SEPTEMBER 2023
WINTERSHALL NOORDZEE B.V.

RAVN DECOMMISSIONING ENVIRONMENTAL IMPACT ASSESSMENT

ESPOO REPORT

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CONTENTS

1 Introduction

1.1 Reading guide

This report comprises the Espoo documentation of Denmark elaborated under the project; decommissioning of Ravn. It contains a description of the project-related transboundary environmental impacts, which are caused by project impacts generated in Denmark and potentially affecting the marine territories (EEZ and/or territorial waters) of neighbouring countries.

Chapters 2 and 3 provide relevant background information on the decommissioning of Ravn. This includes a description of the legal framework and the mechanisms of the Espoo process and a project description. Chapter 4 describes the impact assessment methodology applied. The central part of this report in chapter 5 including the screening of potential transboundary impacts and chapter 6 dealing with the assessment of transboundary impacts. The assessment chapters are organized by environmental receptors that are likely to be affected by various project pressures. For each receptor the assessment results are presented, with information on the expected transboundary impacts. A separate chapter deals with the assessments made on Natura 2000 areas and applicable legislation. The results of the assessment are summarized in the conclusion of chapter 7. References are listed in chapter 10.

The Espoo report and procedure are an integrated part of the EIA procedures and approval processes.

1.2 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

1.3 Project background

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 activities comprise of:

- 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 environmental assessments.

The plug and abandonment program of the wells has been included in a separate EIA report and are thus subject to an independent approval process and for that reason are not included in the present environmental assessment and ESPOO. 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 ESPOO. Thus, the current project in this ESPOO 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.

1.4 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 1-1 and Figure 1-2.

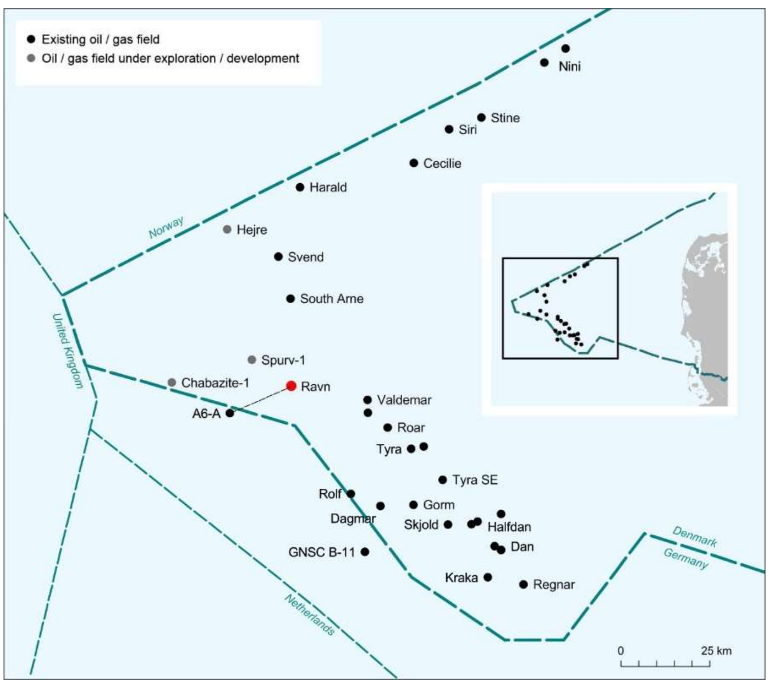


Figure 1-1 Location of the Ravn field and other oil and gas installations in the North Sea. Ravn is marked with red colour.

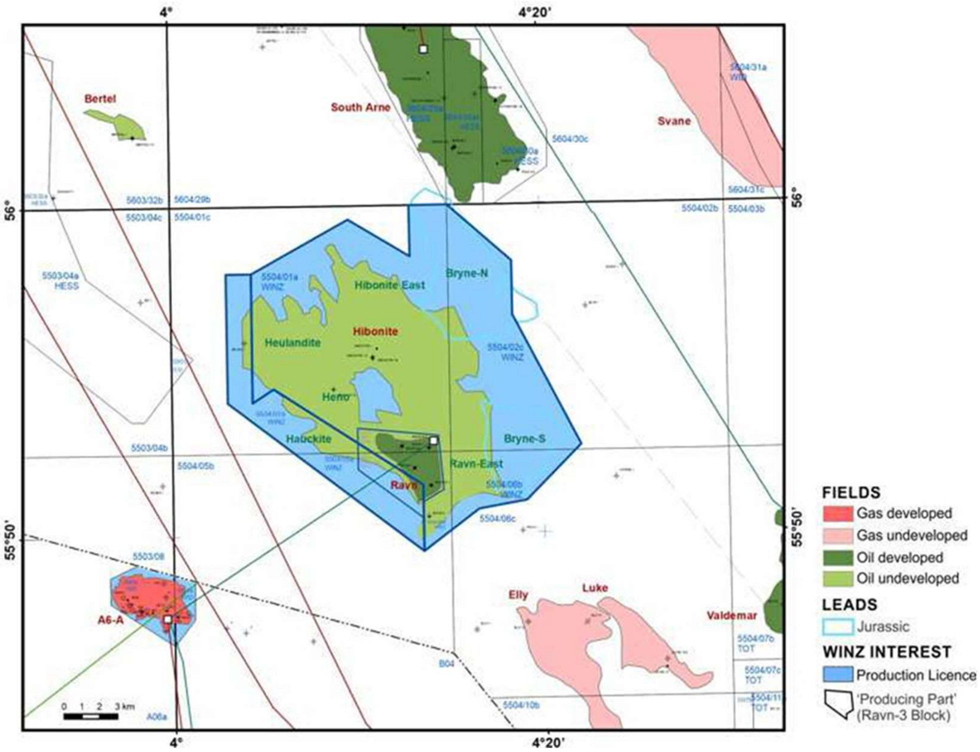


Figure 1-2 Location of the Ravn field and the A6-A field.

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 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.

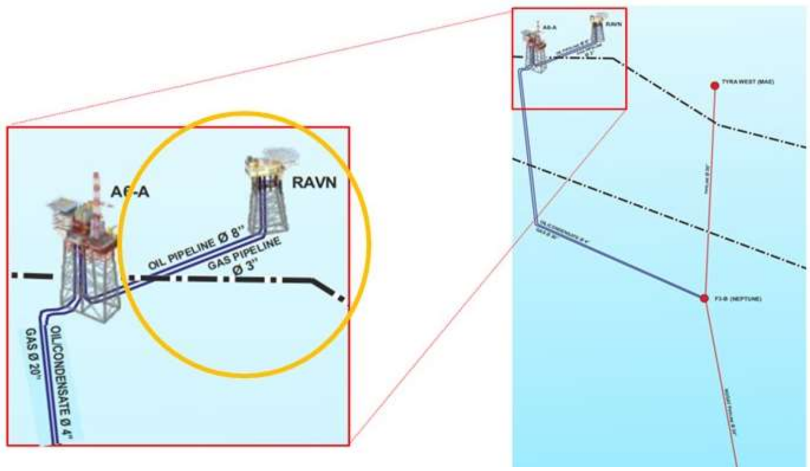
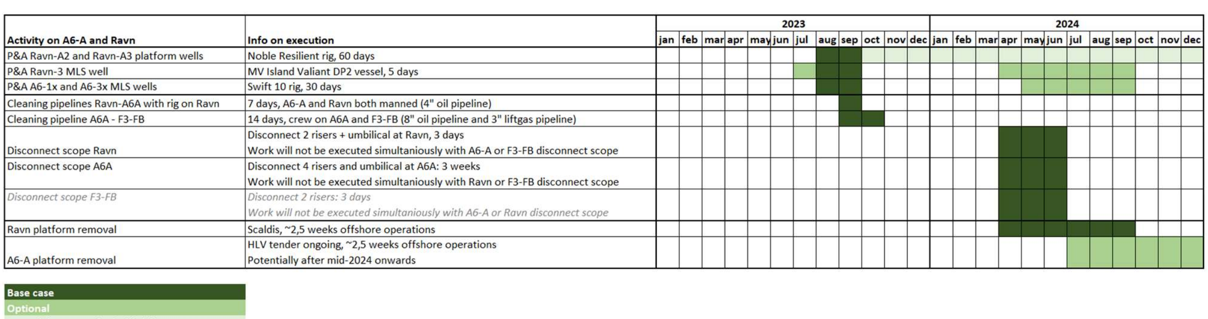


Figure 1-3 Overview of the field layout. The decommissioning scope for Ravn is outlined in orange.

1.5 Time schedule

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, see the figure below.



It is noted that the assessments of 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.

2 Legal framework and ESPOO consultation process

A decommissioning project must comply with a several international conventions and directives on both national and EU level.

2.1 The Espoo Convention and Espoo consultation process

2.1.1 The Espoo Convention

The "Convention on Environmental Impact Assessment in a transboundary context of 25th of February 1991" (Espoo Convention) sets out the obligations of the contracting Parties to assess the environmental impact of certain activities at an early stage of project planning. It also lays down the general obligation of States to notify and consult one another on all major projects under consideration that are likely to have a significant adverse environmental impact across boundaries.

According to the Espoo Convention a transboundary impact is "any non-global impact within the jurisdiction of the Party due to the planned activities, the physical cause of which is wholly or partially located on the area under the jurisdiction of the other Party."

The Party of Origin (PoO) is the Contracting Party or Parties to the Convention, under whose jurisdiction the planned operation is to take place, which in this case is Denmark only.

The Affected Party (AP) is a Contracting Party or Parties to the Convention that may be exposed to a transboundary impact of the planned activities. In relation to the Ravn decommissioning Denmark is both AP and PoO, while Germany and the Netherlands are APs.

2.1.2 The Espoo consultation process

The consultation process foreseen under the Espoo Convention's Articles 3-6 is coordinated by the Espoo Focal Point in the PoO. The consultation process consists of the following major steps:

- Notification in accordance with Article 3: For a proposed activity listed in Appendix I that is likely to cause a significant adverse transboundary impact, the Party of Origin shall, for the purposes of ensuring adequate and effective consultations under Article 5, notify any Party which it considers may be an Affected Party as early as possible and no later than when informing its own public about that proposed activity.

- Preparation of the environmental impact assessment documentation (Espoo report) pursuant to Article 4: The Party of Origin shall furnish the Affected Party, as appropriate through a joint body where one exists, with the environmental impact assessment documentation. The concerned Parties shall arrange for distribution of the documentation to the authorities and the public of the Affected Party in the areas likely to be Affected and for the submission of comments to the competent authority of the Party of Origin, either directly to this authority or, where appropriate, through the Party of Origin within a reasonable time before the final decision is taken on the proposed activity.

- Consultation pursuant to Article 5: The Party of Origin shall, after completion of the environmental impact assessment documentation, without undue delay enter into consultations with the Affected Party concerning, inter alia, the potential transboundary impact of the proposed activity and measures to reduce or eliminate its impact. Consultations may relate to:

a) Possible alternatives to the proposed activity, including the no-action alternative and possible measures to mitigate significant adverse transboundary impact and to monitor the effects of such measures at the expense of the Party of Origin;
b) Other forms of possible mutual assistance in reducing any significant adverse transboundary impact of the proposed activity; and
c) Any other appropriate matters relating to the proposed activity.

The Parties shall agree, at the commencement of such consultations, on a reasonable timeframe for the duration of the consultation period. Any such consultations may be conducted through an appropriate joint body, where one exists.

- Final Decision pursuant to Article 6: The Parties shall ensure that, in the final decision on the proposed activity, due account is taken of the outcome of the environmental impact assessment, including the environmental impact assessment documentation, as well as the comments thereon received pursuant to Article 3 and 4, and the outcome of the consultations as referred to in Article 5. The Party of Origin shall provide to the Affected Party the final decision on the proposed activity along with the reasons and considerations on which it was based. If additional information on the significant transboundary impact of a proposed activity, which was not available at the time a decision was made with respect to that activity and which could have materially affected the decision, becomes available to a concerned Party before work on that activity commences, that Party shall immediately inform the other concerned Party or Parties. If one of the concerned Parties so requests, consultations shall be held as to whether the decision needs to be revised.

The consultation process and content of the environmental impact assessment documentation for the decommissioning of Ravn is considering recommendations given from the Economic Commission for Europe (UNECE, 1996) and the European Commission (European Commission, 2013).

The consultation process started June 30th, 2023 when the Danish EPA as Espoo focal point distributed a letter of notification together with an Espoo Scoping report to the APs.

The following countries have requested to be part of the Espoo process: Germany and the Nederland.

2.2 Further national and international legal requirements

2.2.1 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 a permission for discharges.

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

- Maximum oil concentration in discharged produced water.
- Limitations for total amount of oil to be discharged.
- Monitoring programme for oil concentration in discharge water.
- Continuous control of total oil discharge.
- Classification of offshore chemicals.
- Use and discharge of offshore chemicals depending on classification (explained below).
- Regular reporting on discharge of oil and chemicals.

Classification of offshore chemicals

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 are inorganic and highly toxic (EC/LC < 1 mg/l) and/or have a very low biodegradation (< 20% in 28 days) are classified as red. Substances that meet more than one of three criteria of low biodegradation (< 60% in 28 days), high bioaccumulation (log Pow ≥ 3 and MW < 700) or toxicity (EC_{50}/LC_{50} < 10 mg/l) are also classified as red.

Yellow chemicals exhibit 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 (log Pow ≥ 3 and MW < 700) or toxicity (EC_{50}/LC_{50} < 10 mg/l) are classified as yellow.

Green chemicals are considered not to be of environmental concern (so-called PLONOR-substances that ''Pose Little Or NO Risk'' to the environment) and also includes organic substances with EC_{50}/LC_{50} > 1 mg/l, acids and bases categorized as green chemicals.

Regulation of non-indigenous species

Regulation to prevent introduction of non-indigenous species through ballast water regulated through Executive order no. 1000 of 18/09/2019 about handling of ballast water and sediments from ship ballast tanks. In addition, introduction of non-indigenous species though ballast water 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.

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) and by The Marine Environment Act (Consolidation act no. 1165 of 25/11/2019).

In addition, air emissions from platforms are regulated in the regulation on certain air polluting emissions from combustion installations on offshore platforms (Executive order no. 1449 of 20/12/2012) and in the regulation on prevention of air pollution from ships (Notification no. 9840 of 12/04/2007).

Order of solid and liquid content of sulphur in fuels (Order no 228 of 06/02/2022) regulates the amount of sulphur allowed in ship fuel and thus indirectly impact the emission from ships.

2.2.2 Natura 2000 areas

Natura 2000 is a network of nature protection areas established under the EU Habitats[1] and Birds[2] Directive. The network consists of Special Areas of Conservation (SACs) designated by the member states under the Habitats Directive. The network also consists of Special Protection Areas (SPAs) designated under the Bird Directive. The aim of the network is to assure 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[3]
- The Subsoil Act[4]
- The regulation on EIA[5]
- The Offshore Appropriate Assessment Order[6]
- The Habitats Order[7]

Prior to any decision on projects with potential impact on a Natura 2000 area, documentation has to be presented that the activity will not lead to negative effects on the favourable conservation status of species or habitats that are part of the selection basis or affects the integrity of the area negatively.

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 *2-1*).

[1] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.

[2] Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds. Amended in 2009 it became the Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds.

[3] Consolidated Act no. 119 of 26/01/2017 on Environmental Goals for International Nature Protection Sites (bekendtgørelse af lov om miljømål m.v. for internationale naturbeskyttelsesområder (Miljømålsloven).

[4] Consolidation Act no. 1533 of 16/12/2019 on the Use of the Danish Subsoil

[5] Consolidated Act no. 4 of 03/01/2023 on Environmental Assessment of Plans and Programmes and of Specific Projects

[6] Administrative Order no. 1050 of 27/06/2022 on Impact Assessment of International Nature Protection Sites and Protection of Certain Species at Preliminary Studies, Investigation and Extraction of Hydrocarbon, Storage in the Underground, Pipelines, etc. off-shore (bekendtgørelse om konsekvensvurdering vedrørende internationale naturbeskyttelsesområder og beskyttelse af visse arter ved forundersøgelser, efterforskning og indvinding af kulbrinter, lagring I undergrunden, rørledninger, m.v. offshore).

[7] Administrative Order no. 2091 of 12/11/2021 on appointment and administration of international nature protection sites and protection of certain species (bekendtgørelse om udpegning og administration af internationale naturbeskyttelsesområder samt beskyttelse af visse arter).

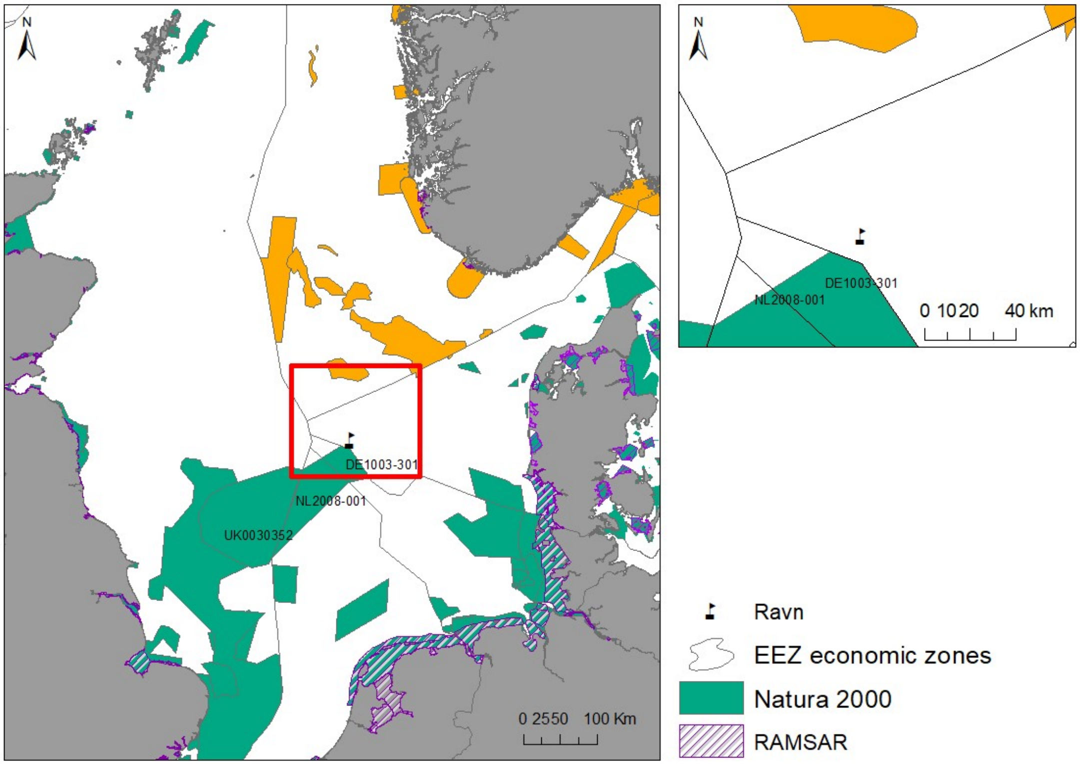


Figure 2-1 Location of Natura 2000-areas (SAC) in the North Sea.

2.2.3 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.

2.2.4 The 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), 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.

The OSPAR commission recommended an elimination of discharges of produced water, so that in 2020 the discharge of produced water would not result in unwanted effects in the marine environment. Discharged produced water should not contain more than 30 mg dissolved oil per litre. The commission is establishing a risk-based approach (RBA) to assess the discharge of produced water. The RBA recommendation 2012/5 and the associated RBA guideline 2012-07 were adopted in 2012, and all contracting parties finalised their implementation plans in 2013 which was followed by full implementation in 2020.

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 legitim 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

2.2.5 Naturally occurring radioactive materials (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.

2.2.6 Marine Strategy Framework Directive

The Marine Strategy Framework Directive[8] (MSFD) aims at achieving Good Environmental Status (GES) of the marine waters of the EU by 2020 and to protect the resource base upon which marine-related economic and social activities depend. The Commission also produced a set of detailed criteria and methodological standards[9] to help Member States implement the MSFD. To achieve GES by 2020, each Member State was required to develop a strategy for its marine waters (Marine Strategy).

The MSFD is implemented in Danish legislation through the Consolidated Act on Marine Strategy[10]. The purpose of the act is to establish the framework for achieving GES in Danish waters. The main instrument in achieving this is the Marine Strategy, which covers all Danish marine waters, including the Danish waters of the North Sea.

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 table below, all 11 descriptors are listed together with relevant environmental targets.

	Descriptors	Relevant environmental targets
D1	Biodiversity (birds)	Populations and habitats for birds are conserved and protected in accordance with objectives under the Birds Directive
D1	Biodiversity (mammals)	Harbour porpoise, harbour seal and grey seal achieve favourable conservation status in accordance with the timeline laid down in the Habitats Directive
D1	Biodiversity (pelagic habitats)	The abundance of plankton follows the long-term average.
D2	Non-indigenous species	The number of new non-indigenous species introduced through ballast water, ship fouling and other relevant human activities is decreasing
D3	Commercially exploited fish stocks	Within the framework of the Common Fisheries Policy, spawning biomass exceeds the level that can ensure a maximum sustainable yield.
D4	Marine food webs	The relevant environmental targets under descriptor 1 (biodiversity) and descriptor 3 (commercial exploited fish stocks)
D5	Eutrophication	Danish part of discharges of nitrate and phosphorous (TN, P) follows the maximal acceptable discharges set in HELCOM.
D6	Sea floor integrity (losses and physical impacts)	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

8 Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

9 Commission Decision (EU) 2017/848 of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment and repealing Decision 2010/477/EU.

10 Consolidated Act no. 1161 of 25/11/2019 on Marine Strategy (bekendtgørelse af lov om havstrategi).

		extent of physical losses and physical disturbances of benthic broad habitat types.
D6	Sea floor integrity (habitat types on the sea floor)	The marine habitat types under the Habitats Directive achieve favourable conservation status in accordance with the timeline laid down in the Habitats Directive
D7	Alteration of hydrographical conditions	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.
D8	Contaminants (concentrations and species health)	Discharges of contaminants in the water, sediment and living organisms do not lead to exceeding of the environmental quality standards applied in current legislation.
D8	Contaminants (acute pollution events)	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 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.
D9	Contaminants in fish and other seafood for human consumption.	Emissions of contaminants generally do not lead to exceeding of the maximum residue levels applicable in the food legislation for seafood. The trend in total Danish dioxin emissions into the air is not increasing.
D10	Marine litter	The amount of marine litter is reduced significantly in order to achieve the UN goal that marine litter is prevented and significantly reduced by 2025.
D11	Underwater noise	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.

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.

OSPAR is currently working on a common framework of indicators and assessment values to be used in the Northeast Atlantic. In the EIA, a draft version of the list of indicators has been used to assess the impact of the project on the objectives of the Marine Strategy.

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 project area is not located within one of these areas.

2.2.7 Maritime spatial plan

Maritime spatial planning is regulated through the Danish legislation in the Act on Maritime spatial planning[11].

The Danish Maritime Authority is responsible for establishing Denmark’s first maritime spatial plan. The maritime spatial plan is to form the basis of the coordination of the many uses of Denmark's sea area in a manner that can support the conditions for sustainable growth in Blue Denmark. The maritime spatial plan is to establish which sea areas in Danish waters can be used

[11] Consolidation act no. 400 of 06/04/2020

for inter alia, offshore energy extraction, shipping, fishing, aquaculture, seabed mining and environmental protection towards 2030.

The maritime spatial plan 2.0 is currently through the process of public hearing and awaits final adoption. The areas of spatial planning at sea of relevance are primarily the zones for offshore energy exploration, see Figure 2-2.

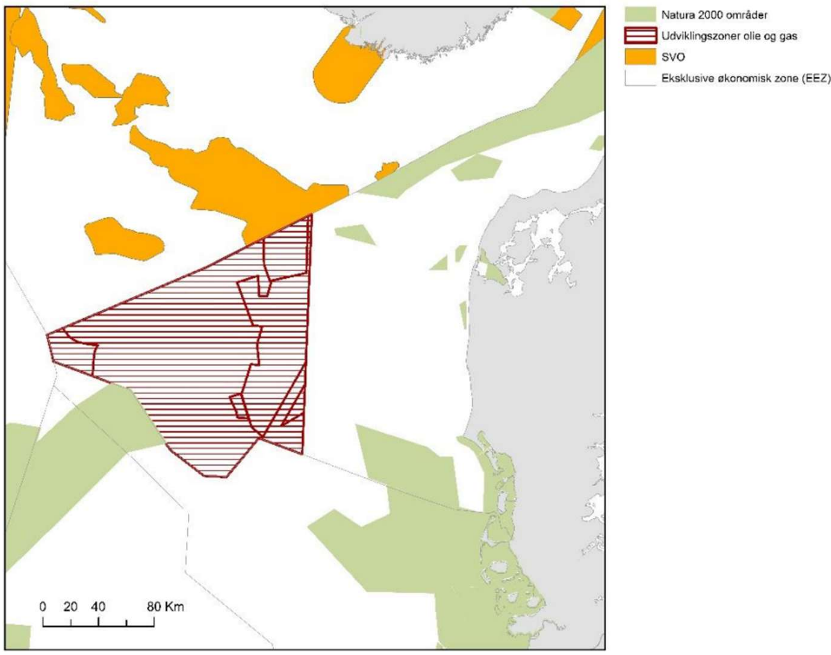


Figure 2-2 Development zone for oil and gas exploration in relation to Norway SVO-areas (especially valuable areas) and Natura 2000 areas in German and Danish sector.

2.2.8 Regulation of decommissioning

Decommissioning is regulated through Danish legislation in the Subsoil Act[4] and the Marine Environment Act.

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 such as pipes and containers 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. Dumping of waste and other matters are also 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).

2.3 National approval procedure in Denmark

2.3.1 Environmental Impact assessment (EIA)

An Environmental Impact Assessment (EIA) is required in order to obtain an approval for offshore exploration and production of oil and gas. This requirement is set forth in Directive on the assessment of the effects of certain public and private projects on the environment (EIA Directive[12]).

The directive is implemented in Danish legislation through the:

- Consolidated Act on Environmental Assessment of Plans and Programmes and of Specific Projects (see footnote 5)

- Subsoil Act (see footnote 4)

- 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. (see footnote 6).

The EIA document on which this Espoo report is based is compliant with the above-mentioned legislation.

[12] 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. Amended in 2014 it became Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment.

The public hearing process for offshore projects is as follows:

The project owners' application, the environmental impact assessment report and a draft permit from the authority will be available on the website of the Danish Energy Agency, and the public will have the opportunity to comment on the EIA through an eight-week public hearing phase. After the hearing period the DEA will decide if a permit for the project will be granted.

Decisions regarding the project and the EIA will be published on the DEA website, and any party with relevant and individual interests in the decision may file a written complaint on environmental issues to the Energy Board of Appeal within four weeks of the publication.

3 Technical description of the project

3.1 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.

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 3-1.

Table 3-1 Coordinates for the Ravn platform.

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

3.1.1 The Ravn installation

The offshore facilities consist of a Normally Unmanned Installation (NUI) platform, see Figure 3-2, 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 3-1.

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.

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.

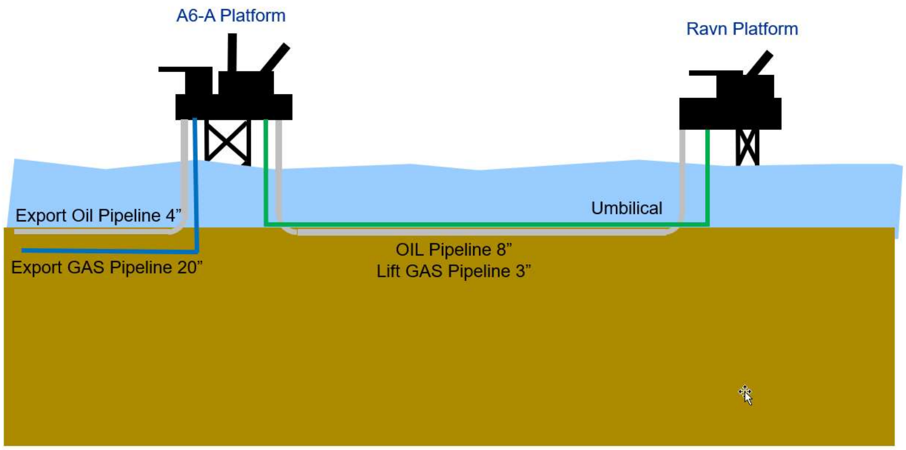


Figure 3-1 Overview of the pipeline connection of Ravn and the A6-A platform.

Figure 3-2 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 3-2.

Table 3-2 Specifications of topside and jacket.

Surface Facilities Information				
Name		Location	Topside/	Jacket

	Facility Type			Facilities					
				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 3-3 and Figure 3-4.

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

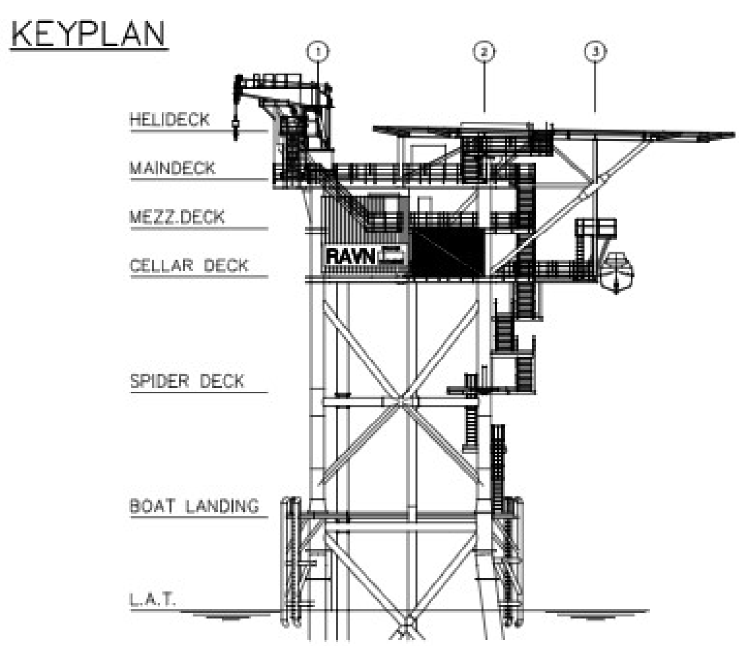


Figure 3-3 Keyplan of the topside.

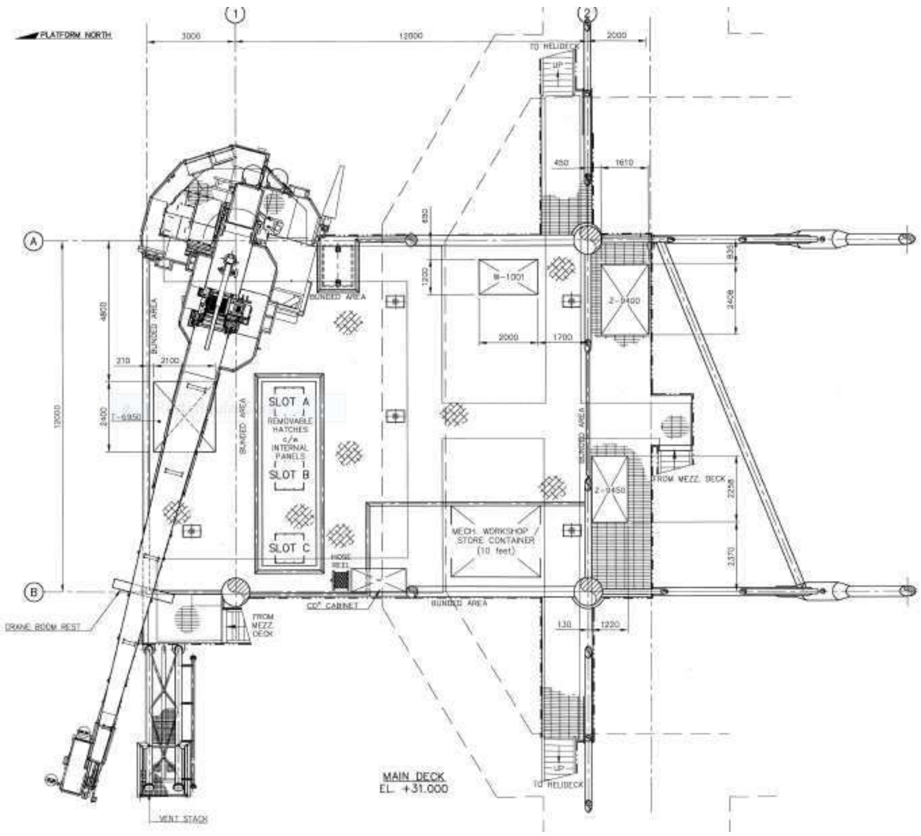


Figure 3-4 Keyplan of the topside main deck level.

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 3-3.

Table 3-3 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 3-5 to Figure 3-7. 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.

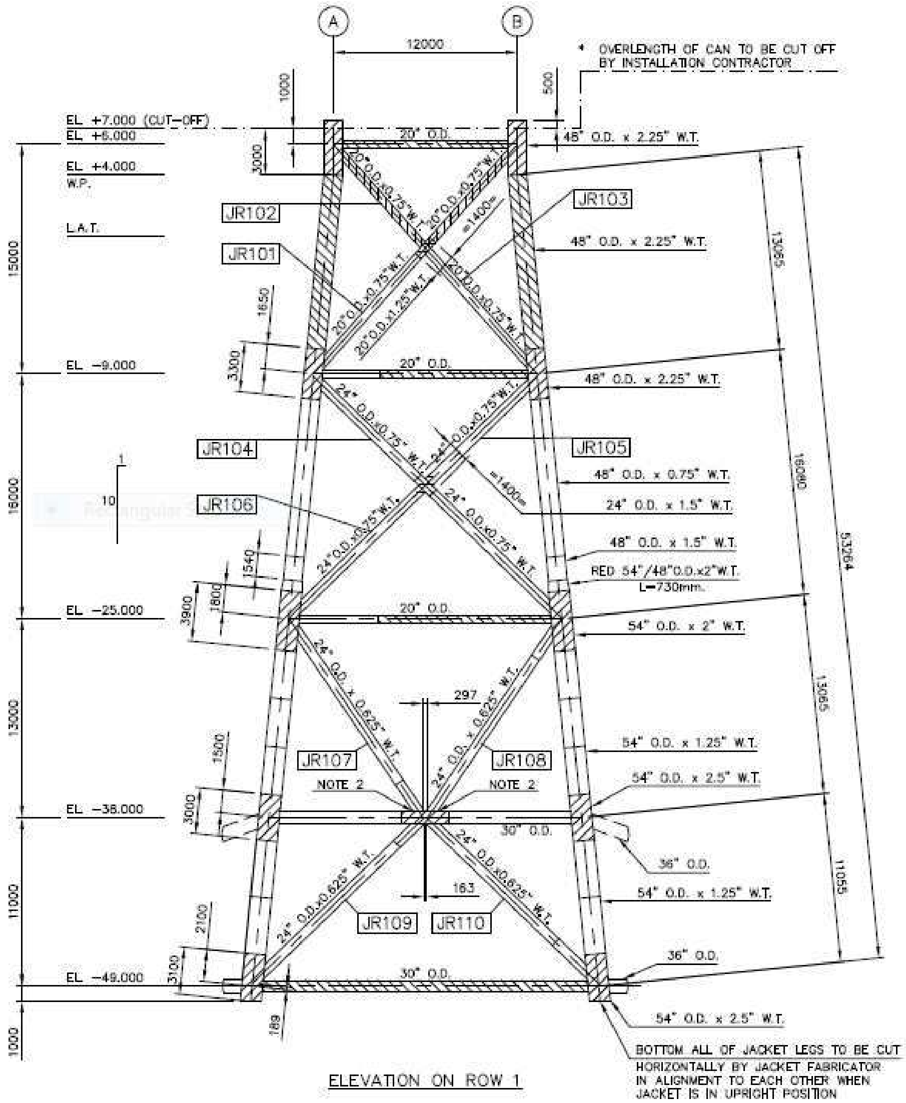


Figure 3-5 Jacket elevation.

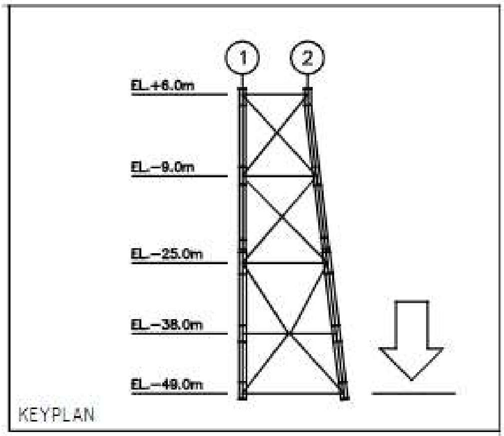


Figure 3-6 Keyplan of the jacket.

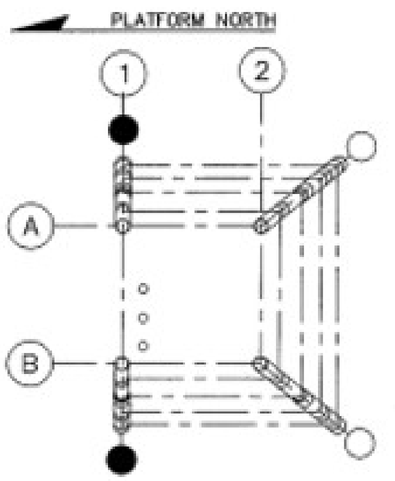


Figure 3-7 Horizontal keyplan of the jacket.

The components and estimated dry weight of the jacket excl. piles are shown in Table 3-4.

Table 3-4 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.

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 necessary 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.

In Table 3-5 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 3-5 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 pipeline except at crossings	Piggybacked to the 8" multi-phase line and trenched over the entire length of the pipeline except at crossings	Trenched over the entire length of the umbilical 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 rock approx. 1,885 tons amour layer and 2,157 tons sprinkle layer at the crossing.

3.2 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

3.2.1 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 3-6, 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 3-6.

Table 3-6 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 it 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 3-8.

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 3-8 Lifting of Topside (example from erecting).

3.2.2 Removal of Jacket

There are three principal methods for jacket removal as shown in Table 3-7. 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 3-7. A final decision on the decommissioning method will be made following a commercial tendering process.

Table 3-7 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 3-9. 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.

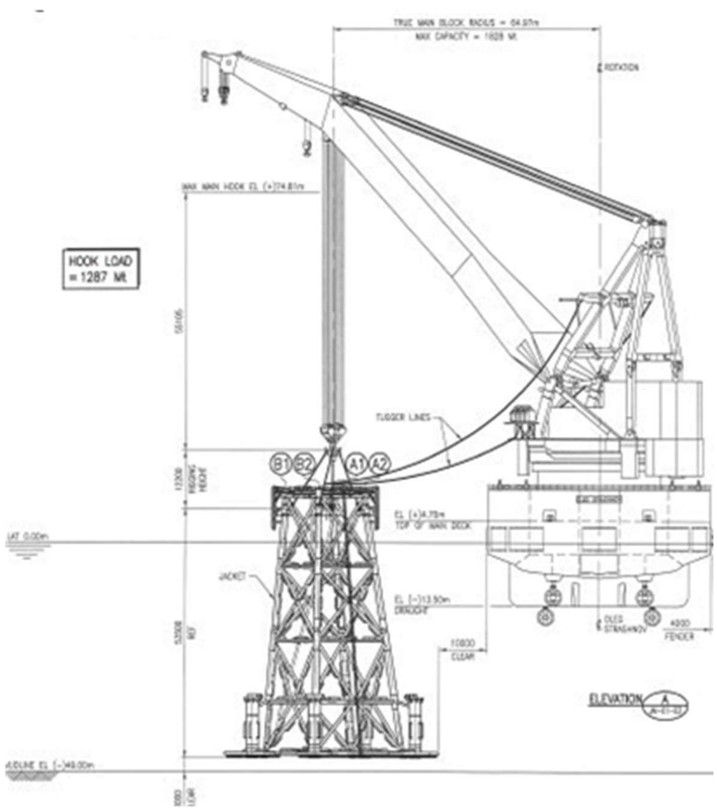


Figure 3-9 Lifting og jacket (example).

3.2.3 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 3-8 the expected transport related to decommissioning activities can be seen.

Table 3-8 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 3-9.

Table 3-9 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**

3.2.4 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 3-10 shows an overview of the subsea spool pieces at the Ravn platform to be removed.

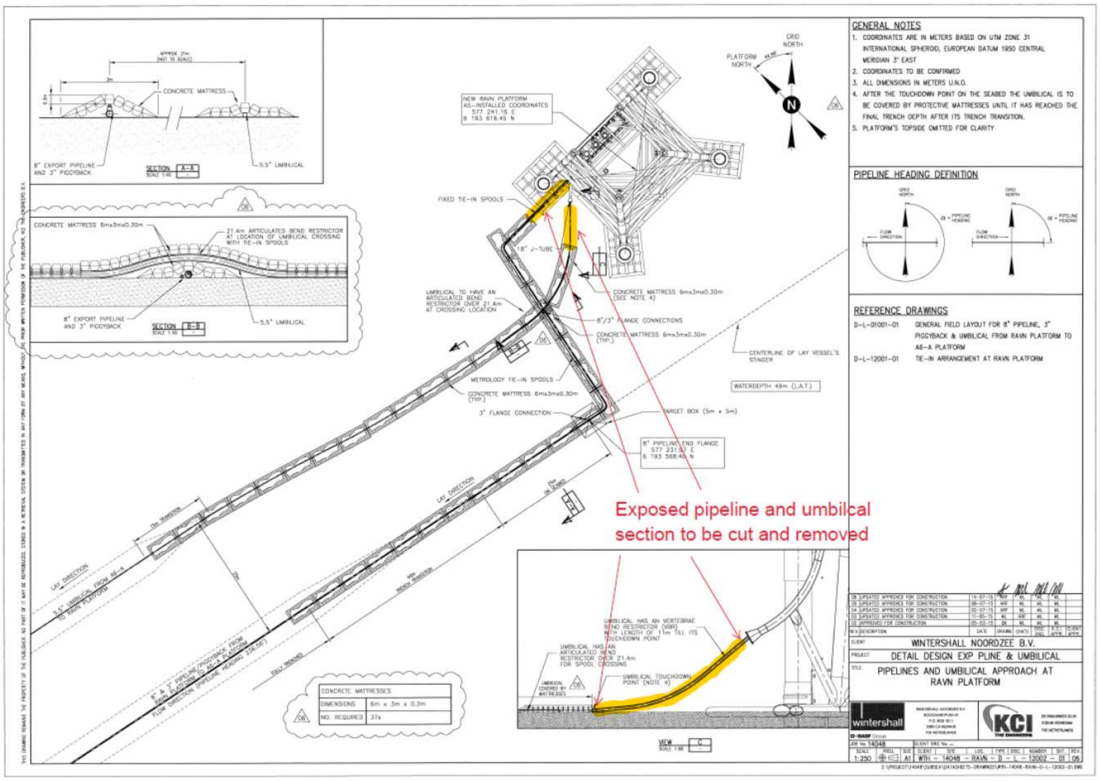


Figure 3-10 8-inch/3-inch pipeline bundle and umbilical sections to be cut and removed at Ravn Platform.

3.2.5 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 3-10 the assessed decommissioning options for the pipelines and the umbilical are presented.

Table 3-10 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 3-11.

Table 3-11 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 the EIA chapter 16. 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 rocks if needed during the preparational phase (clean and disconnect).
- Installed rock layer 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 (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 rock placement 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 3-12.

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 3-12.

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 3-12.

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 3-12 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).

3.2.6 Post decommissioning site survey

After the completion of the abandonment work, a survey of the former platform site (500 m safety 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.

3.2.7 Transport to shore

The waste fractions are to be removed to an onshore disposal yard. 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.

3.2.8 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.

4 Methodology for assessment of impacts

The environmental significance (severity) and risk of impacts of the project on environmental receptors has been evaluated using the following methodology.

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 incident 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.

4.1 The assessment of severity

The assessment of severity includes the following steps:

- Assessments of nature, extent, duration and magnitude of impacts using the criteria shown in Table *4-1* 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 *4-2*.

Table 4-1 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 4-2 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 feature or issue is improved compared to existing conditions
No impact	The assessed ecological 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
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
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)

4.2 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 *4-3*.

Table 4-3 Criteria for assessment of the probability of that and 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

4.3 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 *4-4*).

Table 4-4 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

5 Potential transboundary impacts

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

- 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
- Unplanned/accidental discharge

Almost all abovementioned impacts from the decommissioning of Ravn are based on the methodology described in section 4.

Based on the results of the detailed assessment, the Espoo report presents a screening of the same impacts in relation to their potential transboundary effects. Because of the low range for most of the project impacts, significant transboundary impacts can be ruled out with certainty in many cases. Subsequently, these impacts are not further elaborated on in this chapter, and focus is given to those impacts for which significant transboundary impact cannot be excluded in the first place.

Activity	Potential impact	Transboundary evaluation
Environmental impacts from decommissioning		
Removal of installations	› Impacts of underwater noise arising during the cutting of the legs of the platforms. › Underwater noise from vessel › Removal of artificial reef	› Local impact only › Local impacts/ potential transboundary if pipelines are removed › Local impacts only
Emissions to air	› Release of particles (PM_{10}) and gaseous emissions (SO_x, NO_x, CO_2) from vessels with potential effects on air quality	› Regional and international short term minor impacts

The only potential transboundary 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 the EIA. Lastly the situation of removal the pipelines would happen across the Danish and German sector which could cause disturbance of the seabed and sediment dispersal.

5.1 Emissions

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.

Also, the rig and vessel activity would be comparable with normal operations and will not results in any negative cross-boundary effects.

5.2 Disturbance of the seabed

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.

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.

5.2.1 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.

5.2.2 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 (section 5.3), it is assessed that it will be a local, short-term and a very small magnitude, i.e., a negligible environmental risk.

5.2.3 Removal of pipelines (cut and lift/ reverse installation)

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. 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.

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 og Møhlenberg, 1982). Recovery of the echinoderms including *Amphiura filiformis* may take longer time, due to slow growth and late maturity.

In summary, 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 og cut and lifting.

Transboundary effects

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. 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).

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). 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 offspring.

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.

5.2.4 Underwater noise source and effects

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 5-1.

Table 5-1 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).

Impact	I-type sounds SEL (cum) $L_{E,p,xx,24h}$ (dB re 1μPa^{2}s)[3]	Other sounds SEL (cum) $L_{E,p,xx,24h}$ (dB re 1μPa^{2}s)[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

1) SPL $L_{p,rms,125ms}$

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 μPa^2s 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.

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 from both cutting and vessels is assessed to be **Insignificant.**

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.

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 or negative impacts although the duration of noise generation related activities will be longer for removal of the pipelines.

Based on the above and using the criteria described in chapter 4, 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.**

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 μPa^2 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.

5.3 Other impacts in regard to pipelines

5.3.1 Decomposition of pipeline corrosion protection layers

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 leaching 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.

6 Environmental assessment of accidental oil spill

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

6.1 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 6-1) and an overview of the levels of oil appearances distinguished according to the Bonn Agreement (2016).

Table 6-1 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 6-2 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

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 above consideration and the expected low volume of oil in the unlikely event of an vessel 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 SVOs

6.2 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.

Based on the above it is assessed that the environmental risk due to oil spill is **negligible**.

7 Cumulative effects assessment

*Table 7-1 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 1.5.*

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.

8 Marine Strategy Framework Directive (MSFD)

The impacts identified to have potential transboundary impacts as described in the previous sections in chapter 6 may potentially affect the Marine Strategy Framework Directive's (MSFD) 11 descriptors of Good Environmental Status (GES).

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 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.

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.

The potential impacts from the Ravn decommissioning project activities are compared with the targets for the 11 descriptors and summarized in the table below.

Table 8-1 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.

Descriptor	Assessment of potential impact
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. 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.

9 Conclusion

The potential environmental impacts arising from the decommissioning Ravn project will be of local character and are confined to Danish waters. These impacts have been assessed in the EIA report to have an insignificant or minor impact on the environment. Underwater noise is assessed to have a insignificant and short-term impact and it is confined to Danish waters.

It is further concluded that the decommissioning of Ravn will not negatively affect the conservation status of habitats and species, for which potentially affected Natura 2000-sites have been designated as well as species listed on Annex IV of the EU Habitats directive (Directive 92/43EEC of 21 May 1992). Nor will the project affect the integrity of the areas 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).

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