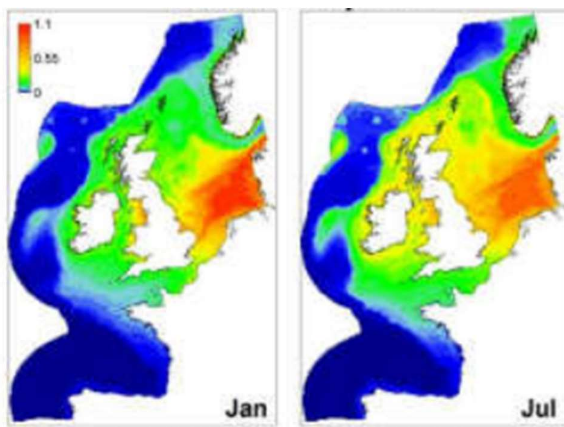
Noisy activities during decommissioning of the Ravn field include broad band noise from heavy lift vessels and service vessels. It has been found that the sound exposure level (SEL_{cum}) of passing vessels during a 30-second long time window reached values between 105–145 dB re 1 $\mu Pa^2 s$ and that harbour porpoises react to this noise level (Dyndo et al., 2015). However, underwater noise from vessels is not expected to exceed the threshold for hearing damage (Tougaard et al., 2016; NOAA, 2018).

In addition to the noise from vessels, it is expected that there will be underwater noise from cuttings, potentially from diamond wire cuttings (Pangerc et al., 2016). It has been shown that underwater noise from decommissioning of a platform at 80 m depth increases the background underwater noise with 4-15 dB which will not lead to hearing damage of marine mammals. Realistically, the structure may be cut by an internal abrasive cutting tool, e.g., an abrasive water jet. There will therefore not be any metal-to-metal contact for the majority of the cutting operations and the noise is expected to be continuous low frequency noise. The cutting is expected to take place in the magnitude of hours. Only local and short-term impacts are thus expected. There is a potential for the use of a Spitznas hydraulic reciprocating saw for disconnecting the pipelines from the spools prior to removal of the spools, and this may produce a higher frequency noise during the cutting. Disregarded, the handheld diver tools like the oxy arc cutting equipment or a Spitznas hydraulic reciprocating saw are expected to produce only local and very short-term impacts.

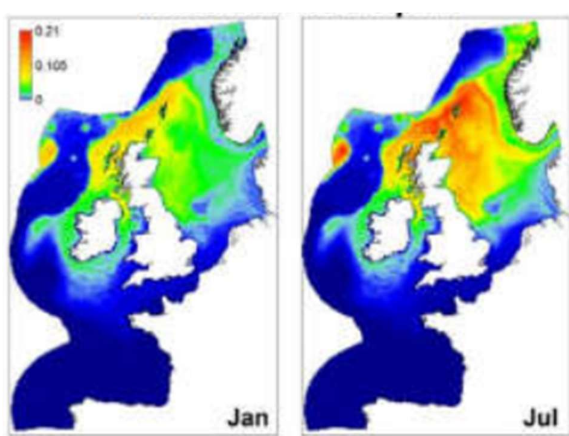
All whale species in the North Sea are listed in Annex IV of the EU habitats directive (Council Directive 92/43/EEC of 21 May 1992). Annex IV lists animal and plant species in need of particularly strict protection. A total of 23 different species of cetaceans have been observed in the North Sea. Only harbour porpoise (*Phocoena phocoena*), white-beaked dolphin (*Lagenorhynchus albirostris*) and minke whale (*Balaenoptera acutorostrata*) are encountered regularly in the western part of the Danish sector of the North Sea. Other cetacean species are rare and do only occasionally migrate into in the North Sea from the Atlantic. This is consistent with the species assessed to be relevant for assessment of impulsive noise sources in Danish waters (DCE 2021).

Annex IV-species have specific protection requirements including prohibition of all forms of deliberate capture or killing of these species in the wild, deliberate disturbance of these species particularly during the period of breeding, rearing and migration and deterioration or destruction of breeding sites and resting places. The harbour porpoise and white-beaked dolphin are very high frequency and high frequency cetaceans respectively. Based on the threshold levels the harbour porpoise tends to be more sensitive to underwater noise compared to the white-beaked dolphin. The minke whale is a low frequency cetacean (Table 9-12).

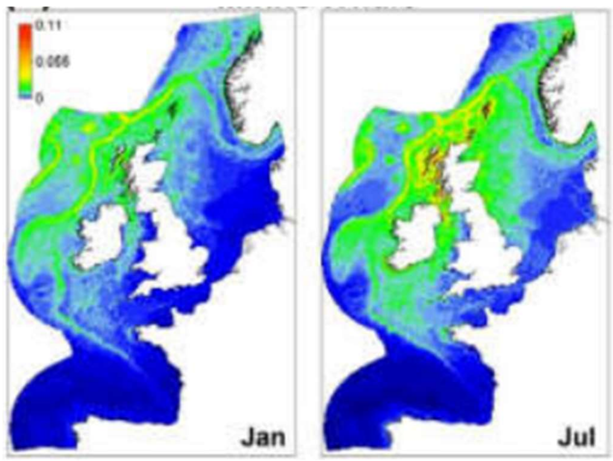
The distribution of the harbour porpoise, the white-beaked dolphin and the minke whale in the North Sea has been modelled (Figure 9-2). The harbour porpoise is the most common marine mammal in Danish waters and harbour porpoises in the project area are expected to belong to the North Sea Population. The white-beaked dolphin is typically found in the northern part of the North Sea, while the minke whale is found in both the central and northern part of the North Sea, particularly during the summer (Figure 9-2). The populations of harbour porpoises, white-beaked dolphins and minke whale are all assessed to be in favourable conservation status (DCE 2021).



Harbour Porpoise



White-Beaked Dolphin



Minke Whale

Figure 9-2 Modelled spatial distribution in animals per km² in January and July in the North-East Atlantic. Note a different colour gradient used for each species. From Waggit et al. 2019.

Cetaceans are probably most sensitive to potential impacts from underwater noise during the period where they mate, deliver the calf and the initial nursing. Harbour porpoises mate during July-September, deliver during the spring and summer with a peak in June. White-beaked dolphins mate during May-August and give birth during the summer. Minke whales mate and deliver during late winter to early spring.

The harbour porpoise and white-beaked dolphin breed during part of the weather window for the activities from April to September. No breeding areas have been established for either the harbour porpoise or the white-beaked dolphin. It may be expected that for example the harbour porpoises will breed in more protected and shallower waters closer to the shore. Minke whales mate and deliver during late winter to early spring, and mostly are observed in the northern part of the North Sea. Based on the expected local impact and very short-term impact, it is not likely that the identified Annex IV-species will be impacted by the activities during their most sensitive periods. Based on this it is assessed that the project activities will not cause a deterioration or destruction of breeding or resting sites for the Annex IV-species.

It is concluded that the underwater noise generated by the decommissioning activities will potentially result in avoidance behavior from cetaceans and in particular harbour porpoises. However, hearing damage is not expected. The environmental impact related to underwater noise generated during the Ravn platform decommissioning is assessed to be **Insignificant** (Table 9-13).

Table 9-13 Environmental severity and risk of impacts of underwater noise generated during decommissioning of the Ravn platform.

	Nature	Magnitude	Extend	Duration	Severity of impact
Impacts of underwater noise from support vessels	Negative	Small	Local	Short-term	**Insignificant**
Impact from diamond wire cutting	Negative	Small	Local	Short-term	**Insignificant**

Impact on fish

Field studies have shown that several species of fish may be disturbed by noise from passing vessels and they may flee from the vessel while other species are not affected (Freon et al., 1993). Noisy activities are marginal, local, and temporary and will not affect fish populations.

Risk assessment

Based on the above and using the criteria described in chapter 8, it is assessed that the environmental risks related to planned activities of planned activities for removal of platform on marine mammals and fish is **Negligible** (Table 9-14).

Table 9-14: Environmental severity and risk of impacts of activities caused by decommissioning of the Ravn platform.

Impact	Extent of impact	Duration of impact	Magnitude of impact	Severity of impact	Probability of impact	Environ-mental risk
Impacts of underwater noise on marine mammals	Local	Short-term	Small	Insignificant impact	Highly probable	Negligible
Impacts of underwater noise on fish	Local	Short-term	Small	Insignificant impact	Highly probable	Negligible

Light and noise from vessels

As the vessels operate 24 hours per day, they will be illuminated during the dark hours. The work vessels must be continuously lit to enable work to be carried out properly and to ensure the safety of the crew. There will be no loud continuous noises during the decommissioning phase.

Impact on birds

Night lights from the vessels may be beneficial for foraging gulls because light attracts prey to the surface waters (zooplankton and/or small fishes). Lights from the vessels may thus create additional foraging opportunities for gulls that normally forage by daylight, thus supplementing their diets and, potentially, increasing their survival and reproductive success (Ronconi, Allard and Taylor, 2015; Tasker et al., 1986). However, illumination of the vessels may also attract and disorient migratory birds.

Since the impacts of light from the vessels is temporary and the magnitude small, it is assessed that the environmental risk is negligible and in no way will affect bird populations.

Impact of airborne noise on birds

Some loud noise will be generated during decommissioning of platform that will temporarily disturb seabirds locally. This will in no way impact seabird population.

Risk assessment

Based on the above and using the criteria described in chapter 8, it is assessed that the environmental risks related to artificial light during decommissioning will have a minor positive effect in terms of improving foraging opportunities for seabirds and negative effect in terms of disorienting migratory birds. The general environmental risk of artificial light on birds is **negligible** (Table 9-14).

Some loud noise will be generated during decommissioning of the platform that will temporarily disturb seabirds locally. The environmental risk of noise on birds is **negligible** (Table 9-15).

Table 9-15 Environmental severity and risk of impacts of activities decommissioning work related to removal of platform on birds.

Impact	Extent of impact	Duration of impact	Magnitude of impact	Severity of impact	Probability of impact	Environ-mental risk
Artificial light from vessels	Local	Short-term	Small	Insignificant impact	Highly probable	Negligible
Noise (airborne)	Local	Short-term	Small	Insignificant impact	Highly probable	Negligible

Removal of artificial light from platform

After decommissioning of the Ravn platform, sources to artificial light in terms of electric light will have disappeared. There has not been flaring at the Ravn platform.

Impact on birds

Removal of artificial light at sea may prevent that certain species of birds are attracted to the platform – especially during bad weather and overcast nights. There are examples that illumination from offshore platforms under such circumstances can attract and disorient the birds and have a trapping effect that leads birds to circle around the light source. In particular, this is the case for migratory songbirds, waders, ducks, and geese, not so much by the light source's intensity, but by specific spectra within the light source (Deda et al., 2006; Van De Laar, 2007). The circling behavior may reduce their energy reserves and especially for migrating songbirds making them unable to cross the North Sea. Removal of the artificial light will hereby have a positive effect on especially migratory birds.

Removal of the platform may also have positive effects due to reduction in the number of migrating birds that may collide with the platform structures. The number of bird killings is however species and site specific and may vary from 0 to thousands of killings per year (Ronconi et al., 2015). Since there has not been flaring at the Ravn field and since the site is not within a major corridor for migrating birds, the number of bird killings under current situation is assumed to be minor.

Removal of night lights from platform may have negative impact from foraging gulls because light attract prey to the surface waters (zooplankton and/or small fishes). Lights from offshore platforms may thus create additional foraging opportunities for gulls that normally forage by daylight, thus supplementing their diets and, potentially, increasing their survival and reproductive success (Ronconi et al., 2015; Tasker et al., 1986). Removal of light from the Ravn field area will potentially reduce foraging opportunities for gulls. The impact is assessed to be small and local and without impact on seabird populations.

Risk assessment

Based on the above and using the criteria described in chapter 8, it is assessed that the environmental risks related to removal of artificial light as a consequence of the decommissioning will have a minor negative effect in terms of removing foraging opportunities for seabirds. In contrast, there will be a positive effect terms of reductions in bird collisions and disorientation of migratory birds. The environmental risk of removal of artificial light on birds is assessed to be **negligible**.

Table 9-16: Environmental severity and risk of impacts of activities removal of artificial light from platform on birds.

Impact	Extent of impact	Duration of impact	Magnitude of impact	Severity of impact	Probability of impact	Environ-mental risk
Positive impact by removal of artificial light from platform	Local	Permanent	Small (**positive** and **negative**)	Insignificant impact	Highly probable	Negligible

Emissions to air from removal of platform

The removal method of the platform considered in the below is the single lift in two lifts, and transported separately, as it is assumed that the piece small method will not require more offshore workdays, and the below assessment is a worst-case scenario.

The emissions to air from removal of the topside and jacket are related to:

- Special vessels for removal of topside, spools and jacket (e.g. HLV and Anchor-Handling-Tugs)

The standard emission factors for vessels are from Norwegian Oil & Gas and are assumed to be diesel oil burned in motors (OLF, 2019). These are similar to emission factors for marine diesel oil/marine gas oil used for ships in the EMEP/EEAs Inventory Guidebook, 2019.

The emissions to air have been calculated for removal of the topside, spools and jacket, see Table 9-17.

Table 9-17 Emission to air for removal of topside and jacket.

Emissions related to removal of topside and jacket	CO_2 [ton]	NO_X [ton]	SO_X [ton]	CH_4 [ton]	nmVOC [ton]
Heavy Lift Vessel (HLV)	1,094	18	0.3	0.05	2
150t Anchor-Handling-Tug	430	7	0.1	0.02	1
Total	**1,524**	**25**	**0.5**	**0.1**	**2.4**

The emissions related to the removal of the jacket, spools and platform correspond to 0.003% of the total annual CO_2-eq. emissions in DK in 2020 or to the emissions from approx. 140 Danes.

Based on the relatively limited emission, small magnitude and thus the minor impact, the overall impact related to emissions to air are assessed to be **negligible** and **low**, as can be seen below in Table 9-18. Due to the characteristics of the greenhouse gases, they will contribute to global warming if emitted, and thus the probability of the impact is assessed to be highly probable. The impacts related to NO_X and SO_X are determined by the surrounding environment and thus are assessed to be probable.

Table 9-18 Environmental severity and risk of impacts of activities related decommissioning of the platform.

Impact	Extension of impact	Duration of impact	Magnitude of impact	Severity of impact	Probability of impact	Environ-mental risk
Impacts of air emissions (NO_X, SO_X)	Regional	Short-term	Small	Minor impact	Probable	Negligible
Impacts of air emissions (CO_2-eq.)	International	Short-term	Small	Minor impact	Highly probable	Low

Emissions related to the transport of the platform are expected to vary with the variation of distance to the disposal yard to be chosen.

At the moment it is expected that the platform will be taken to the Dutch shore for dismantling. The distance for to the Dutch shore will be approx. 500 km from the Ravn location and to the disposal yard port. If e.g. a location in UK is chosen the distance will also be approx. 200 km from the Ravn location. An estimate of the emissions related to the transport is made based on assumptions of the distance, speed and vessels to be used.

The emissions will vary with a factor 4 depending on the route and the vessels to be used. However, the highest estimated emissions will only constitute around 7% of the emissions related to the removal activities of the platform thus the related impacts will be assessed **negligible** and **low**, since the impact will be minor (ref. Table 9-19).

Table 9-19 Environmental severity and risk of impacts of emissions related to transport.

Impact	Extension of impact	Duration of impact	Magnitude of impact	Severity of impact	Probability of impact	Environ-mental risk
Impacts of air emissions (NO_X, SO_X)	Regional	Short-term	Small	Minor impact	Probable	Negligible
Impacts of air emissions (CO_2-eq)	International	Short-term	Small	Minor impact	Highly probable	Low

Non-indigenous species

The vessels used for decommissioning activities can potentially introduce non-indigenous species to the North Sea area through marine fouling on vessels or through discharge of ballast water from the vessels.

The Ballast Water Management Convention is implemented in Danish law through the Statutory Law on Protection of the Marine Environment (LBK 1165 of 25/11/2019) and regulated through the Executive Order on treatment of ballast water and sediments from ships' ballast water tanks (BEK 733 of 19/05/2022) which stipulate the requirements for the vessels management of their ballast water. Vessels solely operating in the Danish sea-territory and exclusive economic zone are exempted from the requirements in the Ballast Water Management Convention. Smaller vessels (<400GT) are until 8 September 2024 also exempted.

If the vessel must fulfil the requirements in the Ballast Water Management Convention, it will either be by exchange of their ballast water (D1 exchange standard) or discharge of treated ballast water (D2 discharge standard). Whether the vessel must comply with the D1 or D2 standard depends on the vessels' renewal date of the IOPP certificate. These vessels must comply with the D2 standard on 8 September 2024 at the latest.

Management of biofouling is currently not regulated in the national Danish legislation. However, there may be some regulations and requirements in specific ports when performing in-water cleaning of the vessels. All vessels are expected to be coated with antifouling to reduce marine fouling. In addition, there is an economic incitement to remove marine fouling from the vessels regularly to minimize use of fuels. This incitement does generally not extend to cleaning of the so-called niche area. There will therefore be a risk, although minor risk, for introducing non-indigenous species by the vessels' biofouling. This risk is reduced as it is expected that the majority of the vessels generally are operating within the North Sea. It is further expected that the vessels are guided by the non-mandatory "IMO Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species" (Resolution MEPC.207(62)) from 2011, which is currently under review in the IMO.

The presence of oil and gas platforms may also represent at pathway for non-indigenous species, as the platforms may be used as steppingstones during a secondary dispersal. However, as the Ravn field platform will be decommissioned, it can be argued that a potential steppingstone for non-indigenous species will be removed.

The severity of a potential impact is theoretically major if the non-indigenous species become established and subsequently invasive. However, based on the arguments above the environmental risk of introduction of invasive species is assessed to be low Table 9-20.

Table 9-20 Risk related to non-indigenous species vessels under construction.

Impact	Extension of impact	Duration of impact	Magnitude of impact	Severity of impact	Probability of impact	Environ-mental risk
Impacts of non-indigenous species	Regional/ national	Long-term	Moderate	Major impact	Very low	Low

Summary of impacts related to decommissioning activities for platform

The impacts are assessed based on the removal methods described above. In Table 9-21 the environmental risks for the different impact categories are summarized for the decommissioning activities for the platform.

It is noted that these assessed impacts are not dependent on certain activities taking place during certain times of the year or seasons. The assessments are thus valid for the entire year and the project activities can based on this be performed throughout the year.

Table 9-21 Environmental risk for activities for removal of platform.

Impact of decommissioning activities for platform	Severity of impact	Probability of impact	Environmental Risk
Impacts of disturbance of seabed and benthic fauna	Insignificant impact	Highly probable	Negligible
Impacts of underwater noise on marine mammals	Insignificant impact	Highly probable	Negligible
Impacts of underwater noise on fish	Insignificant impact	Highly probable	Negligible
Impacts of artificial light from vessels	Insignificant impact	Highly probable	Negligible
Impact of noise (airborne) from vessels	Insignificant impact	Highly probable	Negligible
Impacts of removal of artificial light from platform	Insignificant impact	Highly probable	Negligible
Impacts of air emissions (NO_X, SO_X)	Minor impact	Probable	Negligible
Impacts of air emissions (CO_2-eq.)	Minor impact	Highly probable	Low
Impacts of non-indigenous species	Major impact	Very low	Low

10 Environmental impacts of planned activities onshore

The Ravn platform will be transported from its location in the North Sea and to an onshore approved yard for dismantling. The location for the dismantling yard is not yet decided upon, but the dismantling yard will be designed to handle dismantling of offshore platforms. Temporary storage for later reuse of platform, or parts hereof, are being considered by Wintershall Noordzee B.V.

10.1 Onshore handling facility

To enable optimum reuse and recycling of the topside and jacket structures various skills are required, including:

- Waste material characterization
- Onshore dismantling
- Waste management
- Hazardous material management and disposal

Appropriate infrastructure and equipment requirements shall include the following:

- Onshore cranage (various stationary and mobile)
- Cutting equipment (hydraulic scissors, flame cutters, plasma cutters, wire cutting etc.)
- Handling equipment (front loaders, excavators etc.)
- Onshore disposal yard space
- Quayside strength and extent
- Deepwater access channel
- Dry dock
- Metal recycling facilities and logistics

Determining capacity of a disposal yard to service the decommissioning is a function of a number of parameters relating to processing capability such as footprint, material handling capability, lift/skidding capability, quayside strength, draught, waste processing etc. It is also dependent on the weight of the total installation and the weight and dimension of any subsections delivered to the facility (which is dictated by the removal method).

The typical dismantling yard facilities include the following:

- Large processing area
- Wide quay front
- Water depth up over 14 meters
- Onshore mobile crane capacity (2,000 Te or more)
- Floating crane capacity (500 Te or more)

- Skidding/SPMT area with a min. 70t/m^2 ground bearing capacity to accommodate ultra large offshore package offloads
- Wide ship breaking ramp for floating vessel recycling
- Subterranean water run-off containment and filtration and treatment system
- On-site hazardous waste handling and remediation facilities incl. handling of NORM.
- Large scale recycling facility with sufficient capacity to recycle metal from ships, semi-submersibles, jack-ups, offshore production facilities and associated jackets.

10.2 Waste volumes onshore

The amount of materials to be removed and brought to shore for dismantling, recycling and disposal is summarized below in Table 10-1 based on a material inventory and sorted into main waste fractions.

Table 10-1 Waste fractions in weights (Tons).

Materials	Topside [Tons]	Jacket [Tons]	Subsea, piles [Tons]	Total [Tons]
Metals:				
Steel (incl. spools)	505	1095	316	1916
Chromium steel	1	N/A	N/A	1
Copper	25	N/A	N/A	25
Piping/Steel	94	N/A	N/A	94
Galvanized metal	1	N/A	N/A	1
Aluminum	0	82	N/A	82
Mechanical/ electric (excl. copper, plastic etc.)	86	N/A	N/A	86

Materials	Topside [Tons]	Jacket [Tons]	Subsea, piles [Tons]	Total [Tons]
Plastic	6	N/A	N/A	6
Marine Growth	0	84	N/A	84
Total	**718**	**1261**	**316**	**2295**

Hazardous waste

A hazardous material survey on the Ravn platform has been conducted by SGI Compliance engineers on behalf of Wintershall Noordzee B.V. The survey included visual inspection and sample taking of surfaces and accessible components on the platform. The report is part of an ongoing Inventory of Hazardous Materials (IHM), which was adopted during the IMO Hong Kong Convention on 17 July 2009 and with reference to the EU SRR 1257/2013 and EMSA Guidance for the IHM.

Materials	Amount
Asbestos	According to the IHM report mentioned above there is no asbestos identified.
Batteries	18 kg/piece, 56 pieces containing lead-acid (Pb) present.
Mercury	No liquid mercury droplets have ever been found in the Ravn process installation. Measured mercury vapors when opening the vessels were low and also most mercury contamination found in sludges are low (< 50 mg/kg). Mercury is not expected to be an issue when dismantling this installation.
NORM	According to Wintershall Noordzee B.V. the activities of the radioactive substances present in the production installation of the Ravn platform are below the exemption and clearance limits as stated in the Dutch Radiation Protection legislation. Ravn is not a so-called LSA installation

Materials	Amount
Debris on seabed	Debris survey will be executed from the HLV during/after the removal of the topside and the jacket. Any debris found will be recovered to surface and shipped to the shore and disposed of according to legislation and company policies and under appropriate permit. A work class ROV in combination with a basket will be used to recover debris.
Aluminum anodes	The estimated amount of aluminum anodes on the jacket structure. are 212 anodes of 390 kg=82 tons. The pipeline also contains anodes. If pipeline will be left *in situ* the anodes will not be removed.

10.3 Waste stream management

As much as possible of the installation, by weight, will be recycled. The remaining weight of the materials recovered to shore will be incinerated or disposed of for special treatment or landfill depending on regulations.

As much as possible of the material recovered to shore will be recycled. Experience shows that typically recycling of at least 95% (weight) of all materials combined[2] is possible. For metals the recycling percentage may well be higher and for materials like e.g. concrete and plastic the recycling percentage may be lower. The set recycling percentage seems realistic.

Steel is the primary material used offshore. It forms the basic structure for most offshore platforms. Experience shows that decommissioning projects can achieve very high levels of recycling up to 98 % by weight. However, reuse and refurbishment have a much higher value than scrap recycling (17). Wintershall Noordzee B.V. intends to further investigate the possibilities for reuse of the platform components on new installations and therefore also the possibilities for temporary storage of the components.

As much as possible of the recovered materials will be recycled. The remaining weight of the materials recovered to shore will be disposed of for incineration or landfill.

The overall waste stream management plan is summarized in the table below.

Waste Stream Management Methods	
Waste Stream	Removal and Disposal method

[2] Target set for similar projects e.g. the decommissioning of the Anglia field (Ithaca Energy, 2020).

Liquids	There are no bulk liquids on board the Ravn installation.
Marine growth	Removed partly offshore and onshore. Disposed of according to guidelines.
Hazardous waste	Based on the Material Inventory these wastes will be recovered to shore and disposed of according to legislation and company policies and under appropriate permit.
Onshore dismantling sites	Appropriate licensed sites will be selected. Facilities selected must demonstrate proven disposal track record and waste stream management throughout the deconstruction process and demonstrate their ability to deliver innovative recycling options.

Table 10-2 The overall waste stream management methods.

10.4 Potential impact from onshore handling

The expected potential impacts from the onshore handling, disregarding the location of the disposal yard, is:

- Noise from internal and external transport, handling of materials, high pressure cleaning, pumps, scrapping and cutting.
- Emissions to air from dust, transport, machinery, smell from aerosols etc.
- Pollution of surfaces, groundwater, recipients and surface water from leaking membranes and surfaces, accidental spills, discharge of pollutants and waste, surface water and drain water, wastewater etc.
- Waste (non-hazardous and hazardous), NORM, oil and hydraulic and lubricants, wastewater etc.

The potential impacts from the disposal yard will be regulated by the environmental permit. The environmental permit defines requirements and limits of discharges, emissions, noise and waste handling and disposal and more. Wintershall Noordzee B.V. will ensure that the disposal yard have the relevant permits in place.

11 Impact on cultural heritage

Removal of subsea structures could potentially affect wrecks. There are no registered wrecks in the project area and the area is generally not a hot spot for shipwrecks (Figure 11-1). Potential findings of wrecks or other historical artifacts identified during site investigations will be reported to the Palace and Culture Agency.

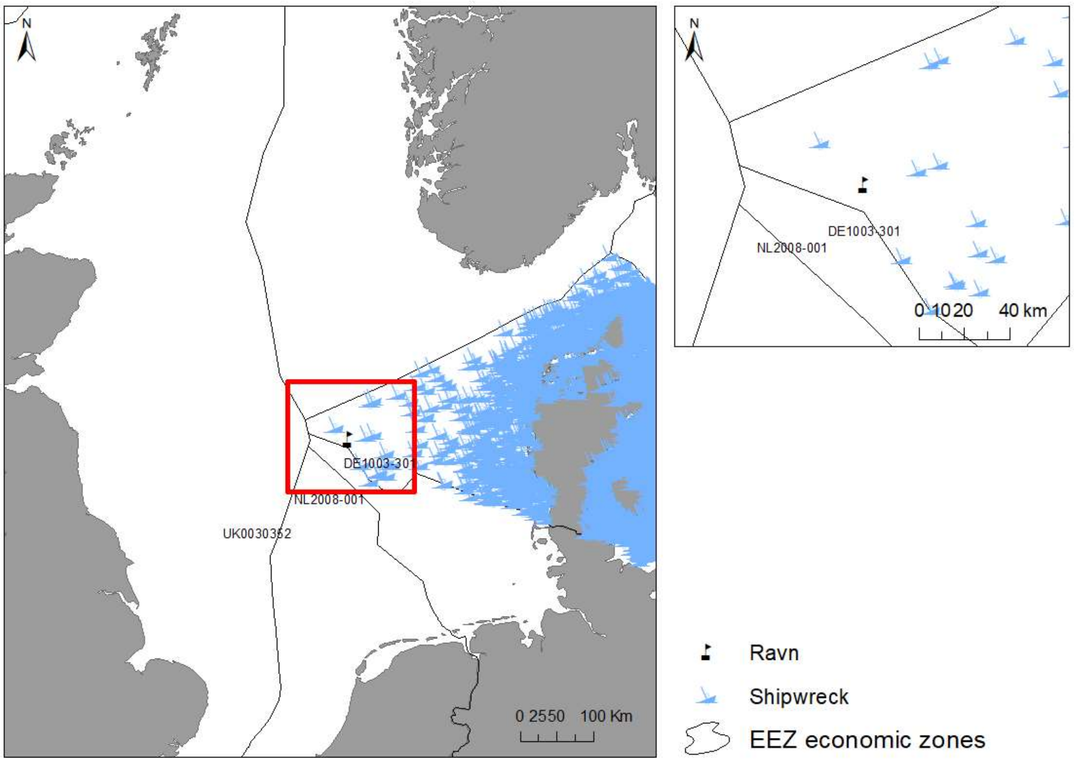


Figure 11-1 Registered wrecks in the project area (Palace and Culture Agency, 2022)

Based on the arguments above the environmental risk related to cultural heritage is assessed to be negligible.

Table 11-1 Risk related to damage of cultural heritage during construction.

Impact	Extension of impact	Duration of impact	Magnitude of impact	Severity of impact	Probability of impact	Environmental risk
Damage of wrecks	Local	Permanent	Small	Minor	Very low	Negligible

12 Environmental Assessment of accidental oil spill

As the wells and the cleaning and disconnection is not in the scope of this EIA, accidental oil spills can occur from oil spill from vessels.

Oil spill from vessels

In addition to the risks mentioned above, oil can be spilled from the vessels. The risk from a large oil spill (>1 m3) from a vessel is comparable to other offshore vessels operating and is thus very small and the extent will be limited.

12.1 Potential impacts of oil spill

In general, environmental impacts of oil spill are most severe if the slick of petroleum hydrocarbons reaches shallow coastal waters and the shore or if the slick passes seabirds, which are particularly sensitive to oil spills.

Impacts of oil spills are a result of both the physical properties and the chemical composition of the oil, i.e.:

- Fresh oil is sticky and may smother organisms in contact with the oil. Sea birds are particularly vulnerable in this respect.
- Oil contains various toxic components that may affect organisms
- Certain components may taint fish or shellfish that have accumulated such components which may affect fisheries and aquaculture
- Oil components of different stages of decay may sink to the bottom or be washed ashore.

Please see below for examples of listed thresholds levels (Table 12-1) and an overview of the levels of oil appearances distinguished according to the Bonn Agreement (2016).

Table 12-1 Sea surface, water column and shoreline thresholds.

Species/habitat exposed to oil	Threshold	Justification
Seabirds	1 µm	The 1 µm threshold is considered below levels which would cause harm to seabirds from exposure of oil. Exposure above threshold will lead to effects such as transferring oil to eggs reducing hatching success (French-McCay, 2009).
	10 µm	The 10 µm threshold for oil on water surface has been observed to lead to 100% mortality of impacted seabirds and other wildlife associated with the water surface (French-McCay, 2009).
Marine mammals (fur-bearing)	10 µm	The 10 µm threshold for oil on water surface has been observed to mortally affect fur-bearing marine mammals such as seals (French-McCay, 2009).

Marine mammals (cetaceans)	100 µm	Cetaceans are less sensitive to oil compared to seals, as it does not stick to their skin. Cetaceans can inhale oil and oil vapour when surfacing to breathe leading to internal injuries (French-McCay, 2009).

Table 12-2 Levels of oil appearances distinguished according to the Bonn Agreement (2016).

Code	Description -Appearance	Layer thickness (µm)	Tonnes per 10 km^2
1	Silver/grey	0.04 - 0.30	0.4 - 3
2	Rainbow	0.30 - 5.0	3 - 50
3	Metallic	5.0 - 50	50 - 5,00
4	Discontinuous true oil colour	50 - 200	5,00 - 20,00
5	Continuous true oil colour	> 200	> 20.00

Based on the above consideration and the expected low volume of oil in the unlikely event of an oil spill, the potential environmental impacts are assessed to be very limited i.e.:

- There will be no significant impact on shorelines.
- The oil spill will not reach any of the important bird areas in the North Sea. However, a limited number of seabirds such as alcidae, shearwaters, gannets and storm petrels may be affected with a radius of ca. 2 km from the spill where a rainbow sheen is expected to occur (3-5 µm). It is assessed that this will not affect the magnitude of the populations of these species in the North Sea.
- Oil components that have settled on the seabed may affect benthic fauna and fish locally around the spill.
- Spilled oil will not reach coastal areas, Nature 2000 areas in the Danish part of the North Sea or the productive front areas in the North Sea.
- Spilled oil will not affect Norwegian SVOs.

12.2 Oil spill contingency plan

The importance for Wintershall Noordzee B.V. to prevent spills is formulated in the Wintershall Noordzee B.V. HSE Policy where is stated "We will make every effort to avoid impact to the environment, loss of integrity of assets and damage to the property of the company and third parties".

The actions to take after a spill of oil or chemicals to the sea are described in the Oil & Chemicals Spill Contingency Plan (HSE-09-P037). This plan follows a tiered approach and describes the actions to be taken depending on the volume of the spill (tier 1 to 3). The plan describes actions for both the contractor offshore as well as the Wintershall Noordzee B.V. organization onshore and includes the external support from specialized organizations (Oil Spill Response Ltd., Wild Well Control).

The Wintershall Noordzee B.V. Company Representative will contact the Wintershall Noordzee B.V. Site contact, who in turn will contact the HSE Liaison and, in case of Tier 2 or Tier 3, the Emergency Coordinator. The Emergency Coordinator will mobilize the Emergency Response Team, in line with the Wintershall Noordzee B.V. emergency response procedure (HSE-09-P001).

The Emergency Procedure describes who is involved in the follow-up of an accident/ incident and what tasks are to be performed. In case of a spill of oil or chemicals the assistance of Oil Spill Response Ltd. will be called in.

The Offshore Installation Manager (OIM) will take over the role of On Scene Commander and will be the ultimate responsible person for the oil combating actions on site. The OIM will be supported by the Emergency Response Team onshore. The effects of the spill to environment are combatted by the Wintershall Noordzee B.V. onshore organization according to the Oil & Chemicals Spill Contingency Plan and the Emergency Response Procedure.

12.3 Risk assessment

Based on the above and using the criteria described in chapter 8 it is assessed that the environmental risk due to oil spill is **negligible**.

Table 12-3 Environmental severity and risk of impacts of accidental spill.

Impact	Extent of impact	Duration of impact	Magnitude of impact	Severity of impact	Probability of impact	Environ-mental risk
Impacts of accidental oil spill	Local	Short-term	Small	Minor impact	Very low	Negligible

13 Socio-economic assessment

This chapter consists of an assessment of the potential derived socio-economic consequences for the population in the area, which could arise from the environmental impact of the decommissioning of the facility. The surrounding area is defined as the entire west coast of Jutland.

13.1 Method

The assessment is a general assessment of the derived socio-economic consequences without detailed impact assessment and economic analysis. The assessment of the derived socio-economic consequences is primarily based on the description of the environmental effects in chapter 9.

13.2 Scope of the assessment

The proposed project is expected potentially to bring predominantly positive changes experienced by local businesses and societal groups or society as a whole. As described in chapter 9, the analysis shows that the environmental impacts related to pipeline decommissioning activities and decommissioning of platform are expected to be low or negligible and therefore the socio-economic impacts of the activities are likewise expected to be limited. However, after the decommission phase, the project is expected to impact the businesses related to the offshore industry. The socio-economic analysis therefore focuses on the effects after the decommissioning phase.

The socio-economic impacts considered in this chapter are:

- Potential changes in fish catch due to lifting or keeping restrictions in the safety zones;
- Potential changes for the shipping industry due to lifting or keeping restrictions in the safety zones.

The focus of the socio-economic analysis is primarily on potential positive effects, due to increased fishing opportunities. However, the Ravn decommissioning can have negative effects on business opportunities for the offshore related service industry in e.g. Esbjerg on the west coast of Jutland, i.e. the decommissioning will mean fewer tasks for these companies in the future. However, the facility in question is of rather limited size so the effects are estimated to be very limited. As a result, this subject will not be addressed further in this chapter.

13.3 The importance of the fishing and shipping industry

Removal of safety zones

A safety zone of 500 meters is established around the oil and gas installation and a safety zone of 200 meters is established along both sides of the pipelines. Vessels are not allowed to access the safety zone unless the purpose of access is related to the operation and maintenance of the installation or related infrastructure or for emergency reasons.

After removal of the production installation and after the pipelines are emptied and cleaned it is expected that the protective zones and safety zones can be lifted for the platform. For the pipeline Wintershall Noordzee B.V. will keep the safety zone. In the event that the safety zones will be lifted fisheries and anchoring are expected to be allowed within the area.

Impact on fisheries

The removal of safety zones will have a very small positive impact on the fisheries in the North Sea, since the area covered by safety zones is quite small and Ravn field is situated in an area with low fishery intensity.

Impact on marine traffic

Data from the AIS system (see chapter 7.13.2) shows that the Ravn field is situated far from major shipping lanes. In the event, that the safety zones are lifted marine traffic will be allowed in the area, though the impact is expected to be small.

13.4 The derived consequences of the environmental impacts

As a result of the minor, but positive, impacts which the decommissioning is expected to cause there are only expected minor derived consequences of the project. The effect depends on the chosen solution for decommissioning the pipelines, but the significance of this is very small

The effects are expected to be:

- Increased fishing landings to the fishing industry and businesses related to the industry. The effects are estimated to be very low.

- Improved sailing possibilities for the marine traffic. These effects are expected to have very small, but positive, impacts on local employment and tax revenue etc.

14 Cumulative effects assessment

Activities in the vicinity of the Ravn Decommissioning project have been assessed in order to identify possible cumulative impacts. The identified activities are listed in Table 14-1. No other activities in the vicinity of the Ravn project have been identified.

The German Federal Maritime and Hydrographic Agency (BSH) has furthermore been consulted as well as the DEA homepage and has no knowledge of projects or activities in the vicinity of the Ravn Decommissioning Project.

Other offshore installations that could give rise to cumulative impacts are situated at a distance of at least 10 km from the Ravn Decommissioning Project. There is no information on activities at these installations. It is furthermore assessed that possible activities connected to these installations that may take place at the same time as the decommissioning project cannot result in cumulative effects due to distance.

*Table 14-1 Known activities in the near vicinity of the Ravn Decommissioning Project and the expected time period where the activity takes place. Possible cumulative impacts are listed. Note *) See time schedule in section 6.3.2*

Activity	Time period*	Possible cumulative impacts and assessment
Decommissioning of the A6-A platform in German EEZ	2024-2027	The decommissioning activities are similar to the activities carried out for the Ravn platform which is situated at a distance of 18 km from the A6-A platform and are assessed to be local and insignificant. No cumulative impacts have been identified.
Decommissioning of 3 km 8'' oil pipeline, 3'' gas pipeline and 5,7'' umbilical in German EEZ	2023-2025	The method for decommissioning of the pipelines in German waters has not been decided yet. Cleaning of the pipelines are covered by the EIA for P&A of Ravn wells A1 and A2. See the summary below. Decommissioning of the pipelines is expected to be carried out in one continuous process. The environmental impacts identified from the process are all considered to be negligible to low and no significant cumulative impacts can be identified. As mentioned above the decommissioning of pipelines area expected to be carried out in one continuous process. Disturbance of seafloor (if removed) will happen in a single process and be planned accordingly. If left in situ no disturbances are foreseen.
P&A of Ravn Field well A1	2023-2025	The P&A activities related to the A1 well are local, have short duration and are assessed to be

Activity	Time period*	Possible cumulative impacts and assessment
		insignificant. The P&A of the A1 well will be carried out prior to the decommissioning of the Ravn platform and will therefore not result in cumulative effects.
P&A of Ravn Field well A2	2023-2025	The P&A activities related to the A2 well are local, have short duration and are assessed to be insignificant. The P&A of the A2 well will be carried out prior to the decommissioning of the Ravn platform and will therefore not result in cumulative effects.
P&A of Ravn Field well 3 MLS	2023-2024	The P&A of the Ravn-3 MLS could occur in the same time period as the removal of Ravn. From the EIA screening of Ravn-3 MLS there is no discharge of chemicals to sea, production of waste, underwater noise from vessels and emissions to air is considered insignificant. It is assessed that the P&A of Ravn-3 MLS will have no cumulative impacts with the P&A of Ravn-A1 and Ravn-A2 and as for the decommissioning of Ravn P&A activities related to the 3 MLS well are local, have short duration and are assessed to be insignificant. The P&A of the Ravn-3 MSL well will be carried out prior to the decommissioning of the Ravn platform and will therefore not result in cumulative effects.

Ravn – A6-A Pipeline cleaning

As mentioned above the cleaning of the 18 km Ravn-A6-A pipeline will be performed in the same time period as the P&A of A1 and A2.

Because the Ravn platform is a satellite platform, Ravn does not have sufficient space to accommodate a cleaning spread to receive the pipeline content during the cleaning operation. This means the cleaning operation needs to be executed from Ravn to A6-A.

The cleaning scope of the pipelines is considered as a cumulative effect in the environmental impact assessment for the plug and abandonment of the well A1 and A2, since this occurs in the same time period as the P&A. This also includes the emissions to air from rig and vessel movement. The activities in regard to materials, noise, disturbance etc. are covered by this EIA and are described in more detail in chapter 1. The potential cumulative effects are there for incorporated by the scope of the EIAs which states that "*...no discharges which could cause cumulative effects in combination with the P&A of A1 and A2 occur during the cleaning of the pipeline*".

Also for rig and vessel activity the level of disturbance is comparable with normal operations and will not pose a risk for cumulative effects.

As mentioned in the chapters above the removal of spools can cause a temporary physical disturbance of the seabed and an increased sedimentation but given the distance to the German sector and the limited area of disturbance there is no cumulative effects from any activities in connection with decommissioning of structures on/ under the seabed in the German sector. Furthermore, the activities would not happen in parallel or simultaneously. As mentioned above the extent of physical disturbance for each habitat type is expected to be reported to the authorities as an expected condition for the permit.

If the pipelines were to be removed, either with reverse installation or cut and lifting a larger area would be affected by physical disturbance, see section 0. As the effects are considered minor and the removal would happen in a consecutive order (in one process) no cumulative effects are expected. It is expected that the potential impacts will be local in extent. Further, they take place in an area where there is already a significant natural physical disturbance. With the expected local extent for a relatively short period of time, for an activity that will not take place simultaneously, no cumulative effects are expected from removal of the pipelines with reverse installation or cut and lifting.

15 Cross-border impacts

Almost all impacts from the decommissioning of Ravn are assessed to be local.

The only potential cross boarder impact resulting from the decommissioning activities are the release of a maximum of approx. 20,000 tons CO_2 and the activities from cleaning the pipeline Ravn-A6-A, which are not a part of the scope of this EIA. Lastly the situation of removal the pipelines would happen across the Danish and German sector.

The emissions from fuel consumption from the activities will only occur for a shorter period during the decommissioning. The CO_2 emissions related to the decommissioning are lower than the yearly emissions from producing platforms, and thus the CO_2 emissions will be reduced from the first year of decommissioning.

The cleaning of the pipeline Ravn-A6-A are described in the EIA for P&A of wells A1 and A2. The EIA states that no discharges could lead to any cross-boundary effect during the cleaning of the pipeline.

As mentioned in the chapter for cumulative effects above the rig and vessel activity would be comparable with normal operations and will not results in any negative cross-boundary effects.

The removal of spools can cause a temporary physical disturbance of the seabed and an increased sedimentation but given the distance to the German sector and the limited area of disturbance there is no cross-boundary effects in connection with decommissioning of structures on/ under the seabed. As mentioned above the extent of physical disturbance for each habitat type is expected to be reported to be reported to the relevant authority as an expected condition for the permit and there will be applied for permits specifically for the activities in the German sector.

If the pipelines were to be completely removed, either with reverse installation or cut and lifting a larger area would be affected by physical disturbance but as described in section 9.1.3 the effects are considered to be minor and reversible and not result in any significant cross-boundary effects.

16 Comparison of impacts from different scenarios for pipelines

A comparative assessment of the decommissioning methods for the pipelines has been conducted including the following aspects:

- Health & Safety
- Environment
- Technical
- Societal
- Cost

The environmental impacts assessed in the present EIA were used as input for the environmental part of the comparative assessment.

The decommissioning methods assessed are:

- Leaving pipelines and umbilical in situ
- Removal of materials above seabed and leaving pipelines and umbilical in situ
- Removal of pipelines and umbilical by reverse installation
- Removal of pipelines and umbilical by cut and lift

A summary of the impact assessment for the different decommissioning methods can be seen in Table 16-1. Please note that the initial impact assessment in section 9.1 only included leaving the pipelines in situ, removal of materials above seabed and removal of the pipelines, without distinguishing between the two different methods for removal of the pipelines by either reverse installation or cut and lift. Therefore, the assessed impacts for reverse installation and cut and lift are identical in Table 16-1 – a more detailed and comparative assessment will be conducted below.

Table 16-1 Summary of impacts assessed for the three decommissioning methods for pipelines.

Impact related to decommissioning of pipelines	Left *in situ*	Removal of material above seabed	Reverse installation	Cut & lift
Impact on benthic fauna from rock placement	N/A	Negligible	N/A	N/A
Impacts of physical disturbance and sediment dispersal on benthic fauna	N/A	N/A	Negligible	Negligible
Impact on fish from dispersion of sediments	N/A	N/A	Negligible	Negligible
Impact from pipeline coating	Negligible	Negligible	N/A	N/A
Impact on sea floor integrity	N/A	Negligible	Low	Low
Impacts of underwater noise on mammals	Negligible	Negligible	Negligible	Negligible
Impacts of underwater noise on fish	Negligible	Negligible	Negligible	Negligible
Impacts of waste	Negligible	Negligible	Negligible	Negligible
Impacts of air emissions (NO_X, SO_X)	Negligible	Negligible	Negligible	Negligible
Impacts of air emissions (CO_2-eq.)	Low	Low	Low	Low

Below a short summary of the impacts of the four decommissioning methods are presented in a comparison context.

16.1 Physical disturbance of the seabed

The physical disturbance of the seabed will have a small and local impact on the seabed integrity and the benthic fauna and fish regardless of the chosen scenario.

The removal of pipelines either by reverse installation or by cut and lifting will result in physical disturbance of the seabed in a larger area than if materials above seabed are removed or if the pipelines are left *in situ*, as the whole pipeline route will be impacted. In addition, the excavation of the pipelines prior to removal will result in the biggest impact as a wide corridor along the entire route. If left *in situ* only the area around the pipeline ends and around the spools and crossings will be impacted if the option with removal of material above seabed is chosen.

Removal of structures beneath the seabed will result in suspension of sediments to the water column which may have a negative impact on the benthic fauna in the vicinity of the affected area where the sediment will settle. Pelagic fish eggs may also be affected by the sediment plume. Suspended sediment is not expected to affect fish stocks.

The severity of the impact on benthic fauna from removal of the pipelines is assessed to be small and temporary while leaving them *in situ* or removing structures above seabed is insignificant. The environmental risk on benthic fauna of both scenarios is assessed to be negligible. This reflects that the expected impacts are local and short-term, and in addition that the pipelines are located in a sandy area which is not as such a sensitive area combined with the area being a natural highly dynamic environment. Finally, the benthic infauna is expected to recover within a period of less than 3 years. In general, sandbanks as the Dogger Bank are the least sensitive habitat type for laying and operation of pipelines due to the natural dynamic environment and relatively fast recovery (ARSU, 2022).

The removal of pipelines will have a small temporary and negative impact on the sea floor integrity. If the excavation results in a 20 m wide impacted area on each side of the pipeline and the umbilical will be included as well, it will result in a 70 m wide impacted corridor along the entire length of the pipeline and thus a total area of 1,260,000 m² (ARSU, 2022). Of these approximately 210,000 m² will be within German waters and 1,050,000 m² in Danish waters. In contrast, leaving the pipelines in situ will not cause disturbance of the seabed and will not change the sea floor integrity. Based on this argumentation, removal of pipelines will have a small negative impact on the sea floor integrity while leaving the pipelines *in situ* will have no negative impact on the sea floor integrity.

It is expected that the concrete mattresses used for e.g. stabilization and especially at crossings of the pipelines will be left in situ if the pipelines are left in situ. In Danish waters, the pipelines are crossing at one location, the gas pipeline Europipe I. In German waters the pipelines are crossed by the oil and gas pipe Norpipe. For the mattresses to be left in situ will not result in an additional impact of the seafloor integrity as the mattresses are already present.

16.2 Emissions to air

The vessel activities for removal of the pipelines will be conducted over a longer period than the activities for *in situ* or removal of materials above seabed options for the pipelines, and thus a larger amount of emissions to air will be related to the fully removal methods.

However, if looking at a lifecycle perspective of the pipelines, it can be expected that if the pipelines are removed and shipped to shore, the steel can be recycled, and thus virgin materials can be substituted by these materials saving some energy in the production of new materials.

In Table 16-2 the estimated emissions to air can be seen for the four scenarios.

Table 16-2 Estimates of emission related to vessel activities for decommissioning of pipelines.

Decommissioning options	CO_2 [ton]	NO_X [ton]	SO_X [ton]	CH_4 [ton]	nmVOC [ton]
Leaving in situ[1)]	10-15	0.5-1	0.005-0.01-	0.0005-0.001	0.01-0.05
Removal of materials above seabed[2)]	6,000-8,000	100-150	2-4	0.5-1	10-15
Removal by reverse installation[3)]	8,000-10,000	150-200	3-5	0.5-1	15-20
Removal by cut and lift[4)]	15,000-20,000	250-300	5-7	1-2	25-30

1) Estimate for one survey. Assumed 24 hours of survey vessel per survey. The frequency of surveys will based on a risk assessment with the authorities.
2) Assumed 28 days of DSV (fuel consumption 30 m³/day), rock placement vessel (fuel consumption 27 m³/day) and supply vessel (7 m³/day).
3) Assumed 55 days of reel vessel (fuel consumption 10 m³/day), DSV vessel (fuel consumption 30 m³/day), S-lay vessel (fuel consumption 10 m³/day), guard vessel (fuel consumption 0.5) and supply vessel (7 m³/day).
4) Assumed 100 days of DSV (fuel consumption 30 m³/day), offshore construction vessel (fuel consumption 20 m³/day) and supply vessel (7 m³/day).

16.3 Emission to water

Leaving the pipeline *in situ* means that a gradual corrosion and leachate of chemicals in the coating will take place. The steel pipe including PP and LDPE coating will be left *in situ*. The fate of the leachates from the pipeline coatings and their degradation has been considered based on experiences reported.

16.4 Underwater noise

For all decommissioning scenarios for decommissioning of pipelines, vessels will be used, and these will generate underwater noise. However, the underwater noise is expected to be limited (below threshold shift for marine mammals) and thus will have no significant impact on mammals and fishes. No damage to hearing is expected, however some avoidance behavior must be anticipated.

Removal of the pipelines are expected to generate more noise compared to leaving the pipelines in situ or the removal of material above seabed. This is a result of increased vessel activity and excavation activities in addition to potential cutting of the pipeline etc. However, it is expected that the underwater noise levels for the removal of the pipelines and if pipelines are left *in situ* will not cause damage to hearing. The duration of noise generation related activities will be longer for removal of the pipelines.

For the protection of harbour porpoises, there are specific protection measures implemented in German waters as stated in the "Concept for the Protection of Harbour Porpoises from Sound Exposures during the Construction of Offshore Wind Farms in the German North Sea" (ASCOBANS, 2014). It is noted, that in the Dogger Bank area, both the harbour porpoise and the harbour porpoise reproduction is a target of the conservation.

It is further noted, that these requirements mainly focus on effects from piledriving of offshore windmills. The level of impulse sounds from removal of pipelines are expected to be very limited, if any. It is therefore expected, that less than 10% of the area will be impacted by sound exposure level (SEL) threshold of 160 dB re 1 μPa² s or the peak sound pressure level (SPL) threshold of 190 dB re 1 μPa at a distance of 750 m). The same applies to the sensitive reproduction phase during May to August, as less than 1 % of the area will be impacted. The potential impacts are expected to be avoidance behaviour and no permanent or temporary hearing damage are expected.

Based on the above, the decommissioning activities are expected to be in compliance with the specific protection measures in the Dogger Bank.

16.5 Waste

When leaving the pipeline and umbilical *in situ,* they will not be recovered. The steel pipe including PP and LDPE coating will be left *in situ*. This results in the least amount of material and waste being shipped to shore but also less materials to be recycled.

Leaving the pipelines in place, means the pipelines will be filled with seawater and that a gradual corrosion and leachate of chemicals from the coating will take place. The fate of the leachates from the pipeline coatings and their degradation has been considered based on experiences reported. It is assessed that the impact is marginal and is not expected to impact either benthic fauna or fish.

If removing the pipelines, the waste amounts shipped to shore will be significantly larger. However, some of these materials can be recycled. The estimated amounts of the different elements are given in Table 16-3.

Table 16-3 Estimated total amounts of waste from the pipelines.

Element	Total weight material [tons]
Concrete mattresses	450
Steel pipes incl. spools	2,600
Aluminum anodes	1.3
PP coating	20
LDPE coating	15

In Table 16-4 the estimated waste amounts can be seen for the four scenarios. Included are concrete mattresses, pipelines, coating and anodes.

Table 16-4 Estimated amounts shipped onshore and left in situ for the four pipeline decommissioning methods.

Decommissioning scenarios for pipelines	Total waste shipped to shore [tons]	Total waste left in place [tons]
In situ	0	3,061
Removal of material above seabed	477	2,584
Reverse installation	3,061	0
Cut and lift	3,061	0

16.6 Summary of environmental comparative assessment

Table 16-5 summarize the results of the comparison of the environmental impacts of the four decommissioning methods for the pipelines. Please note that the three shadings are used to indicate the difference between the four methods and not the severity of the impact. For example, an impact for an aspect can for all four scenarios be assessed to be negligible, however there may still be differences between the methods in terms of impact and thus have a darker shading. The shadings rather indicate the difference between the four methods, where the difference between an impact is bigger between two methods where one is the brightest and one is the darkest, compared to where one is the brightest and one is the intermediate shading.

Table 16-5 Comparison of the environmental impacts related to the four decommissioning methods for pipelines.

Comparative impacts assessed	Leaving *in situ*	Removal of material above seabed	Removal by reverse installation	Removal by cut and lift
Environment	Least impact on benthic fauna, marine growth, and fish.	Least impact on benthic fauna, marine growth, and fish, but slightly higher than for left *in situ*.	Medium impact on benthic fauna, marine growth and fish.	Medium impact on benthic fauna, marine growth, and fish.
	Least impact on physical disturbance and disturbance on water column.	Least impact on physical disturbance and disturbance on water column, but slightly higher than for left *in situ*.	Medium impact on physical disturbance and disturbance on water column.	Medium impact on physical disturbance and disturbance on water column.
	Least impact on sea floor integrity.	Least impact on sea floor integrity, but slightly higher than for left *in situ*.	Medium impact on sea floor integrity.	Medium impact on sea floor integrity.
Pipeline corrosion and decompositio n	Larger impact on the aquatic environment.	Larger impact on the aquatic environment.	No impact as pipeline is removed.	No impact as pipeline is removed.
Underwater noise	Least underwater noise levels with no impact on mammals and fish.	Least underwater noise levels with no impact on mammals and fish, but slightly higher than for left *in situ*.	Medium underwater noise levels with no impact on mammals and fishes.	Medium underwater noise levels with no impact on mammals and fishes.
Emissions to air (NO_X, SO_X)	Least amount of emissions due to vessel activities.	Least amount of emissions due to vessel activities, but slightly higher than for left *in situ*.	Medium amount of emissions due to vessel activities.	Largest amount of emissions due to vessel activities.
Emissions to air (CO_2-eq.)	Least amount of short-term emissions due to vessel activities.	Least amount of short-term emissions due to vessel activities, but slightly higher than for left *in situ*.	Medium amount of short-term emissions due to vessel activities.	Largest amount of short-term emissions due to vessel activities.
	Larger amount of long-term emissions due to no recycling potential for the pipeline materials and thus an indirect energy use for production	Larger amount of long-term emissions due to no recycling potential for the pipeline materials and thus an indirect energy use for production	Least amount of long-term emissions due to recycling potential of materials from pipelines and thus substitution of primary materials	Least amount of long-term emissions due to recycling potential of materials from pipelines and thus substitution of primary materials

Comparative impacts assessed	Leaving *in situ*	Removal of material above seabed	Removal by reverse installation	Removal by cut and lift
	of primary materials.	of primary materials.	and saved energy related to production.	and saved energy related to production.
Waste	Least amounts of waste shipped to shore.	Medium amounts of waste shipped to shore.	Larger amounts of waste shipped to shore.	Larger amounts of waste shipped to shore.
	Least amounts of materials to be recycled and thus no substitution of primary materials/resources. Risk of gradual corrosion and leachate of chemicals in the coating over time.	Medium amounts of materials to be recycled and thus no substitution of primary materials/resources. Risk of gradual corrosion and leachate of chemicals in the coating over time.	Larger amounts of materials to be recycled and thus substitution of primary materials/resources.	Larger amounts of materials to be recycled and thus substitution of primary materials/resources.

17 Natura 2000 screening

17.1 Identification of Natura 2000 areas (SAC)

The Ravn field platform is situated far from Danish Natura 2000 areas. However, approximately 15 km southwest of the Ravn field is the German Natura 2000 area DE 1003-301 *Doggerbank*. As an extension of this area is the Dutch NL 2008-001 *Doggerbank* and the UK0030352 *Dogger Bank* in the UK sector (Figure *17-1*).

The designation basis of Danish Natura 2000 areas in the North Sea and the Natura 2000 areas at Dogger Bank are listed in Table 17-1.

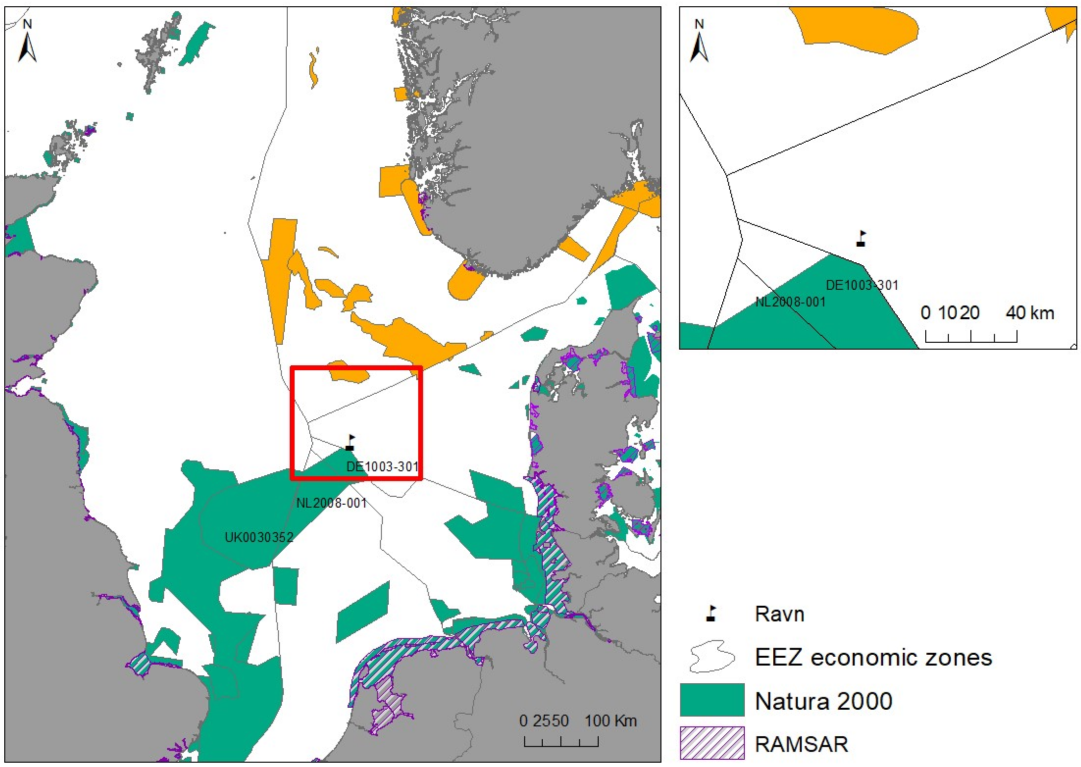


Figure 17-1 Location of Natura 2000-areas (SAC) in the North Sea.

Table 17-1 Habitats and species that are basis for the designation of Natura 2000 areas at the Dogger Bank and Danish Natura 2000 areas in the Danish sector of the North Sea. Distances from Ravn field to Natura 2000 areas are measured to the nearest protectionborder.

Natura 2000 area	Basis for designation	Distance from Ravn field
UK0030352 Dogger Bank	1110 Sandbanks which are slightly covered by sea water all the time 1351 Harbour porpoise 1365 Harbour seal 1364 Grey seal	75 km
NL 2008 -001 Doggerbank	1110 Sandbanks which are slightly covered by sea water all the time	45 km

	1351 Harbour porpoise 1365 Harbour seal 1364 Grey seal	
DE 1003-301 Doggerbank	1110 Sandbanks which are slightly covered by sea water all the time 1351 Harbour porpoise 1365 Harbour seal Birds: Fulmar (Fulmarus glacialis) Lesser black-backed gull (Larus fuscus) Gannet (Morus bassanus) Kittiwake (Rissa tridactyla) Common murre (Uria aalge)	15 km
DK00VA348 *Thyborøn stenvolde*	1170 Reef	228 km
DK00VA257 Jyske Rev, *Lillefiskebanke*	1170 Reef	179 km
DK00VA340 *Sandbanker ud for Thyborøn*	1110 Sandbanks which are slightly covered by sea water all the time 1170 Reef 1351 Harbour Porpoise	248 km
DK00VA259 *Gule rev*	1170 Reef 1351 Harbour Porpoise	273 km
DK00VA301 *Lønstrup rødgrund*	1170 Reef	368 km
DK00VA258 *Store rev*	1170 Reef 1180 Submarine structures made by leaking gases 1351 Harbour Porpoise	361 km
DK00FX112 *Skagens Gren og Skagerrak*	1110 Sandbanks which are slightly covered by sea water all the time 1180 Submarine structures made by leaking gases 1351 Harbour Porpoise 1103 Shad	400 km
DK00EX023 *Agger Tange*	1365 Harbour seal 1364 Grey seal 19 different species of sea birds including species of terns, ducks, and wading birds.	264 km
DK00VA347 *Sydlige Nordsø*	1110 Sandbanks, which are slightly covered by sea water all the time 1351 Harbour Porpoise 1365 Harbour Seal 1364 Grey Seal Birds: Red-throated diver, Black-throated diver, and Little gull	165 km

17.2 Potential impacts

Due the distance between the Ravn field and any Danish Natura 2000-areas, it is unlikely that the decommissioning of Ravn will impact the habitat types within these areas. It cannot be ruled out that species like the Harbour porpoises, Grey seals and Harbour seals, which constitute the basis for designation for some of the Danish Natura 2000-areas, may be found in the area around the Ravn field, including some of the bird species. However, the potential risk from decommissioning the Ravn platform impacting any Natura 2000-areas must first and foremost be the German DE 1003-301 *Doggerbank* area.

The following potential impacts from the decommissioning of the Ravn platform on Natura 2000 habitats and species have been assessed:

- Impact of an oil spill
- Impact of underwater noise generated during decommissioning (cutting noise, noise from vessels)
- Impact from removal of the pipelines (if applicable)

Other operations taking place during the decommissioning of the Ravn platform are not assessed further since they are local and since the magnitude of the impacts are small.

17.3 Impact of oil spill

The potential impacts of an accidental oil spill have been assessed in chapter 12 and it was concluded that the environmental risk is negligible.

In addition to the risks mentioned above, oil can be spilled from the vessels. The risk of a large oil spill (>1 m_3) from a vessel is comparable to risks related to other offshore vessels operating and is thus very small and the extent will be limited.

It is noted, that the designation basis for the German DE 1003-301 *Doggerbank* area, included the habitat sandbanks and the two species Harbour porpoise and Harbour seal. In the unlikely event of a small accidental oil spill, these species is expected to flee the area. In addition, for an oil spill limited in extent will not impact the sand banks significantly. It is therefore not expected that the integrity of this area will be impacted.

The following bird species are on the basis for designation for the German DE 1003-301 Doggerbank area: Fulmar (Fulmarus glacialis), Lesser black-backed gull (Larus fuscus), Gannet (Morus bassanus), Kittiwake (Rissa tridactyla) and Common murre (Uria aalge). The environmental assessment of potential impacts on birds concluded, that the oil spill will not reach any of the important bird areas in the North Sea. However, a limited number of seabirds such as alcidae, shearwaters, gannets and storm petrels may be affected with a radius of ca. 2 km from the spill where a rainbow sheen is expected to occur (3-5 µm). It is assessed that this will not affect the magnitude of the populations of these species in the North Sea. Further, the German DE 1003-301 *Doggerbank* area is located in a distance of approximately 15 km, this is far away from the potential area of radius of 2 km.

Based on the low risk of spill, the expected small amount and the short duration of a potential accidental spill, it is assessed that there is no environmental risk of an impact on designated Natura 2000 habitats and species.

17.4 Impact of underwater noise

The noise producing activities from the Ravn decommissioning include noise from cuttings of underwater structures and noise from machinery of vessels.

Based on the distance from the Ravn field to the nearest Natura 2000 site (15 km) and the assessment of potential impacts from underwater noise (section 0) which concluded that there is no risk of hearing damage but potentially a avoidance behaviour for a short period of time, it is assessed that underwater noise from removal of Ravn installations will have an insignificant impact on the conservation objectives of the habitat types and species in the nearby Natura 2000 sites.

For the Annex IV-species which requires specific protection, including the harbour propoise, whitebeaked dolphin and minke whale, it is assessed, that the project activities will not cause a deterioration or destruction of breeding or resting sites (section 0).

17.5 Impact of removal of the pipelines (if applicable)

A comparative assessment of the decommissioning methods for either leaving the pipelines *in situ* or removal of the pipelines and umbilical has been conducted for the pipelines in the Danish part of the North Sea (chapter 16). A similar comparative assessment has been made for the pipelines in the German part of the North Sea, i.e. within the DE 1003-301 *Doggerbank* area (ARSU 2022).

The potential removal of the pipelines will among others cause an increase of suspended sediment and subsequent sedimentation in the nearby area. This could potentially impact the habitat types in the nearest Natura 2000-area. However, for the assessment within the DE 1003-301 *Doggerbank* area it was concluded, that neither leaving the pipelines *in situ* nor removing the pipelines, will significantly influence the conservation objectives of the area (ARSU 2022).

The pipelines run through the "Dogger bank" FFH site, where the conservation objectives and protection requirements of which have to be given special consideration. Due to the heavy use of bottom trawl fishing, there is a pre-existing pressure on the "sandbank" habitat type in the area. The range of species recorded is typical for this area of the North Sea as it is a benthic community characteristic of homogeneous sandy areas with moderate currents. Potential impact associated with the removal of the pipelines are assessed to be temporary. The potential impacts are assessed to be temporary low frequency underwater noise from vessel activities and temporary adverse influence on the seabed. With regard to the benthic community, a regeneration period of approx. 3 - 5 years can be assumed (ARSU 2022).

Leaving the pipelines in situ would result in a permanent land usage on the seabed by the crossing structures, rubble introduced and the protection dome. Furthermore, a volume of around 811 m^3 in the seabed would be taken up by the pipelines themselves. If the pipelines are left the seabed, it is necessary to ensure that other uses (shipping, fishing) are not jeopardized (ARSU 2022).

With regard to the compatibility of the project with the "Dogger bank" FFH site, it is assumed on the basis of a rough assessment that neither option will lead to significant adverse influences on the conservation objectives. However, the temporary effects of removal of the pipeline will have a greater impact on the specific conservation objectives with regard to hydromorphological conditions, the habitat type "sandbank", the general habitat structures, the function as a regeneration area for the benthos, Further, there will be no disturbance on the harbour porpoise (ARSU 2022).

With regard to potential environmental impacts, both removal of the pipeline and leaving the pipeline in-situ have advantages and disadvantages. Leaving the pipelines in situ avoids the adverse influences caused by removal work and which are generally comparable with impacts during the actual installation of the pipelines, but has a more deleterious effect in terms of the permanent land and volume use and generally in terms of the risk of accident and the time factor. In addition, there is the presence of foreign bodies of material in the sediment (ARSU 2022).

The assessment parameters for the comparative assessment as described in chapter 16 covered the area and volume of disturbance, sedimentation, vibration and noise, light, spills and discharges as well as emission to air and onshore impacts.

17.6 Conclusion

Underwater noise, accidental spills and the removal of the pipelines (if applicable) may potentially affect designated species and habitats of Natura 2000 areas. There will however be no impacts in the Danish Natura 2000-areas due to the distance between these and the Ravn field.

The nearest Natura 2000-site is the German DE 1003-301 *Doggerbank* area located approximately 15 km from the Ravn field. In general, the potential impacts from underwater noise and accidental spills are expected to be local and for a relatively short period of time. Decommissioning of the topside at the Ravn field is therefore not expected to negatively impact the conservation status of habitats and species in this Natura 2000-area.

There are 18 km of pipelines between the Ravn field and the A6-A platform, where the 3 km of pipelines are located directly in the German DE 1003-301 *Doggerbank* area. The decommissioning of the pipelines within this area has been assessed and it has been concluded that neither leaving the pipelines *in situ* or removal of the pipelines will significantly influence the conservation objectives negatively. Please note, that for the decommissioning of the pipelines and the umbilical in German waters will be subject to a separate approval process with the German authorities (Abschlussbetriebsplan).

18 Marine Strategy Framework Directive (MSFD)

The EU Marine Strategy Framework Directive (MSFD) is put in place to protect the marine ecosystem and biodiversity upon which the health and marine-related economic and social activities depend.

To help EU countries achieve a good environmental status (GES), the directive sets out 11 illustrative qualitative descriptors (Section 4.11). The descriptors D1, D4 and D6 are related to the existing conditions of the marine environment while descriptor D2, D3, D5-D11 are related to the impact on the marine environment from human activities.

According to the Danish Marine Strategy II (Ministry of Environment and Food 2019), which implement the MSFD, the most important impacts in the North Sea/Skagerrak are caused by these aspects: nutrients, non-indigenous species, fisheries, noise, contaminants, marine litter (micro plastic in sediment), shipping and physical modifications (Danish Marine Strategy II figure 19.6). Not all of these aspects are relevant for the general oil and gas production activities.

The most relevant and important descriptors for oil and gas production activities in general are D8 Contaminants, specifically for acute pollution events, and D11 Underwater noise (Ministry of Environment and Food, 2019).

The EU Commission has defined criteria and methodological standards on good environmental status of marine waters (GES Commission Decision (EU) 2017/848 of 17 May 2017). The Ministry of Environment and Food has defined environmental targets for each descriptor, based on the criteria defined in the GES Decision. According to the Marine Strategy Act (Consolidation act no. 1161 of 25/11/2019, (§18), the Danish authorities may not issue approvals etc. which are in conflict with these environmental targets in addition to the programme of measures.

The activities during decommissioning of the Ravn field platform may potentially affect the Marine Strategy Framework Directive's (MSFD) 11 descriptors and their associated indicators for Good Environmental Status (GES). The project activities that potentially may affect the descriptors are listed below (Table 18-1). Planned and unplanned discharge of chemicals and oil to the sea may affect the MSFD descriptors. The activities may also introduce underwater noise and other disturbances to the marine environment. In addition, foreign vessels may introduce non-indigenous species from marine fouling or discharge of ballast water.

In the following sections the potential impacts are compared with the environmental targets from the Danish Marine Strategy II.

Table 18-1 Activities potentially affecting the 11 MSFD descriptors.

Activity
› Removal of fisheries safety zones › Vessel noise › Physical disturbance and damage of the seabed › Spreading of non-indigenous species though ballast water and marine fouling on vessels › Accidental spill

18.1 Descriptor 1 – Biodiversity

The environmental targets for descriptor 1 from the Danish Marine Strategy II for birds, marine mammals, fish and pelagic habitats are shown in Table 18-2. It is also marked if the descriptor is impacted by the Ravn Decommissioning project.

Description of the status of birds, marine mammals, fish and pelagic habitats in the project area are included in section 7.5, 7.8, 7.9 and 7.10. The environmental targets for descriptor 1 are described in Table 18-2.

Table 18-2 Environmental targets for descriptor 1 according to the Danish Marine Strategy II.

	Targets	Impact from the Ravn Decommissioning project	Comments
Birds	1.1 Incidental by-catch of birds is at a level that does not threaten the species in the long-term	Not applicable	
	1.2 Populations and habitats for birds are conserved and protected in accordance with objectives under the Birds Directive.	Population identified in the project area, which are covered by the Danish Marine Strategy is Guillemot (*Uri aalge*). The trend for the population is increasing according to table 22.4 in the Danish Marine Strategy II. During decommissioning there may be impacts caused by light and noise disturbance, although impacts are assessed to be negligible. After removal of the Ravn platform, there will be no resting place for birds at the location.	Population described in Section 7.9. The project area is not considered as important for seabirds.
	1.3 The Ministry of Environment and Food contributes to regional work regarding establishment of threshold values and determination of good environmental status, and works to ensure that the status for biological diversity is in accordance hereto	N/A	
	1.4 More knowledge about by-catch of seabirds is collected pursuant to the relevant monitoring programmes.	N/A	
Marine mammals	1.5 Need for protection initiatives for HELCOM and OSPAR Red List species is assessed. If there are any Red List species that are endangered or not sufficiently protected, the Ministry of Environment and Food will assess specifically the need for further initiatives in collaboration with relevant ministries.	Information is included about the population of seals, harbour porpoise, white-beaked dolphin and minke whale in the projects area covered by the Danish Marine Strategy II. The three cetaceans occur in the Ravn platform decommissioning area, although the project area is not a core area for these species.	Population described in section 7.10.
	1.6 Incidental by-catch of harbour porpoise is reduced as much as possible, and as a minimum to a level below 1.7% of the total population	N/A	

	Targets	Impact from the Ravn Decommissioning project	Comments
	1.7 Incidental by-catch of seals is at an adequately low level that does not threaten populations in the long-term.	N/A	
	1.8 Harbour porpoise, harbour seal and grey seal achieve favourable conservation status in accordance with the timeline laid down in the Habitats Directive.	The potential impacts are assessed to be underwater noise and disturbance and are assessed to be temporary and will not influence the populations. Underwater noise is not expected to cause any hearing damage.	Impacts on marine mammals from project activities are described in section 9 and unplanned oil release is described in section 12. Mitigating actions described in section 20.
	1.9 The Ministry of Environment and Food contributes to setting population-specific threshold values for by-catches of harbour porpoise in a regional context with a view to subsequently setting environmental targets for vulnerable populations of harbour porpoise.	N/A	
	1.10 More knowledge about by-catches of marine mammals is collected pursuant to the relevant monitoring programmes.	N/A	
Fish	1.11 The Ministry of Environment and Food carries out an analysis of by-catches of shark and ray in Danish marine areas, and the possibility of a DNA-based approach to determining species is investigated.	N/A	
	1.12 The Ministry of Environment and Food establishes a national indicator to evaluate the status of Danish fish that are not exploited commercially, and the opportunities to further develop regional indicators are investigated.	N/A	
Pelagic habitats	1.13 The abundance of plankton follows the long-term average.	The primary production of plankton is generally higher in the coastal regions compared to offshore areas. The Ravn field is located in an area with low plankton production	The conditions of plankton in the project area are described in section 7.5.
	1.14 The Ministry of Environment and Food is tracking developments and improving the knowledge base about plankton through monitoring.	N/A	

18.2 Descriptor 2 – Non-indigenous species

Distribution of non-indigenous species (NIS) related to oil and gas installations are described in OGD's report from February 2017 "Descriptor-based review of 25 years of seabed monitoring data collected around Danish offshore oil and gas platforms", see section 7.12.

The environmental targets for descriptor 2 are described in Table 18-3.

Table 18-3 Environmental targets for descriptor 2 according to the Danish Marine Strategy II.

	Goals	Impact from the Ravn decommissioning project	Comments
Non-Indigenous species	2.1 The number of new non-indigenous species introduced through ballast water, ship fouling and other relevant human activities is decreasing	The rare occurrence and low abundance reported is not indicative of a well-established population considering that the four benthic NIS observed in the areas with oil and gas installations have been present in the North Sea coastal areas for several decades. Vessels may potentially introduce non-indigenous species by growth on the hull or discharge of ballast water, however it is assessed that there is a low risk. Non-indigenous species may use platforms as stepping stones for dispersal, however this risk for the Ravn platform is removed after the decommissioning.	Non-indigenous species are described in section 7.12. Impacts from NIS described in section 0.
	2.2 The distribution of certain invasive species is, as far as possible, at a level so that significant adverse effects are stable or decreasing.	See above 2.1	See above 2.1
	2.3 The Ministry of Environment and Food contributes to regional work regarding establishment of threshold values and determination of good environmental status, and works to ensure that the number of new non-indigenous species and impacts from invasive species are in accordance hereto	N/A	

18.3 Descriptor 3 – Commercially exploited fish stocks

The commercially exploited fish in the area are described in section 7.8. The only stock in poor condition is cod. However, the area around the Ravn field is not considered as a core area for cod, see

Table *7-6*. The environmental targets for descriptor 3 are described in Table 18-4.

Table 18-4 Environmental targets for descriptor 3 according to Danish Marine Strategy II.

	Targets	Impact from the Ravn decommissioning project	Comments
Commercially exploited fish stock	3.1 The number of commercially exploited fished stocks regulated pursuant to the MSY principles in the Common Fisheries Policy is increasing.	The diversity of fish in the Ravn field area and the fishing intensity is low. Removal of the Ravn platform may open up for more commercial fishing in the area.	Descriptions of fish in the project area is described in section 7.8. Fisheries in the area is described in section 0.
	3.2 Within the framework of the Common Fisheries Policy, fish mortality (F) is at levels that can ensure a maximum sustainable yield (F_{msy}).	The impact from O&G in relation to fish mortality is expected to be insignificant. Short-term impact can be expected in connection with an unplanned oil spill, see section 12.	Descriptions of fish in the project area is described in section 7.8. Fisheries in the area is described in section 0.
	3.3 Within the framework of the Common Fisheries Policy, spawning biomass (B) exceeds the level that can ensure a maximum sustainable yield (MSY $B_{trigger}$).		Commercially exploited fish stocks are described in 0.

18.4 Descriptor 4 – Marine food webs

Marine food webs can potentially be affected by physical disturbance of the seabed, underwater noise, artificial light, planned discharge of chemicals and unplanned oil spill (blowout). The environmental targets for descriptor 4 are described in Table 18-5.

Table 18-5 Environmental targets for descriptor 4 according to Danish Marine Strategy II.

	Targets	Impact from the Ravn Decommissioning project	Comments
Food webs	4.1 The Ministry of Environment and Food contributes to regional work regarding establishment of threshold values and determination of good environmental status and works to ensure that the anthropogenic impacts on the food web are in accordance hereto.	N/A	

	4.2 The Ministry of Environment and Food contributes to regional knowledge and methodology development on marine food webs.	N/A	
	4.3 The Ministry of Environment and Food is tracking the development in the food web through monitoring the individual sub-elements of the web	N/A	

18.5 Descriptor 5 – Eutrophication

As described in the Danish Marine Strategy 2, section 12 the loads related to eutrophication is mainly due to discharge from land-based activities.

The environmental targets for descriptor 5 are described in Table 18-6.

Table 18-6 Environmental targets for descriptor 5 according to the MSDF II.

	Targets	Impact from the Ravn decommissioning project	Comments
Eutrophication	5.1 The Ministry of Environment and Food contributes to regional work regarding establishment of threshold values and determination of good environmental status for the North Sea, including the Skagerrak, and works to ensure that anthropogenic eutrophication and its effects are in accordance hereto	N/A	
	5.2 Danish inputs of nitrogen and phosphorus (TN, TP) comply with the maximum acceptable inputs stipulated under HELCOM.	N/A	
	5.3 Coastal waters: Target loads and needs for measures for fjords, estuaries and coastal waters determined in accordance with the Water Framework Directive are complied with. Targets and needs are described in the Danish river basin management plans	N/A	

18.6 Descriptor 6 – Sea Floor Integrity

The physical loss of the seabed from oil and gas installation in general is limited as described in Tabel 13.3 in the Danish Marine Strategy II. The decommissioning of the Ravn field will not cause any loss of seabed. However, depending on the decommissioning choice of the pipelines and umbilical, there may be some direct (footprint) and indirect (increased sedimentation) disturbance of the seafloor during the decommissioning of Ravn. These potential impacts are expected to be temporary.

The environmental targets for descriptor 6 are described in Table 18-7.

Table 18-7 Environmental targets for descriptor 6 according to the Danish Marine Strategy II.

	Targets	Impact from the Ravn Decommissioning project	Comments
Losses and physical impacts	6.1 Ministry of Environment and Food contributes to work regionally and in the EU regarding establishment of threshold values and determination of good environmental status, and works to ensure that losses, physical disturbance and adverse effects on the sea floor are in accordance hereto.	N/A	
	6.2 The knowledge base about the Danish sea floor, as well as the abundance and the location of the benthic habitats and their status, is improved pursuant to the monitoring programme (NOVANA)	N/A	
	6.3 Through regional work and the work in the EU, better understanding of the impacts on the seafloor in relation to losses, disturbances and adverse effects is achieved.	N/A	
	6.4 In connection with licensing offshore activities requiring an environmental impact assessment (EIA), the approval authority encourages assessment and reporting to the Danish Environmental Protection Agency (monitoring programme) of the extent of physical losses and physical disturbances of benthic broad habitat types.	The project will give input on physical disturbance of the seabed if required by the authorities. The physical disturbance will in case it is required and after completion of the project, to the extent possible, be evaluated for the specific habitat types as defined in the Marine Strategy Framework Directive (section 6.4 in the Danish Marine Strategy II). The impact from the Ravn decommissioning project on the seabed will potentially be during the removal of the platform, spools and pipelines (if applicable) under the footprint and due to increased sedimentation. The physical disturbance is assessed to be temporary. Decommissioning of Ravn will decrease the footprint from oil and gas installations in the North Sea.	Potential impacts on the seabed are described in section 0, 0 and 0.
Habitat types and sea floor	6.5 The marine habitat types under the Habitats Directive achieve favourable conservation status in accordance with the timeline laid down in the Habitats Directive.	See above 6.4	See above 6.4
	6.6 The northern Sound is designated as a marine protected area pursuant to the Marine Strategy Framework Directive, and new licences to extract mineral resources are stopped. This will not result in any changes in relation to the existing fisheries regulation.	N/A	

	Targets	Impact from the Ravn Decommissioning project	Comments
	6.7 The most important habitats contain the typical species and communities for Danish marine areas.	See above 6.4	See above 6.4
	6.8 When threshold values for losses, disturbances and adverse effects are established through cooperation at regional and Union level, the Ministry of Environment and Food will initiate a project to form the basis for establishing environment targets in accordance with the thresholds and good environmental status.	N/A	
	6.9 Need for protection initiatives for HELCOM and OSPAR Red List habitats is assessed. If there are any natural habitats on the Red Lists that are endangered or not sufficiently protected, the Ministry of Environment and Food will assess specifically the need for further initiatives in collaboration with relevant ministries.	N/A	
	6.10 The need for additional marine protected areas or other initiatives in the Baltic Sea and the North Sea is assessed, and a similar assessment is subsequently carried out for the Danish Straits.	N/A	

18.7 Descriptor 7 – Hydrographical changes

The hydrographical conditions are described in section 7.2 in the present EIA. The platform is expected to be removed by a lifting vessel and thus there will be no expected impacts on the hydrographical conditions during the decommissioning activities.

The environmental targets for descriptor 7 are described in Table 18-8.

Table 18-8 Environmental targets for descriptor 7 according to the Danish Marine Strategy II.

	Targets	Impact from the Ravn Decomissioning project	Comments
Alteration of hydrographical conditions	7.1 Anthropogenic activities that are particularly associated with physical loss of the sea floor, and which cause permanent hydrographical changes, only have local impacts on the sea floor and in the water column and are designed to take account of the environment and what is technically possible and financially reasonable to prevent harmful effects on the seabed and in the water column.	The decommissioning of the Ravn platform will not cause physical loss of the seabed.	Hydrographical conditions described in 7.2.

	7.2 In connection with licensing offshore activities requiring an environmental impact assessment (EIA), the approval authority is encouraging reporting to the Danish Environmental Protection Agency (monitoring programme) of hydrographical changes and the adverse effects of these.	No expected changes to be reported.	Hydrographical conditions described in 7.2.

18.8 Descriptor 8 – Contaminants

Flushing, purging, and cleaning of topside and pipelines may potentially introduce limits amounts of contaminants to the marine environment, in addition to accidental spills.

The environmental targets for descriptor 8 are described in Table 18-9.

Table 18-9 Environmental targets for descriptor 8 according to the Danish Marine Strategy II.

	Targets	Impact from the Ravn project	Comments
Contaminants	8.1 Discharges of contaminants in the water, sediment and living organisms do not lead to exceeding of the environmental quality standards applied in current legislation	According to the Danish Marine Strategy Directive II threshold values are decided for PFOS, PBDE, Benz(A)pyrene and mercury. The thresholds are defined by concentrations in fish or mussels. It is not expected that these substances will be discharged.	Sediment composition is described in section 7.6. Discharge of oil during decommissioning are described in section12 and 17.3. The impact from unplanned discharges of oil is described in section 12.
	8.2 Emissions, discharges and losses of PBDE and mercury are ceased or phased out	See 8.1	
	8.3 The Ministry of Environment and Food contributes to work regionally and in the EU regarding establishment of threshold values and determination of good environmental status and works to ensure that the quantities of contaminants are in accordance here to.	Information about chemicals used offshore is communicated to the Authorities as part of the discharge applications and permit reporting conditions.	
	8.4 There is a gradual decrease in the levels of imposex/intersex in marine gastropods.	N/A	
	8.5 By 2021, a process has been carried out to trace the source of the most polluting substances which prevent meeting the environmental targets laid down for surface water bodies in the Water Framework Directive. If necessary, the relevant	N/A	

	Targets	Impact from the Ravn project	Comments
	licences and permits will be revised as far as possible		
	8.6 The Ministry of Environment and Food is working to ensure that more indicators for contaminants are established	N/A	
	8.7 The Ministry of Environment and Food ensures increased coordination between policy areas/directives when new national environmental quality requirements are set for selected substances in matrices, where there is monitoring data.	N/A	
	8.8 The Ministry of Environment and Food is working to develop additional regional joint tests for biological impacts.	N/A	
	8.9 The spatial extent and duration of acute pollution events is gradually reduced as much as possible through prevention, monitoring and risk-based scaling of contingency and response facilities.	Acute pollution events are extremely rare events. The risk is further reduced as all pollutants will be removed prior to decommissioning.	Minimizing the effect of acute pollution events is described in section 20.
	8.10 Adverse effects on marine mammals and birds from acute pollution events are prevented and minimised as much as possible. For example, this may be secured by means of floating booms as well as through contingency plans for marine mammals and birds injured in oil spills	Acute pollution events are extremely rare events. The risk is further reduced as all pollutants will be removed prior to decommissioning.	O&G operators is in cooperation with the Authorities about effective contingency plans. Unplanned discharge of oil and chemicals are reported to the Authorities Minimizing the effect of acute pollution events is described in section 21.3.
	8.11 Up to the next monitoring programme (2020), the Danish Environmental Protection Agency will examine how the adverse effects of the most significant pollution events can be monitored and registered in the specific cases	N/A	

18.9 Descriptor 9 – Contaminants in seafood for human consumption

As mentioned, the Ravn field is situated in an area with low fishery intensity and the area is not considered as a core area for seafood.

The environmental targets for descriptor 9 are described in Table 18-10.

Table 18-10 Environmental targets for descriptor 9 according to the Danish Marine Strategy II.

	Targets	Impact from the Ravn Decommissioning project	Comments
Contaminants in seafood for human consumption	9.1 Emissions of contaminants generally do not lead to exceeding of the maximum residue levels applicable in the food legislation for seafood.	No major discharge of contaminants is expected from the decommissioning activities.	Impacts from major oil spills are described in section 12. Minimizing the effect of acute pollution events is described in section 20.
	9.2 The trend in overall Danish dioxin emissions to the air does not rise in the environmental target	See 9.1	
	9.3 The Danish Environmental Protection Agency is monitoring developments in relation to emissions of POPs (including dioxins) from wood-burning stoves to assess the need for further initiatives.	N/A	
	9.4 The Danish Environmental Protection Agency is gradually improving emission estimations of POPs into the air	N/A	
	9.5 Danish Veterinary and Food Administration is inspecting concentrations of contaminants, particularly dioxins and PCBs to monitor developments in organisms at risk of containing high concentrations.	N/A	

18.10 Descriptor 10 – Marine litter

All waste generated during decommissioning will be transported to an onshore facility by vessel. The waste will be further sorted out to improve recycling, send for further treatment at approved waste treatment plants, send for combustion or for final disposal.

The environmental targets for descriptor 10 are described in Table 18-11.

Table 18-11 Environmental targets for descriptor 10 according to the Danish Marine Strategy II.

	Targets	Impact from the Ravn Decommissioning project	Comments
Marine litter	10.1 The amount of marine litter is reduced significantly to achieve the UN goal that marine litter is prevented and significantly reduced by 2025.	All general waste is transported to shore. All topside material and spools will be transported to a suitable shipyard on land for decommissioning. If the pipelines are left in situ it can be argued that some waste is left as marine litter, leachates of compounds from degradation and corrosion of the pipeline may potentially introduce plastic, although it is assessed that this risk is	Impacts described in section 0 and 0.

	Targets	Impact from the Ravn Decommissioning project	Comments
		negligible as the pipelines are buried within the seabed.	
	10.2 The Ministry of Environment and Food contributes to work regionally and in the EU regarding establishment of threshold values and determination of good environmental status, and works to ensure that the quantities of marine litter are in accordance hereto	N/A	
	10.3 Losses of fishing gear in Danish waters are prevented to achieve the UN goal that marine litter is prevented and significantly reduced by 2025	N/A	
	10.4 The Ministry of Environment and Food implements the National Plastics Action Plan and the associated Political Agreement on collaboration of 30 January 2019, with a view to improving recycling of plastic and reducing plastic litter and pollution from plastic litter	N/A	
	10.5 The Ministry of Environment and Food is working to develop indicators and measurement methods for microplastics in seabed sediments and the water column.	N/A	
	10.6 The Danish Fisheries Agency draws up an estimate of the amount of lost fishing gear in Danish marine areas up to 2020.	N/A	
	10.7 The Ministry of Environment and Food prepares a catalogue of potential and targeted measures to prevent marine litter	N/A	

18.11 Descriptor 11 – Underwater noise

Underwater noise can be expected during the Ravn decommissioning in relation to ship traffic, removal of the topside and removal of the subsea installations.

The environmental targets for descriptor 11 are described in Table 18-12.

Table 18-12 Environmental targets for descriptor 11 according to the Danish Marine Strategy II.

	Targets	Impact from Ravn Decommissioning project	Comments
Underwater noise	11.1 As far as possible, marine animals under the Habitats Directive are not exposed to impulse sound which leads to permanent hearing loss (PTS). The limit value for PTS is currently assessed as 200 and 190 dB re.1 uPa2s SEL for seals and harbour porpoise, respectively. The best knowledge currently available is on these species. However, it is likely that these limits will be revised as new knowledge on the area becomes available. The values are the sound-exposure level accumulated over two hours.*	Very limited (if any) impulse noise is expected during the decommissioning activities. The low frequency noise will not cause hearing damage however may cause temporary avoidance behavior by the marine mammals.	Impacts are described in section 0 and 0.
	11.2 Anthropogenic activities causing impulse sound are planned such that direct adverse effects on vulnerable populations of marine animals from the spatial distribution, temporal extent, and levels of anthropogenic impulsive sound are avoided as far as possible and such that these effects are assessed not to have long-term adverse effects on population levels.	See 11.1	
	11.3 Activities by the authorities under the Ministry of Defence that cause impulse noise in the marine environment are, as far as possible, being assessed and adapted to reduce possible adverse effects on marine animals under the Habitats Directive, provided this does not conflict with national security or defence objectives. Defence Command Denmark applies current NATO standards when carrying out environmental assessments.	N/A	
	11.4 When conducting preliminary seismic studies, adequate remedial action is taken in accordance with the Danish Energy Agency's guidelines on standard terms and conditions for preliminary studies at sea.	N/A	
	11.5 The Ministry of Environment and Food contributes to work regionally and in the EU regarding establishment of threshold values and determination of good environmental status and is working to ensure that the level of underwater noise is in accordance hereto.	N/A	
	11.6 In connection with licensing offshore activities requiring an environmental impact assessment (EIA), the approval authority is encouraging reporting to the Danish Environmental Protection Agency (monitoring programme) of registrations of impulse noise.	Very limited (if any) impulse noise is expected during the decommissioning activities. No monitoring programme has been agreed.	Impacts are described in section 0 and 0.
	11.7 Through increased monitoring, the Ministry of Environment and Food is improving knowledge about the extent and levels of low-frequency noise in the Baltic Sea and the North Sea.	No monitoring programme has been agreed.	Impacts are described in section 0 and 0.

*The threshold values for permanent hearing loss (PTS) are currently within the Marine Strategy Framework Directive assessed to be 200 and 190 dB re.1 $\mu Pa^2 s$ SEL for seals and harbour porpoises, respectively. It is stated that these values will be revised once more knowledge becomes available. In May 2022 the Danish

Energy Agency released 'Guideline for underwater noise' and these thresholds levels are presented in Table 9-12. The project has in September 2022 been in contact with the Ministry of Environment to establish whether the threshold values in the Marine Strategy Framework Directive will be revised according to the threshold values in the DEA guidelines. Potentially yes, but not for now. Therefore, when evaluating potential impacts according to the Marine Strategy Framework Directive the 200 and 190 dB re.1 $\mu Pa^2 s$ SEL for PTS for seals and harbour porpoises will be utilized, for other assessments the threshold values in the DEA guidelines will be utilized.

18.12 Summary of impacts on the descriptors

The potential impacts from the Ravn decommissioning project activities are compared with the targets for the 11 descriptors as described in section 18.1 to 18.11. These impacts are summarized in Table 18-13 below.

Table 18-13 Potential impacts on the environmental targets in the Danish Marine Strategy II which implements EU's Marine Strategy Framework Directive (MSFD).

Descriptor	Assessment of potential impact
D1 Biodiversity	Birds may potentially be impacted by light and noise disturbances although impacts are assessed to be negligible. The project area is not considered important for seabirds. The marine mammals may potentially be impacted by underwater noise and disturbance. The noise levels are not expected to cause any hearing damage, but the mammals may exhibit avoidance behaviour. The project area is not assessed to be a core area for marine mammals. The impacts will be temporary and not expected to affect the marine mammal populations.
D2 Non-indigenous species	Vessels may potentially introduce non-indigenous species by growth on the hull or discharge by ballast water, however it is assessed that there is a low risk. Non-indigenous species may use platforms in the North Sea as steppingstones for dispersal, however this risk for the Ravn platform is removed after the decommissioning.
D3 Commercially exploited fish stocks	The diversity of fish in the Ravn field area is low, as is the fishing intensity. Decommissioning of the Ravn platform may open up for more commercial fishing in the area. Decommissioning of Ravn is not expected to impact fish mortality or spawning biomass. There may however be local impacts caused by an unplanned oil spill.
D4 Marine Food webs	The decommissioning of Ravn is not expected to impact the marine food webs in the area.
D5 Eutrophication	The decommissioning of Ravn is not expected to impact the level of eutrophication in the area.
D6 Sea floor integrity	The decommissioning of Ravn may cause physical disturbance of the seabed under the footprint (direct) and increased sedimentation (indirect) during the removal of the platform, spools and pipelines (if applicable). The physical disturbance is expected to be temporary.

Descriptor	Assessment of potential impact
	The extent of physical disturbance for each habitat type is expected to be reported to be reported to the authorities as an expected condition for the permit. The decommissioning of Ravn will decrease the footprint from oil and gas installations in the North Sea.
D7 Hydrographical changes	The decommissioning of the Ravn platform will not cause physical loss of the seabed. There will only be very limited and local temporary impacts.
D8 Contaminants	According to the Danish Marine Strategy II threshold values are decided for PFOS, PBDE, Benz(A)pyrene and mercury. None of these substances are expected to be discharged during decommissioning. Acute pollution events are extremely rare events. In addition, the platform and pipelines contain no hydrocarbons.
D9 Contaminants in seafood for human consumption	No major discharges of contaminants are expected from the decommissioning activities.
D10 Marine litter	All general waste is transported to shore. All topside material will be transported to a suitable shipyard on land for decommissioning or storage for reuse. If the pipelines are left in situ it can be argued that some waste is left as marine litter, leachates of compounds from degradation and corrosion of the pipelines may potentially introduce plastic, although it is assessed that this risk is negligible as the pipelines are buried within the seabed.
D11 Underwater noise	Very limited (if any) impulse noise is expected during the decommissioning activities. The low frequency noise will not cause hearing damage to the marine mammals but may cause disturbance so the mammals may exhibit temporary avoidance behaviour. This is not expected to impact the populations.

Based on the assessment above it is concluded, that the Ravn decommissioning project will not prevent or delay the achievements of good environmental status for each descriptor as defined by targets in the Danish Marine Strategy II.

The Danish Environmental Protection Agency (DEPA) has issued a monitoring programme specifically for the Marine Strategy Framework Directive (Ministry of Environment and Food, 2020). Monitoring activities have been defined for each of the 11 descriptors. The Ravn decommissioning project is assessed not to impact any of the monitoring activities described in the monitoring programme.

Denmark's current programme of measures is from 2017 (Ministry of Environment and Food, 2017), however a new programme of measures is expected to be released in 2022. Measures have been introduced for each of the 11 descriptors and include measures and efforts to be implemented to achieve or maintain a good environmental status. The Ravn decommissioning project is assessed not to impact any of the measures described in the programme of measures.

Multiple pressures may impact the marine environment. If these pressures enhance the overall impact beyond what each pressure would, they are called cumulative impacts. According to the Marine Strategy Framework Directive there is a requirement to assess the cumulative impacts, both from pressures within the same project (discussed below) and from pressures from different projects (discussed in chapter 14). When assessing cumulative impacts, aspects like the duration of the impact, severity of impact, location for the impact and its vulnerability must be considered.

During the decommissioning, benthic infauna and fish may potentially be impacted simultaneously by spreading of sediment and discharges (planned and unplanned discharges/accidental spills) and marine mammals may be simultaneous impacted by underwater noise and unplanned discharges/accidental spills. These impacts are all classified as negligible. In addition, fish and marine mammals will swim away from potential impacts from spreading of sediment and noise impacts, thus reducing the risk of impacts from discharges. Finally, unplanned discharges/accidental spills occur very rarely, and the risk is reduced significantly as the platform and pipelines contain no hydrocarbons. Based on these considerations it is concluded that the potential cumulative impacts from different impacts from the project will not prevent or delay the achievements of good environmental status for each descriptor in the Danish Marine Strategy II.

19 Monitoring programme

A post decommissioning monitoring program will be set up for the Ravn field. In accordance with the DEA Guidelines, a close out report will be submitted to DEA explaining any variations from the decommissioning including debris removal and independent verification of seabed clearance.

The final monitoring programme covering decommissioning and post-decommissioning surveys and monitoring to be agreed upon with relevant Authorities.

19.1 Post decommissioning monitoring and evaluation

After the completion of the abandonment work, a survey of the former platform site (500 m safey zone) will be performed to verify that the removal has been performed in accordance with the agreed plans, both in terms of the environmental aspects and the baseline survey for the *in situ* decommissioned pipelines.

After removal of spools, an as-left survey will be performed in the area, where the activities have taken place (500 m safety zone) to prove that the pipeline and umbilical ends are covered with rocks/mattresses.

During the annual pipeline surveys any debris within the 50 m wide corridor at each side along each pipeline route will be detected.

Based on the information from these surveys a monitoring program will be set up to follow the development of any findings from the baseline. The post decommissioning survey should be agreed with the Authorities.

19.2 Close-out report

A close-out report will be prepared as documentation for the decommissioning process including the following information:

- Description of the decommissioning
- Reporting of generated waste and management of waste based on documentation from the decommissioning contractor and documentation from the waste handling companies
- Information about monitoring programme agreed with DEA

20 Mitigating measures

In the following is a brief description of how and which mitigating measures are applied. The mitigating measures are through environmental management procedures conducted generally by Wintershall Noordzee B.V. in relation to the decommissioning of the Ravn platform and in relation to other installations owned by Wintershall Noordzee B.V. and the specific mitigating measures which will be taken to minimize specific impacts on the project.

20.1 Wintershall Noordzee B.V. Corporate Policy

Wintershall Noordzee B.V. operates with a HSE policy and Management system. People and organisations working for Wintershall Noordzee B.V. have to do their daily work at any time with responsible care for health, safety and environmental aspects. For contingency plan in regards to oil spill from vessels please see section 12.2.

20.2 Waste Management

In general, the methods to be selected with the main structures of the field to be taken to shore in large pieces for further dismantling or reuse, will limit the work offshore and no waste production is foreseen offshore. All production chemicals will be removed before dismantling of structures.

Onshore, the platform will be stored for later reuse or the dismantling of platform structures and waste sorting will be performed on a regulated site approved for this type of work.

In line with the waste hierarchy, the re-use of an installation (or parts thereof) is first in the order of preferred waste management options. Options for the reuse of installations (or parts thereof) are currently under investigation.

Waste generated during decommissioning (if any) will be segregated by type and periodically transported to shore in an auditable manner through licensed waste contractors. Steel and other recyclable metals are estimated to account for the greatest proportion of the material inventory.

As much as possible of the material recovered to shore will be recycled. Experience shows that typically recycling of at least 95% (weight) of all materials combined is possible.

20.3 Air emissions

With the purpose of minimizing air emissions in relation to use of vessels following actions are required:

- Supply and support operations should be optimized to minimize the operation time
- All engines are to be maintained according to standards from suppliers to achieve efficient performance.

21 Data quality and limitations

21.1 Environmental assessment of emissions to air

The assessment of emissions to air is attached with some uncertainties regarding the fuel consumption, emission factors, days of operation of vessels etc.

The emission factors that are used calculating emissions from vessels are generic emission factors. This also means, that the actual emission from vessels could be different if measuring the emissions.

The standard emission factors for vessels are from Norwegian Oil & Gas and are assumed to be diesel oil burned in motors (OLF, 2019). These are almost similar to emission factors for marine diesel oil/marine gas oil used for ships in the EMEP/EEAs Inventory Guidebook, 2019. The standard emission factors for helicopters are from E&P Forum (E&P Forum, 1994).

Likewise, the fuel consumption are generic data, as the actual vessel fleet is not decided upon yet, and thus it could be other types of vessels used when actually carrying out the work. However, it is tries to use data for vessels that could be expected to be used.

The estimated days of operation are estimated and include weather delays and other unforeseen events. Thus, these can be expected to be conservative.

21.2 Environmental assessment of waste amounts

The assessment of the waste amounts is based on the technical documentation received from Wintershall Noordzee B.V. No on-site visible inspection has been made. This has limited the possibility to take measurement of components and structures and to inspect the state of component inside.

Thickness of insulation has been assumed in many cases, due to missing information on the drawings. Type of insulation material could not be verified without site visits or more detailed information.

The uncertainty on the estimate presented is -15% / +15%

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