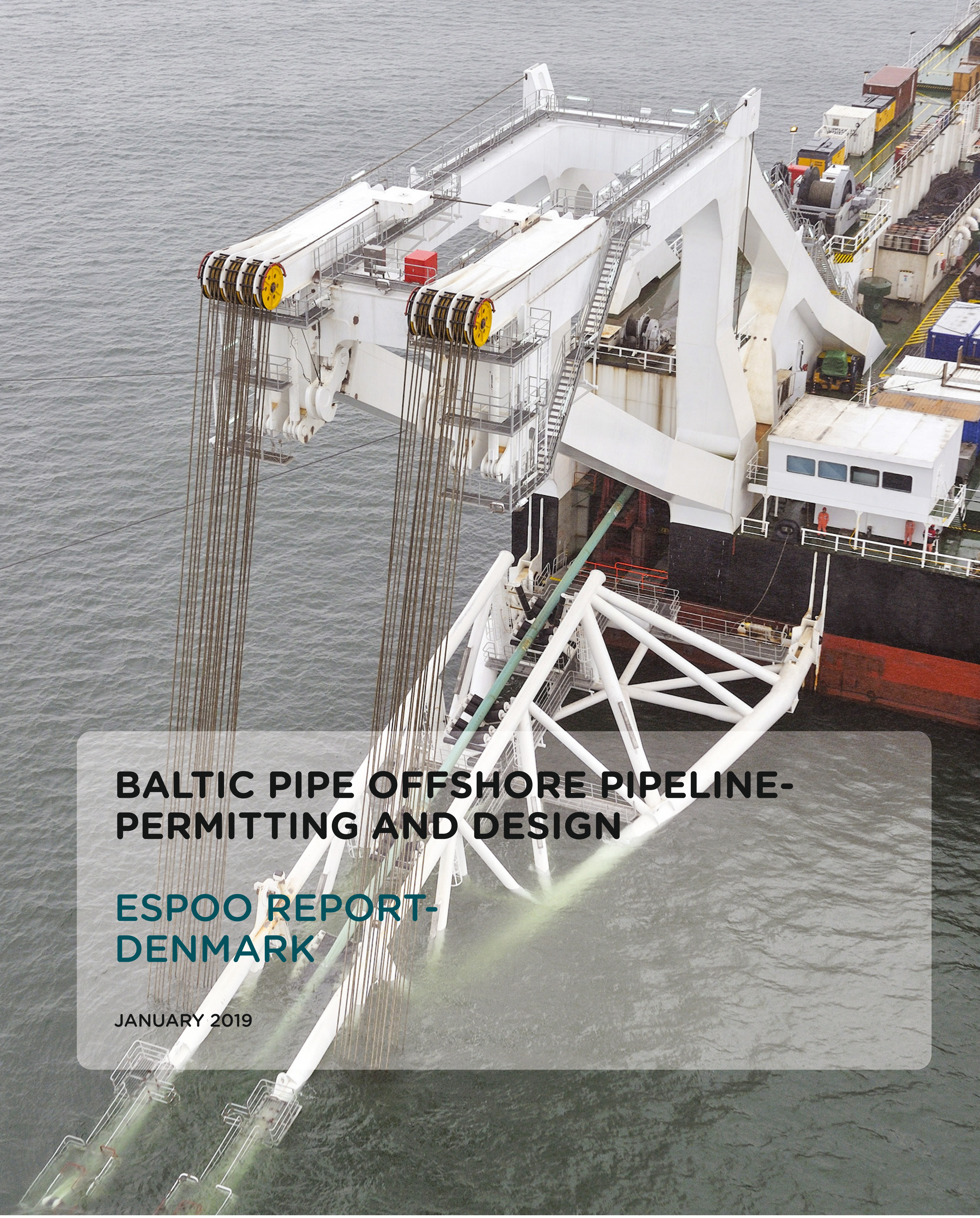

BALTIC PIPE OFFSHORE PIPELINE-PERMITTING AND DESIGN

ESPOO REPORT-DENMARK

JANUARY 2019

BALTIC PIPE PROJECT | GAZ system

Co-financed by the Connecting Europe Facility of the European Union

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BALTIC PIPE OFFSHORE PIPELINE – PERMITTING AND DESIGN

ESPOO REPORT - DENMARK

NON-TECHNICAL SUMMARY

The Baltic Pipe is a strategic gas infrastructure project that will enable the transport of gas from fields in Norway to the Danish and Polish markets and beyond. The Baltic Pipe project is planned and implemented as a collaboration between GAZ-SYSTEM S.A. and Energinet and is scheduled to be operational by 2022.

The offshore pipeline in the Baltic Sea between Denmark and Poland is an important part of the overall Baltic Pipe project and the subject of this Espoo report. The Espoo report and procedure are an integrated part of the environmental impact assessment (EIA) procedures and approval processes in the respective countries of origin. Based on the results of each country EIA report, the Espoo report analyses the extent to which activities originating in each country could have a transboundary impact on environmental and socio-economic receptors in neighbouring countries.

The main conclusions are summarised for Denmark in the below table.

Affected Party (AP)	Party of Origin (PoO) Denmark
Sweden	Denmark and Sweden share two borders along the pipeline route. Potential long-range project impacts include sediment dispersion and underwater noise. Modelling of sediment dispersion shows that significant transboundary impact is unlikely due to the limited duration and range. Significant transboundary impacts on marine mammal and fish populations caused by underwater noise from munitions clearance (detonation) can be avoided by applying mitigation measures. The pipeline route crosses the Swedish Natura 2000 site "Sydvästskånes utsjövatten". It is concluded that no activities originating in Denmark can have a significant transboundary impact on this site.
Poland	Denmark and Poland share one border along the pipeline route. Potential long-range project impacts include sediment dispersion and underwater noise. Modelling of sediment dispersion shows that significant transboundary impact is unlikely due to the limited duration and range. Significant transboundary impacts on marine mammal and fish populations caused by underwater noise from munitions clearance (detonation) can be avoided by applying mitigation measures. The pipeline route crosses two overlapping Polish Natura 2000 sites, "Ostoja na Zatoce Pomorskiej" and "Zatoka Pomorska". It is concluded that no activities originating in Denmark can have a significant transboundary impact on these sites.
Germany	The Baltic Pipe route does not enter German waters. Potential long-range project impacts include sediment dispersion and underwater noise. Given the distance from project activities in Denmark to the German EEZ, transboundary impacts can be excluded.

Overall, no impacts from the Baltic Pipe project that originate in Denmark will lead to any significant transboundary impacts in Sweden, Poland, and/or Germany.

Entire Baltic Pipe route through the Baltic Sea
It has been concluded in the report that cumulative impacts from the Baltic Pipe project in combination with other plans and projects in the Baltic Sea region can be ruled out.

Cumulative impacts caused by the Baltic Pipe project itself when considering all impacts from the entire project have also been assessed. Landfall construction is planned to occur simultaneously in the nearshore areas of Denmark and Poland, but due to the distance between the landfall areas, cumulative impacts can be excluded. Offshore construction will occur as a continuous, linear process. Potential short-term impacts during offshore construction have been assessed not to be significant. As pipe-lay will occur as a continuous, linear process, cumulative impacts within the project are unlikely. Long-term or permanent impacts have been assessed not to be significant in any given country nor in the entire project area. As such, cumulative impacts from the project as a whole can be excluded.

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ABBREVIATIONS LIST

AIS - Automatic identification system
ALARP – As Low As Reasonably Practicable
AP – Affected Party
API – American Petroleum Institute
BWM – Ballast Water Management Convention
CAB – Country Administrative Board of Skåne
C-POD – Harbour Porpoise Click Detector
CPT – Cone Penetration Test
CPUE – Catch per unit effort
CRA – Construction Risk Analyses
CWA – Chemical Warfare Agents
DA – Disputed Area
DEA – Danish Energy Agency
DK – Denmark
DP – Dynamical Positioning
DPS – Dynamical Positioning System
EEZ – Exclusive Economic Zone
EIA – Environmental Impact Assessment
EPA – Danish Environmental Protection Agency
EU – European Union
FAR – Fatal Accident Rate
FCG – Flooding, cleaning and gauging
FPV – Fall Pipe Vessel
GE – Germany
GES – Good Environmental Status
GHG – Greenhouse Gas
GT – Gross Tonnage
GWP – Global Warming Potential
HAZID – Hazard Identification
HELCOM – Helsinki Commission, Baltic Marine Environment Protection Commission
ICES – International Council for the Exploration of the Sea
ID – Inner Diameter
IGV – International guidance values
IMO – International Maritime Organization
IR – Individual Risk
IUCN – International Union for Conservation of Nature
K.C. – Kampfstoff Cylindrisch
KP – Kilometre Point
KPI – Kilometre Point Interval
LNG – Liquid Natural Gas
MARPOL – International Convention for the Prevention of Pollution from Ships
MEG – Mono Ethylene Glycol
MMO – Marine Mammals Observer
MSFD – Marine Strategy Framework Directive
NIS – Non-indigenous species
NM – Nautical Mile
NSP – Nord Stream Pipeline
OSPAR – Convention for the Protection of the Marine Environment of the North East Atlantic
PAH – Polyaromatic hydrocarbon

PAM – Passive acoustic monitoring
PCI – Project(s) of Common Interest
PL – Poland
PLONOR – Pose Little or No Risk to the Environment
PM – Particulate matter
POM – Particulate organic matter
PoO - Party of Origin
PSU – Practical salinity unit
PTS – Permanent threshold shift
QRA – Quantitative Risk Assessment
RAC – Risk Assessment Criteria
RDOS - Regional Directorate for Environmental Protection in Szczecin
ROV – Remotely Operated Vehicle
SAC – Special Area(s) of Conservation
SCADA – Supervisory Control and Data Acquisition
SCI – Site(s) of Community Interest
SD – Subdivision
SE – Sweden
SEAC – Submarine Exercise Area Coordinator
SEPA – Swedish Environmental Protection Agency (Naturvårdsverket)
SPA – Special Protection Areas
SPL – Sound Pressure Level
SSC – Suspended sediment concentration
TBM – Tunnel boring machine
TNT - Trinitrotoluene
TOP – Top of pipe
TSS - traffic separation scheme
TTS – Temporary threshold shift
TW – Territorial Waters
UNCLOS – United Nations Convention on the Law of the Sea
UXO – Unexploded Ordnance
VMS – Vessel Monitoring System
WFD – Water Framework Directive
WWII – World War II

1. INTRODUCTION

1.1 Reading guide

This report comprises the Espoo documentation of Denmark elaborated under the Baltic Pipe project. It contains a description of the project-related transboundary environmental and socio-economic impacts, which are caused by project impacts generated in Denmark and potentially affecting the marine territories (EEZ and/or territorial waters) of Sweden, Poland and Germany.

The Espoo report has originally been conceptualized to serve as common report for all the three countries of origin: Denmark, Poland and Sweden. However, since the publication of the Espoo report in each country is bound to the national EIA process and these processes are not fully synchronized between the countries, each country is producing their own report, of which the Danish is the first to be published. Chapters 2-7 provide relevant background information on the Baltic Pipe project, herein a project description, the legal framework and the mechanisms of the Espoo process, as well as a section on risk assessment and the assessment methods applied. The central part of this report in Chapter 8 deals with the assessment of transboundary impacts. The assessment chapters are organized by environmental/ socio-economic 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 impact Sweden Poland and Germany. 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 12..

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

1.2 Project background and justification

The Baltic Pipe is a strategic gas infrastructure project, with the goal of creating a new natural gas supply corridor on the European market. The project will ultimately make it possible to transport gas from fields in Norway to the Danish and Polish markets, as well as to customers in neighbouring countries. If required, the Baltic Pipe will enable the reverse supply of gas from Poland to the Danish and Swedish markets. The offshore pipeline between Denmark and Poland is an important part of the overall Baltic Pipe project.

The Baltic Pipe project is planned and implemented as a collaboration between GAZ-SYSTEM S.A., the Polish gas transmission company and Energinet, the Danish operator of transmission systems for natural gas and electricity. Energinet and Gaz-System have concluded a Construction Agreement, in which they divided the responsibility for specific main component of the Baltic Pipe. According to the Construction Agreement, Energinet will construct, own and operate Norwegian Tie-In, the expansion of the Danish transmission system and the Compressor Station, while Gaz-System will construct, own and operate the offshore interconnector between the Polish shore and the Danish shore on the island of Zealand, as well as the expansion of the Polish transmission system. Details of the division of ownership and operatorship can be found at: https://www.baltic-pipe.eu/the-project/.

The Baltic Pipe project consists of five key components (see Figure 1-1):

1) A new gas pipeline in the North Sea (length 120 km) from the Norwegian offshore gas fields to the Danish coast. In the North Sea, the pipeline ties in to the existing Europipe II pipeline connecting Norway and Germany.
2) A new gas pipeline is planned, which extends over approx. 220 km across Jutland, Funen, and southeast Zealand in Denmark.
3) A new compressor station (CS Zealand) at the Danish shore in Zealand.

4) An offshore pipeline in the Baltic Sea linking Denmark and Poland for bi-directional gas transmission, with Sweden as transition country (see Figure 1-1).
5) The necessary expansion of the Polish gas system to receive gas from Denmark.

Figure 1-1 Schematic representation of the five major components of the Baltic Pipe project.

The main objective of the Baltic Pipe project is to further strengthen supply diversification, market integration, price convergence and security of supply in primarily Poland and Denmark and secondarily in Sweden, Central and Eastern Europe and the Baltic region.

For these reasons the Baltic Pipe project was included in the first list of Projects of Common Interest (PCI), drawn up by the European Commission in 2013, and in the subsequent list adopted by the European Commission on 18 November 2015, underlining its regional importance. The Baltic Pipe is project No. 8.3 in the Union list of projects of common interest (Annex VII, (8), 8.3).

Because of the PCI status, the project may benefit from accelerated planning and permit granting, a single national authority for obtaining permits, improved regulatory conditions, lower administrative costs due to streamlined environmental assessment processes, increased public participation via consultations, and increased visibility to investors.

The anticipated construction time is approximately 2 years, and the gas pipeline is planned to be ready for operation in 2022.

2. LEGAL FRAMEWORK AND ESPOO CONSULTATION PROCESS

A linear transnational project such as the Baltic Pipe project must comply with numerous international conventions as well as directives and laws on the EU and national levels. This chapter provides an overview of the legal framework and national approval processes, which apply to the Baltic Pipe project and which also contains the procedures to be followed under the Espoo Convention. Separate national approval procedures are applied in Denmark, Sweden and Poland.

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 includes Denmark, Sweden and Poland.

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 Baltic Pipe project Denmark, Sweden and Poland are both APs and PoOs, while Germany is AP, only.

The convention states that the PoOs shall, consistent with the provisions of the convention, ensure that APs are notified of a proposed activity, such as a large-diameter oil and gas pipelines (#8 - Appendix 1 of the conventions) that is likely to cause a *significant adverse* transboundary impact.

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 Points in each of the PoOs. 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 time-frame 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 Baltic Pipe project is considering recommendations given from the Economic Commission for Europe (UNECE, 1996) and the European Commission (European Commission, 2013).

The consultation process started in December 2017, when the Danish EPA as Espoo focal point distributed a letter of notification together with an Espoo Scoping report to the APs. In addition, all Baltic Sea, which are not expected to be affected by the project, received a letter of information.

In Table 2-1 a schedule of the consultation process is presented. As can be seen from the table, all three countries have issued a response. The responses were analysed and integrated into the further planning process, particularly spatial conflicts with military zones in Germany and Sweden that needed to be resolved.

Table 2-1 Milestones of the Espoo Consultation process. DK: Denmark, SE: Sweden, PL: Poland, GE: Germany.

Milestones	Explanation	Schedule
Initial Consultations	Espoo informal information meeting: Meeting with Espoo focal points of DK, and PL and point of contact of SE, plus Energinet, Ramboll and GAZ-SYSTEM S.A.	22/11/2017
Notification (Article 3)	EPA issues notification letters and Espoo Scoping report to all countries of the Baltic Sea Region. This includes the APs SE, GE and PL. In addition, letters of information are sent to Finland, Russia, Estonia, Latvia, and Lithuania, which are not considered to be APs.	19/12/2017
Response	Responses received from: **Germany:** Bundeswehr; and Bergamt Stralsund. **Sweden (Espoo hearing):** SEPA (Naturvårdsverket), which conducted a national hearing among institutions and stakeholders from 9 Feb -22 Mar and collected responses, which were sent to the Danish Focal Point. **Poland**: General Directorate for Environmental Protection	Responses received in the period: 15/02/2018 to 28/03/2018
Consultations	Consultations: Focal point meeting of DK, and PL and point of contact of SE	13/06/2018
Distribution of Espoo report	An Espoo report will be distributed from DK to GE, SE and PL on 08/2 2019 for aligning with the DK EIA consultation phase beginning 15/02 2019. SE and PL will issue their the report as soon as the focal points are ready and aligned with their national EIA procedures. GE will thus receive three Espoo reports with shifted consultation phases according to the procedures in the PoO.	25/01/2019 (delivery of Espoo report to DK authorities)
Final Decision in DK	The Danish Focal Point informs APs of their decision	Expected by the end of July 2019
Final Decision in SE	No final decision regarding the Espoo process	-
Final Decision in PL	The Polish Focal Point informs APs of their decision	Expected by the end of August 2019

2.2 Further international legal requirements

2.2.1 The EU Habitats and Wild Birds Directives

Together, the Habitats[1] and Birds[2] Directives form the cornerstone of the legislative framework for protecting and conserving wildlife and habitats in the European Union (EU) and establish the EU-wide Natura 2000 ecological network of protected areas, safeguarded against potentially damaging developments. The aim of the network is to ensure favourable conservation status for the species and habitats, which form the designation basis of the habitats and bird protection sites, across their natural range.

The Natura 2000 network comprises;

- *Birds sites (Special Protection Areas (SPA))*: sites designated for the protection of rare and vulnerable bird species listed in Annex I of the Birds Directive, as well as of regularly occurring migratory bird species. Sites are also known as bird protection sites. Ramsar sites[3] are also included, as protected wetland areas with special importance for birds; and
- *Habitat sites (Special Areas of Conservation (SAC)/Site of Community Interest (SCI))*: designated sites under the Habitats Directive, designated for natural habitats and species.

Strictly protected species: The Habitats Directives Annex IV contains a list of species that are strictly protected across their entire natural range within the EU, both within and outside Natura 2000 sites.

Denmark

The main implementation of the Habitats and Birds Directives in Danish legislation is through the Act on Environmental Goals[4] and the Habitats Order[5], but the directives are also implemented in other parts of Danish legislation, including the Offshore Appropriate Assessment Order[6].

In addition, the Administrative Order on Offshore Appropriate Assessments applies to the project for assessment of the significant impact on Natura 2000 sites as well as for the strictly protected species, Annex IV species.

Sweden

The implementation of the Habitats and Birds Directives in Swedish legislation is through Chapter 7 of the Environmental Code (1998:808) and the Species Protection Ordinance (2007:845).

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[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] Ramsar sites are identified as part of the UN Convention of the Wetlands of International Importance especially as Waterfowl Habitat (also known as the Ramsar Convention). In the EU all Ramsar sites are included in the network of Special Protection Areas (SPAs) under the Birds Directive.

[4] 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)*.

[5] Administrative Order no. 1595 of 06/12(/2018 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)*.

[6] Administrative Order no. 434 of 02/05/2017 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).*

Poland
The Habitats and Birds Directives were implemented to Polish legislation through the Nature Protection Act[7] and numerous implementing orders to these acts, as they not only determine the habitats and species for which there is legal obligation for protection by means of site delimitation, but also are the source of Natura 2000 sites delimitation.

Another important act implementing these two directives is the Act of 3rd October 2008 on sharing of information on the environment and its protection, public participation in environmental protection and on environmental impact assessments[8] as it contains the rules and procedures for appropriate assessment in the Polish legal system.

2.2.2 Marine Strategy Framework Directive

The Marine Strategy Framework Directive[9] (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[10] to help Member States implement the MSFD. To achieve GES by 2020, each Member State is required to develop a strategy for its marine waters (Marine Strategy).

Denmark

The MSFD is implemented in Danish legislation through the Consolidated Act on Marine Strategy[11]. The purpose of the act is to establish the framework for achieving GES in Danish waters. The central instrument in achieving this is the Marine Strategy, which covers all Danish marine waters, including the Danish waters of the Baltic Sea.

Sweden
The MSFD is implemented in Swedish legislation through Chapter 5 of the Environmental Code (1998:808) and the Marine Environment Ordinance (2010:1341). The purpose of the ordinance is to establish the framework for achieving GES in Swedish marine waters, including the Baltic Sea. GES will be achieved through marine strategies involving establishing reference conditions, environmental targets and monitoring programs.

Poland
In Poland MSFD is implemented through the Water Law Act[12]. According to the aforementioned act Marine Strategy is set of various documents including among others initial assessment of the current status of marine waters[13], determination of good environmental status of waters

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[7] Ustawa z dnia 16 kwietnia 2004 r. o ochronie przyrody (t.j. Dz. U. z 2018 r. poz. 1614).
[8] Ustawa z dnia 3 października 2008 r. o udostępnianiu informacji o środowisku i jego ochronie, udziale społeczeństwa w ochronie środowiska oraz o ocenach oddziaływania na środowisko (t.j. Dz. U. z 2018 r. poz. 2081).
[9] 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).
[10] 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.
[11] Consolidated Act no. 117 of 26/01/2017 on Marine Strategy *(bekendtgørelse af lov om havstrategi)*.
[12] Ustawa z dnia 20 lipca 2017 r. Prawo wodne (t.j. Dz. U. z 2018 r. poz. 2268 z późn. zm.).
[13] Wstępna ocena stanu środowiska wód morskich polskiej strefy morza bałtyckiego. Główny Inspektor Ochrony Środowiska, Warszawa 2013.

concerned[14] and National Program of Marine Waters Protection[15] being a program of measures for achieving GES in all Polish marine waters.

Assessments required under the MSFD are integrated into the EIA reports.

2.2.3 Water Framework Directive

The Water Framework Directive[16] (WFD) is the legislative framework for protection of water in EU (rivers, lakes, groundwater, inland waters, surface water and coastal waters). The Directive sets a new approach for water management and protection by river basins – the natural geographical and hydrological unit – instead of according to administrative or political boundaries. The overall objective for the Directive is that all waters must achieve "good status". Good status is achieved when both the ecological and chemical status is good. The Directive covers coastal waters up to 1 nautical mile (NM) off the coast for ecological status and 12 NM for chemical status.

Denmark

The main implementation of the WFD in Danish legislation is through the Consolidated Act on Water Planning[17] and associated administrative orders[18][19]. A central element of implementing the WFD is river basin management plans, which contain information about how the river basins are affected, monitoring, assessment of the status, environmental targets and measures to achieve the targets.

Sweden

The main implementation of the WFD in Swedish legislation is through Chapter 5 of the Environmental Code (1998:808) and the Water Quality Management Ordinance (2004:660). A central element of implementing the WFD is the river basin management plans, containing information about how the river basins are affected, monitoring, and assessment of the status, environmental targets and measures to achieve the targets.

Poland

In Poland WFD is implemented to through the Water Law Act.[20] The administrative orders associated to this act contain among others the rules for the assessment of water bodies status[21] and the requirements for monitoring[22]. The assessment of water bodies statues, risk and pressures on individual waters bodies, environmental targets and program of measures for achieving the targets are stipulated by river basins management plans. In this respect plan which

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[14] Rozporządzenie Ministra Środowiska z 17 lutego 2017 r. w sprawie przyjęcia zestawu celów środowiskowych dla wód morskich (Dz. U. poz. 593)

[15] Rozporządzenie Rady Ministrów z dnia 11 grudnia 2017 r. w sprawie przyjęcia Krajowego programu ochrony wód morskich (Dz. U. z 2017 r. poz. 2469)

[16] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy

[17] Consolidated Act no. 126 of 26/01/2017 on water planning *(bekendtgørelse af lov om vandplanlægning)*.

[18] Administrative Order no. 1522 of 15/12/2017 on Environmental Targets for Surface Water and Groundwater *(bekendtgørelse om miljømål for overfladevandområder og grundvandsforekomster)*.

[19] Administrative order no 1521 of 15/12/2017 on programmes for river management districts *(bekendtgørelse om indsatsprogrammer for vandområdedistrikter)*.

[20] Ustawa z dnia 20 lipca 2017 r. Prawo wodne (t.j. Dz. U. z 2018 r. poz. 2268 z późn. zm.).

[21] Rozporządzenie Ministra Środowiska z dnia 21 grudnia 2015 r. w sprawie kryteriów i sposobu oceny stanu jednolitych części wód podziemnych (Dz. U. z 2015 r., poz. 85); rozporządzeniu Ministra Środowiska z dnia 21 lipca 2016 r. w sprawie sposobu klasyfikacji stanu jednolitych części wód powierzchniowych oraz środowiskowych norm jakości dla substancji priorytetowych (Dz. U. z 2016, poz. 1187).

[22] Rozporządzenie Ministra Śrdowiska z dnia 19 lipca 2016 r. w sprawie formy i sposobu monitoringu jednolitych części wód powierzchniowych i podziemnych (Dz. U. z 2016, poz. 1178)

has the importance for conducting assessment of impacts of Baltic Pipe is Water management plan for Oder River Basin[23].

Assessments required under the WFD are integrated into the EIA reports.

2.2.4 Helsinki Convention

The Convention on the Protection of the Marine Environment of the Baltic Sea Area (the Helsinki Convention) covers the whole of the Baltic Sea area. Measures are also taken in the whole catchment area of the Baltic Sea to reduce land-based pollution.

The governing body of the Convention is the Baltic Marine Environment Protection Commission – Helsinki Commission, also known as HELCOM. The present Contracting Parties to HELCOM are Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia, and Sweden. One of the most important duties of HELCOM is to make Recommendations on measures to address certain pollution sources or areas of concern. These Recommendations are to be implemented by the Contracting Parties through their national legislation.

The HELCOM Baltic Sea Action Plan was adopted in 2007 (and is updated regularly) and provides a concrete basis for HELCOM work. Its overall objective is to restore the good ecological status of the Baltic marine environment by 2021 and it sets goals and objectives for eutrophication, biodiversity, hazardous substances, and maritime activities.

2.2.5 The OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic or OSPAR Convention (1992 and 1998) is the current legislative instrument regulating international cooperation on environmental protection in the North-East Atlantic.

In accordance with the provisions of the Convention, the Contracting Parties shall take all possible steps to prevent and eliminate pollution and take the necessary measures to protect the maritime area against the adverse effects of human activities so as to safeguard human health and to conserve marine ecosystems and, when practicable, restore marine areas which have been adversely affected.

Regarding the establishment and dismantling of offshore installations the Contracting Parties are obliged to apply best available techniques and best environmental practices in congruence with the criteria set forth in Appendices I-III of the convention.

2.3 National approval procedure in Denmark

2.3.1 The Continental Shelf Act

According to Sections 3(a) and 4 of the Continental Shelf Act[24], pipelines for transporting hydrocarbons in Danish territorial waters and on Danish continental shelf require a permission from the Minister of Energy, Utilities, and Climate (a construction permit). As a prerequisite for the construction permit, an opinion from the Foreign Minister on the compatibility of the project with Denmark’s foreign policy, security policy and defence policy is required.

[23] Rozporządzenie Rady Ministrów z dnia 18 października 2016 r. w sprawie Plany gospodarowania wodami na obszarze dorzecza Odry. (Dz. U. z 2016 r., poz. 1967).

[24] Consolidated Act no. 1101 of 18/11/2005 on the Continental Shelf *(Bekendtgørelse af lov om kontinentalsoklen)* with amendments, including LOV no. 1401 of 05/12/2017.

Requirements and terms for the permitting process for pipelines for the transportation of hydrocarbons between two foreign states are regulated by the Administrative Order on Pipeline Installations[25].

2.3.2 Environmental Impact Assessment (EIA)

The EIA procedure is regulated by the Consolidated Act on Environmental Assessment. In congruence with European legislation (EIA Directive[26]) Annex I of the Consolidated Act contains projects for which EIA is mandatory. The Baltic Pipe project is covered by Annex I (section 16(a)) of the Consolidated Act on Environmental Assessment, and thus EIA is mandatory.

The Danish Energy Agency (DEA), as representative for the Ministry of Energy, Utilities and Climate, is the authority regarding the EIA process for projects in Annex 1, section 16(a).

As the project is included in the current list of PCIs, the DEA will act as a one-stop-shop, coordinating and facilitating the permit granting process in Denmark. The DEA will coordinate the permit granting process in cooperation with the Danish EPA as the competent authority for the onshore part of the Baltic Pipe project in Denmark.

The approval procedure comprises several milestones, which are explained in Table 2-2.

Table 2-2 Milestones of the national approval process in Denmark.

Milestone	Explanation	Date
Notification	In accordance with § 18 of the Consolidated Act on Environmental Assessment the project has been notified to the DEA, containing a short description of the project together with a definition of the project. The notification has been submitted jointly with Energinet's notification.	08/11/2017
Scoping	Although not legally required in Denmark, GAZ-SYSTEM S.A. decided in agreement with the authorities to conduct a national scoping process for the Baltic Pipe project to inform of the expected level of baseline studies and the content of the EIA. A scoping document containing the envisaged environmental programme and assessment approach has been delivered to the DEA. The DEA is to ensure that all relevant authorities are consulted and have the possibility of commenting on the scope. The scoping decision has resulted in requirements from the authorities regarding the environmental assessment scope.	Scoping report delivered 21/12/2017 Scoping statement received 28/09/2018
First public hearing (scoping phase)	The first public hearing took place as a part of the scoping phase. Together with the Danish EPA, the DEA has called for ideas and proposals for the scoping of the onshore and offshore EIAs in Denmark via their website (www.ens.dk). The public hearing took place from 21/12/2017 to 22/01/2018. For compliance with PCI regulations public meetings were arranged, which took place in six Danish cities in January 2018. The incoming comments from the 1st Public Hearing have been used as input for the EIA.	21/12/2017 to 22/01/2018

[25] Administrative Order no. 1520 of 15/12/2017 on Pipeline Installations *(bekendtgørelse om visse rørledningsanlæg på søterritoriet og kontinentalsoklen).*

[26] 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.

Milestone	Explanation	Date
EIA report	The purpose of the EIA procedure is to ensure that the likely significant environmental impacts of the proposed project are assessed systematically prior to project implementation. The EIA report identifies, describes, and assesses the likely significant impacts (direct and indirect) from the project on receptors for the three environments; physical-chemical, biological, and socio-economic.	07/02/2019
Second public hearing (EIA phase)	This public hearing will take place after the EIA is finished and submitted to the DEA, which will be notified on the DEA homepage (www.ens.dk). As part of the second public hearing, the DEA may also decide to arrange public meetings or distribute information on the project by other means to members of the public who have an interest.	From 08/02/2019 Public hearing phase 8-10 weeks
Approval	Based upon a thorough inspection of the plan approval documents, and comments received from the public and interested parties, the DEA will grant consent for the Baltic Pipe project and formulate the conditions and requirements for implementation.	Expected 01/07/2019

3. PROJECT DESCRIPTION

This chapter presents the technical design of the Baltic Pipe project and outlines the various activities and phases related to construction and operation. The description of construction activities will geographically focus on the offshore part (Baltic Sea only), which is the point of origin for potential transboundary impact.

3.1 Pipeline route

The route for the offshore part of the Baltic Pipe, linking Denmark and Poland, is shown in Figure 3-1. Other route alternatives that have been considered, are described in Chapter 5.

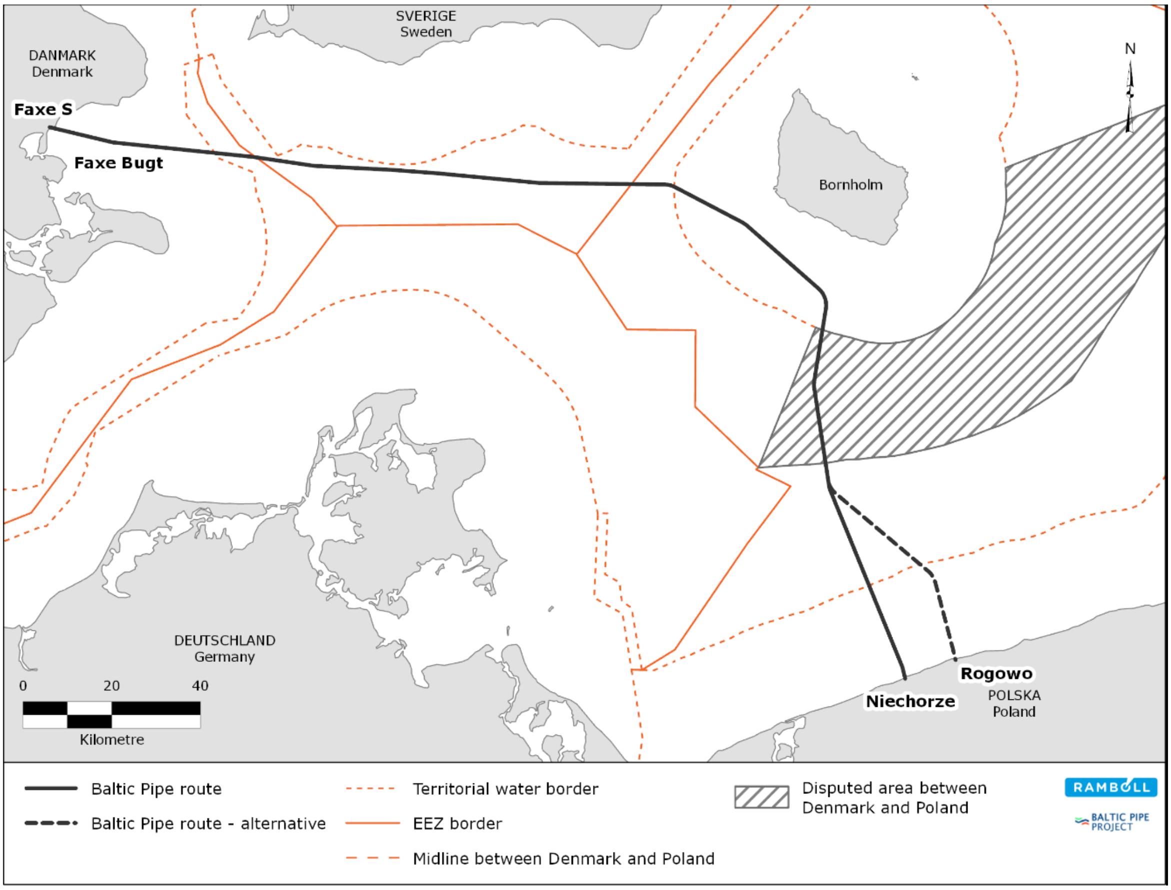

Figure 3-1 Baltic Pipe route from Denmark to Poland[27].

From Faxe Bugt the pipeline route enters the Swedish EEZ and then re-enters the Danish EEZ/territorial waters around Bornholm. From there, it enters the disputed area between Denmark and Poland, before entering the Polish EEZ/territorial waters. The Polish landfall is expected to be at Niechorze, alternatively at Rogowo.

The lengths of the various route segments are shown in Table 3-1.

[27] Agreement on precise border between Denmark and Poland has not been ratified by the time of issue of the Baltic Pipe Espoo report.

Table 3-1 Route length within the different TW and EEZs. The disputed area is an area between Denmark and Poland where the EEZ border has not been agreed. The disputed area extends from Danish TW to the midline between Denmark and Poland.

Route section	Route lengths in different TW and EEZs (km)				
	Danish	Swedish	Disputed area	Polish	Total
Proposed pipeline route	107.3	84.7	30.3	51.1	**273.7**

3.2 Field surveys

Geophysical and geotechnical surveys have been carried out, starting in October 2017. The survey results are providing the basis for the detailed engineering design of the pipeline system and are used together with environmental surveys for the environmental baseline description and in assessing the possible environmental impacts of the pipeline project.

Additional geophysical and/or geotechnical surveys might be carried out during the pipeline installation phase. This could include a survey for possible UXO (Unexploded Ordnance) objects and other surveys for ensuring an optimal and safe pipeline installation.

3.2.1 Geophysical surveys

The geophysical investigations include multibeam bathymetry, side scan sonar, magnetometer measurements and high frequency seismic investigation of the uppermost 10 m of the seabed.

Geophysical investigations are carried out in a 500 m wide corridor around the centreline of the pipeline route (250 m at each side). Within Natura 2000 sites, the survey corridor has been expanded to 1,000 m around the centreline. In some areas with special challenges related to crossings and the environmental conditions, the survey corridor has been expanded to 2,000 m around the route centreline.

The results of the geophysical surveys are used for optimizing the final route and construction design. This optimisation includes identification of possible UXO objects at the seabed for ensuring that they do not pose a risk to the pipeline (see Section 4.7) and identification of possible cultural heritage objects for ensuring that no damage to these takes place.

3.2.2 Geotechnical surveys

The geotechnical investigations include CPT (Cone Penetration Test) measurements and vibrocore sediment sampling along the route alternatives. In the nearshore areas (less than 10 m water depth), cone penetration tests and vibrocore sampling are carried out at three positions per kilometre. At depths greater than 10 m, cone penetration tests and vibrocore sampling are carried out at one position for every three kilometres of the route. In the landfall areas (onshore and nearshore), geotechnical drilling down to approximately 30 m below surface level is carried out.

3.3 Pipeline design

The following sections describe the mechanical design activities for the Baltic Pipe and Section 3.3.4 presents the estimated inventory of materials.

3.3.1 Wall thickness

The pipeline system will be designed in accordance with the DNVGL offshore standard F101 Submarine Pipeline Systems (DNVGL-ST-F101, 2017), and any other national requirements that the authorities may have or disclose during the liaison process (Ramboll, 2017).

The following assumptions have formed the basis for the design of the wall thickness of the pipeline:

- Pipeline size: 36 inch (fixed inner diameter of 872.8 mm);
- Estimated annual transfer volume: up to 10 billion m^3/year;
- Expected input pressure to the onshore network in Poland: 84 barg[28];
- Design pressure: 120 barg.

The offshore pipeline will be constructed using high-quality carbon steel, commonly used for the construction of high-pressure pipelines. Pipe joints with a length of approximately 12.2 m will be welded together during a continuous pipe-lay process. Steel pipes with standard thickness will be used.

The selected wall thicknesses are shown in Table 3-2, and have been calculated according to the risks to the pipeline integrity along the pipeline route. With the required wall thickness, no buckle arrestors are required to prevent propagating buckling (Ramboll, 2018d).

Table 3-2 Selected wall thickness for the 36 inch diameter Baltic Pipe. The safety zone 2 is the highest safety class, applied onshore at the Danish landfall (and Polish landfall), extending 500 m from the shore. The rest of the pipeline is zone 1, i.e. medium safety class (Ramboll, 2017).

Wall thickness criteria	Safety Zone	Unit	Wall thickness [mm]
Selected API (American Petroleum Institute) wall thickness	Zone 1	mm	20.6
	Zone 2	mm	23.8

3.3.2 Coating

Internal flow coating

The line pipe joints will be coated with internal flow coating to limit flow friction. The coating will consist of 0.1 mm epoxy paint.

External anti-corrosion coating

External anti-corrosion coating will be applied to the pipeline to prevent corrosion. This coating consists of 4.2 mm polyethylene (PE).

Concrete weight coating

The on-bottom stability design complies with the requirements from DNVGL's recommended practice On-bottom stability design of submarine pipelines (DNVGL-RP-F109, 2017).

Concrete weight coating with a thickness ranging between 50 mm and 140 mm will be applied over the pipeline's external anti-corrosion coating to provide on-bottom stability. While the primary purpose of the concrete coating is to provide stability, the coating also provides additional external protection against external load, e.g. trawl gear.

To assess the on-bottom stability of the offshore part of the Baltic Pipe as subject to wave and current loading, calculations have been made of how thick a of concrete weight coating is required, and to identify where seabed interventions are required.

[28] Barg pressure is the pressure, in units of bars, above or below atmospheric pressure.

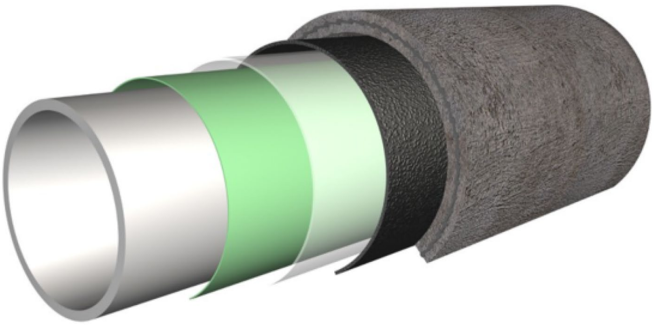

Figure 3-2 External concrete coating on top of the three-layer anticorrosion coating covering the steel line pipes.

While the concrete thickness ranges from between 50 mm and 120 mm, the concrete density is between 2,250 and 3,300 kg/m^3. In this report, the average concrete weight coating is assumed to be 100 mm thick with at density of 3,040 kg/m^3.

For some sections of the pipeline, stability cannot be proven by weight coating alone. In these areas, the pipeline will be trenched and/or rock dumped for stability purposes. Ideally it will be trenched, but if trench depths cannot be achieved, rock dumping may be used. In addition, in the very nearshore region, rock backfill may be used within the trench (instead of sand backfill).

Field joint coating
To facilitate welding of the 12.2 m long steel pipe joints on the installation vessel, the pipe coating is stopped before the steel pipe ends. The cut-back lengths are estimated at 240 mm for the anticorrosion coating and 340 mm for the concrete coating. After completion of the circumferential weld, the bare steel area is protected by a heat shrink sleeve, and the void between the adjacent concrete coatings is filled with moulded polyurethane (PU), either solid or foam.

3.3.3 Corrosion protection design

The design of corrosion protection design has been made to comply with the requirements of DNVGL-ST-F101, (2017), DNVGL-RP-F106, (2017), and DNVGL-RP-F103, (2016). The operating temperature is conservatively assumed to equal the maximum design temperature with respect to the technical design, and the external barrier coating is envisaged as 4.2 mm, 3-layer PE coating in accordance with DNVGL-RP-F106, (2017).

External coating will be applied to the pipeline to prevent corrosion. Further corrosion protection will be achieved by sacrificial anodes of aluminium alloy. The sacrificial anodes are a dedicated and independent protection system to that of the anticorrosion coating. The cathodic protection shall provide sufficient anode mass to protect the pipeline during the entire design life (Ramboll, 2017).

For concrete coated pipelines, it shall be ensured that the anodes do not protrude from the coating. Therefore, an anode thickness of 45 mm will be adopted, irrespective of the concrete coating thickness (Ramboll, 2017). The dimensions and properties of the anodes are shown in Table 3-3.

Table 3-3 Anode properties (Ramboll, 2017). The anodes consist of aluminium alloy (aluminium-zinc-indium).

36 inch pipeline					
Anode inner diameter (ID)	Anode thickness	Anode length	Anode weight	Anode current output	
				Buried	Exposed
932 mm	45 mm	240 mm	86.41 kg	0.10 A	0.36 A

The Baltic Pipe offshore pipeline has been designed with an anode mass of 1,180 kg/km. This amount ensures a sufficiently large anode surface; the anode consumption has been calculated to be a maximum of 495 kg/km during the 50-year design life of the pipeline. This corresponds to a maximum anode consumption of 7.9 kg/km/year.

In practice, the release will be much lower as the role of the anodes is to provide back-up protection in case the coating of the pipeline is degraded or damaged; only a small fraction of this amount will be released.

The recommended composition of the anode material is outlined in Table 3-4.

Table 3-4 Recommended compositional limits for anode materials (DNVGL-RP-F103, 2016).

Element	Aluminium-zinc-indium anodes	
	Min (%)	Max (%)
Al	-	Remainder
Zn	4.50	5.75
In	0.016	0.030
Cd	-	0.002
Fe	-	0.090
Cu	-	0.003
Si	-	0.12

3.3.4 Inventory of materials

Table 3-5 summarises the expected inventory of materials to be used for construction of the offshore pipeline.

Table 3-5 Use of materials for construction of the offshore pipeline (approximate amounts).

Material	Total offshore route (273.7 km)
Steel [t]	125,000
Internal flow coating, 0.1 mm epoxy paint [t]	85
External epoxy coating, 4.2 mm, 3 layers PE [t]	2,900
Field joint coating, Heat shrink sleeve [no.]	22,500
Concrete weight coating 100 mm, 3,040 kg/m^3 [t]	253,000
Field joint coating PU [t]	5,900
Concrete (tunnel elements) [t]	6,000
Steel, landfalls (tunnel element reinforcement, sheet piles) [t]	1,100

3.4 Construction

3.4.1 Landfall construction in Denmark and Poland

The landfall in Denmark (Faxe S) is located south of Faxe Ladeplads in Faxe Bugt. Two landfall locations for Baltic Pipe are currently considered in Poland. Niechorze is the preferred landfall location, however, Rogowo is also considered feasible (Figure 3-1). In both Polish landfall locations, the onshore and nearshore routes cross the Natura 2000 sites, and in both locations, routes were optimized to avoid impact on habitats which form the designation basis of the Natura 2000 sites.

For both the Danish and the Polish landfall, tunnelling has been chosen as the preferred landfall construction method. Tunnelling is a method where a lined tunnel is installed, enabling the accommodation of the pipeline and other services as well, such as a fibre optic cable. The hole is drilled using a conventional tunnel boring machine (TBM) with a full-face rotating drill head. As the TBM advances, concrete jacking pipe elements are pushed in behind it, forming a permanent tunnel lining. Pipeline joints will be welded on land and dragged into the tunnel by use of wires installed on a vessel. Since landfall construction activities do not give rise to any impact in a transboundary context, they are not further assessed in this report.

Faxe S landfall
The Danish landfall is located at an agricultural field with a 15-17 m high cliff along the beach. Photos of the landfall location are shown in Figure 3-3.


Figure 3-3 Danish landfall location.

Niechorze landfall
The area of the landfall location onshore is characterised by wide beach and dunes. The onshore section of Niechorze landfall variant will be located in a forest area. Photos of the landfall location are shown in Figure 3-4.


Figure 3-4 Niechorze landfall location.

Rogowo landfall
The area at the landfall location onshore is characterised by wide beach and dunes and proximity of forest. The onshore section in Rogowo landfall variant will be located in a forest area. Photos of the landfall location are shown in Figure 3-5.

Figure 3-5 Rogowo landfall location.

3.4.2 Offshore construction

Offshore construction includes the following overall activities: seabed preparation, pipe-lay and seabed interventions.

Seabed preparation
When the data from the geophysical and geotechnical surveys have been analysed, the detailed pipeline route will be defined. This route will be selected so that objects resting on the seabed (possible wrecks, munitions objects etc.) will be avoided to the greatest extent possible.

A detailed magnetometer survey covering a corridor around the pipeline route will be executed before seabed interventions and pipe-lay activities are executed. This is to re-assure that no buried munitions objects or similar are present in the area. The magnetometer survey will be planned in agreement with the relevant national authorities responsible for unexploded ordnance (UXO). Unless the UXO poses a general safety risk, UXO clearance cannot be carried out before a construction permit has been obtained. Since objects resting on the seabed are avoided as much as reasonably practicable when designing the route, the possible occurrence of munitions objects identified from the magnetometer survey is considered an unplanned event and is dealt with in the risk chapter of this report (Chapter 4).

Pipe-lay
Pipe-lay will take place in different steps and with different methods, which are described in the following.

The pipeline installation method for the deep-water part of the 36” gas transmission pipeline is by S-lay vessel, a typical configuration for which is presented in Figure 3-6.

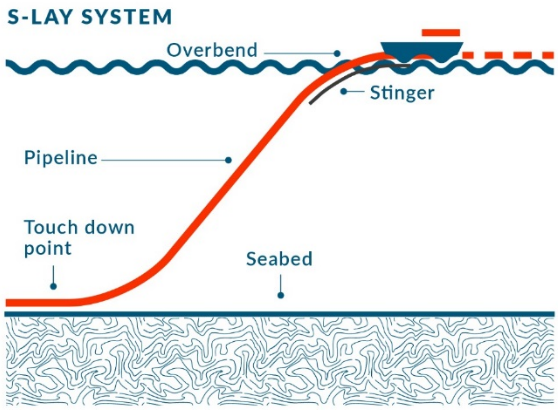

Figure 3-6 A typical pipeline installation by S-lay vessel.

Onboard the lay vessel, the coated pipe joints are welded onto the pipeline, which leaves the vessel via the stinger from which where it follows an S-curve to touchdown on the seabed. The critical locations during pipe-lay are the overbend on the stinger and the sag bend at the touchdown point. The overbend stresses are controlled by a suitable stinger configuration, while buckling at the sag bend is prevented by tension in the pipeline, provided by tensioners on the lay vessel.

In deeper water (i.e. greater than 20-25 m water depth) the lay vessel may be provided with a dynamical positioning system (DPS) and powerful thrusters, enabling it to maintain position and move forward.

In shallower water (e.g. less than 20-25 m water depth), the Dynamic Position (DP) vessel will not be able to operate. In these areas, it is necessary to use a shallow-water lay barge. The lay barge moves forward from under the pipeline by pulling itself on anchors, which are periodically shifted forward by anchor handling vessels.

The final step of pipeline installation is to connect the open end of the offshore pipeline with the open end of the landfall pipeline, which has been installed in the tunnel. This is done by a "tie-in" operation as explained in the following:

Above water davit lift tie-in is an operation in which two laid pipeline sections on the seabed are welded together after being lifted above water using vessel davits. The procedure is outlined in Figure 3-7.

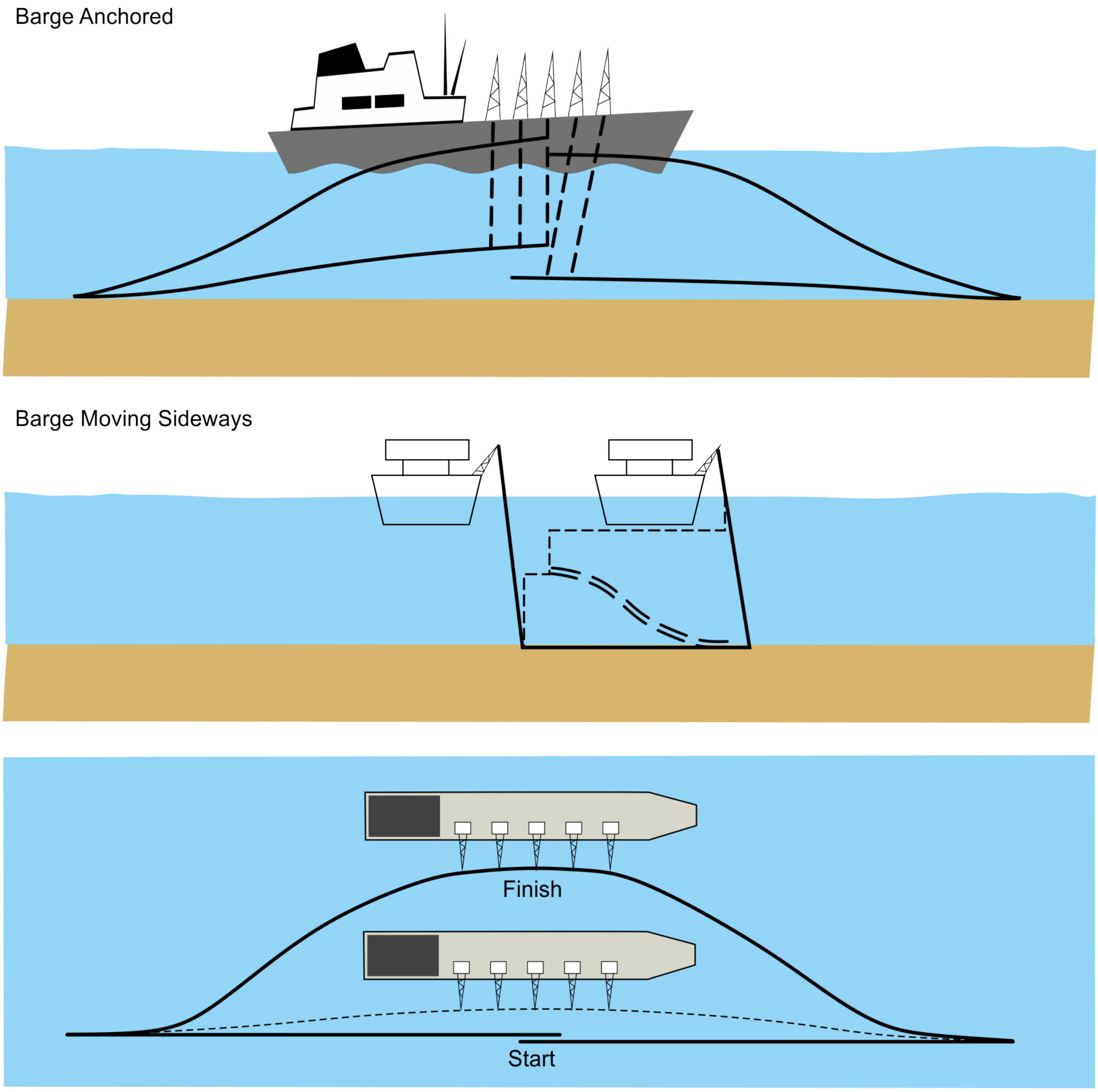

Figure 3-7 Typical davit lift tie-in procedure. The pipeline ends are raised, connected, and laid down at the seabed again. The top and middle figures show profiles, whereas the figure at the bottom is shown from above (after Braestrup *et al.*, 2005).

- Both pipeline ends are provided with pre-installed clamping sections and laid down on the seabed next to each other, with an over length for the tie-in;
- Davit lift cables are connected to the pipelines, which are lifted and clamped into position;
- The pipeline ends are cut to measure, aligned, and welded together on the side of the vessel;
- After application of the field joint coating, the joined pipeline is lowered to the seabed as the vessel moves sideward to avoid overstressing of the pipeline.

The number of davit lift tie-ins will depend on the detailed design of the pipeline installation scenario; i.e. whether part of the offshore route requires installation by a low-water barge. In total two davit tie-in lifts are anticipated.

Seabed interventions

Trenching

In the coastal areas at the landfalls of Denmark and Poland as well as in shallow waters of less than 20 m water depth, it is envisaged to bury the pipelines in the seabed. Trenching will take place to at least 2 m below the seabed surface, to ensure at least 1.0 m between mean seabed level and top of pipe (TOP). In shallow waters, coastal sediment transport causes variations in the seabed profile. In these areas, the pipeline will be installed in a tunnel to a greater depth, so that there is at least 1.0 m between TOP and the Lower Envelope Curve (separating the stable seabed from the dynamic surface sediment layer), which will ensure stability during the lifetime of the pipeline. In the Danish section approximately 63.5 km has been planned to be trenched.

In areas with a water depth of less than approximately 15 m, trenching can be performed using backhoe dredgers on barges (see Figure 3-8). For this method, the trench is excavated before pipeline installation. The side slope of the trench will depend on the seabed composition, being 1:6 in sand (or other soft sediments) and 1:1 in stiff clay. The bottom of the trench will have a width of 5 m, and the average depth is assumed to be approximately 2 m. The total width of the pre-lay trench will thus be between 10 m and 30 m, depending on the sediment type (Figure 3-9).

The excavated material will be left on the seabed immediately adjacent to the trench and will be excavated back into the trench after pipeline installation.

Figure 3-8 Typical backhoe dredge for trenching in shallow water.

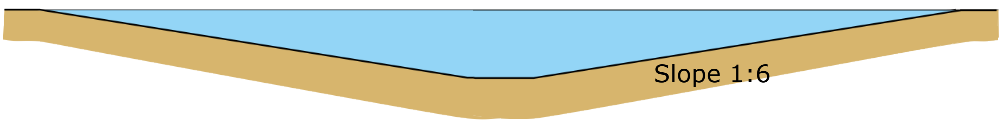

Figure 3-9 Schematic of a typical trench excavated using a backhoe dredger.

Trenching *after* pipeline installation is the simplest solution at water depths greater than approximately 15 m, possibly assisted by jetting. Trenching in these areas is planned by post-lay ploughing. Ploughing implies using a pipeline plough deployed onto the pipeline from a vessel located above the pipeline. A tow wire and control umbilical will be connected to the plough from the vessel, which will pull the plough along the seabed, laying the pipeline into the ploughed trench as the plough advances (Figure 3-10). Depending on the seabed conditions, other excavation methods such as cutter suction dredging or trailer suction hopper dredging might be required for parts of the pipeline route. Also, ploughing might be assisted by water jetting.

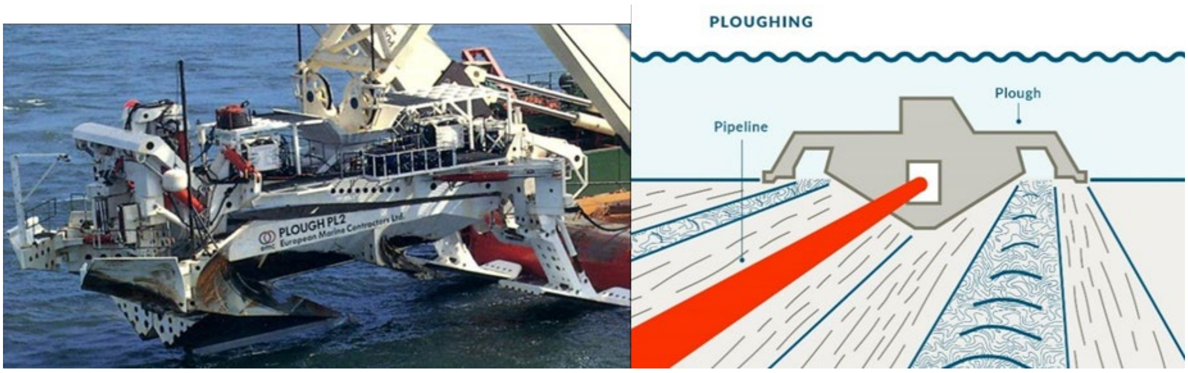

Figure 3-10 Pipeline plough before being lowered to the seabed from the towing vessel (left) and schematic of a trenching operation using ploughing (right).

The excavated material displaced from the plough trench (also known as spoil heaps) will be left on the seabed immediately adjacent to the trench. Where backfilling is required, the spoil heaps will be pushed back into the trench after pipeline installation.

A principle schematic of a cross section of a trench is shown in Figure 3-11. The depth of the trench will be at least 2 m, with side slopes around 35 degrees. The width of the post-lay trench will depend on the chosen trenching method, seabed types, trenching depth, etc. Based on the assumed dimensions the width of the post-lay trench will be at least 8 m.

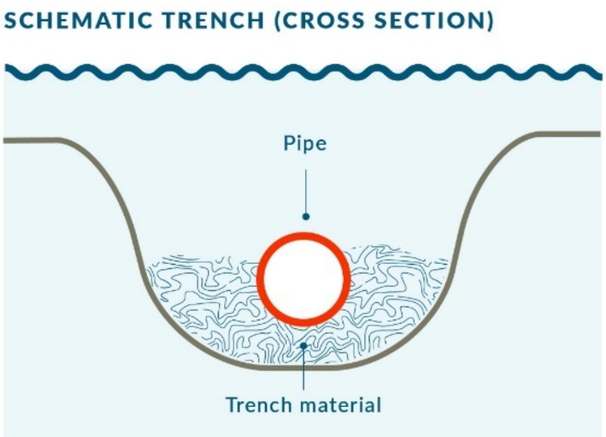

Figure 3-11 Principle schematic of the cross section of a trenched pipeline.

<u>Backfilling</u>
Backfilling can be performed either by filling seabed materials and/or materials provided from other sources (in this project rocks from existing quarries) into the trench (artificial backfilling) or by leaving the trench to be gradually filled by sediments due to natural sediment transport mechanisms in the area after installation of the pipeline in the trench (natural backfilling). In this project, backfilling of the trenched pipeline will generally be performed by artificial backfilling using the seabed material excavated from the trench.

Rock installation and concrete mattresses

Rock installation is the use of unconsolidated rock fragments graded in size to locally reshape the seabed, thereby providing support and/or cover for sections of the pipeline system to ensure its long-term integrity. Rocks are supplied from onshore sources in Scandinavia. In some areas where trenching is planned, the geological seabed conditions may cause unexpected problems for post-lay trenching. In such areas, it may be required to use rock installation instead as a mean of protection.

Rock installation is planned to be performed by a rock installation vessel, equipped with a flexible fall pipe, which can be lowered into the water beneath the vessel (see Figure 3-12). The rock design is shown in Figure 3-13.

Rock installation can be replaced by or used in combination with concrete mattresses. Concrete mattresses will be installed at pipeline and cable crossings to ensure minimum separation between the services.

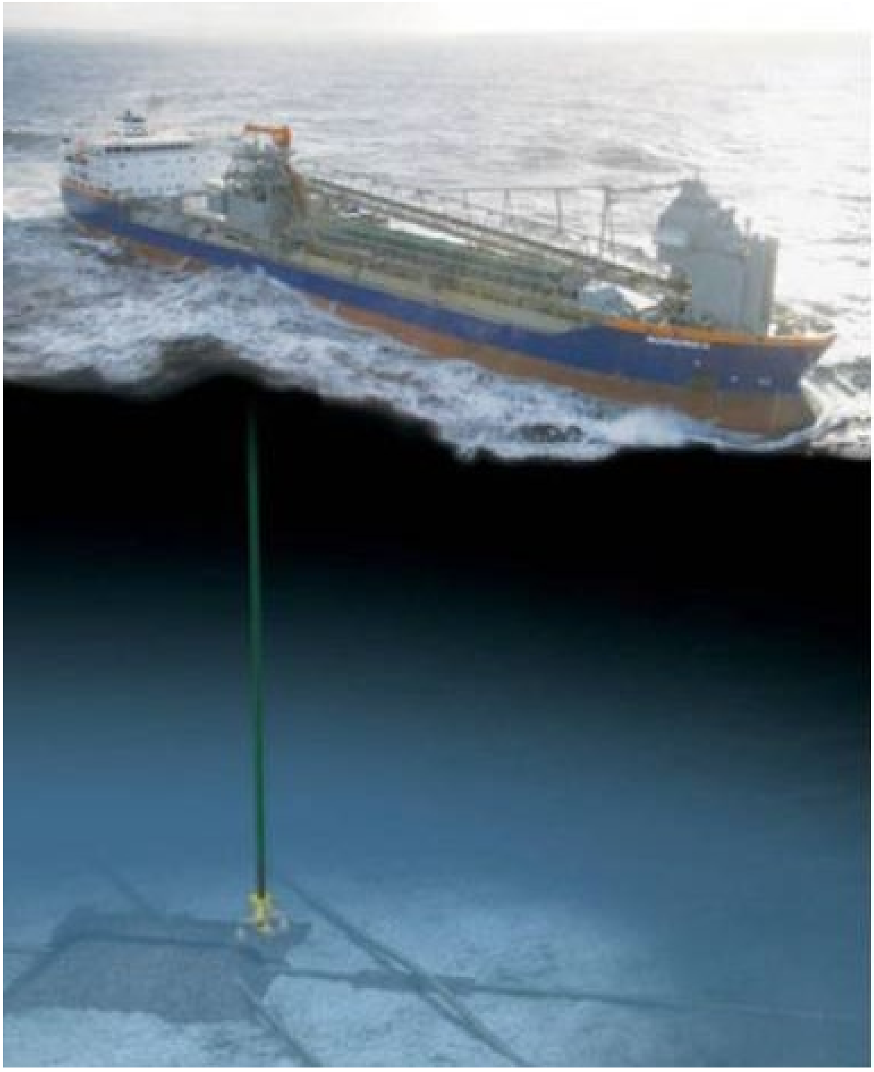

Figure 3-12 Fall pipe vessel for rock installation (Beemsterboer, 2013).

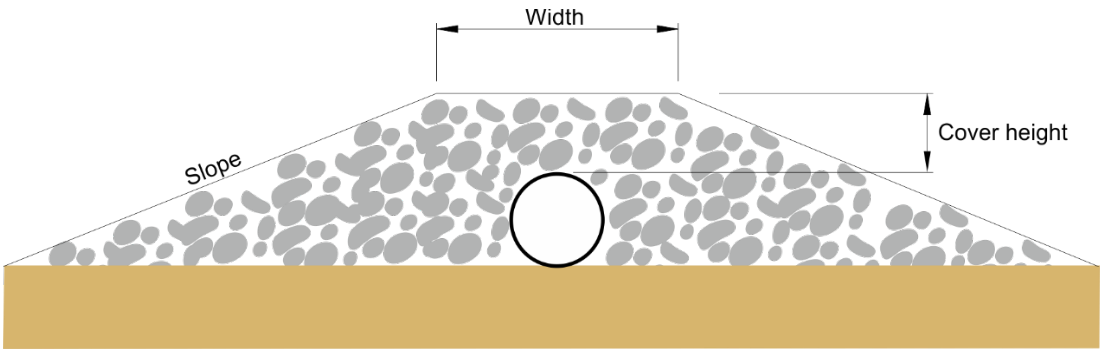

Figure 3-13 Schematic of post-lay rock design.

Crossing of marine infrastructure (pipelines and cables)

The Baltic Pipe route crosses existing pipelines, telecom cables and power cables at the seabed of the Baltic Sea. The infrastructure that will be crossed has been identified after consultation with the relevant authorities in Denmark, Sweden, Germany and Poland.

Before construction of the offshore part of the Baltic Pipe, agreements will be reached with all involved owners of the crossed infrastructure. Also, the exact position of each crossing will be established by detailed geophysical surveys.

A detailed crossing design for each crossing will be prepared. The crossing design will be based on survey results and provide input to the rock installation design.

The crossings will be constructed using pre-lay separation, e.g. rock installation and concrete mattresses. After installation, the Baltic Pipe will be covered to TOP for protection. For both pre-lay and post-lay, a side slope of 1:2.5 is assumed to be sufficient (see Figure 3-14).

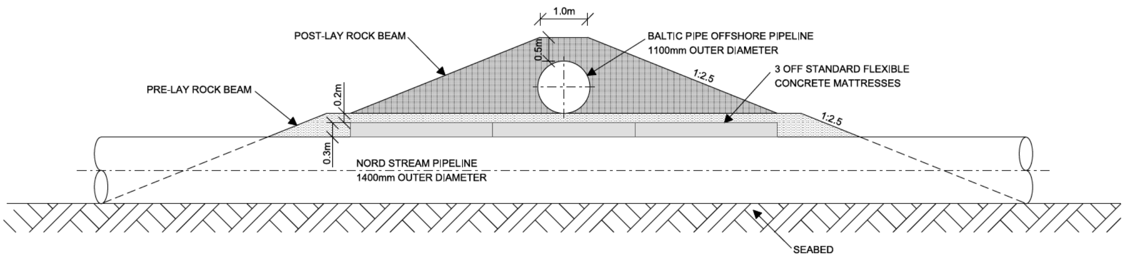

Figure 3-14 Schematic of a pipeline/pipeline crossing.

Overview of seabed intervention works

The need for pipeline protection has been established based on a quantitative risk assessment (Ramboll 2018f). The main reasons for the pipeline protection requirements considered in this study is dragged and dropped anchors. Furthermore, the pipeline is expected to be protected by trenching and backfilling in research areas and military areas. At the landfall locations the pipeline requires protection due to the low water depth. Where the water depth is less than 20 m, the pipeline will be trenched into the seabed.

The lengths of the sections where offshore trenching at water depths less than 12 metres is anticipated are presented in Table 3-6. At each section, the type of seabed material will influence the cross-sectional geometry and therefore determine the volumes that will be handled. The table also shows the lengths to be trenched at water depths greater than 12 m. The trenched volumes are presented in Table 3-7 together with the expected excavated volumes for recovering the TBM nearshore.

Figure 3-15 presents an overview over the various types of anticipated seabed interventions. In the figure it has been assumed that trenching takes place at 0-20 m water depth, in research areas and military areas, and where crossing shipping lanes, and that rock installation takes place where crossing pipelines and cables.

The material that has been dredged at the Danish landfall will be temporarily stored at the seabed beside the trench, and then backfilled on top of the pipeline after it has been installed.

Rock material for rock installation will be provided directly from existing rock quarries. The inventory of rock volumes for pipeline and cable crossings for the different route sections is shown in Table 3-8.

Table 3-6 Trenching lengths in the various countries of origin.

Route section	Trench lengths		Total length
Water depth	*<12 m*	*>12 m*	
Danish EEZ/TW	15.1 km	41.4 km	56.5 km
Swedish EEZ	N/A	23 km	23 km
Disputed area	N/A	7.0 km	7.0 km
Polish EEZ/TW	0.8 km	36.8 km	37.6 km

Table 3-7 Trenching and excavation volumes in the various countries of origin.

Route section	Trench volumes		Total volume
Water depth	*<12 m*	*>12 m*	
Danish EEZ/TW	332,200 m^3	384,940 m^3	717,140 m^3
Swedish EEZ	N/S	326,600 m^3	326,600 m^3
Disputed area	N/A	68,000 m^3	68,000 m^3
Polish EEZ/TW	17,600 m^3	147,200 m^3	164,800 m^3

Table 3-8 Protection at pipeline and cable crossings in the various countries of origin.

Route section	Cable crossing	Pipeline crossing	Pre-lay	Postlay
Danish EEZ/TW	9	4	Mattresses + 12,000 m^3 rock (pipeline crossings)	8,000 m^3 rock (pipeline crossing)
Swedish EEZ	6	N/A	Mattresses	N/A
Disputed area	1	N/A	Mattresses	N/A
Polish EEZ/TW	4	N/A	Mattresses	N/A

The numbers are only approximate, as the planned seabed interventions works will be optimised during the detailed design process.

As a base case, the pipeline is expected to be protected in shipping lanes by trenching and backfilling. However, the detailed design studies may conclude that in some areas, rock installation is required. The maximum rock volume to be used (assuming rock installation is used instead of trenching in all shipping lane areas) is 610,000 m^3 (based on the concept study; Ramboll, 2017).

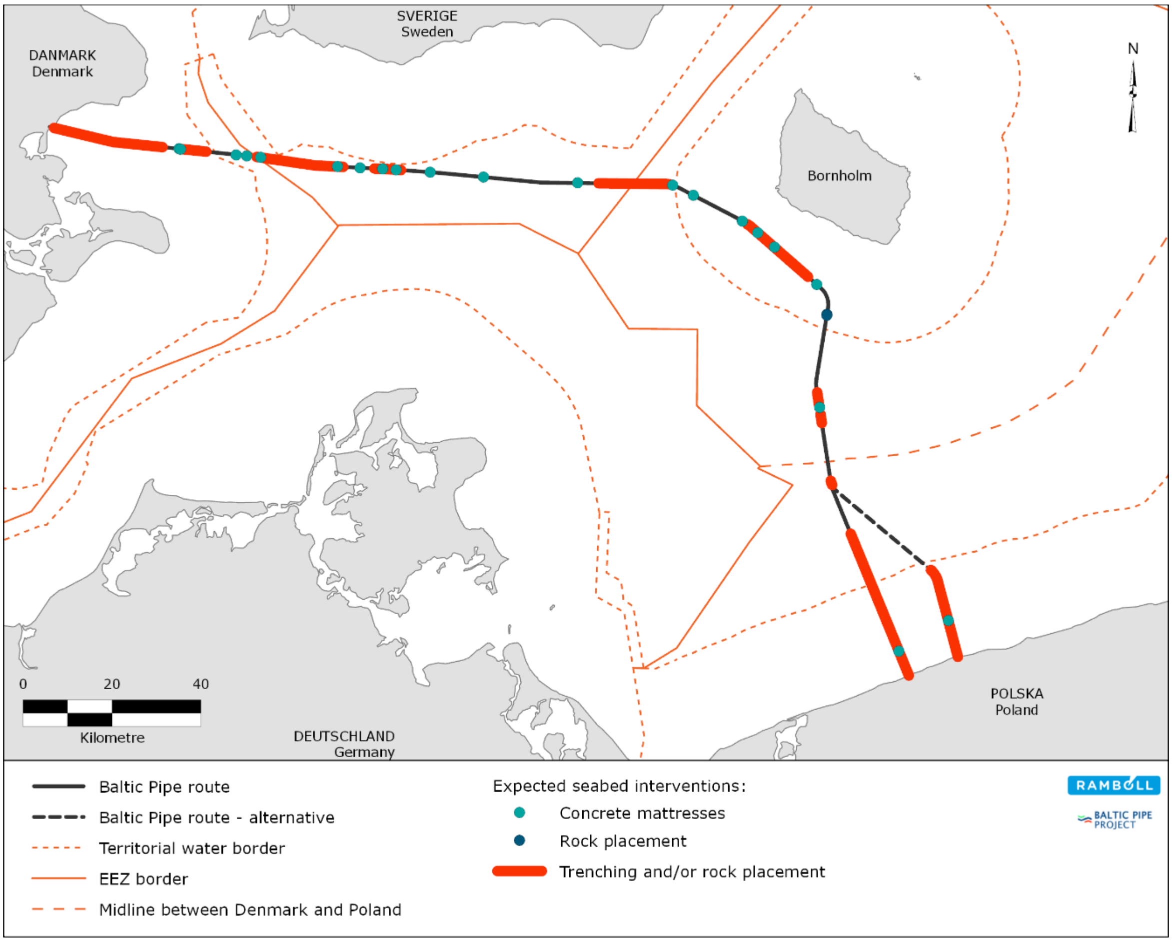

Figure 3-15 Overview of the anticipated seabed interventions works. In the figure it has been assumed that trenching takes place at 0-20 m water depth, in research and military areas and where crossings of shipping lanes, pipelines and cables take place. The final seabed interventions design at the shipping lane will be optimized during the detailed design phase.

3.4.3 Construction timeline

The construction activities for the whole project are planned to commence in July 2020 and to end in March 2022. Construction of landfalls is expected to commence in October 2020, and the pre-lay seabed interventions work is anticipated to begin in November 2020. The actual pipeline installation is expected to be carried out within the period April – August 2021. Post-lay seabed interventions are planned to be carried out in September 2021 – January 2022, and first gas is expected to take place, after pre-commissioning and commissioning, on 15 March 2022.

With respect to the Danish part of the project, the following is expected (and is subject to changes as the detailed planning progresses):

Landfall site preparation:	Q4 2020;
Tunnelling:	Q1 – Q3 2021;
Seabed Intervention (pre-lay, post-lay):	Q3 2020 – Q2 2022;
Pipeline Installation:	Q3 2021 – Q2 2022;
Pre-commissioning:	Q2 2022;
Landfall site re-instatement:	Q3 2022 (after pre-commissioning).

3.4.4 Offshore logistics during construction and operation

The offshore logistics during construction includes numerous activities for preparation and construction of the pipeline. The detailed schedule of the offshore construction will be planned at a later stage, by GAZ-SYSTEM S.A. together with the contractors selected to carry out the work. A possible inventory of equipment is shown in Table 3-9.

Table 3-9 Overview of the use of machinery for the construction works for the entire offshore pipeline.

Activity	Equipment example	Power (kW)
Trenching and backfilling		
Trenching (0-12 m)	Backhoe dredger	1,500
Backfilling (0-12 m)		
Postlay trenching	Ploughing vessel / jet sled vessel	24,000
Backfilling, ploughing		
Rock installation		
Rock installation (sailing)	Fall pipe vessel	6,500
Rock installation (rock installation)	Fall pipe vessel	3,700
Pipe-lay		
Pipe-lay (deep water)	Allseas Solitaire	36,000
Pipe-lay (shallow water)	Allseas Tog More	3,750
Pipe-lay (shallow water)	Anchor handling vessels	10,000
Tie-in (Davit-lift)	Allseas Solitaire	36,000
Pipe supply	Pipe supply vessel	7,700
Other marine logistics		
Crew exchange	Helicopter	3,600
Survey	Survey vessels	7,200

During operation there will be a minor need for maintenance work related to the rock installations. Furthermore, survey vessels will be used during the entire operating life of the pipeline for geophysical surveys of the pipeline. Surveys are expected to take place every year within the first five years of operation and every third year thereafter. In Table 3-10, the vessels expected to be used during operation are shown.

Table 3-10 Information about vessels to be used offshore during operation of the pipeline in the Baltic Sea.

Activity	Equipment example	Power (kWh)
Survey	Survey vessels	7,200
Rock supply (maintenance)	Fall pipe vessel	6,500

3.4.5 Waste production and management

Construction of the offshore pipeline will produce some waste, mainly onboard the vessels participating in the construction work. The waste will be managed according to the applicable national and international regulations and standards, including the International Maritime Organization (IMO) MARPOL 73/78 Annex V, which defines the Baltic Sea as an area where special mandatory measures for the prevention of marine pollution by garbage are required (IMO, 2013). This means that the discharge of all garbage at sea is prohibited, except for 1) cleaning agents and additives (if not harmful to the environment) contained in deck and external surfaces wash water and 2) comminuted or ground food waste if ≥ 12 NM from the nearest land and *en route*.

Due to the similarities between the types of projects, the waste types produced from the construction of the Baltic Pipe offshore part is expected to be comparable with the distribution of waste types from the construction of the Nord Stream Pipelines (NSP). The distribution of waste from NSP is shown in Table 3-11.

Table 3-11 Distribution of types of waste from the offshore construction of the NSP project (Nord Stream AG, 2017).

Waste type	Weight % of total waste
Concrete (from the concrete coating of the pipes)	46%
Metals (scraps from end millings from the bevelling and welding processes)	25%
General/domestic waste (combustible; plastic, paper, cardboard, food)	23%
Chemicals/hazardous (greases, other oils, paints, electric waste, etc.)	3%
Other (wood from pallets etc.)	3%

Experience from comparable pipeline projects suggests that the total amount of waste when constructing offshore pipelines is approximately 3-4 tonnes per kilometre, i.e. approximately 1000 tonnes for the offshore part of the Baltic Pipe project.

Concrete waste, which comprises the largest part, is typically reused in road construction, and metal waste is recycled. The other types of waste are disposed according to the waste hierarchy in Directive 2008/98/EC on waste (Waste Framework Directive).

The produced waste will be sorted at the source and stored in suitable containers. It will be transported to shore and subsequently transported to licenced waste contractors, which will treat the waste in compliance with local legislation.

Waste management plans will be prepared for vessels participating in the project to ensure that wastewater is delivered to approved port reception facilities in compliance with HELCOM requirements.

3.5 Pre-commissioning

Before commissioning of the pipeline, pre-commissioning will be conducted. Pre-commissioning includes the activities described in the following sections (Ramboll, 2018b).

3.5.1 Flooding, cleaning, gauging and hydrotesting

Hydrotesting is carried out, after all construction activities (pipelay, tie-in and seabed intervention, including crossing construction) have been carried out.

Hydrotesting requires that the pipeline be water-filled using seawater pumped into the pipeline through a simple water winning arrangement that includes filtering. To prevent internal corrosion of the line-pipe steel, the seawater may be treated with oxygen scavenger. A typical oxygen scavenger is sodium bisulphite ($NaHSO_3$), a dosage of 65 mg/l (ppm) being required for an oxygen concentration of 10 ppm. In total, approximately 20,000 kg of sodium bisulphite is expected to be required for flooding of the entire pipeline system (Ramboll, 2018b).

The chemicals planned to be used in the pre-commissioning operation include oxygen scavenger (OR-6045), Mono Ethylene Glycol (MEG) and nitrogen gas. According to the OSPAR classification system for offshore chemicals they are all classified as chemicals which are considered to Pose Little Or No Risk to the Environment (PLONOR) (Ramboll, 2018b). The environmental concern related to the chemicals is therefore more related to the fact that the discharged pressure test water will be oxygen depleted rather than the possible residual amounts of the used chemicals.

No other chemical additives are planned to be used in the pressure test water. Ultraviolet treatment may be applied to reduce the number of bacteria present in the pressure test water.

If no other chemicals are used, the test water is environmentally harmless and may be discharged to the sea via temporary discharge lines. The end of the discharge lines will be placed at a minimum of 4 m water depth in Faxe Bugt. The outlet would be provided with a diffuser head, ensuring that any chemicals are diluted to concentrations (of remaining chemicals that are unharmful to aquatic wildlife and local oxygen depletion is avoided. Further treatment of the discharge water is not required.

It shall be documented that there are no dents in the line-pipe wall which could induce failure in the long term or obstruct the passage of cleaning and batching pigs. For this purpose, gauging and calliper pigs are propelled through the pipeline during water filling. The calliper pig is a so-called intelligent pig, equipped with sensors that measure the internal diameter at a number of points around the circumference.

During and after water filling, the pipeline interior shall be cleaned. The cleaning trains include both brush pigs and swabbing pigs, the latter removing any brushes that may have broken off. The pig trains are normally propelled by the treated seawater pumped in for the purpose of the hydrotesting, but further cleaning by running brush and swabbing pigs in air may take place during and after de-watering. In Figure 3-16 a typical flooding, cleaning, and gauging pig train is shown.

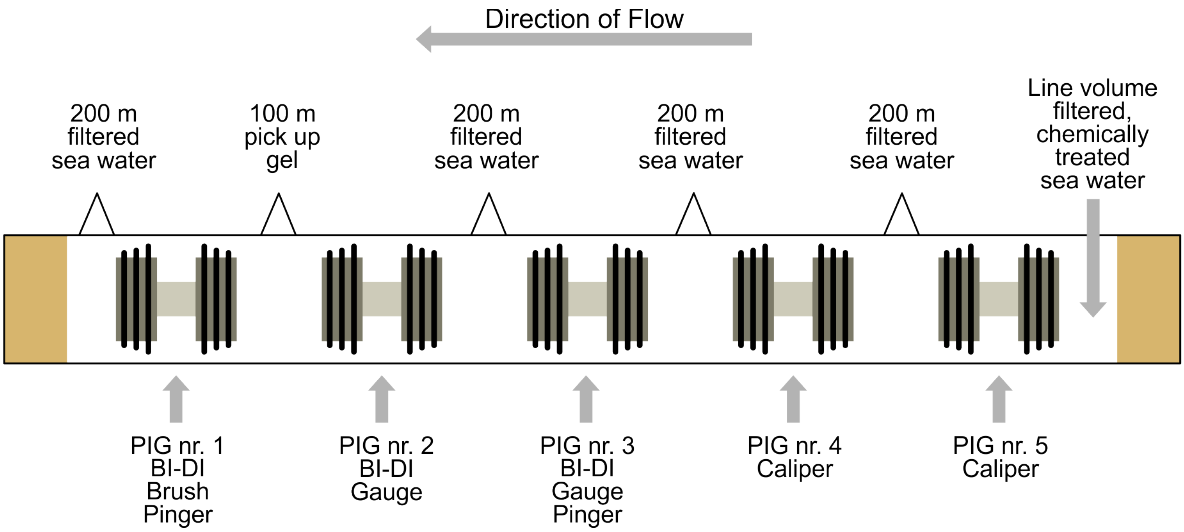

Figure 3-16 Example of a pig train used for flooding, cleaning and gauging. For the present project, four pigs are anticipated.

The cleaning operation may be facilitated by gel-slug technology. A gel is a plastic fluid with the capability to pick up loose and loosely adhering solids. The gel slug is inserted into the pipeline, followed by an appropriately designed scraper pig. The gel slug is disposed of at the receiving end (in Poland).

The total volume of slugs for flooding, cleaning and gauging (FCG) is approximately 720 m^3. The water slugs, used for the FCG operation will have to be collected upon arrival at the Polish landfall, in temporary water storage tanks until disposal according to local regulations. It is envisaged that 2-3 tanks will be required at the Polish landfall (Ramboll, 2018b).

Pipeline debris in front of the dewatering pigs will be collected and deposited at a controlled waste site. Water used for cleaning and gauging will be deposited at a controlled disposal site in Denmark. Mono Ethylene Glycol (MEG) used for conditioning will also be deposited at a controlled disposal site in Denmark or recycled.

3.5.2 De-watering and drying

Pipeline de-watering runs are carried out by means of air-propelled pig trains during or after cleaning, see above.

To dry the pipeline, the following methods may be used, alone or in combination:

- MEG conditioning)
- Dry air drying;
- Vacuum drying.

With the MEG conditioning method, a batch of MEG is enclosed between pigs and propelled through the pipeline with compressed air. Residual water will be dissolved in the hygroscopic substance, leaving a film that is mostly MEG.

An alternative procedure, which combines cleaning and drying in one operation, is gel pigging, as described above. Modern gel-forming agents can produce gels from an array of liquid components. By incorporating gels based on hygroscopic fluids, such as MEG, into the cleaning train, the water is removed along with the debris. For this project, the volume of pick-up gel (which will be biodegradable) is expected to be 10-20 m^3. The debris and the pick-up gel will be delivered to a controlled waste plant.

Dry air drying utilises the ability of dry air to contain a large amount of water as vapour, whereas vacuum drying relies on the lowering of the boiling point of water at low pressures. For the 250-300 km long Baltic Pipe offshore pipeline, the vacuum pumps will have to work for several days to decrease the pipeline pressure below a few millibar. To limit the required time, vacuum drying is often used as the last step, i.e. after most of the water has been removed by MEG conditioning or gel pigging.

3.5.3 Nitrogen purging and gas filling

To prevent any internal corrosion between pre-commissioning and operation, in case the pipeline is not immediately operational, the pipeline may be filled with a non-corrosive gas, such as nitrogen.

When completed, the pipeline is found in what would normally be the final ‘hand-over’ condition, and the installation or pre-commissioning contractor will de-mobilise.

3.5.4 Pigging and monitoring

As explained above, the pre-commissioning activities entail the insertion of pig trains. As such, temporary facilities for launching and receiving pigs will need to be installed at each landfall, to be removed prior to tie-in of the adjoining onshore sections. As the medium is dry sales gas, no operational pigging is foreseen, but to monitor the integrity of the pipeline system, inspection pigging, using intelligent pigs should be carried out at regular intervals. The corresponding bi-directional pigging facilities will typically be installed at the compressor station in Denmark and at the receiving station in Poland.

The internal inspection monitors the following aspects:

- Internal diameter (presence of dents);
- Wall thickness (metal loss due to corrosion).

In addition, external inspections by Remote Operated Vehicle (ROV) and cathodic protection (CP) measurement equipment are carried out at regular intervals, to monitor the general condition of the pipeline, with the as-built survey results serving as a baseline.

The external inspection monitors the following aspects:

- General condition (debris or snagged equipment);
- Free span development (scouring);
- CP performance (functioning of anodes).

3.6 Commissioning and operation

Commissioning entails filling the pipeline with gas for the first time and includes all activities that occur after the pre-commissioning phase until the moment when the pipeline is ready for gas transfer.

After pre-commissioning, the pipeline will be filled with dry air. To prevent a mixture of air and dry gas immediately before injection, the pipeline will be filled with nitrogen (inert gas) which will work as a buffer between the air and gas. Nitrogen will most likely be provided from a mobile nitrogen generation plant.

When adequate separation has been provided by nitrogen, the natural gas is introduced from one end (Danish compressor station). At the opposite end, the air and nitrogen will be discharged through an air silencer or flare, until gas content/traces are detected (Polish receiving terminal).

The air and nitrogen emissions do not cause any environmental impact, and the emission facilities will be designed to ensure that there also will be no health impacts.

3.7 Operation

The expected pipeline life is 50 years. During that period constant supervision of the gas transfer as well as scheduled and unscheduled checks and works related to the maintenance will be carried out.

During pipeline operation technical operations will be conducted with the purpose of ensuring the integrity of the pipeline, in particular maintaining the proper pressure and secure infrastructure.

These activities will include geophysical surveys to control the integrity of the pipeline and the surrounding seabed. Also, pigs will be used for monitoring the wall thickness and the possible corrosion of the pipeline.

Supervision of the gas transfer will be carried out from the project management centre at a location to be designated at a later stage of the project.

3.8 Decommissioning

The Baltic Pipe offshore pipeline will be constructed based on a design life of 50 years of operation. After this period (and a possible prolongation), the pipeline system will be decommissioned.

Below is an overview of the existing legislation and best practice with respect to decommissioning of offshore pipelines. The actual method of decommissioning will be agreed with the relevant authorities in due time before the decommissioning activities. In addition, an EIA will be prepared to assess the impact on environment. It is not possible to detail the method to be used for decommissioning at this time, as it will depend on the legislative regime as well as the technical options available at the time of decommissioning.

3.8.1 International legislation and best practice

The overriding principle of all international regulations and guidance is that decommissioning activities should not result in any harm to other users of the sea or to the environment (IOGP, 2017).

The process of decommissioning is regulated by international, regional and national conventions and legislation in terms of the removal of installations (primarily concerned with the safety of navigation and other users of the sea) and disposal of materials (primarily aimed at pollution prevention). The primary conventions are noted below:

- **United Nations Convention on the Law of the Sea (UNCLOS), 1982**. Article 60 contains provisions on the construction and removal of offshore installations and requires coastal State authorization for any installation or structure intended to remain on the seabed.
- **London (Dumping) Convention, 1972.** The convention (and the subsequent 1996 Protocol) promotes the effective control of all sources of marine pollution and provides generic guidance for any wastes that may be dumped at sea. New guidelines, which specified different classes of waste, including platforms and other man-made waste, were adopted in 2000.
- **International Convention for the Prevention of Pollution from Ships (MARPOL), 1973, 1978.** MARPOL sets the standards and guidelines for the removal of offshore installations worldwide.
- **Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention), 1992, 1998.** The OSPAR Convention seeks to prevent and eliminate pollution of the marine environment in the North-East Atlantic from land-based sources, dumping and incineration, and offshore sources. The OSPAR Convention does not include the environment of the Baltic Sea, which is regulated by the HELCOM Commission.

None of the international guidelines provide specific guidance in relation to pipelines or cables (IOGP, 2017). And no specific guidelines exist for decommissioning in the Baltic Sea.

For the North Sea / North Atlantic, Norway and the United Kingdom (UK) have developed guidance notes on decommissioning. They mainly concern decommissioning of offshore installations, but they also address decommissioning of pipelines and cables.

The Norwegian requirements regarding decommissioning of pipelines have been expressed in the Norwegian Parliament White Paper No. 47 of 2001 (Norwegian Parliament, 2001). As a general rule, pipelines and cables may be left in place as long as they do not cause obstruction or present a safety risk for bottom fishing, considering the costs of burial, covering or removal of these items. Final decisions on the disposal are made by the Norwegian authorities. The following disposal solutions are usually considered:

- Clean and leave *in situ*;
- Burial/trenching;
- Rock installation;
- Removal.

As a response to the above, Norwegian industry guidelines on environmental impact assessment for offshore decommissioning were developed (DNV, 2001). An overview of the various technical options for decommissioning is provided in DNVGL-RP-N102 (2017).

The UK authorities have issued guidance notes on decommissioning of offshore oil and gas installations and pipelines (BEIS, 2017). As these are probably the best developed existing guidelines, they are briefly outlined in the below.

The general approach to decommissioning of pipelines includes the following:

- All feasible decommissioning options should be considered, and a comparative assessment should be made;
- Any removal or partial removal of the pipeline should be performed in such a way as to cause no significant adverse effects upon the marine environment;
- Any decision that a pipeline may be left in place should regard the likely deterioration of the material involved and its present and possible future effect on the marine environment;
- Account should also be taken of other users of the sea and future fishing activities in the area.

Determination of any potential effect on the marine environment at the time of decommissioning should be based upon scientific evidence. The factors to be considered should include (BEIS, 2017):

- The effect on water quality and geological and hydrographic characteristics;
- The presence of endangered, threatened or protected species;
- Existing habitat types;
- Local fishery resources;
- The potential for pollution or contamination of the site by residual products from, or deterioration of, the pipeline.

To evaluate the potential environmental impact, it is necessary to evaluate the contents of the pipeline and outline the cleaning operations that will be undertaken (BEIS, 2017).

Where it is proposed that a pipeline should be decommissioned in place, either wholly or in part, then the decommissioning programme should be supported by a suitable study which addresses the degree of past and likely future burial/exposure of the pipeline and any potential effect on the marine environment and other uses of the sea. The study should include the survey history of the pipeline with appropriate data to confirm the actual status of the pipeline including the extent and depth of burial, trenching, spanning and exposure. It should also detail levels of fishing activity in the area (BEIS, 2017).

Where rock installation has been used to protect a pipeline, it is recognised that removal of the pipeline is unlikely to be practicable and it is generally assumed that the rock installation and the pipeline will remain in place. Where this occurs, it is expected that the rock installation will remain undisturbed (BEIS, 2017).

3.8.2 Environmental impacts of decommissioning

In case the pipeline is left *in situ*, for a number of years the potential environmental impacts will be comparable to some of the impacts caused by the presence of the pipelines during the operational phase. This includes the continued presence of the pipeline on the seabed, which potentially leads to a "reef effect", and there can potentially be an impact on commercial fisheries. Also, there will be a continuation of the release of metal from the sacrificial anodes.

In addition to the above, there will be a release of mainly iron from the gradual corrosion of the steel pipelines in the marine environment. This release will be slow and is not expected to have any negative impact on the marine environment.

In case the pipeline is fully or partly removed, the potential impacts on the marine environment are expected to be comparable to the impacts of construction of the entire or parts of the offshore pipeline. In addition, there will be a large amount of materials recovered which will partly cause waste creation and will partly provide resources for recycling (e.g. the pipeline steel).

3.9 Mitigation measures

This section provides an overview of the mitigation measures applied for the Baltic Pipe project. The mitigation measures for the offshore part are divided in three different types:

- Mitigation measures that already have been implemented in the project design;
- Mitigation measures applied for unplanned events;
- Mitigation measures that comprise common practise or regulatory measures.

3.9.1 Mitigation measures implemented in the project design

The project design and the pipeline route selection are generally based on the consideration of reducing impact from the project on the environment. In Chapter 5, Alternatives, a thorough description of the route selection, including some of the incorporated environmental consideration, is outlined. In Table 3-12, other significant mitigation measures or project optimisations implemented in the project design to reduce the environmental impacts are presented.

Table 3-12 Examples of mitigation measures implemented in the project design.

Receptor	Mitigation measure
Benthic habitats, flora and fauna	**Disposal area for trenched material at 7 m sea level** As part of the tunnelling activities nearshore, trenched material from the exit point of the TBM and trenched material from the associated transition zone at approximately 4 m depth will be transported to a temporary disposal area on the seabed at a water depth of at least 7 m in order to minimise the potential impact on eelgrass.
Benthic habitats, flora and fauna	**Restoration of seabed** To reduce the impact on the seabed from the TBM and the associated transition zone, the seabed will be restored up to 7 m water depth.
Landscape Protected areas, natural habitats, flora, and fauna (onshore) Biodiversity (onshore) Hydrography and water quality	**Tunnelling** Tunnelling has been determined as the preferred construction method at the landfall, rather than excavation. The height of the cliff at Faxe Syd is 15-17 m, and excavation would leave a large mark in the landscape which is not easily reinstated. Furthermore, excavation volumes would be excessive, causing a significant disturbance to the cliff and, moreover, sediment dispersion from the shallow-water excavation works. By using tunnelling, the cliff remains undisturbed as a natural habitat and potential breeding site for sand martins.

3.9.2 Mitigation measures for unplanned events

If munitions clearance as an unplanned event takes place, there could potentially be an effect on fish and marine mammals at the individual level (Sections 7.3.1 and 7.3.2); hence, suggested mitigation measures have been listed in Table 3-13.

Table 3-13 Suggested mitigation measures in the event of munitions clearance.

Receptor	Mitigation measure (unplanned event)
Fish	**Sonar survey** A sonar survey to identify shoaling or schooling fish in the area should be carried out by a work boat to assess whether the timing of the munitions clearance is suitable or if the detonation should be postponed. This assessment can be helpful to protect parts of fish populations that may be present in the area.
Marine mammals Annex IV species – harbour porpoise (offshore)	The marine mammals mitigation plan includes the following mitigation measures: **Visual observations and passive acoustic monitoring (PAM)** Visual monitoring by a marine mammal observer is undertaken from the source vessel (from a suitable viewing platform). Visual monitoring should be restricted to periods of good visibility during daylight hours, as visibility decreases during poor weather or lighting conditions. If marine mammals are present prior to munitions clearance, the detonation should be postponed. Visual observations prior to munitions clearance do not guarantee that marine mammals are not affected, as marine mammals may stay below the surface and hence remain undetected for long periods. However, a visual survey prior to clearance can help to protect animals, which are sighted. Acknowledged guidelines from JNCC should be applied as good practice for visual observation methodologies (JNCC, 2017). PAMs are hydrophones deployed into the water column, and the detected sounds are processed using specialised software. PAM will be implemented as a supplement to the visual observations done by the observer. **Seal scarer** Seal scarers are acoustic devices, which can be used to deter seals and harbour porpoises from e.g. construction activities, fishing gear etc. The range, or the efficiency of the devices depends on the type of scarer and the setup. Seal scarers will be used prior to detonation of possible munitions finds that need to be cleared. **Seasonality** To avoid impact on the endangered Baltic Sea harbour porpoise population, munitions clearance could be done during the summer period, if reasonable practically. If this measure is followed, the risk of blast injury and PTS is negligible.

3.9.3 Regulatory or common practice mitigation measures

The Baltic Pipe project will, naturally, comply with the applicable regulation in force and with common practice industry norms, some of which also contribute to the mitigation of the environmental impacts from the project. In this regard, an environmental management plan will be developed. The regulatory or common practice mitigation measures listed in Table 3-14 are examples that preferentially could be part of the environmental management plan. However, it should be emphasised that the list is not exhaustive.

Table 3-14 Examples of regulatory or common practise mitigation measures (not exhaustive).

Receptor	Mitigation measure
Commercial fisheries	**Economic compensation of fishermen** Compensation will be a measure to reduce the economic impact on fishermen fishing in areas that will be temporarily closed due to the safety zones around the construction vessels. In cooperation with the contractor and the Danish Maritime Authority, the developer will announce the planned periods of construction activities.
Population and human health (onshore) Tourism and recreational areas (onshore)	The following measures should apply during construction on land: • Fencing the work site; • Avoid lighting that dazzles the nearest neighbours; • Maintain access to Skansestien; • Prevent spread of contaminated soil, e.g. in the form of dust during excavating or transport; • In areas of work, measures to prevent spillage of oil / petrol products from construction machinery, mobile refuelling plants and the like (e.g. drip trays) should be implemented; • Handle waste according to applicable regulation; • Use recyclable materials when possible and recycle all potential recyclable waste fractions; • Information should be given to local citizens, recreational harbours, recreational sailors, local divers, anglers and organizers of special activities at Feddet/Strandegård about possible inconvenience from activities during construction (not as a standard, but when the activity and the duration changes); • Construction related traffic will be assigned routes to use, appointed by the local authorities and the police, to minimise the impact on neighbours and users of the roads; • Along the route used by construction related traffic, signs warning about the construction activities will be posted.
Biodiversity (offshore)	**The Ballast Water Management Convention** The Ballast Water Management (BWM) Convention aims to prevent the spread of harmful aquatic organisms from one region to another (non-indigenous species (NIS)) by establishing standards and procedures for the management and control of ships' ballast water and sediments. All vessels participating in the Baltic Pipe project will be requested to comply with the BWM Convention and the HELCOM Guide to alien species and ballast water management in the Baltic Sea.
	Light reducing Electric lighting on ships poses a collision risk for nocturnal migrants because it attracts birds and/or bats. Decreasing illumination and restricting the spectrum of light is an approach to reducing impacts to biological resources and still maintaining safe operations.
Biodiversity (onshore)	**Light reduction** For the sake of wildlife, all lights at the work site can be focussed at the work site and turned off when no work is done. Yellow or orange light can be used instead of white as it attracts fewer insects and thus fewer bats to the construction site.

Receptor	Mitigation measure
Emissions to air (offshore)	**SO_X and NO_X emission control areas (SECA and NECA)** The IMO has designated the Baltic Sea as Emission Control Area (ECA) from 2015 under regulation 14 of MARPOL Convention Annex VI to limit the emission of SO_X (also known as SECA) and from 2021 the Baltic Sea is designated under regulation 13 of MARPOL Convention Annex VI to limit the emission of NO_X (also known as NECA). The ships and fuel used in the construction activities for the Baltic Pipe project will be required to comply with the legislation in force, including the regulations resulting from the designation of NECA and SECA areas.
Emissions to air (onshore)	**Euronorm stage IIIA** To limit the emissions to air, construction equipment covered by the European emission standards (in Denmark known as Euronorms) for engines in non-road machinery, e.g. dredgers and dozers, should as a minimum comply with stage IIIA.
	Reducing emissions A general recommendation is to prevent engine idling to reduce emissions at the work site.
Archaeology (onshore)	**The Museums Act** Part of the Museums Act applies to construction activities. The responsible museum (Museum of Southern Denmark) has prepared a statement according to the act about risk of encountering archaeological objects during project construction. Based on this statement, the museum will make a preliminary study of the areas affected by the construction activities. Furthermore, the Museum Act § 27 applies at all times, which means that construction activities should be stopped if archaeological objects appear during construction.
Archaeology (offshore)	The handling of marine archaeology will be based upon the final evaluation of potential cultural heritage objects along the preferred route for the offshore pipeline, which is in process. The Viking Ship Museum (VIR) is responsible for this evaluation. Furthermore, the Museum Act § 29h applies at all times within 24 NM from land, which means that construction activities should be stopped if archaeological objects appear during construction.

4. RISK ASSESSMENT

4.1 Introduction

This chapter presents a summary of the results of the risk assessment related to the risk of environmental accidents and the risk to the population (3rd party risk, or societal risk). Herein the term "risk" means the likelihood of an accidental event combined with the consequence of the event.

Risk is defined as the likelihood of an accidental event combined with the consequence of the event. For the offshore part of the Baltic Pipe project, detailed risk analyses have been carried out and documented in the Construction Risk Analysis, CRA (Ramboll, 2018e) and in the Quantitative Risk Assessment, QRA (Ramboll, 2018f) for the construction and operational phases, respectively.

In the following, a summary of the results of the risk assessment related to the risk of environmental accidents and the risk to the population (3rd party risk, or societal risk) is provided. With respect to working environment and the risk to personnel participating in the construction work, this is not part of this report and reference is made to the above-mentioned CRA report (Ramboll, 2018e).

The framework for controlling the risks during construction and operation is the Health, Safety and Environmental Management System of the operator GAZ-SYSTEM S.A.

4.2 Application of the ALARP principle

Design of the Baltic Pipe project has been carried out using the principle of reducing the risk to a level As Low As Reasonably Practicable (ALARP). This principle is illustrated in Figure 4-1.

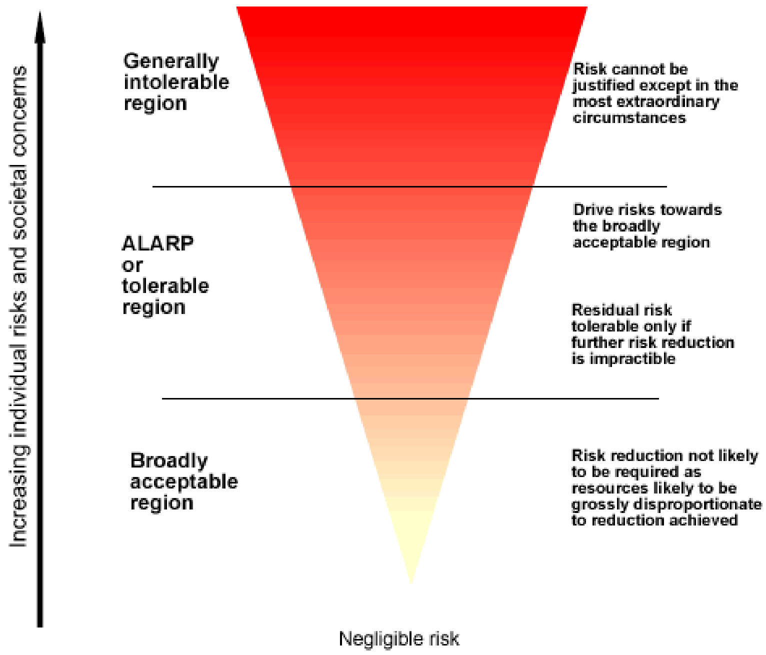

Figure 4-1 The ALARP triangle. Risks in the upper intolerable shall always be reduced; the risk exceeds legal requirements, company performance standards or similar. Risks in the ALARP region need to be reduced to a level As Low As Reasonably Practicable (ALARP), i.e. until the cost involved in reducing the risk further would be grossly disproportionate to the benefit gained.

ALARP demonstration is the final step of the risk assessment methodology to identify whether there is any reasonably practicable additional safety measure that could be implemented to reduce the risks. ALARP demonstration for the offshore part of the Baltic Pipe project is documented in Ramboll, 2018g.

4.3 Risk acceptance criteria

The risk assessment criteria (RAC) established for the Baltic Pipe offshore pipeline are in line with industry best-practice based on previous experience from large offshore pipeline projects (Ramboll, 2018l).

For human safety, a RAC has been established for individual risk (IR), which is the risk of loss of life for individuals (i.e. each individual person). The criterion is different for 1st and 3rd persons.

For 1st person (a person involved in work for the project, e.g. the installation contractor), the fatal accident rate (FAR) should be <10 per 108 exposure hours for pipeline installation.

A 3rd persons is defined as any person from the public who could be exposed to activities originating from GAZ-SYSTEM S.A. (e.g. the public at landfalls or passengers on ships). Societal risk (or group risk) is the risk of loss of life for a population (i.e. a number of different individuals and groups of people). A tolerance criterion has only been defined for 3rd persons and it is described by the F-N curve in Figure 5 2. Risk levels below the tolerance criterion are in the ALARP region and shall be evaluated according to the ALARP principle (see Section 4.2), (Ramboll, 2018l).

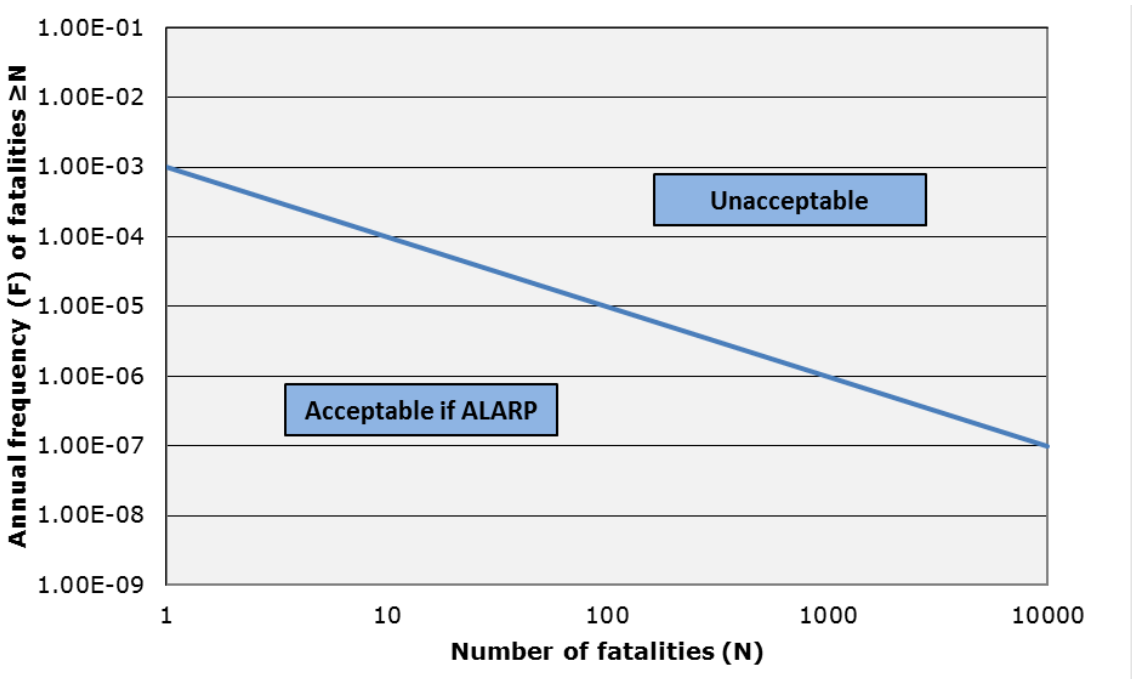

Figure 4-2 Risk acceptance criterion for 3rd person societal risk (Ramboll, 2018e).

The most critical 10 km section along the pipeline is evaluated against the tolerance criteria, including risks from all relevant accidental scenarios.

4.4 Hazard identification

A HAZID workshop was carried out in Copenhagen, Denmark on the 20th and 21st of June 2018 with the focus on identification of issues and hazards which will influence the design and layout of the Baltic Pipe offshore pipeline and form the starting point for the risk management process for the design of the offshore pipeline.

The conclusion from the HAZID study is that the main challenges related to the Baltic Pipe offshore pipeline include the following (Ramboll, 2018d):

- The pipeline will be routed through areas with a high density of ship traffic, making the QRA an important tool to ensure that appropriate protection is installed along the relevant lengths of the pipeline.
- The pipeline will cross a number of cables and most importantly the Nord Stream pipeline(s). This requires a well-developed crossing design, in which the crossing location, height of crossing structure and avoidance of electromagnetic corrosion are taken into account.
- The pipeline will cross close to a military submarine exercise area. The risk related to this shall be handled carefully.
- The pipeline will pass through several Natura 2000 sites (this includes one in the Swedish EEZ and two in Polish waters). The planned EIA must focus on a number of key concerns and is expected to further clarify any complications related to pipeline installation through these areas.
- Most of the hazards in the installation phase are related to asset risks, especially project delays.
- The planning of the installation phase as well as clearly defined requirements for all contractors in the installation phase are critical to reducing risks from a variety of hazards.
- Seabed intervention work as well as potential unexploded ordnance/chemical warfare agent (UXO/CWA) objects along the pipeline route.
- Man-access to the tunnel which will require focus in the execution phase of the project. The hazards related to the tunnel are: operation in a confined space under compressed air, retrieval of TBM, heavy/blind lifting on the work site. The latter two risks are level III human safety risks.

All identified hazards are detailed in a HAZID register, which includes 15 main actions and a number of sub-actions. The follow-up and closing of the actions, together with the residual risk assessment, is an important step of the risk management process in order to demonstrate that an effort has been made to eliminate, prevent, control and mitigate the hazards and that the risk has been reduced to ALARP, as outlined in Section 4.2.

4.5 Ship traffic

The traffic intensity for ships in the area of the pipeline has been analysed using historical Automatic Identification System (AIS) data from 2016. Only ships with a gross tonnage (GT) over 300 GT are obliged to have AIS equipment installed. To account for the increasing ship traffic intensity in the future, the ship traffic is estimated in the year 2032, 10 years after operation start, for use in further analysis.

The majority of the ship traffic in the area follows the various shipping lanes in the southwestern part of the Baltic Sea (see Figure 5 3). The main directions of ship traffic are east-west from the inner Baltic Sea and towards Fehmarn Belt, north-south from southern Scania (Trelleborg/Ystad) to Swinoujscie, and north-southwest from southern Scania (Trelleborg/Ystad) to Fehmarn Belt (Rostock/Lübeck). To increase navigational safety, the ship traffic between Bornholm and Sweden is regulated by the Bornholmsgat Traffic Separation Scheme (TSS), which separates the ship traffic towards the southwest from the ship traffic towards the northeast.

As seen in Figure 4-3, seven different critical zones have been identified along the pipeline. All the critical zones are located in the major traffic lanes, where the release frequency is high. Red dots indicate the kilometre point interval (KPI) where the release frequency is critically high and yellow dots indicate KPIs included to extend the critical zone to a fitting length.

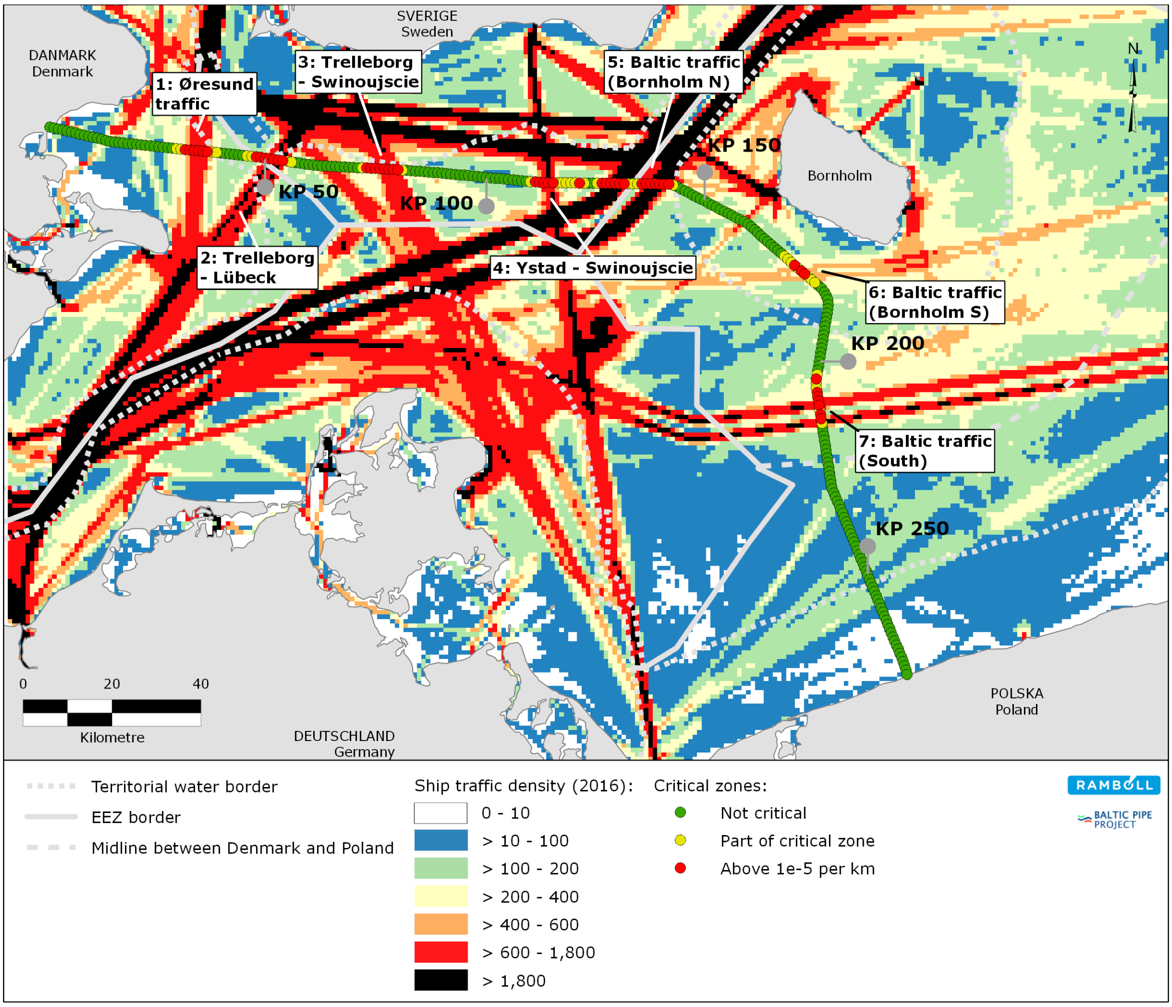

Figure 4-3 Ship traffic intensity map based on AIS data from 2016 (Ramboll, 2018f).

The yearly ship traffic across the pipeline route is shown in Figure 4-4. To account for the increased maritime activity in the future, ship traffic is estimated for the year 2032 which is 10 years after operation start.

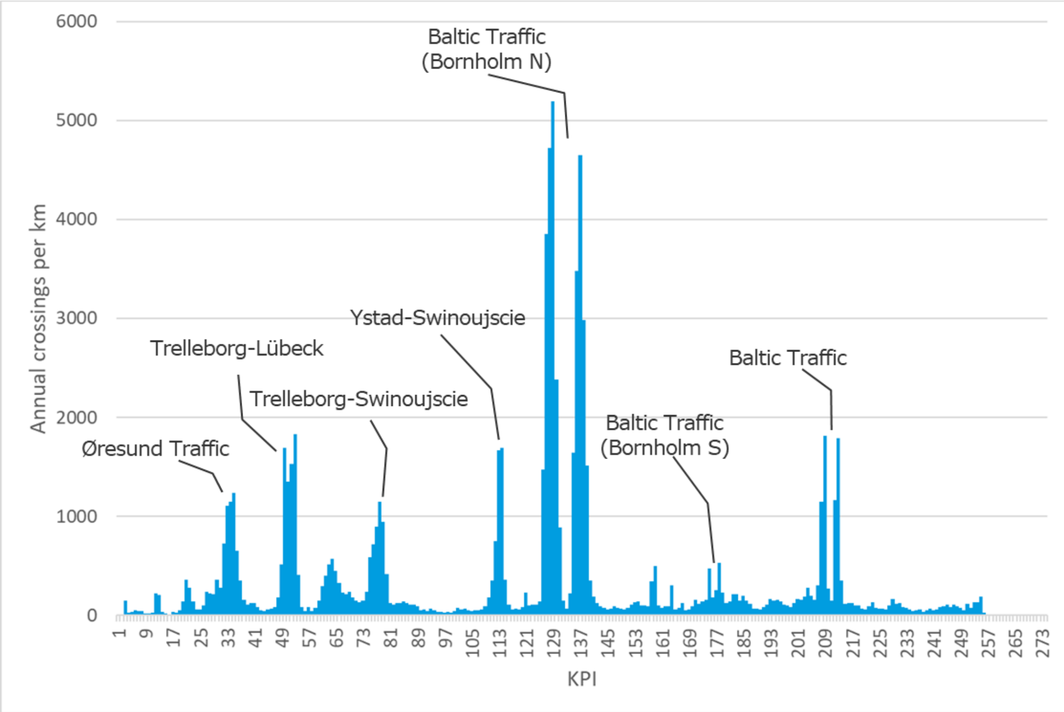

Figure 4-4 Expected annual ship crossings along the Baltic Pipe route in 2032 (Ramboll, 2018f).

4.6 Hazards and risks during the construction phase

4.6.1 Methodology

During construction of the offshore Baltic Pipe pipeline, there will be an increase in ship traffic in the project area due to the presence of the work vessels. The main contribution to the increase is the pipe-lay and seabed interventions work vessels travelling along the pipeline, as well as the pipe carrier vessels supplying the pipe-lay from one or more shore bases. The shore base(s) to be used during the construction phase have not yet been selected. In order to be able to carry out a risk analysis regarding the pipe carrier vessel, the calculations have been made assuming that Rønne (Bornholm) is used as shore base for storage of the pipe sections. Both the pipe-lay vessel, the seabed interventions vessels and the pipe carrier vessels cross existing ship traffic lanes (see Figure 4-3), which increases the risk for ship-to-ship collisions resulting in loss of life or substantial oil releases.

As part of the Baltic Pipe CRA (Ramboll, 2018e), it was concluded that mitigation measures will be recommended for pipelay and rock lay vessels, in order to prevent potential collisions with ambient traffic. Mitigation measures include the use of notices to nearby mariners, safety zones and AIS communication technology. These mitigation measures have been included in the following results.

4.6.2 Risk related to oil spills

The risk of larger oil spills during the construction phase relates to the risk of third-party vessels colliding with one of the work vessels participating in the construction works. In addition to this, there is a risk of a minor oil spill from e.g. bunkering operations. The main risks of oil spill relate to third party collision with the lay barge, and, to a minor extent, third-party collision with other construction vessels. In particular, these risks are linked to the critical zones where the pipeline crosses shipping lanes (see Figure 4-3, Figure 4-4 and Table 4-2).

The frequencies of oil spills of various sizes have been calculated for the various parts of the pipeline route (see Table 4-1). Spills from bunker operations, which can have a size of 0-200 tonnes of bunker oil, appear in a separate row. The spills in the remaining rows have been calculated for lay barges and seabed interventions vessels after implementation of mitigation measures, and for the pipe carried without mitigation measures. The methods and assumptions for the calculations are documented in Ramboll, 2018e.

Table 4-1 Frequencies of oil spills of various size during the construction period. Bunker spill, which is in the range 0-200 t, is in a separate row.

Oil spill size [tonnes]	Denmark	Sweden	Poland	Disputed zone	Total
200 (bunker)	7.12×10^{-5}	8.56×10^{-5}	1.47×10^{-6}	1.34×10^{-5}	1.72×10^{-4}
500	1.67×10^{-5}	1.89×10^{-5}	2.26×10^{-7}	3.53×10^{-6}	3.93×10^{-5}
1,000	7.70×10^{-6}	$8{,}80\times10^{-6}$	9.73×10^{-8}	1.57×10^{-6}	1.82×10^{-5}
10,000	4.82×10^{-6}	5.39×10^{-6}	6.59×10^{-8}	1.01×10^{-6}	1.13×10^{-5}
50,000	1.06×10^{-6}	1.32×10^{-6}	8.79×10^{-9}	1.98×10^{-7}	2.58×10^{-6}
100,000	1.26×10^{-7}	1.59×10^{-7}	5.41×10^{-11}	1.64×10^{-8}	3.02×10^{-7}
>100,000	2.52×10^{-8}	3.18×10^{-8}	1.08×10^{-11}	3.28×10^{-9}	6.03×10^{-8}
Total	$\mathbf{1.02\times10^{-4}}$	$\mathbf{1.20\times10^{-4}}$	$\mathbf{1.87\times10^{-6}}$	$\mathbf{1.97\times10^{-5}}$	$\mathbf{2.43\times10^{-4}}$

As expected, the frequencies of small spills from bunker operations are higher than the frequency of larger spills as a consequence of a potential collision between a third-party vessel (oil tanker) and a work vessel. The frequency of oil spills caused by vessel collision is highest in Danish and Swedish waters, which coincides with the areas where the ship crossing traffic is highest, as outlined in Figure 4-4.

Risk acceptance criteria are usually related to human safety and not to the risk of oil spills. Also, because larger oil spills are fortunately relatively rare, it is difficult to find statistics to compare with for establishing whether the calculated spill frequencies are acceptable. Figure 4-5 shows FN-curves for annual spill frequencies of oil and chemicals, respectively, for an average offshore installation on the UK continental shelf during the period 2005-2010. This figure is not directly comparable with the conditions related to construction of a pipeline in the Baltic Sea, but it does, however, give an indication of what is considered acceptable in other industries with very high safety requirements and in a comparable environment.

Figure 4-5 shows that no oil spills larger than 2-300 tonnes occurred in the area/period serving as the basis for the figure. The annual frequency of a spill in the range of 10-100 tonnes is on the order of magnitude of 10^{-2} to 10^{-3} for an average offshore installation on the UK continental shelf during the period 2005-2010. When comparing with the calculated frequencies for the construction period for the Baltic Pipe (Table 4-1), these are on the order of magnitude of 10^{-4}-10^{-5} spills, i.e. the likelihood of an oil spill as a consequence of the construction of the Baltic Pipe is on the order of magnitude of 10^{-2}-10^{-3} of the yearly likelihood of an oil spill from an offshore oil and gas installation on the British continental shelf. It is expected that this proportion is also the same for larger oil spills than the spills coverer by the statistics shown in Figure 4-5.

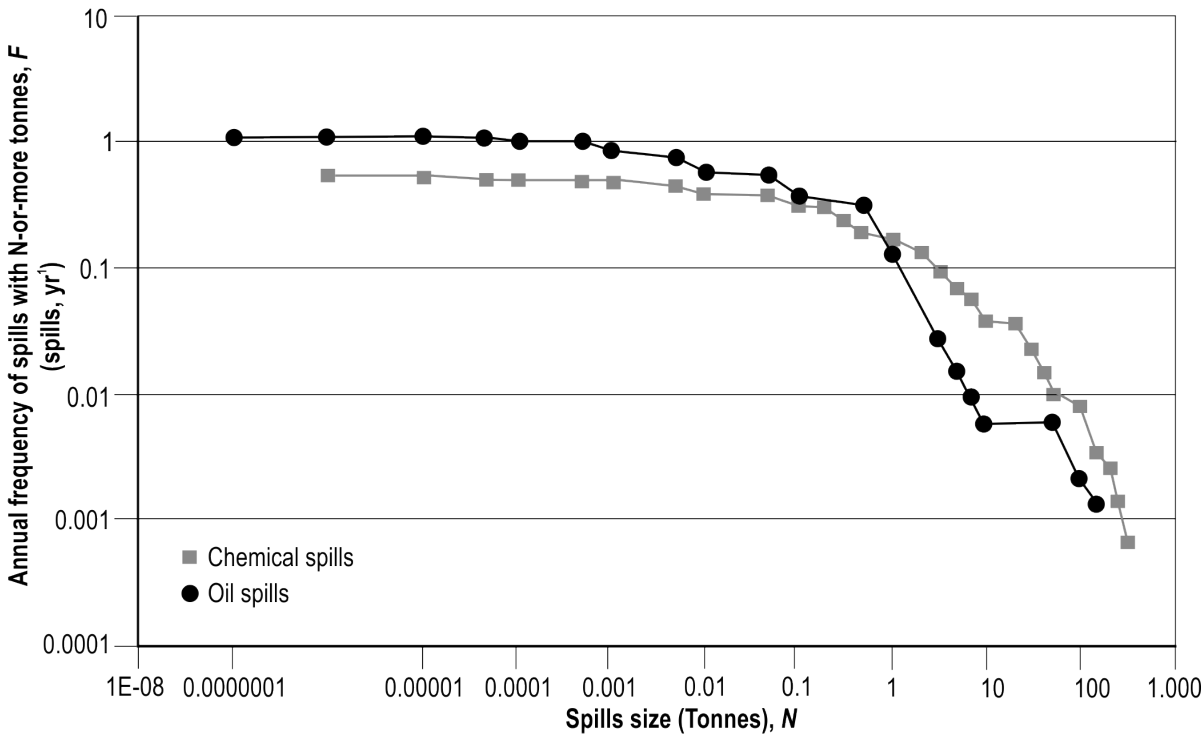

Figure 4-5 FN-curve for accidental releases of oil and chemicals, respectively, normalised to an average offshore installation (drilling or producing platform) on the UK continental shelf. The data are based on statistics for all UK offshore installations for the period 2005-2010 (after Energy Institute, 2012).

The above shows that the frequencies of possible oil spills as a consequence of the project are low, relative to e.g. oil and gas exploration and production, which have an inherent risk of oil spills. This is due to the fact that the project does not introduce oil to the area, except for bunker oil on the vessels. Therefore, the risk of a major oil spill as a consequence of the project is solely related to the possible interaction between work vessels and third-party tankers etc. The risk of oil spill introduced by the Baltic Pipe project is comparable to the risk introduced by many other maritime activities in the Baltic Sea, including commercial fishing, shipping, etc.

4.6.3 Risk to human safety (3rd party)

The risk to third party personnel has been calculated, using the same ship traffic data s used for the oil spill frequency calculations. The method and assumptions are documented in Ramboll, 2018e.

Societal (3rd party) risks are evaluated using an FN curve, which presents the number of fatalities (N) against the annual frequency (F) of incidents with fatalities ≥N. The FN curve is presented for pipeline construction phase in the Danish, Swedish and Polish waters in Figure 4-6. The risk in the disputed area is included both in the risk curve for the Danish area and in the risk curve for the Polish area.

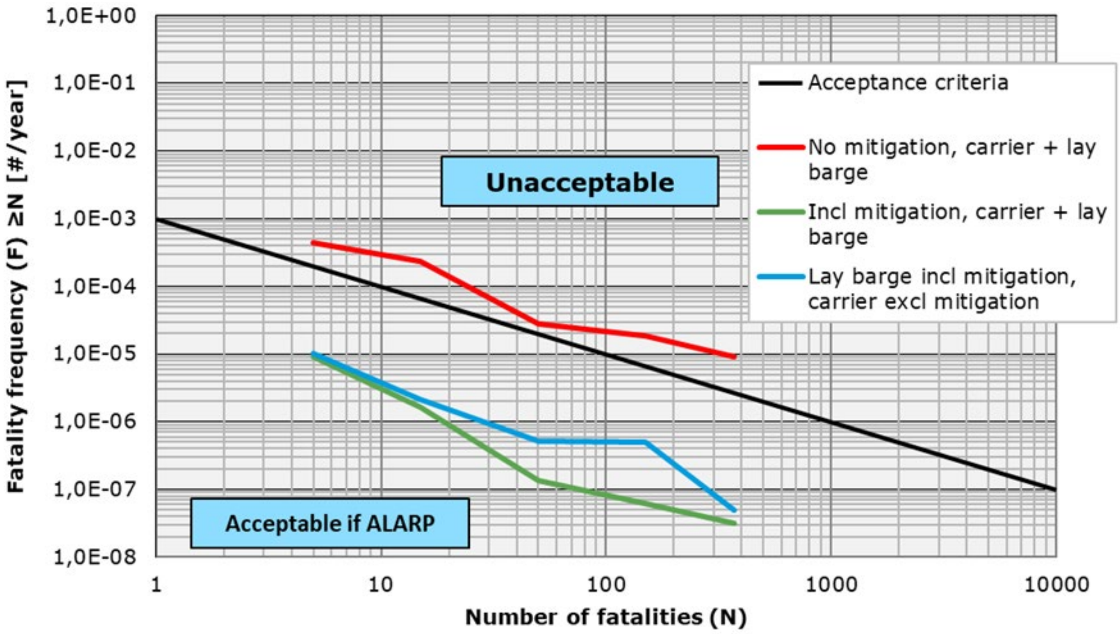

Figure 4-6 FN-curve illustrating societal risk (3rd party) for the construction phase. The frequencies have been calculated after mitigation measures have been implemented for the pipe-lay vessel and for the pipe carrier and rock installation vessel without mitigation measures (Ramboll, 2018e).

When comparing with the risk acceptance criteria (Section 4.3) the risk to third party is well below the acceptance criteria, i.e. in the ALARP zone, where risks need to be reduced to a level as low as reasonably practicable.

4.6.4 Environmental consequences of oil spills during construction

Due to the low probability of oil spills of the consequence of the Baltic Pipe construction works (see Section 4.6.2), no modelling of the dispersion of oil has been conducted for this project. Below is a short qualitative overview of the potential consequences of a possible oil spill.

Oil spilled to the marine environment will rapidly spread out and move on the sea surface with wind and currents while undergoing a number of chemical and physical changes (weathering). Some of these processes, such as natural dispersion of the oil into the water, lead to the removal of the oil from the sea surface, and facilitates its natural breakdown in the marine environment. Others, particularly the formation of water-in-oil emulsions, cause the oil to become more persistent, and remain at sea or on the shoreline for prolonged periods of time (ITOPF, 2014a).

Oil may impact an environment by one or more of the following mechanisms (ITOPF, 2014b):

- Physical smothering, with an impact on physiological functions;
- Chemical toxicity, giving rise to lethal or sub-lethal effects or causing impairment of cellular functions;
- Ecological changes, primarily the loss of key organisms from a community and the takeover of habitats by opportunistic species;
- Indirect effects, such as the loss of habitat or shelter and the consequent elimination of ecologically important species.

More specifically, if oil spill is introduced to the Baltic Sea, direct impacts can occur on seabirds and marine mammals by smothering of feathers and skin and ingestion of oil adhered to the food source (HELCOM, 2018). More indirectly, oil spill introduces a severe threat to marine life throughout the food web from plankton to seabirds, where especially polycyclic aromatic hydrocarbons (PAHs) can cause impacts on both invertebrates and vertebrates due to their carcinogenic, mutagenic and lethal effects. PAHs can accumulate in fatty tissue and be introduced via plankton to higher trophic level organisms.

As the risk of oil spill from the Baltic Pipe project is low, the risk and detailed impact assessments will not be dealt with further.

4.7 Risk related to possible munitions finds

The pipeline route extends through areas where there is a risk of encountering both conventional and chemical munitions. Potential munitions objects will as far as possible be avoided, by designing the route based on the findings from the geophysical surveys. There is, however, a risk that e.g. buried munitions objects might be encountered during the detailed magnetometer survey carried out prior to pipe-lay.

An overall UXO hazard location plan is shown in Figure 4-7. In addition to the conventional munitions, there is additionally a risk of encountering chemical munitions for the part of the pipeline Southwest for Bornholm.

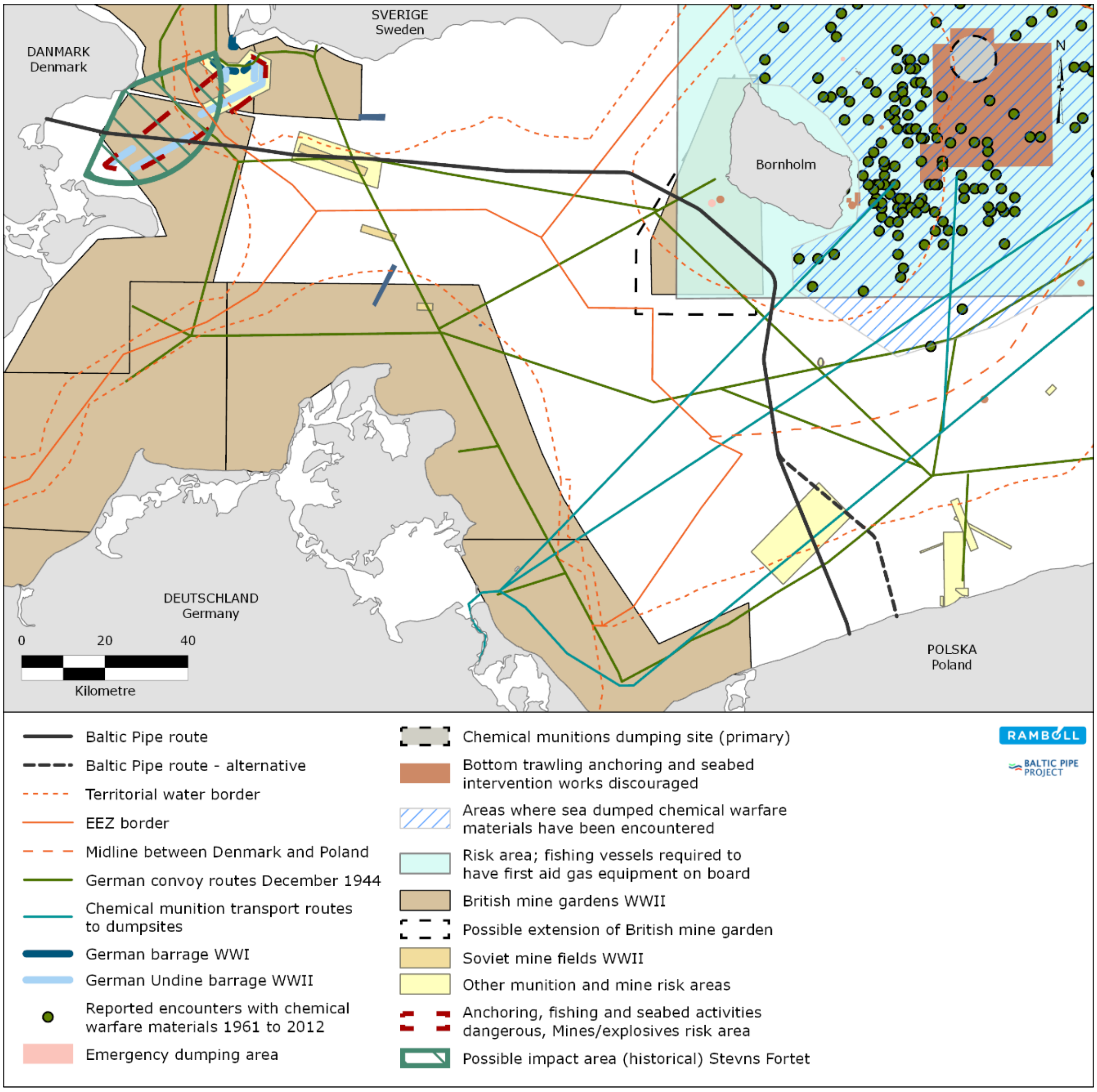

Figure 4-7 Overview map of munitions risk areas (Ramboll, 2018k). The areas are approximations only, based on the available information, including information from HELCOM, 2013c.

4.7.1 Risk of unplanned conventional munitions encounter

It is difficult to quantify the risks caused by the presence of munitions, due to the limited experience with infrastructure projects in the area.

With regards to conventional munitions, the risks to personnel, marine life and assets arises from the possible detonation of the munition objects. The risk can be divided into the risk of having to clear identified munitions objects and the risk of accidental detonation of munitions.

The risk of having to clear munitions is mitigated by, as far as possible, re-routing the pipeline to avoid munition objects visible at the seabed. Following a dedicated munitions survey, using magnetometers to identify also possible munitions buried in the seabed, additional munitions objects may be identified. In some case re-routing is not feasible at this stage (e.g. if re-routing would require an additional munitions survey covering the changed route), detonation triggered by a donor charge might be required. This would be carried out by the applicable national defence authority, in compliance with their very strict safety procedures. The risk to personnel is therefore considered negligible.

The main issue in case munitions clearance will be required is the possible impacts on marine mammals and fish caused by the underwater noise (see Sections 7.3.1 Fish and 7.3.2 Marine mammals).

The likelihood of accidental detonation of munitions is much smaller than the likelihood of having to clear munitions objects. The consequences of such would be largest in the near-shore areas, where back-hoe dredging takes place, i.e. personnel could in theory be exposed in case of an accidental detonation. Further offshore, a possible detonation could only cause damage to the pipeline or equipment during the construction phase, i.e. when the pipeline is not gas-filled.

Based on the fact that detailed geophysical surveys and a dedicated munitions survey have been carried out, and the experiences from other projects in the Baltic Sea, the risk related to possible accidental detonation of munitions is considered negligible.

4.7.2 Risk of unplanned chemical munitions encounter

The pipeline route extends through a chemical munitions risk area, in which fishing vessels are required to have first aid gas equipment onboard. The pipeline route does not, however, cross the designated chemical munitions dumping site, which is situated to the northeast of Bornholm. Moreover, it does not extend through areas in which sea dumped chemical warfare materials have been encountered during the period 1961-2012 (see Figure 4-7).

Therefore, it is very unlikely that any chemical munitions objects will be encountered during the construction of the Baltic Pipe. The vessels participating in the construction work in the risk area southwest of Bornholm will be required to have first aid gas equipment onboard, and to have procedures in place for dealing with possible encounters. Exposure to e.g. lumps of mustard gas could take place in the case of contamination of the trenching plough, anchors or other equipment in contact with the seabed.

4.8 Environmental hazards and risks during the operational phase

4.8.1 Methodology and hazards considered

During the operational phase, the hazards and risks relate to possible leaks of gas in the case of damage to the integrity of the pipeline system. A QRA has been performed in compliance with DNV, 2010 and DNV GL, 2017. The assessment is documented in Ramboll, 2018f. The overall methodology applied is illustrated in Figure 4-8.

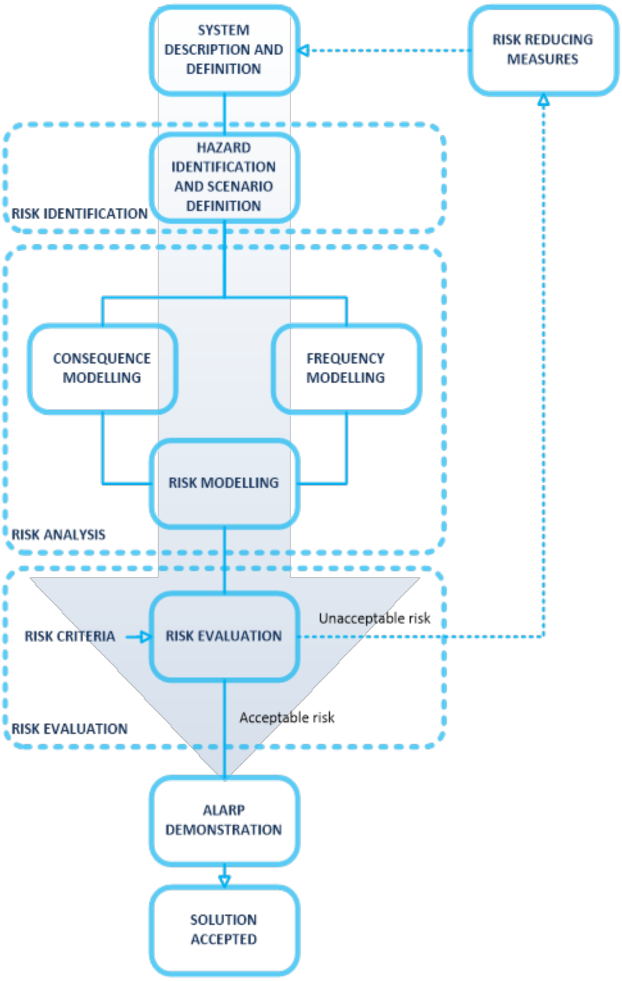

Figure 4-8 Overview of the overall methodology for the QRA.

The hazard identification (HAZID) study conducted during the detailed design phase for the Baltic Pipe project identified the following main hazards during the operational phase of the pipeline system (Ramboll, 2018d):

- Interaction from anchors (emergency anchoring and unintentionally dragged anchors);
- Sinking ships;
- Ship groundings;
- Dropped objects.

Other risks were identified during the HAZID workshop i.e. risks related to unexploded ordnances (UXO), internal corrosion, material defects, earthquakes and slugging. These risks will either be very unlikely to occur or be handled through proper operational planning and management. Therefore, these risks were rated as negligible and were therefore not considered further (Ramboll, 2018d). The remaining hazards are described below.

Dropped and dragged anchors

Incidents where dropped anchors have hooked and damaged or ruptured subsea cables have occurred numerous times in the Baltic Sea. It is believed that dropped and dragged anchors represents one of the main hazards to the Baltic Pipe (Ramboll, 2018d).

Sinking ships
There are also examples of ships sinking following a collision in the area. An example of this is the Chinese bulk carrier Fu Shan Hai, which sunk following a collision with the container vessel Gdynia in 2003. The risk for collisions is inherently increased in highly trafficked shipping lanes such as those crossed by the Baltic Pipe and that there is a possibility that a sinking ship could hit and severely damage the pipeline (Ramboll, 2018d).

Ship groundings
The draught of ships entering and exiting the Baltic Sea is limited by the water depth below the Great Belt Bridge, which is 19 m going into the Baltic Sea. Thus, a grounding ship with a direct impact on the pipeline is only considered possible at water depths of less than 19 m. This is the case near the landfalls and at Rønne Banke. As the grounding frequency at Rønne Banke is expected to be extremely low, and the significance of groundings at the nearshore areas are expected to be very low, the hazard for grounding ships is disregarded and has not been further quantified (Ramboll, 2018d).

Dropped objects
Objects dropped from passing ships has been considered as a hazard to the pipeline integrity. However, this hazard has been qualitatively evaluated to not represent a significant factor in the overall risk picture, and is thus not quantified (Ramboll, 2018d).

4.8.2 Gas release

Gas release frequencies
The ship traffic scenario which has made the basis for the QRA includes the input and cases outlined in Figure 4-9.

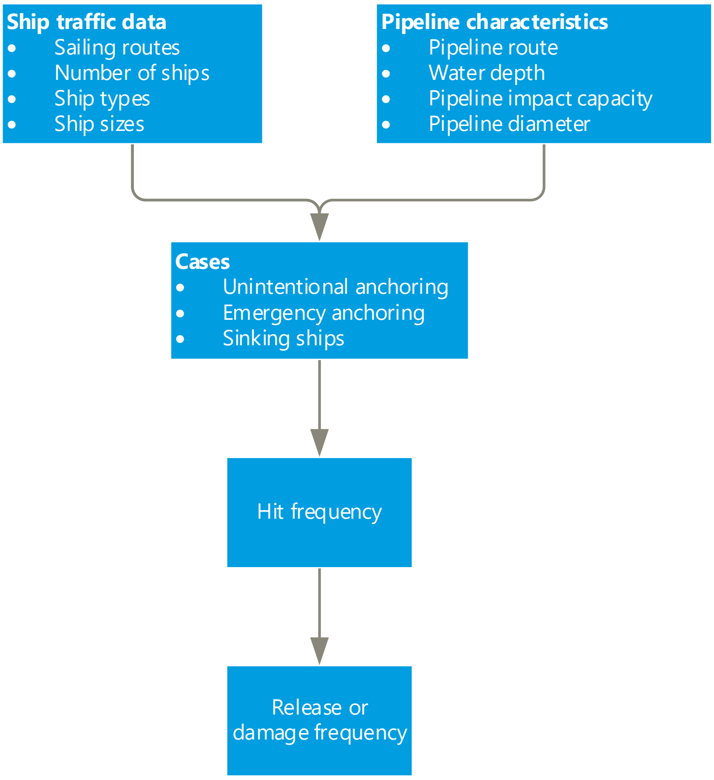

Figure 4-9 Methodology for ship traffic frequency assessment (Ramboll, 2018f)

Figure 4-10 shows the release frequencies calculated for the individual KPI along the pipeline route, using the above methodology. The figure is based on the expected number of ships of various size classes crossing the pipeline in 2032 (see Figure 4-3). The highest number of crossings are found at KPI 129 (in Swedish waters) and 137 (in Danish waters), with approximately 5,200 and 4,700 crossings respectively. These maxima and the remaining local peaks correspond clearly to the various main traffic lanes crossed by the pipeline.

Critical zones, which are parts of the pipeline (of at least 10 km each) where the release frequency is higher than the acceptance criteria of 10^{-5} incidents per year, have been defined. The identified critical zones are shown below in Table 4-2. The table also shows the dimensions of additional protection in the form of rock cover placed on top of the pipe, and the release frequencies with this additional protection in place. The release frequencies are, with this protection, in all cases below one incident per year.

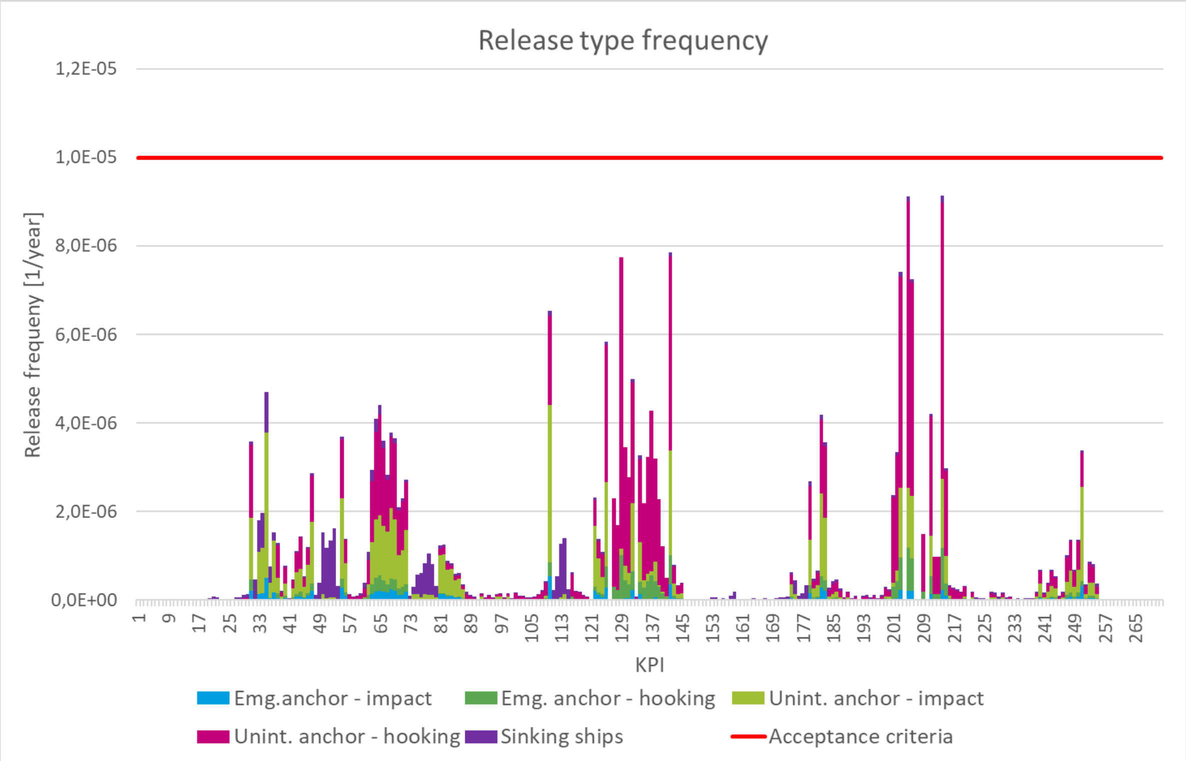

Figure 4-10 Overall yearly release type frequencies for individual KPI's of the pipeline, after adding protection to reach the 10^{-5} acceptance criterion for each KPI, distributed on causes of leaks.

Table 4-2 Description of critical zones along the BP pipeline route, release frequencies without protection, the protection applied, and the release frequencies without protection (Ramboll, 2018f). The crossings are in Danish waters (DK), Swedish waters (S) and the Disputed Area (DA).

Critical zone	Description	Initial KPI	Final KPI	Unprotected release frequency [$year^{-1}$]	Protection thickness [m]	Protection length [km]	Protected release frequency [$year^{-1}$]
1 (DK)	Øresund traffic	30	39	5.28×10^{-4}	0.9	6	1.65×10^{-5}
2 (S)	Trelleborg-Lübeck	46	56	1.21×10^{-3}	0.9	7	1.56×10^{-5}
3 (S)	Trelleborg-Swinoujscie	72	81	6.35×10^{-4}	0.9	8	8.57×10^{-6}
4 (S)	Ystad-Swinoujscie	110	122	5.18×10^{-4}	0.8-1-1	6	2.65×10^{-5}
5 (S/DK)	Baltic Traffic (Bornholm N)	125	142	2.97×10^{-3}	1.0-1-1	13	7.16×10^{-5}
6 (DK)	Baltic Traffic (Bornholm S)	172	181	1.27×10^{-4}	0.6-0.9	3	7.58×10^{-5}
7 (DA)	Baltic Traffic (South)	203	214	4.28×10^{-4}	1.2-1.3	7	8.07×10^{-5}

Critical zones 1 and 6 are situated in Danish waters, whereas the critical zone 5 is situated partly in Swedish and partly in Danish waters; it includes the Bornholmsgat TTS, as outlined in Section 4.5.

Release types

The distribution of leak sizes is given for generic failures and for ship traffic related releases in Table 4-3, together with the corresponding release rate. The shown release rates for small, medium and large releases are calculated as the initial mass flow rate, while the rupture flow rate is calculated as the weighted mean mass flow of the initial 20 minutes of the release.

Table 4-3 Leak size distribution and corresponding release rate for generic and ship traffic related releases

Leak size	Ship Traffic Release Distribution	Generic Release Distribution	Release rate [kg/s]
Small	0%	74%	7.9
Medium	0%	16%	49.2
Large	50%	2%	125.8
Rupture	50%	8%	3613

Small, medium and large releases exhibit a relatively constant mass flow throughout the first hour as the released mass is small compared to the mass available, while the flow rate of a rupture decreases exponentially.

As illustrated in Figure 4-11, the gas from a ruptured subsea pipeline will disperse into the surrounding water column in a cone-like shape while heading towards the sea surface. This underwater dispersion can be divided into three flow zones; Zone of Flow Establishment (ZOFE), Zone of Established Flow (ZOEF) and Zone of Surface Flow (ZOFS).

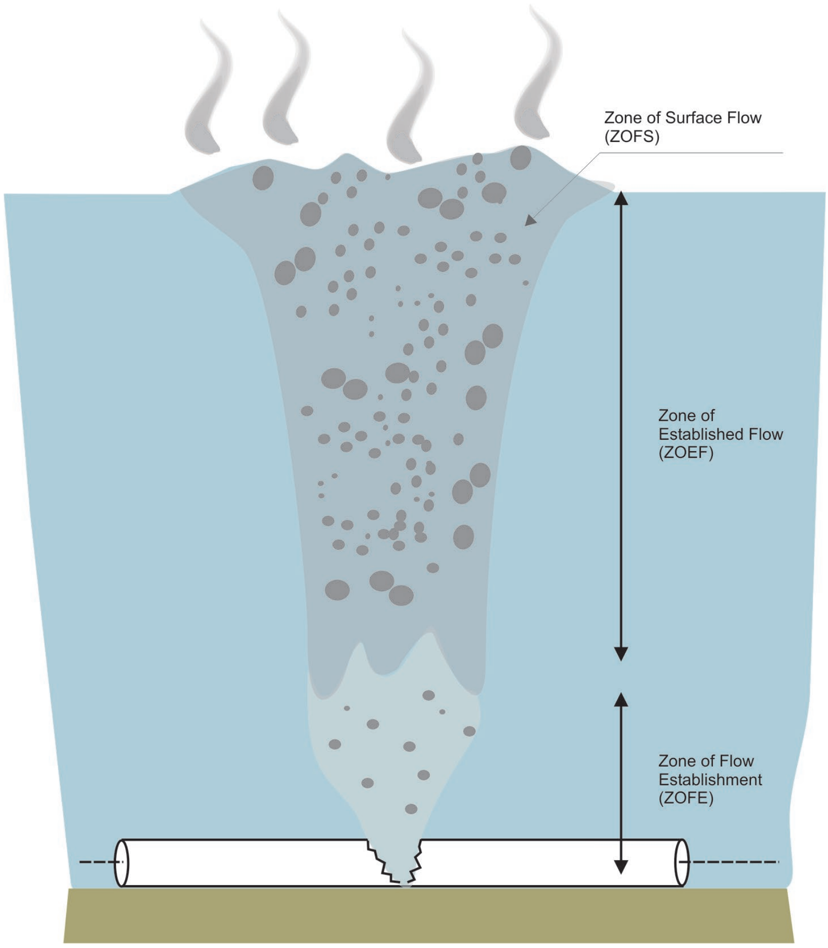

Figure 4-11 Gas release from a ruptured subsea pipeline (Ramboll, 2018c)

In most cases, a gas leak will not be ignited, but will instead escape to the atmosphere and contribute to the global pool of greenhouse gases (GHG). Methane (CH_4), which is the main constituent of natural gas, is a strong GHG, which has a global warming potential (GWP) of approximately 28 times relative to CO_2 (IPCC, 2014).

Calculations of the dispersion of released gas in the atmosphere using computational fluid dynamic (CFD) simulations have been carried out as part of the QRA. These calculations have been used for quantification of the likelihood of an explosion, which subsequently has been used in the analysis of risk to human safety (Ramboll, 2018f).

Consequence assessment

The release of gas from a subsea gas pipeline can result in a gas cloud close to the sea surface. If the gas cloud reaches a critical air-to-gas ratio, an explosion may occur due to an ignition source (e.g. a passing ship) and cause a fatal accident. Therefore, it is important to clarify the dispersion and consequence of such a gas leakage.

In order to evaluate the plume distribution of the dispersed gas into the atmosphere, the extent of the leakage needs to be specified. The size of the leakage relates to the size of the inflicted hole. Four different hole sizes are considered and presented in Table 4-4.

Table 4-4 Hole size and size interval of gas releases

Leak size	Size interval [mm]	Applied size [mm]
Small	< 20	20
Medium	20 – 80	50
Large	> 80	80
Rupture	Rupture	914

Approximations of the gas mass flows have been calculated using PHAST (Process Hazard Analysis Software, by DNV GL), version 8.11. In order to adjust the PHAST calculations to the underwater situation, the pressure inside the pipeline has been reduced to compensate for the water pressure. The calculations assume a release depth of 40 m, which corresponds to a water pressure of roughly 4 barg (Ramboll, 2018f).

4.8.3 Risk to human safety (3rd party)

The risk to human safety is assessed both in terms of individual risk (3rd party) and societal risk (3rd party). Individual risk presents the summarized frequency per year for fatality of the person expected to be most exposed to risk based on the total failure frequency of the pipeline system and the consequences following a release of gas from the pipeline. Societal risk represents the summarized frequencies per year for fatal accidents and the expected number of fatalities for these accidents based on the total failure frequency of the pipeline system and the consequences following a release of gas from the pipeline (Ramboll, 2018d).

The individual risk (3rd party) was evaluated for the most exposed individual crossing the 10 most critical KPI’s of the pipeline. Evaluation was performed with respect to ship traffic and generic failure related accidents. Individual Risk (3rd party) was found to be 4.28×10^{-6} incidents pr. year prior to protection and 1.07×10^{-6} incidents pr. year post protection. The individual risk (3rd party) is thus considered acceptable below the acceptance criteria of 10^{-5} per year both prior to and post protection (Ramboll, 2018f).

The societal risk was evaluated using a FN curve. The FN curve, prior to and post protection, is shown in Figure 4-12. It is clearly seen that the societal risk (3rd party) is lowered to a level acceptable when subject to the ALARP principle, when the above-mentioned protective measures are introduced.

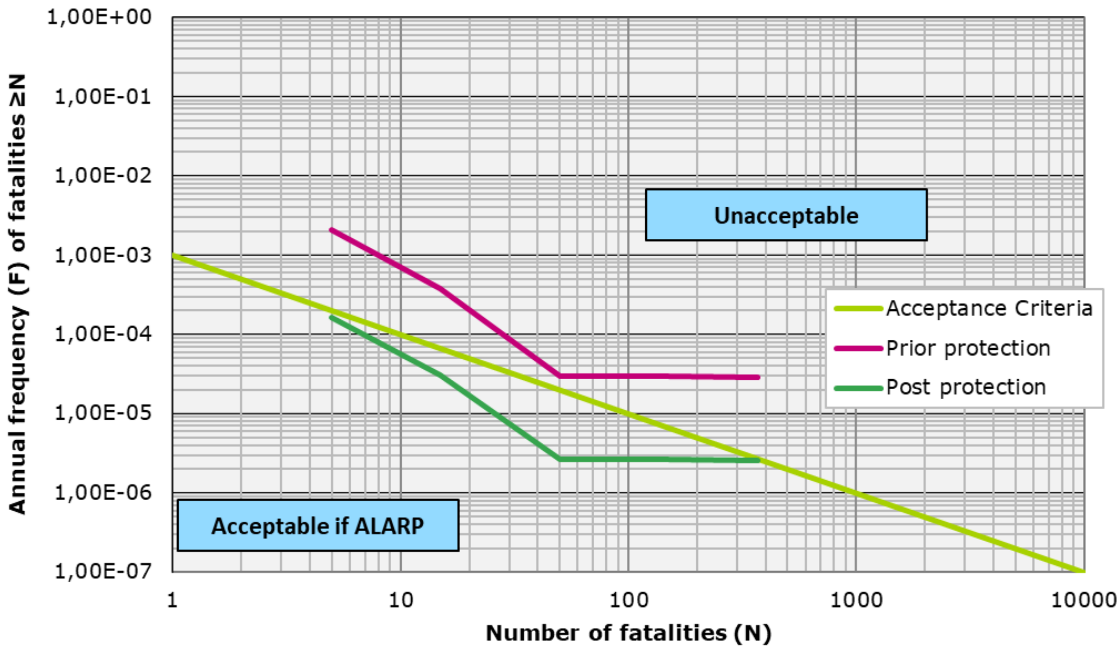

Figure 4-12 FN curve illustrating societal risk (3rd party) for unprotected and protected pipeline (Ramboll, 2018f).

4.8.4 Environmental consequences of gas leaks during operation

A potential gas leak will cause vertical mixing of the water column above the rupture, as shown in Figure 4-11. A large rupture will harm marine life (e.g. marine mammals, fish and birds) in the plume, which can have a diameter expanding to up to approximately 40 m at the water surface in the case of a full rupture (Ramboll, 2018f). The vertical mixing of the water column will potentially impact salinity, water temperature and oxygen conditions above the rupture. The seawater temperature may also be impacted by the cooling caused by the pressure drop induced gas expansion. The above potential impacts will be local and short term only.

The solubility of natural gas in seawater is low, and almost all the leaked gas will end up in the atmosphere. If the gas is ignited, the explosion will have an impact on marine life in the impacted area. If the gas is not ignited, it will mix with the atmospheric air and contribute to the global pool of GHG. The pipeline has a total length of L = 273.7 km and an inner diameter of ID = 0.8728 m, i.e. the total volume of the pipeline is approximately V = 163,755 m^3. The maximum density of the gas in the pipeline under operational conditions will be approximately ρ= 85.6 kg/m^3 (Ramboll, 2018m). Conservatively assuming that this maximum density prevails in the entire pipeline system, the pipeline can contain up to approximately 14,000 tonnes of natural gas. Assuming that all of it is methane, and that the GWP is as outlined in Section 4.8.2, this amount is equivalent to approximately 392,000 tonnes of CO_2. For comparison, this corresponds to 2.7% of the yearly CO_2 emissions from all vessels in the Baltic Sea in 2016.

4.9 Seismic activity

The Baltic Sea is situated on the Eurasian continental plate, providing relatively stable geological conditions. The area is nearly devoid of earthquake activity in global terms (Mäntyniemi, 2004). However, seismic activity in the form of small-scale earthquakes occurs occasionally. This activity is mainly the result of stress release in the lithosphere caused by uplift following deglaciation at the end of the latest ice age.

Seismic activity is defined as the types, frequency and size of earthquakes that happen over a period of time in a certain area. The southern Baltic Sea and the adjacent areas of Germany, Poland, the Baltic states and the Kaliningrad enclave are characterized by very low seismicity. Three earthquakes, in Germany and in Kaliningrad, measured to be in the range of 3.1-4.7 Mw (moment magnitude scale – corresponds to the Richter scale for medium-sized earthquakes), are the largest measured in the region in historical times (Grünthal *et al.*, 2008). This is in line with the conclusion that the largest earthquakes in the Eastern European Platform do not exceed Mw = 5.0-5.5, and that the East Baltic region is classified a territory of low or very low seismic activity (Pačėsa & Šliaupa, 2011). This also conforms with measurements of seismic activity in Denmark, which has similar magnitudes as in the Fennoscandian Shield and the East European Platform. Earthquakes in the region are generally not associated with fault zones such as e.g. the deep fault zone called the Tornquist zone, which is a 30-50 km wide zone of extensive faulting developed in late Cretaceous/early Tertiary time and extending from Poland through Bornholm and further west-northwest. There are no signs of geologically recent faulting or recent crustal deformation in the area, which corroborates the characterization of Denmark and its neighbouring areas as having a small earthquake potential (Voss *et al.*, 2017).

The above is in line with investigations carried out for the Nord Stream pipelines. During the planning of the Nord Stream pipelines, a probabilistic seismic hazard analysis was prepared for the entire route and region. It was concluded that seismicity in the region, and hence along the route, is very low to low, also compared with other regions in Europe. The same was concluded for the risk of seismic hazard. Submarine landslides have not been reported in the Baltic Sea in recent geological time (Ramboll / Nord Stream 2 AG, 2017).

Earthquakes might be a hazard to submarine pipelines due to 1) direct impact on the pipeline from the seismic activity (this is particularly the case in areas where the pipeline is buried and crosses an active fault zone), and 2) impact from e.g. submarine landslides triggered by seismic activity (this is particularly the case at the slopes of continental shelves). With respect to the direct impact, methods and criteria to be used for ensuring that pipelines are designed to withstand the foreseeable seismic activity are outlined in NORSOK, 2007 and ISO 19901-2, 2017.

The Baltic Sea area is, however, an area where the level of seismic activity is so low that no special precautions need to be taken for ensuring the integrity of the pipeline. This is due to the tectonic stability of the region and the fact that the pipeline does not cross any active faults. The foreseeable magnitudes of any future earthquakes will not pose a direct risk to the pipeline system.

With respect to possible indirect impacts, earthquakes can trigger landslides e.g. at the continental slopes. Such conditions do not exist along the pipeline route in the Baltic Sea, and as stated above, no submarine landslides have been reported from the area in the present geological setting.

Therefore, in the Baltic Sea it is not considered necessary to carry out specific analysis with respect to possible earthquakes in relation to submarine pipelines.

4.10 Extreme weather

A met-ocean study has been carried out in order to establish the operational and extreme weather conditions along the Baltic Pipe route. The study included simulation of waves, currents and water levels at the 55 positions along the Baltic Pipe route alternatives shown in Figure 4-13 (Ramboll, 2018o). A Weibull analysis has been carried out for 12 wave directional sectors and for each month at each of the 55 points along the proposed pipeline routes. The points have been chosen to ensure that the conditions along the entire pipeline route are well-represented. A so-called peak-over-threshold analysis has been carried out to derive the extreme significant wave heights, current velocities and water levels for the return periods 1, 5, 10, 50 and 100 years for all points along the pipeline.

The results of the met-ocean study have been used as input to the design of the pipeline system. This is e.g. the case with respect to forecasting of the coastal morphology at the Polish (Ramboll, 2018p) and Danish (Ramboll, 2018q) landfalls, respectively. These forecasts have been prepared to ensure that the coastal morphological development at the landfalls does not cause exposure of the pipeline where it is buried in the seabed. In general, the met-ocean study has been used as the basis for the design of the pipeline system, e.g. when implementing the detailed design of the seabed interventions works to be carried out (Ramboll, 2018r). In this way, the hazards related to extreme weather conditions have been mitigated in the pipeline design.

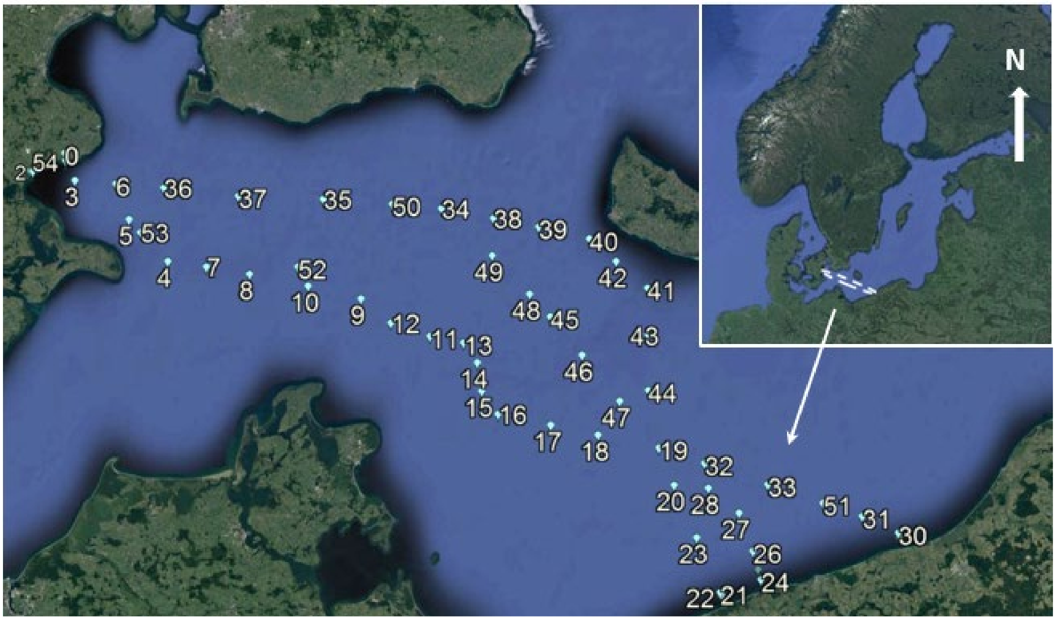

Figure 4-13 Location of points used in the met-ocean data analysis (Ramboll, 2018o).

4.11 Sabotage and terrorist attack

Pipelines are vulnerable to sabotage / terrorist attacks using explosives or other physical means. Oil and gas pipelines have globally been favoured targets of terrorists, militant groups, and organized crime (Parfomak, 2016). The majority of the attacks on pipelines have historically taken place in less stable regions of the world, e.g. in Columbia, former Soviet states, India, Nigeria, Mexico and the Middle East; no attacks appear to have taken place in Europe. The vast majority of the attacks have taken place on land. One attack has however been reported on an underwater pipeline operated by Shell in the Nigerian Delta in 2016, resulting in an oil spill and disruption of the production for some weeks (Laessing, 2016).

Pipelines are vulnerable, as they are ‘soft’ targets difficult to defend, and relatively easy to hit. Although energy supply chains in Europe have so far not been targeted, the threat of hydrocarbon supply disruptions is real, and the risks are growing (EU, 2009). With respect to the Baltic Pipe, the pipeline will lay exposed at the seabed at large distances offshore; at the landfalls, the pipeline will be buried in the ground, but not deeper than it would be possible to access it relatively easily. Therefore, it is technically possible to damage the pipeline using e.g. explosives attached to the pipeline surface. But there is no apparent reason that the Baltic Pipe should attract specific attention from terrorists with a political agenda. The pipeline is rather uncontroversial, both with respect to the countries involved and the environmental impacts of the operation of the pipeline system. With respect to sabotage and terrorist attack, the following can therefore be concluded in connection with possible physical damage to the Baltic Pipe offshore part:

- Norway, Denmark and Poland are not high profile political targets compared to many other countries operating oil and gas pipelines.
- The territory through which the pipeline extends (Denmark, Sweden, Poland) is well-managed and with well-functioning national intelligence agencies alert on possible plans to carry out terrorist attacks.
- The pipeline system would not cause attention from extreme environmentalists; more environmentally-damaging fossil fuels such as coal, shale oil and similar would be more relevant targets. Furthermore, where natural gas substitutes coal, it can even have a positive environmental impact.
- It is more complicated to carry out a subsurface attack than to damage the pipeline onshore; this is illustrated by the fact that apparently only one subsurface sabotage action targeting a subsea hydrocarbon pipeline has taken place, compared to the numerous onshore attacks registered.

Disruption of the computer systems controlling the operation of the Baltic Pipe system is a more likely threat to the operation of the system. The energy sector has incurred more cybersecurity incidents than any other sector over the past several years, and the yearly number of attacks is increasing. Among the more commonly utilized operational control systems employed in the energy sector are the Supervisory Control and Data Acquisition (SCADA) systems. SCADA systems are software-based control systems that can collect real-time data such as line pressure from sensors located throughout the pipeline network, which can be monitored from the control room. SCADA-related problems were identified to be part of, if not the proximate cause of recent pipeline accidents (Dancy & Dancy, 2017). This risk is mitigated by ensuring that the SCADA system, and the control system of the Baltic Pipe operation in general, is robust and continuously updated to the highest standards.

4.12 Possible explosions in neighbouring industrial or military objects and resulting from transport

The route of the Baltic Pipe system does not expose the pipeline to possible explosions from neighbouring industrial or military objects and resulting from land transport. The possible risk arises from the ship traffic that will cross the pipeline, as outlined earlier in this chapter.

4.13 Emergency response

4.13.1 General

An emergency response (ER) setup will be developed by GAZ-SYSTEM before construction and operation, respectively, takes place. The ER setup will be tailored according to the activities which are planned to take place and the risks associated with these activities, as outlined above.

The framework for the ER setup is the Health, Safety and Environment (HSE) management system of GAZ-SYSTEM, which has been developed in accordance with the standards OHSAS 18001 / ISO 45001: Occupational Health and Safety Management Systems, and ISO 14001: Environmental Management Systems.

4.13.2 Emergency Response during the construction phase

A Project Health Safety and Environment Plan (GAZ-SYSTEM, 2019a) has been prepared and is further developed as the project progresses. The plan is applicable to all work carried out as part of the Baltic Pipe Offshore Pipeline Project, whether work is carried out in the Project or at the Contractor's offices, construction sites or on marine construction and associated vessels.

Complementary to the above plan is a Contractor HSEQ Requirements Specification (GAZ-SYSTEM, 2019b) and the Contractors' HSE Management Plans, which they will develop prior to commencement of any worksite activities. The ER Plans and Procedures for all construction sites and vessels will be detailed within the Contractors' HSE Management Plans. Prior to mobilization of rigs and vessels, the necessary combined operations bridging documents will be developed between the relevant parties.

GAZ-SYSTEM will forward information about the ER setup, including the setup for handling possible oil spills, to the DEA on a yearly basis during the construction period.

4.13.3 Emergency Response during the operations phase

GAZ-SYSTEM will, in cooperation with Energinet, establish an ER setup for the operations phase. GAZ-SYSTEM will own and operate the offshore interconnector between Denmark and Poland and will therefore be responsible for the ER setup for this part of the system. Details about the ER setup for the operations phase will be developed at a later stage, and it will be part of the application for permit to operate the pipeline system.

4.14 Conclusion

The main risks of accidental events, both in the construction and in the operational phase, relate to the fact that the pipeline route crosses several shipping lanes. This means that there is a risk that third party vessels collide with one of the construction vessels, which may cause harm to humans and/or spills of oil to the sea. This also means that there is a risk of interference between the vessel traffic and the pipeline during the operational phase, e.g. from anchors or sinking ships.

The likelihood of an oil spill during the construction phase has been shown to be low, and comparable with other maritime activities in the Baltic Sea not involving the transport of production of oil. Comparing the likelihood of oil spills during the period of constructing the Baltic Pipe system with the likelihood of oil spills from offshore installations in the North Sea confirms this conclusion. With respect to possible gas leaks, the environmental impacts of such will be local and short-term. In case of a large rupture, the methane escaped to the atmosphere will contribute to the global pool of GHG. In such an unlikely major event, the possible impact on human lives will, however, be the main concern.

Munitions objects are, as far as reasonably practicable, avoided by re-routing. If re-routing is not possible, there is a risk that munitions clearance will need to take place. In such a situation, mitigation measures will be implemented.

Mitigation measures have been included in the design of the pipeline system, so that the risk to human safety (3rd party) is below the risk acceptance criteria, and measures are implemented to ensure that the risks are further reduced to a level as low as reasonably practicable (ALARP). This is the case for both the construction and operational phases.

5. ALTERNATIVES

Both EU legislation[29] and the provisions of the Espoo Convention (Article 5) require the developer to assess reasonable alternatives, including the no-action (or zero) alternative.

Within the Baltic Pipe project alternatives refer mainly to alternative routes, both offshore and onshore. Except for the zero alternative, there is no technical alternative to a pipeline. This chapter presents the main alternative routes through the Baltic Sea which have been assessed during the planning phase, and the major constraints for each route are listed.

5.1 The zero alternative

The no-action (or zero) alternative means not implementing the project at all, i.e. all activities connected with project would not take place. Consequently, there would be no environmental or social impact (negative or positive) from the project itself.

The zero alternative represents therefore the baseline environmental conditions, which will be described in-depth in the EIA, as will the impacts of implementing the project.

5.2 Considered route alternatives

The proposed pipeline route from Denmark to Poland, which crosses Danish territorial waters and within the Danish EEZ, is the basis for this EIA, as outlined in Chapter 1, Introduction. This proposed route has been selected based on analysis and evaluation of different route alternatives (Figure 5-1).

[29] 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.

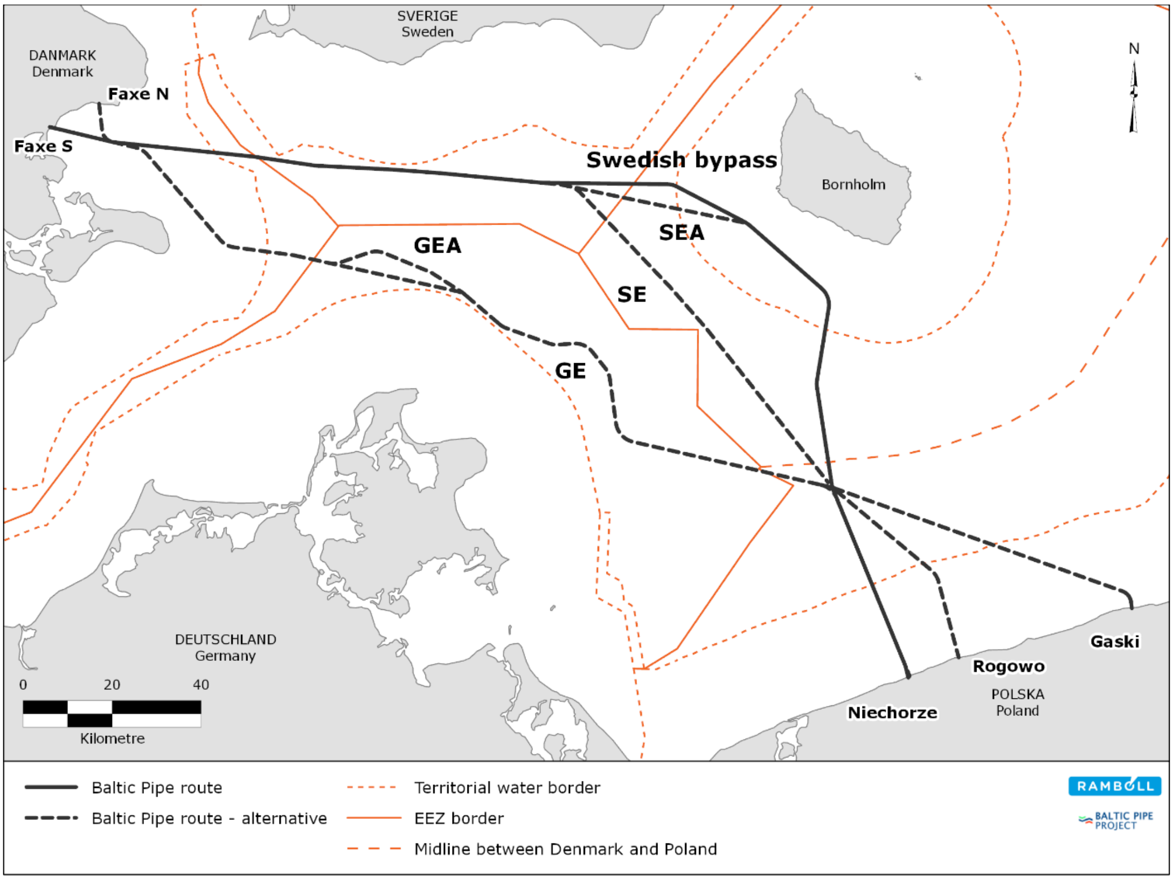

Figure 5-1 Route alternatives trough German EEZ and Swedish EEZ along with Polish and Danish landfalls (Ramboll, 2018h). The abbreviations are explained in the text.

The lengths of the various route alternatives are shown in Table 5-1.

Table 5-1 Lengths of the various route alternatives.

Area	Route Section	Length (km)
Danish landfalls	Faxe North (Faxe N)	9.7
	Faxe South (Faxe S)	14.1
Offshore routes	Swedish bypass route	213.4
	Swedish base case route (SE)	192.9
	Swedish alternative route (SEA)	211.4
	German base case route (GE)	191.8
	German alternative route (GEA)	193.8
Polish landfalls	Niechorze	46.2
	Rogowo	50.1
	Gaski	74.2

5.2.1 Landfall and offshore alternatives

The following alternatives were considered in Danish waters (Figure 5-1):

- Landfall routes in Denmark:
  - Faxe North (Faxe N);
  - Faxe South (Faxe S).

- Offshore routes:
  - Swedish bypass route (preferred alternative);
  - Swedish base case route (SE);
  - Swedish alternative route (SEA);
  - German base case route (GE);
  - German alternative route (GEA).

- Landfall routes in Poland:
  - Niechorze;
  - Rogowo;
  - Gaski.

Methodology for route selection
Various route alternatives have been studied during preceding feasibility and concept studies and during the initial phase of the present project phase. The optimisation of route alternatives has been complex, as the southern Baltic Sea has many restricted areas, shipping lanes, existing installations, and service lines. The development of the preferred route is the result of an iterative process in which a variety of authorities and stakeholders have been involved in commenting and a detailed analysis of the various alternatives has been undertaken with consideration of the following themes:

- Standard industry criteria for offshore pipeline design;
- Possibility of obtaining construction permit;
- Environmental concerns;
- Compatibility with the project time schedule;
- Cost.

The two landfall route alternatives and the four offshore route alternatives presented to the authorities and stakeholders were all selected with due regard to industry standard for safety of the public and personnel, protection of the environment, and the probability of damage to the pipeline or other facilities. Factors taken into consideration included the following, taken from the DNVGL guidance on pipeline design (DNV GL, 2017):

- **Environment:** Archaeological sites, exposure to environmental loads, areas of natural conservation interest such as oyster beds and coral reefs, marine parks, turbidity flows.
- **Seabed characteristics:** Uneven seabed, unstable seabed, seabed geotechnical properties (hard spots, soft sediment, and sediment transport), subsidence, seismic activity.
- **Facilities:** Offshore installations, subsea structures and well heads, existing pipelines and cables, obstructions, coastal protection works.
- **Third-party activities:** Ship traffic, fishing activity, dumping areas for waste, ammunition, etc., mining activities, military exercise areas.
- **Shore crossing:** Local constraints, third-party requirements, environmentally sensitive areas, vicinity to people, limited construction period.

Due to the iterative nature of the route selection process, the final decision on the preferred route deviates slightly from the route presented during the first public hearing to the Danish EIA, in order to satisfy the wishes and requirements of the relevant authorities.

5.2.2 Landfall routes in Denmark
Both landfall routes in Denmark (i.e. Faxe N and Faxe S) were designed to avoid the raw material extraction sites and the Natura 2000 site "Havet og Kysten mellem Præstø Fjord og Grønsund" in Faxe Bugt (Figure 5-2).

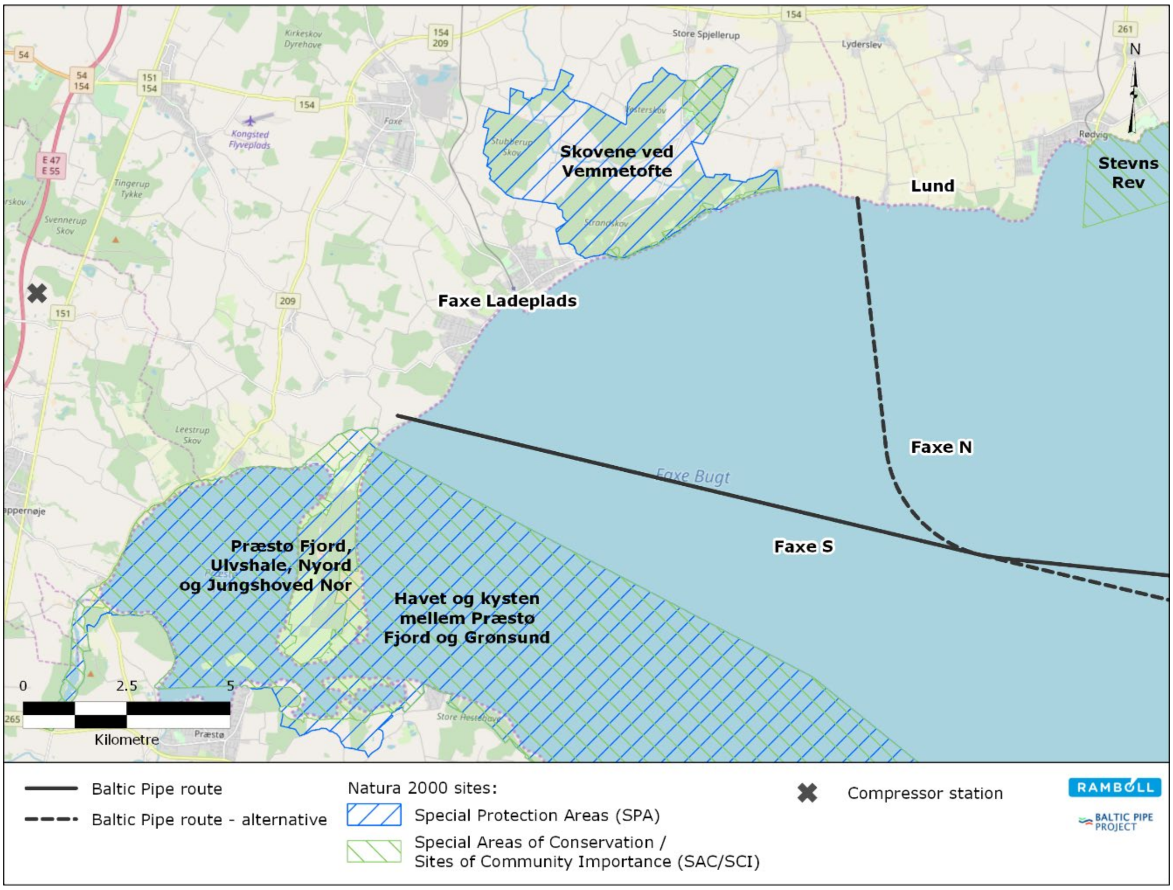

Figure 5-2 Landfall alternatives in Denmark.

The shore crossing at the Faxe N landfall route is located west of the village of Lund (Figure 5-2). As the pipeline would be located only about 500 m from the village, some impact from construction activities could be expected. The pipeline is then routed northwest around the Natura 2000 site "Skovene ved Vemmeltofte". South of the Natura 2000 site, the pipeline is extended to the compressor station. As can be seen in Figure 5-2, this section from the landfall to the compressor station is considerably longer than the Faxe S landfall route.

At the Faxe S landfall, the shore crossing is located about 3 km south of Faxe Ladeplads. This landfall is associated with some biological and geological concerns due to the presence of the protected bird species sand martin, which nests in the cliff at the landfall site, and the cliff itself, which is registered as of geological interest. These concerns can, however, be mitigated by using tunnelling instead of an open trench (see Chapter 3, Project description). As there are only few dwellings in the area and no impact is expected on the preserved archaeological site "Skansen ved Strandegård" (about 300 m from the landfall routing), the only socio-economic concern associated with the landfall Faxe S is related to farming activities. Therefore, Faxe S is the preferred landfall site, as the route from the shore crossing to the compressor station is shorter, fewer dwellings are negatively affected and the concerns related to biological impacts at Faxe S landfall can be mitigated.

5.2.3 Offshore route alternatives

Two main offshore routes were considered; a Swedish base case route (SE) and a German base case route (GE). In addition to these, alternative alignments for parts of each route were considered (marked with dotted lines in Figure 6 3); these are referred to as the Swedish alternative route (SEA) and the German alternative route (GEA), respectively. Each of these proposed offshore alternatives are described in turn in the following sections. Some of the most influential receptors in the process of considering route alternatives have been military areas and Natura 2000 sites; these are presented in Figure 5-3 and Figure 5-4, respectively.

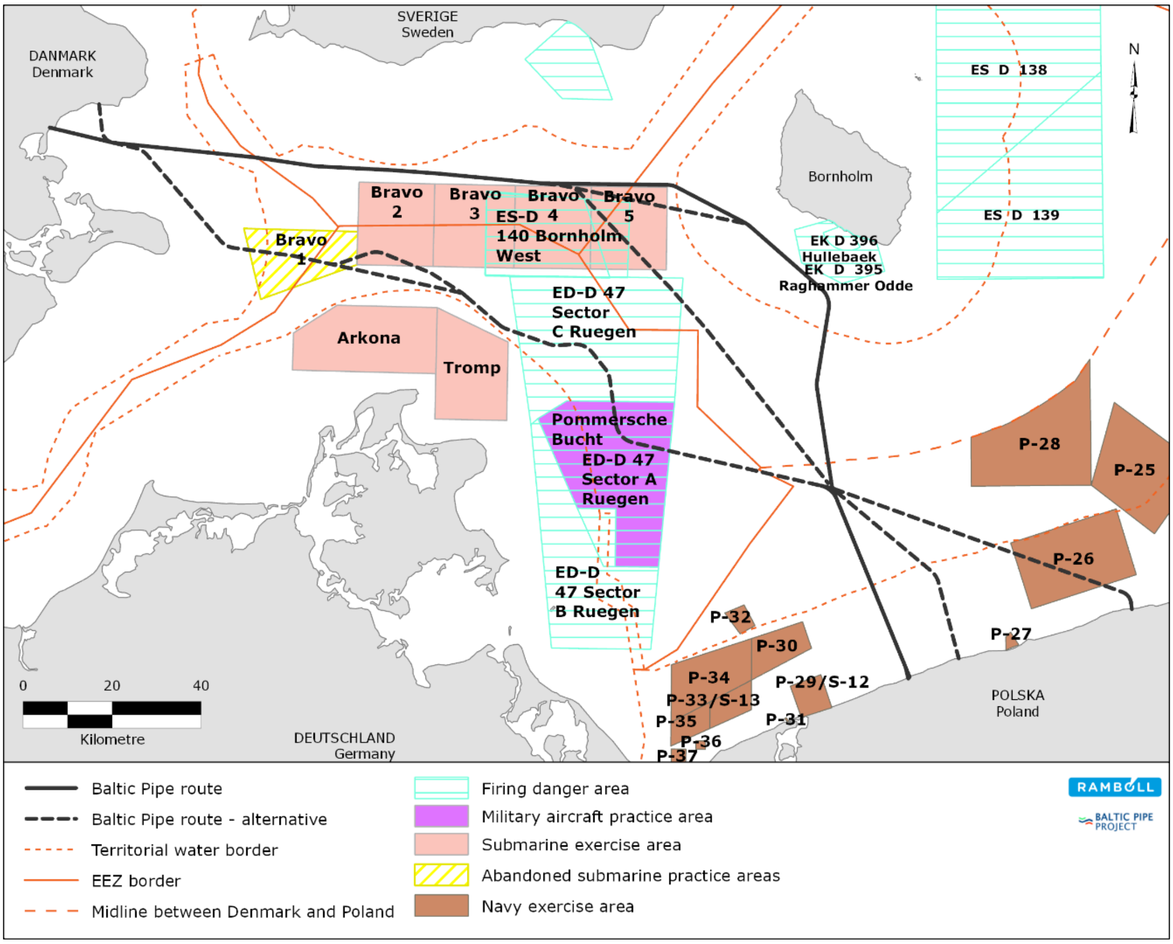

Figure 5-3 Military areas.

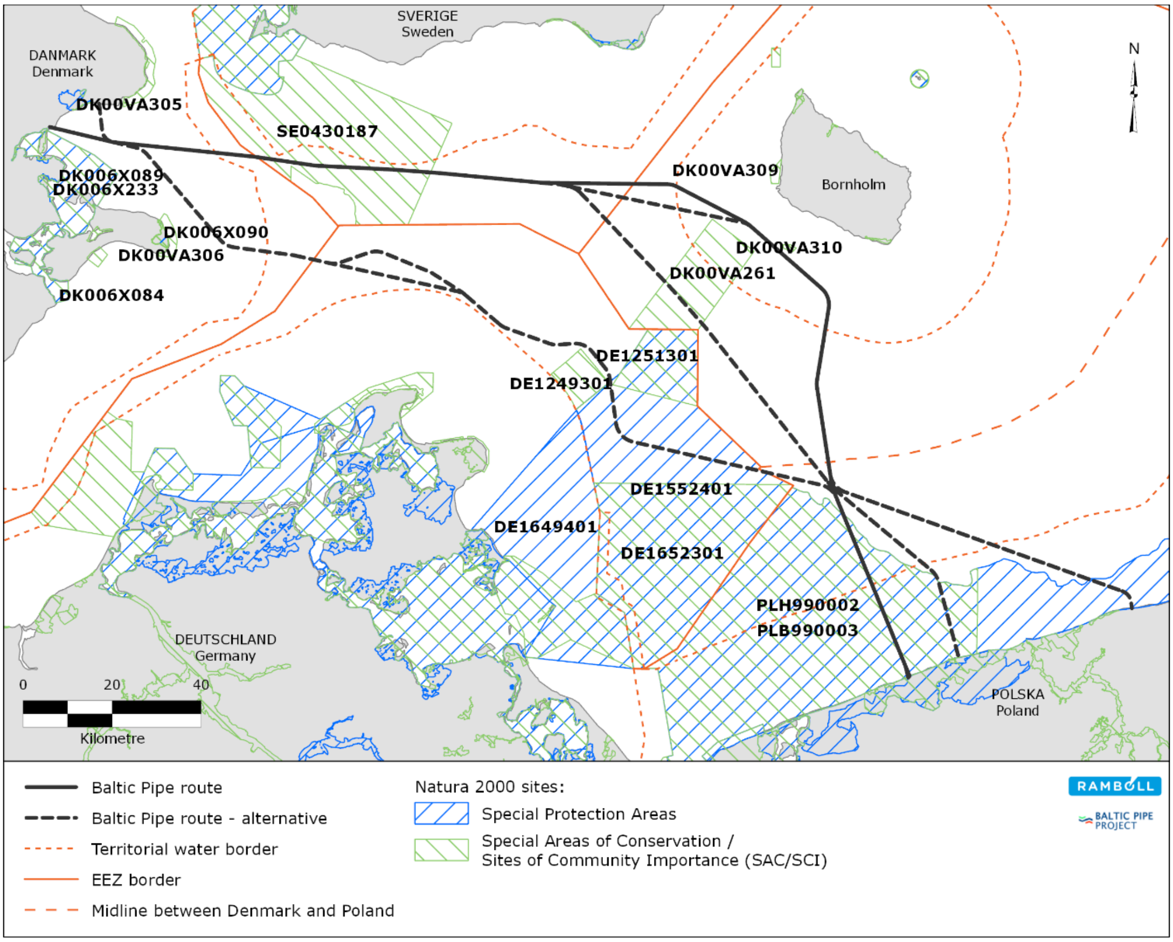

Figure 5-4 Natura 2000 sites.

German offshore routes

The German base case route and alternative routes follow the same 70 km alignment within Danish waters from the landfall site to the German EEZ (Figure 5-1). Within the German EEZ, the two route options follow largely the same course, but they diverge close to the Swedish and Danish EEZ borders, which results in reduced impacts on one receptor and increased impacts on another. Specifically, the German alternative is routed further northwest so as to cross a major shipping lane at a more perpendicular angle, which will lead to a lower impact on maritime traffic. However, the German alternative route crosses into the NATO submarine exercise area, Bravo 2, which is avoided by the German base case route.

After the two German route options merges again, the remainder of the route crosses other major shipping routes as close to perpendicularly as possible, and no other submarine exercise areas are crossed. However, other types of military practice areas are crossed by the German route, including a research area and a firing danger area.

In addition to maritime traffic and military practice areas, several other socio-economic and biological considerations taken into account in the development of the German route have included offshore infrastructure, extraction sites, commercial fishery and protected areas.

With respect to infrastructure, the German route has been designed to avoid existing and planned wind farms, including those currently under construction. However, the route does cross 25 cables and the Nord Stream Pipeline (NSP) is crossed at the shallow depth of 21.7 m.

Crossing of NSP in such shallow waters would be technically difficult, due to the risk of grounding of ships above the rock installation required for the pipeline crossing.

Impacts on other socio-economic receptors has also been minimised, as the route avoids raw material extraction sites and trenching of the pipeline in the areas with the highest commercial fishery catches will reduce the risk of snagging of fishing gear on the pipeline.

In addition, no Special Areas of Conservation (SACs) are crossed by the route, and although routing through Special Protection Areas (SPAs) has been minimised to the extent possible, the route does inter the SPA Pommersche Bucht. However, no biological impacts which cannot be mitigated have been identified during the evaluation of the German route options.

Through dialogue with the German Defence Forces during the scoping process, it became evident that the presence of a pipeline would be incompatible with the military activities ongoing in the NATO submarine exercise areas and the firing danger area Pommersche Bucht (BSH, 2019). Therefore, the German offshore routes were assessed not to be feasible (Ramboll, 2018h).

Swedish offshore routes

From the landfall site, the Swedish base case route and the Swedish alternative route follow the same alignment, which runs between the raw materials extraction sites in Faxe Bugt, north of the Krieger’s Flak wind farm and into the Swedish EEZ. Before re-entering the Danish EEZ to the southwest of Bornholm, the route options split into two main alternatives: the base case route, which follows a more south-westerly path within the Danish EEZ before crossing the disputed area and entering Polish waters; and the Swedish alternative route, which enters Danish territorial waters southwest of Bornholm prior to crossing the disputed area further east of the Swedish base case route. The most significant difference between the two main Swedish route options is that the Swedish alternative route avoids crossing the Natura 2000 site “Adler Grund og Rønne Banke”, which is crossed by the Swedish base case route.

Both route options cross the major international, bi-directional shipping lanes running along the border between the Swedish and Danish EEZs. The Swedish base case route crosses the TSS Bornholmsgat, the most heavily trafficked shipping lane in the Baltic Sea, at a more perpendicular angle than the Swedish alternative.

With respect to military practice areas, near the Danish EEZ border, the route crosses the northern edge of the Bravo 4 submarine exercise area and from here, the Swedish alternative route splits from the Swedish base case route. Both routes pass inside the submarine exercise area Bravo 5, and the Swedish base case route, having re-entered Danish waters, subsequently crosses the corner of the military firing danger area Ruegen (sector C). The section of the Swedish alternative which runs along the coast of Bornholm is routed southwest of the firing danger area Raghammer Odde.

Concerning offshore infrastructure, the both Swedish routes have been designed to avoid existing and planned wind farms, including those currently under construction. Both route options cross 13 cables, considerably fewer than the German route options, as well as the NSP pipelines. The NSP pipelines are crossed at a water depth of 45.7 m, which is much deeper than for the German route and represents a safer option with respect to the risk of ship grounding.

Both Swedish route options avoid currently active raw material extraction sites and potential future sites of resource extraction were avoided to the extent possible.

Both routes cross a mine belt from World War II as well as the British minefield, Pollack, near the coast of Bornholm. The alternative crosses through the centre of the minefield, whereas the base case route crosses only the extended minefield area. This poses a risk of encountering CWA and UXO. However, local re-routing can be implemented if UXO or CWA are identified along the route.

Biological considerations were also important in the route design process, and protected areas were avoided where possible. The Swedish route option crosses into the Swedish EEZ within the Natura 2000 site "Sydvästskånes Utsjøvatten", but the route avoids the designated habitat type reef. The route options split close to the Danish EEZ border, and after entering Danish waters, the Swedish base case route crosses the Natura 2000 site "Adler Grund og Rønne Banke", where crossing the designated habitat type reef cannot be avoided. The Swedish alternative route is designed to avoid crossing this Natura 2000 site i.a., as the reef most likely will be destructed due to construction or presence of pipeline.

Summary

On the basis of the above considerations and dialogue with the authorities, military practice areas and Natura 2000 sites were regarded as the most important topics in the selection of the preferred route. The German Defence Forces were contacted regarding the crossing of the submarine exercise areas Bravo 4 and Bravo 5. While re-routing of the German routes was not feasible, bypassing these exercise areas by re-routing to the north was possible for the Swedish alternative. This led to the development of the Swedish bypass route, a variation of the Swedish alternative, which runs 550 m north of the Bravo areas. On this basis, the Swedish alternative route, with the bypass variant, is selected as the preferred offshore route, as it avoids military areas and the Natura 2000 site "Adler Grund og Rønne Banke" in Danish waters.

5.2.4 Polish landfall routes

Three landfall routes were assessed in Poland as part of the route selection process: Niechorze, Rogowo and Gaski. Due to a negative opinion from the National Polish Defense, the Gaski variant was considered no longer feasible and was deselected. Niechorze was chosen as the preferred landfall in Poland due to technical issues, primarily of geological character, and Rogowo will be assessed as an alternative as part of the permitting process in Poland.

6. METHODOLOGY FOR TRANSBOUNDARY IMPACT ASSESSMENT

Overall the methodology applied for the transboundary impact assessment is equal to the one applied in the Danish EIA. However, this report focuses geographically on the marine border zones between the PoOs. The project encompasses three border zones, of which two are between Denmark and Sweden and one between Denmark and Poland. The impact assessment addresses the potential environmental and social impact of all parts of the project life cycle – construction, operation and decommissioning – on the relevant environmental and social receptors.

The assessment covers the direct and indirect, cumulative and transboundary, permanent and temporary, and positive and negative impacts of the project, and considers the objectives defined at the EU (e.g., Marine Strategy Framework Directive and the Water Framework Directive) and national levels.

Impacts will be evaluated based on their nature and scale and in relation to the receptor (social and environmental). The impact assessment will distinguish between the sensitivity of the receptor and the magnitude of the impact to predict the significance of the impact.

The methodology to be used for assessment of impacts includes the following criteria for categorising environmental and social impacts:

- Sensitivity of the resource/receptor;
- Nature, type and reversibility of the impact;
- Intensity, scale and duration of the impact; and
- Overall significance of the impact.

The impact assessment methodology serves to provide the means of characterising identified impacts and their overall severity.

6.1 General methodology

6.1.1 Basis for assessment

Assessments must always be based on a solid description of the environment in which the potential impact is located (baseline). The amount of baseline detail required for the assessment depends on various factors, such as the nature of project impacts and the properties of the receptor and will be determined individually for each receptor. In some instances, it is sufficient to rely on external data from scientific or grey literature, including data from public institutions and monitoring, in other instances supplementary surveys are needed. The following table provides an overview of the marine receptors that can potentially be affected by the Baltic Pipe project and to what extent targeted surveys have been conducted for the project. Extensive literature studies have been undertaken for all receptors.

Table 6-1 Overview of targeted surveys conducted for the Baltic Pipe project.

Receptor	Baseline surveys
Physical-chemical environment	
Bathymetry	multibeam echo-sounding, side-scan sonar
Hydrography and water quality	Water quality sampling along pipeline route, incl. CTD profiles
Surface sediments and contaminants	Shallow seismic acoustic profiles, seabed sampling, cone penetration tests, magnetic surveys
Climate and air	-
Underwater noise	-
Biological environment	
Plankton	Water quality sampling along pipeline route (incl. chlorophyll *a*)
Benthic habitats, flora and fauna	Mapping of phytobenthos and sampling of macrozoobenthos along pipeline route
Fish	-
Marine mammals	Aerial surveys, observations from shore, C-POD studies
Seabirds and migrating birds	Aerial surveys, ship surveys
Migrating bats	-
Annex IV species	See marine mammals
Biodiversity	See other receptors for biological environment
Natura 2000 offshore	-
Marine Strategy Framework Directive (entire marine area, environmental status according to 11 descriptors)	See other receptors for biological environment
Water Framework Directive (ecological status 1 NM zone, chemical status 12 NM zone)	See other receptors for physical-chemical and biological environment
Socio-economic environment	
Shipping and shipping lanes	-
Commercial fisheries	-
Archaeology (cultural heritage)	-
Cables, pipelines and windfarms	-
Raw material extraction sites	-
Military practice area	-
Environmental monitoring stations and research areas	-
Tourism and recreational areas	-
Conventional and chemical munitions sites	Magnetic surveys

6.1.2 Potential impacts from project activities

This Espoo report focuses on project activities conducted within the territory of Denmark including the territorial waters, EEZ and disputed area, which can potentially cause adverse effects within the territories of the APs Sweden, Germany and Poland. It is assessed that onshore construction and operation does not give rise to any transboundary impact due the local nature and range of project effects. The same applies to the offshore activities in the North Sea, which only concern the EEZ and territorial waters of Denmark. Thus, only offshore activities within the Baltic Sea are considered in this report.

The relevant marine receptors, which can be potentially impacted, are shown in Table 6-2.

Table 6-2 Environmental receptors relevant to the EIA the Baltic Pipe project (offshore part within the Baltic Sea).

Physical-chemical environment	Biological environment	Socioeconomic environment
• Bathymetry • Hydrography and water quality • Surface sediments and contaminants • Climate and air • Underwater noise	• Plankton • Benthic habitats, flora and fauna • Fish • Marine mammals • Seabirds • Seabirds and migrating birds • Migrating bats • Annex IV species • Biodiversity • Protected areas/Natura 2000	• Shipping and shipping lanes • Commercial fisheries • Archaeology (cultural heritage) • People • Tourism and recreational areas • Cables, pipelines and windfarms • Raw material extraction sites • Military practice areas • Conventional and chemical munitions sites • Environmental monitoring stations and research areas

Table 6-3 presents an overview over the potential project impacts together with the receptors that may be affected. The assessment in Chapter 7 addresses all these potential conflicts listed in Table 6-3.

Table 6-3 Characteristics of potential transboundary impacts.

Potential impact	Impact characteristics
Construction phase	
Physical disturbance of seabed	When carrying out seabed interventions work during construction (Section 3.4.2), the seabed will be impacted. Trenching (Section 3.4.2, offshore construction): Total pipeline length in the Baltic Sea: 273,7 km; trench length will be 63.5, 23 and 37.5 km in DK, SE and PL respectively; trench width: 10-30 m, depending on water depth and sediment type. Spoil heaps from the trenched sediment will be placed along the trench. Rock /concrete mattress installation: Rock and concrete mattress installation are means of protecting the pipeline and will be used when crossing existing marine infrastructure (pipelines, telecom and power cables) and potentially also in shipping lanes. The rocks will be placed at the seabed using a dynamic positioning fall pipe vessel equipped with a flexible fall pipe, which will ensure that the rocks are placed correctly. Concrete mattresses will be deployed by crane from a vessel. The physical disturbance of the seabed during construction will be limited to the specific area where rock installations will take place (expected to be at 14, 6 and 4 locations in DK, SE and PL respectively). Impacts from construction vessels: The DP vessel area of influence on the seabed will correspond: Corresponding to the width of the applied ship, approximately 40 m. The anchors and anchor chains area of influence on the seabed will be approximately: Approximately 1,500 m around the pipeline. The impact will hence be localised around the intervention works.

Potential impact	Impact characteristics
Suspended sediment (increased sediment concentration (SSC))	Sediment spill primarily originates from the seabed, where the seabed interventions take place. Sediments are dispersed in the water column and transported with the currents before they re-settle to the seabed. The sediment spill has been modelled (Ramboll, 2018a) and the model results show that the increase in SSC will be very limited and that the duration of SSC exceeding 10 mg/l in the close border areas will be less than 1 hour (Figure 6-1).
Contaminants and nutrients (release of contaminants and nutrients associated with the sediment)	The sediments that are spilled and dispersed in the seawater may potentially include heavy metals and organic contaminants. This is particularly the case for fine-grained sediments and particulate organic matter (POM). A proportion of the particle-associated contaminants may be released to the water column as a result of the shift in the chemical environment when the particles are suspended in the water. The majority of the contaminants are, however, expected to continue being associated with the particles and will therefore settle back to the seabed. Analyses performed in the Danish EIA (Ramboll, 2018a), conclude that the water quality only can be affected very locally and temporarily by an increase in the concentrations of contaminants and nutrients caused by the construction works.
Sedimentation	Following dispersion in the water column, the spilled sediments will gradually settle to the seabed at a rate depending on the characteristics of the sediments, the hydrographic conditions, and the water depth. Sedimentation has been modelled for the layer of spilled sediments (in the unit g/m^3), and the results show a very limited impact (Figure 6-2).
Underwater noise	The Baltic Pipe construction activities will cause emissions of underwater noise of varying frequencies and intensities, which may impact marine mammals and fish. The underwater noise generated from the vast majority of the construction activities is not distinguishable from the ambient noise levels in the Baltic Sea, which is characterized by large volumes of ship traffic and therefore a relatively high background underwater noise level[30]. Hence, only noise from munitions clearance is included in the underwater noise propagation modelling and the following impact assessment on marine life. Based on the route design strategy, munitions clearance is treated as an *unplanned event* and is dealt with as such in the assessments (see Sections 7.3.1 and 7.3.2).
Physical disturbance above water during construction (e.g. from presence of vessels, noise and light)	Physical disturbance above water mainly relates to the presence and activity of construction vessels, including supply vessels with pipe and food supply potentially affecting marine animals and interfering with human activities (e.g. shipping, commercial fisheries).
Safety zones (around construction vessels)	During construction, safety zones will be established around the construction vessels to ensure navigational safety. Experience from other pipeline construction projects suggests that a construction exclusion zone will be established around the pipe-lay vessel, with a radius of 1,500 m centred around the pipe-lay vessel. Likewise, safety zones with a radius of 500 m will be defined around other vessels carrying out surveys, seabed intervention works, etc. However, supply vessels are not expected to impose safety zones. The extent of the safety zones will be agreed with the applicable national maritime authorities.

[30] Further characteristics of the different noise sources are given in section 9.5.1. of Ramboll 2018a

Potential impact	Impact characteristics
Emissions to air (emissions of air pollutants and greenhouse gasses (GHGs))	The combustion of fossil fuels by the vessels used during construction of the Baltic Pipe project will result in the emission of several components. Based on experience from other comparable projects, the following are considered to be the four main air emissions: CO_2 (carbon dioxide), NO_X (nitrogen oxides), SO_X (sulphur oxides)), and PM (particulate matter). Furthermore, production of the materials used for the project will generate emissions. These air emissions can potentially have an impact on climate, air quality and human health. Air emission calculations for the Baltic Pipe project have been undertaken in the Danish EIA (Ramboll, 2018a), and are dealt with in Section 7.2.1.
Discharge to sea	Discharges to sea will occur place as part of the pre-commissioning activities. Potential impacts will be restricted to nearshore areas and will not be dealt with no further in this Espoo report.
Airborne noise	Impacts from airborne noise will be restricted to the onshore part and is hence not dealt with in the Espoo report. Impact from airborne noise from vessels is dealt with under "Disturbance above water"
Non-indigenous species	All vessels participating in the Baltic Pipe project will be requested to comply with the BWM Convention and the HELCOM Guide to alien species and ballast water management in the Baltic Sea (HELCOM, 2014). Therefore, the risk of introducing NIS by Baltic Pipe project activities is considered to be very low. As rocks are supplied from onshore sources, the risk of introducing NIS from this source is negligible.
Operational phase	
Presence of pipeline	The presence of the pipeline may change the seabed conditions and hydrodynamics, resulting in temporary disturbance or permanent loss of habitats for benthic flora and fauna; another potential impact is the introduction of a new substrate i.e. an artificial reef. The pipeline length in Danish waters is 137.6 km, of which a large proportion is laid directly on the seabed and not trenched or supported by rock installations. Rock installations placed at numerous locations create new substrate at the seabed.
Physical disturbance above water during operation (e.g. from maintenance vessels, noise and light)	The physical disturbance above water during operation is mainly related to the presence and activity of survey and maintenance vessels. The physical disturbance is of the same nature as during the construction period, but with a much lower frequency. The expected frequency of surveys and maintenance is once per year.
Safety zones (around maintenance vessels)	For the vessels carrying out survey and maintenance, exclusion zones will be defined around vessels carrying out the work, corresponding to the safety zone for "other" vessels during operation (500 m radius around the vessels). The establishment of safety zones results in all ship traffic being requested to avoid these exclusive zones, thus potentially having an impact on both commercial and leisure shipping as well as fishery. The frequency of the survey and maintenance activities are, however, low, i.e. approximately once per year.
Restriction zone (around the pipeline)	Under the administrative order on protection of submarine cables and submarine pipelines, cable or pipeline fields are given a 200 m wide restriction zone along and on each side of the infrastructure. Ships may not, without urgent necessity, anchor in the cable and pipeline fields established for such infrastructure (e.g. pipelines for the transport of hydrocarbons, etc.), which cover the associated restriction zones. In the restriction zones, suction dredging, fishing for stones as well as any use of tools or other gear that is dragged on the seabed is prohibited.

Potential impact	Impact characteristics
Heat from pipeline	For the situation with gas flow from Poland to Denmark, the temperature along the pipeline will be very close to the temperature of the surrounding seawater and seabed surface sediments (Ramboll, 2018a).
Contaminants from anodes	Sacrificial anodes mainly consisting of aluminium will be used as a back-up corrosion protection system in case of damage to the coating of the pipeline. Beyond the immediate vicinity of the anode (i.e. <5 m), the concentrations of metal ions within the water column because of anode degradation during the operational phase will generally be indistinguishable from background concentrations.

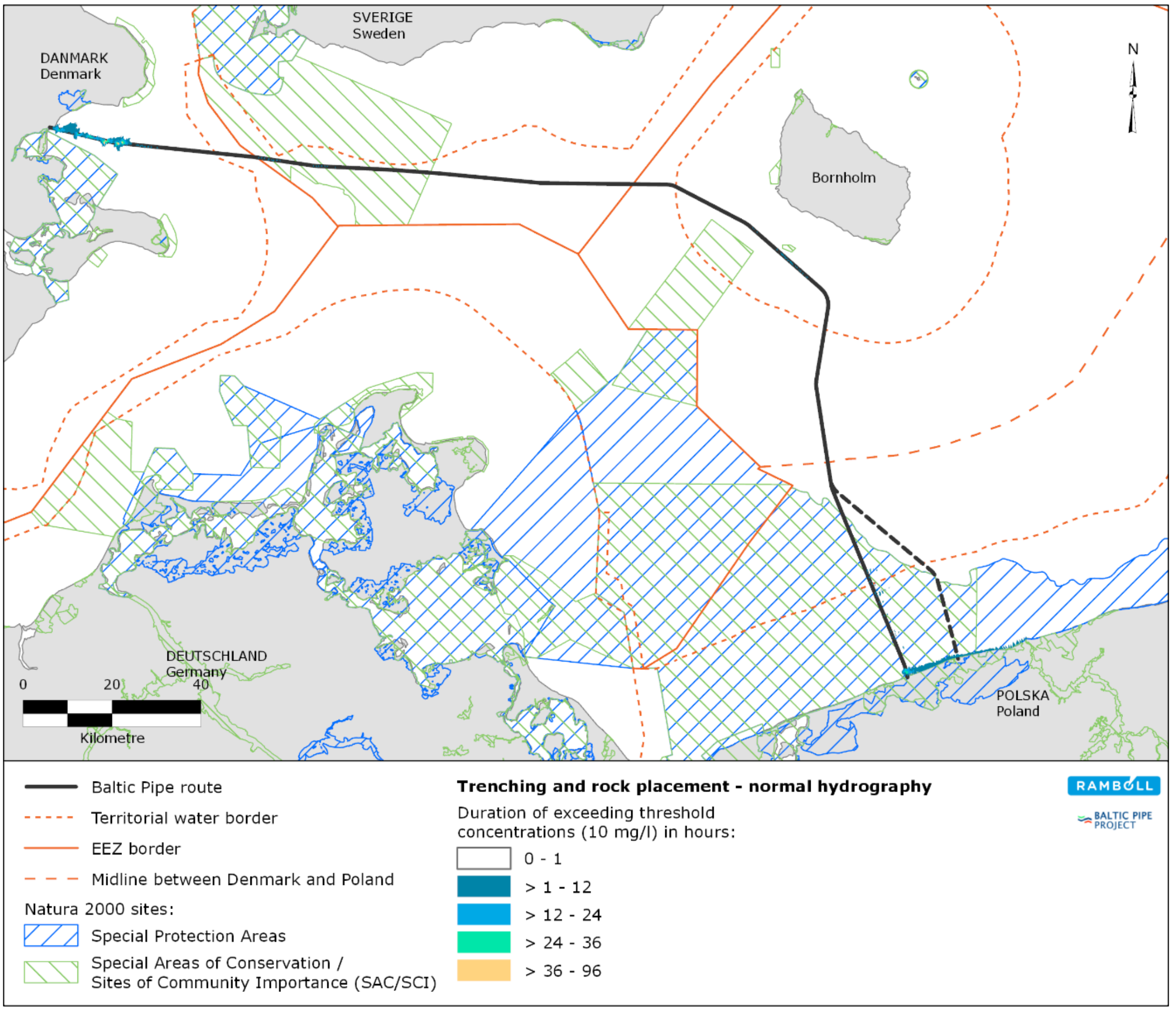

Figure 6-1 Simulation of the time the sediment concentration is increased to at least 10 mg/l (suspended sediment) due to trenching (using post-lay ploughing).

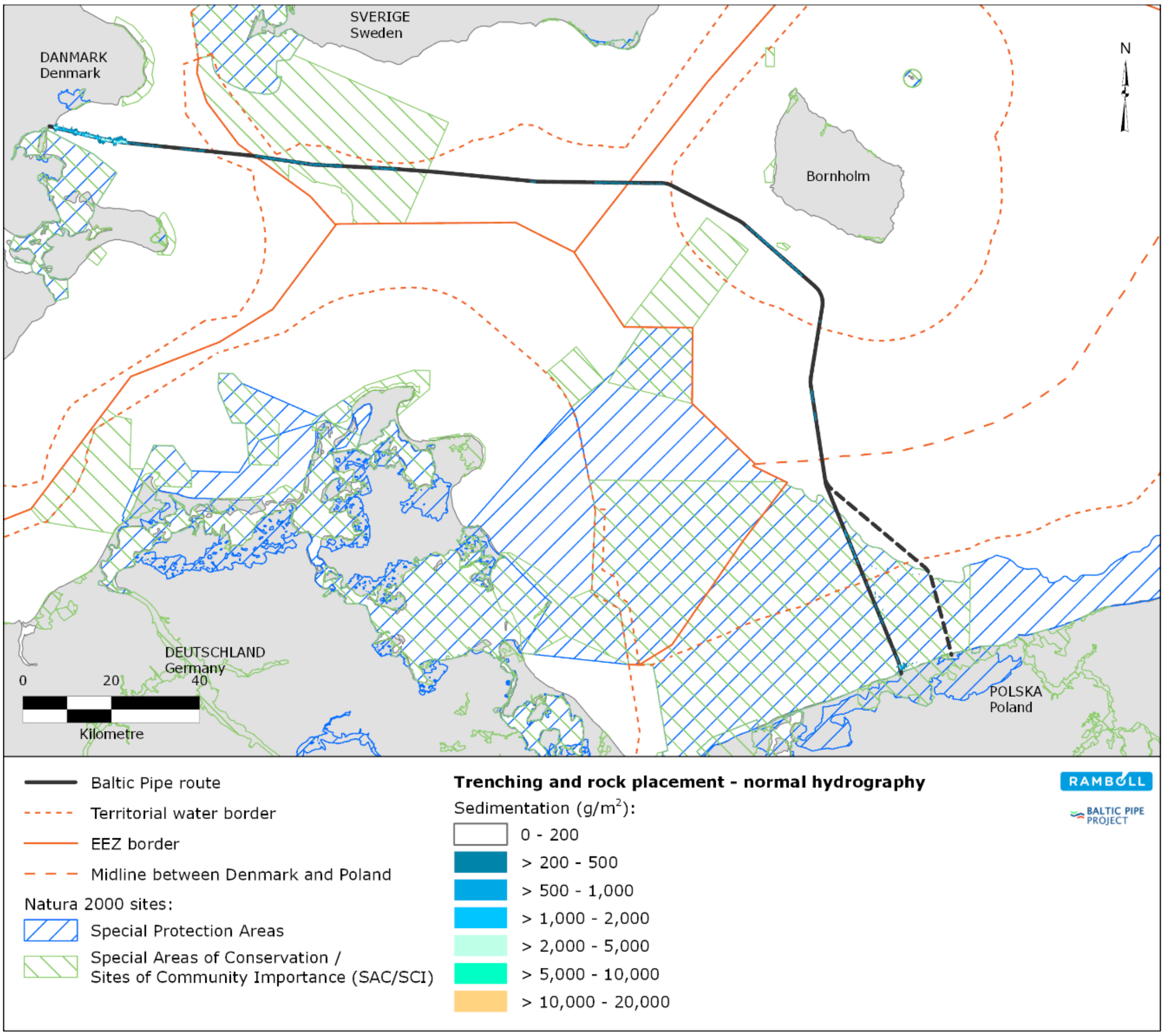

Figure 6-2 Simulation of spilled sediment deposits (sedimentation) at the seabed one week after finalisation of trenching (using post-lay ploughing).

6.1.3 Sensitivity of receptor

The overall significance of the impacts is evaluated based on the evaluation of the single impact variables, as described above, and on the sensitivity of the resource/receptors affected.

It is imperative to place some form of value on the sensitivity (low, medium or high) of a resource/receptor that could potentially be affected by project activities. Such a value may be regarded as subjective to some extent.

However, expert judgement and stakeholder consultation ensure a reasonable degree of consensus on the intrinsic value of a resource/receptor. The allocation of a value to a resource/receptor allows for the assessment of a resource's/receptor's sensitivity to change (impact). Various criteria are used to determine value/sensitivity, including, among others, resistance to change, adaptability, rarity, diversity, value to other resources/receptors, naturalness, fragility and whether a resource/receptor is actually present during a project activity. These determining criteria are elaborated upon in Table 6-4.

Table 6-4 Criteria used to evaluate the sensitivity of a resource/receptor.

Sensitivity	
Low:	A receptor that is not important to the functions/services of the wider ecosystem or that is important but resistant to change (in the context of project activities) and will naturally and rapidly revert to pre-impact status once activities cease.
Medium:	A receptor that is important to the functions/services of the wider ecosystem. It may not be resistant to change, but it can be actively restored to pre-impact status or will revert naturally over time.
High:	A receptor that is critical to ecosystem functions/services, not resistant to change and cannot be restored to pre-impact status.

6.1.4 Nature, type and reversibility of impacts

Impacts are initially described and classified according to their nature (either negative or positive), their type and their degree of reversibility. Type refers to whether an impact is direct, indirect, secondary or cumulative. The degree of reversibility refers to the capacity of the impacted environmental or social component/resource to return to its pre-impact state.

Nature, type and reversibility are elaborated upon in Table 6-5.

Table 6-5 Classification of impacts: Nature, type and reversibility of impacts

Nature of impact	
Negative	An impact that is considered to represent an adverse change from the baseline (current condition) or to introduce a new, undesirable factor.
Positive	An impact that is considered to represent an improvement to the baseline or to introduce a new, desirable factor.
Type of impact	
Direct	An impact that results from a direct interaction between a planned project activity and the receiving environment.
Indirect	An impact that results from other activities that are assessed to happen as a consequence of the project.
Secondary	An impact that arises following direct or indirect impacts as a result of subsequent interactions within the environment.
Additive	Combined impacts of project-related activities.
Cumulative	An impact that may occur in combination with other plans or projects that are currently under consideration, or any existing or proposed projects and plans.
Transboundary	An impact that occurs across borders.
Degree of reversibility	
Reversible	An impact on receptors that ceases to be evident, either immediately or following an acceptable period of time, after termination of a project activity.
Irreversible	An impact on receptors that is evident following termination of a project activity and that remains for an extended period of time. An impact that cannot be reversed by the implementation of mitigation measures.

6.1.5 Intensity, scale and duration of impacts

The predicted impact magnitude is defined and assessed in terms of a number of variables, primarily the intensity, scale and duration of an impact. Ascribing values to the variables is, for the most part, objective. However, awarding a value to certain variables may be subjective in that the extent, and even direction, of change often is difficult to define.

An explanation of the classifications and values applied in the EIA is presented in Table 6-6.

Table 6-6 Classification of impacts in terms of intensity, scale and duration.

Intensity of impacts	
No impact:	No impacts on the structure or function of the receptor within the affected area.
Minor impact:	Minor impacts on the structure or function of the receptor within the affected area, but basic structure and /function remain unaffected.
Medium impact:	There will be partial impacts on the structure or function inside the affected area. Structure/function of the receptor will be partially lost.
Large impact:	The structures and functions of the receptor are altered completely. Structure/function loss is apparent inside the affected area.
Geographical extent of impacts	
Local impacts:	Impacts are restricted to the project area (1 km on each side of route)
Regional impacts:	There will be impacts outside the immediate vicinity of the project area (local impacts).
National impacts:	Impacts will be restricted to the national sector.
Transboundary impacts:	Impacts will be experienced outside of the Danish/German/Swedish/Polish sector. Impacts can also be across a national border within the Parties of Origin.
Duration of impacts	
Immediate:	Impacts during and immediately after the project activity; however, the impacts stop shortly after the activity is stopped.
Short-term:	Impacts throughout the project activity and up to one year after.
Medium-term:	Impacts that continue over an extended period, between one and ten years after the project activity has ended.
Long-term:	Impacts that continue over an extended period, more than ten years after the project activity has ended.

6.1.6 Overall significance of impacts

The severity of the impact is then defined by comparing the impact magnitude of the project and the sensitivity of the environmental receptors. It is classified according to a scale which ranges from "negligible" to "major", defined as presented in Table 6-7, where the distinction between a significant/not significant impact is also specified.

Table 6-7 Criteria for evaluation of the significance of an impact (a combination of impact magnitude and sensitivity).

Impact significance	Impact severity	
Not significant	Negligible	There will be no or negligible impact on the environment.
Not significant	Minor	Minor adverse changes that might be noticeable but fall within the range of normal variation. Impacts are short-term and natural recovery takes place in the short term.
Not significant / Significant	Moderate	Moderate adverse changes in an ecosystem. Changes may exceed the range of natural variation. Potential for natural recovery in the medium-term is good. However, it is recognised that a low level of impact may remain. Impact may or may not be significant depending on the impact type. Mitigation measures may be applied to reduce the impact.
Significant	Major	The structure or function in the area will be changed, and the impact will also have impact outside the project area. Mitigation measures will be considered to reduce the impact.

Positive impacts are shown with a "+" in the comprehensive tables for the potential impacts.

6.2 Natura 2000 assessments

In accordance with Articles 6(3) and (4) of the Habitats Directive, it is required to perform an assessment of whether a project may result in significant impacts on Natura 2000 sites. For the Baltic Pipe project, the assessments of potentially affected Natura 2000 sites are documented in the respective national EIA reports of Denmark, Sweden and Poland.

The methodology for Natura 2000 assessments is a four-step process comprising:

- Screening;
- Appropriate assessment;
- Assessment of alternative solutions; and
- Assessment where no alternative solutions exist and where adverse impacts remain.

The initial step of the assessment is a Natura 2000 screening, which identifies the potential impacts of a project on a Natura 2000 site(s), either alone or in combination with other projects or plans and considers whether these impacts are likely to be significant. In the case that the screening reveals that significant impact on the designation basis of the Natura 2000 site can be ruled out with certainty, no further assessment steps are required. In the case that impact is likely to be significant, an appropriate assessment must be conducted. In the latter case, the assessment also includes transboundary impacts, so that all aspects of potential impacts on the site are covered.

Section 7.3.4 of the Espoo report summarizes the results from the Natura 2000 assessments and emphasizes the transboundary impacts where relevant.

6.3 Annex IV assessments

Article 12 of the Habitats Directive aims at the establishment and implementation of a strict protection regime for animal species listed in Annex IV(a) of the Habitats Directive within the whole territory of Member States.

In accordance with the Directive, the following is prohibited for strictly protected species:

- All forms of deliberate capture and keeping and deliberate killing;
- Deliberate damage to or destruction of breeding or resting sites;
- Deliberate disturbance of wild fauna particularly during the period of breeding, rearing and hibernation, in so far as disturbance would be significant in relation to the objectives of this Convention;
- Deliberate destruction or taking of eggs from the wild or keeping these eggs even if empty;
- Possession of and internal trade in these animals, alive or dead, including stuffed animals and any readily recognisable part or derivative thereof, where this would contribute to the effectiveness of the provisions of this Article.

The assessments of the ecological functionality of present Annex IV species will be included as a part of the national EIAs and will be summarised in the Espoo report (Section 7.3.3).

7. TRANSBOUNDARY IMPACT ASSESSMENT

7.1 Screening of potential transboundary impact

This Espoo report focuses on project activities conducted in the marine territory of Denmark (territorial waters, EEZ and disputed area) that can potentially cause adverse effects in the APs Sweden, Germany and Poland. It was judged in advance that onshore construction and operation does not give rise to any transboundary impact due the local nature and range of project impacts. The same is true for the activities in the Danish North Sea, which only concern EEZ and territorial waters of Denmark. Thus, only the offshore activities within the Baltic Sea are subject to the Espoo procedure and considered in this report. Figure 7-1 presents the project area.

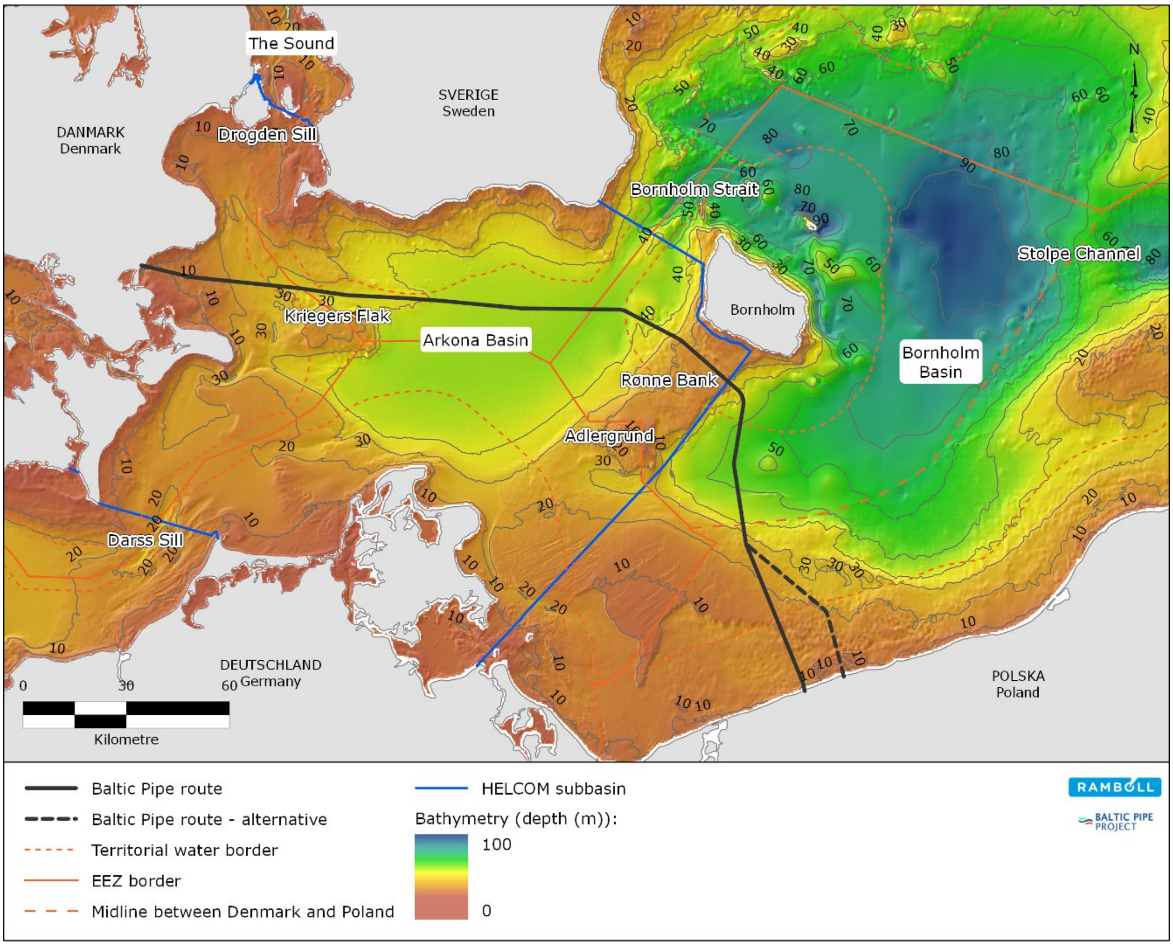

Figure 7-1 Overview of the project area for the Baltic Pipe project.

In the EIA report (Ramboll, 2018a) a detailed assessment of all relevant potential impacts on marine receptors has been conducted and documented. 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 round.

Table 7-1 shows the screening and gives an indication of those impacts that are assessed in more detail further below in this chapter.

Table 7-1 Screening of potential transboundary impacts.

Receptor	Potential impact	Transboundary evaluation
Physical and chemical environment		
Bathymetry	• Physical disturbance of seabed • Sedimentation • Presence of pipeline	The impacts are assessed to be not significant and occurring only locally. Transboundary impact can be excluded.
Hydrography and water quality	• Suspended sediments (SSC) • Contaminants and nutrients • Discharge to the sea • Release of contaminants from anodes • Presence of pipeline • Heat from pipeline	All potential impacts are assessed to be minor or negligible. Transboundary impact can be excluded.
Surface sediments and contaminants	• Physical disturbance of seabed • Contaminants and nutrients • Sedimentation • Presence of pipeline • Release of contaminants from anodes	The impacts are assessed to be not significant and occurring only locally. Transboundary impact can be excluded.
Climate and air quality	• Emissions to air	Transboundary impact from emissions cannot be excluded (see Section 7.2.1 below).
Underwater noise	• Underwater noise from construction activities • Underwater noise from unplanned events	The impact from construction noise is assessed to be negligible. Transboundary impact can be excluded. The impact from *unplanned events* is assessed in relation to the receptors fish and marine mammals (see below).
Biological Environment		
Plankton	• Suspended sediments (SSC) • Contaminants and nutrients	The impact is assessed to be not significant and occurring only locally, mostly nearshore. Transboundary impact can be excluded.
Benthic habitats, flora and fauna	• Physical disturbance of seabed • Suspended sediments (SSC) • Sedimentation • Presence of pipeline	A significant impact is assessed on eelgrass in Faxe Bugt during the construction phase. All other impacts are minor or negligible and not significant. Transboundary impact can be excluded.
Fish	• Physical disturbance of seabed • Suspended sediments • Sedimentation • Underwater noise	Transboundary impact from underwater noise cannot be excluded (see Section 7.3.1 below).
Marine mammals	• Suspended sediments (SSC) • Physical disturbance above water • Underwater noise (construction activities, unplanned events)	Transboundary impact from underwater noise cannot be excluded (see Section 7.3.2 below).
Seabirds and migrating birds	• Physical disturbance above water	The impact is assessed to be negligible. Transboundary impact can be excluded.
Migrating bats	• Physical disturbance above water (collision with construction vessels)	The impact is assessed to be negligible. Transboundary impact can be excluded.
Annex IV species	• Deliberate capture or killing • Deliberate disturbance	Transboundary impact from underwater noise cannot be excluded (see Section 7.3.3 below).
Biodiversity	• Physical disturbance of sediment • Suspended sediment • Sedimentation • Underwater noise – (construction activities, unplanned events) • Physical disturbance above water	All potential impacts are assessed to be minor or negligible. Transboundary impact can be excluded.

Receptor	Potential impact	Transboundary evaluation
	• Presence of pipeline • Non-indigenous species	
Natura 2000 offshore	• Suspended sediment (SSC) • Sedimentation • Underwater noise • Physical disturbance above water • Presence of pipeline	Transboundary impact from underwater noise from unplanned events (clearance of UXO) cannot be excluded (see Section 7.3.4 below).
Marine Strategy Framework Directive (entire marine area, environmental status according to 11 descriptors)	• Physical disturbance of seabed • Suspended sediment • Contaminants and nutrients • Underwater noise • Non-indigenous species • Presence of pipeline	Impacts on the 11 descriptors are assessed to be minor or negligible in the Danish national context. Significant transboundary impact can be excluded.
Water Framework Directive (ecological status 1 NM zone, chemical status 12 NM zone)	• Suspended sediment • Contaminants and nutrients • Release of contaminants from anodes	Impacts on the ecological or chemical status are assessed to be minor or negligible. Significant transboundary impact can be excluded.
Cumulative impacts	• Physical disturbance of sediment • Suspended sediment • Sedimentation • Underwater noise – (construction activities, unplanned events) • Physical disturbance above water • Presence of pipeline (in combination with similar impacts from other projects)	Cumulative impacts through overlapping of impacts from different projects cannot be excluded (see Section 7.5)
Socio-economic environment		
Shipping and shipping lanes	• Safety zones • Restriction zone (around pipeline)	Restriction zones and the presence of the pipeline in Danish waters can potentially have an impact on international shipping lanes
Commercial fisheries	• Safety zones • Restriction zone (around the pipeline) • Presence of pipeline • Presence of vessels	Restriction zones in Danish waters can potentially have an impact on fishermen from Sweden, Germany and Poland (See Section 7.4.2 below).
Archaeology (cultural heritage)	• Physical disturbance of seabed	Unexpected findings of archaeological objects during construction will be handled according to applicable law in Denmark. Transboundary impacts can be excluded.
Cables, pipelines and windfarms	• Physical disturbance of the seabed • Presence of pipeline	The risk of damage of internationally important cables and pipelines is minimized by the methodology applied to establish the crossings. Transboundary impact is thus avoided. The pipeline does not significantly restrict future development of marine infrastructure.
Raw material extraction sites	• Safety zones • Restriction zone (around the pipeline)	The pipeline route does not cross existing or potential extraction sites. Disturbance of adjacent extraction activities can only occur

Receptor	Potential impact	Transboundary evaluation
		locally within short periods of time (days). Transboundary effects can be excluded.
Military practice areas	• Safety zones	The pipeline route passes close to internationally important military practice areas. During construction, impact on these areas cannot be excluded (See Section 7.4.3 below).
Environmental monitoring stations	• Suspended sediments	There are no monitoring stations in Swedish or Polish waters near the border to the Danish waters. Transboundary effects can be excluded.
Tourism and recreational areas	• Physical disturbance • Safety zones • Restriction zone (around the pipeline) • Airborne noise	The impacts are assessed to be minor or negligible. Significant transboundary impact can be excluded.

7.2 Physical and chemical environment

In this section, the baseline description of the potentially impacted receptors is described and the potential transboundary impacts on the physical-chemical environment are assessed.

7.2.1 Climate and air

Establishment of the Baltic Pipe gas pipeline is associated with emissions of greenhouse gases and pollutants to the atmosphere, originating from the use of machinery and the production of materials. Greenhouse gas emissions have a transboundary impact contributing to global climate change, whereas air pollutants can have a local and/or regional impact. Both factors influence the environment and the living conditions for flora and fauna as well as humans.

In this section, the contribution of the Baltic Pipe to these emissions is assessed. The assessment focuses on emissions during construction and operation/maintenance only, and does not include the greenhouse gas emissions arising from the combustion of the delivered natural gas. The latter can be found in Chapter 8 dealing with the role of the Baltic Pipe project in the context of Polish and European energy policies.

During construction and operation of the Baltic Pipe project, there will be a need for vessels undertaking surveys, carrying out construction works, transporting materials etc. The combustion of fossil fuel from the operation of vessels will result in the emission of several components. Based on experience from other comparable projects, the following are considered as the four main air emissions: CO_2 (carbon dioxide), NO_X (nitrogen oxides), SO_X (sulphur oxides) and PM (particulate matter).

In addition, production of all components of the Baltic Pipe is associated with emissions to air, in particular CO_2 from steel, concrete, aluminium and coating production.

Statutory requirements

The statutory requirements relevant to the Baltic Pipe project are divided into requirements for greenhouse gas emissions (CO_2) and for air quality in the following.

<u>Greenhouse gas emissions (CO_2)</u>

Denmark has ratified the UN Kyoto Protocol on reduction of greenhouse gas emissions and committed to reduce CO_2 emissions by 21% in 2020 (compared to 1990) in line with the EU implementation of Kyoto 2nd period 2013-2020. In addition, Denmark has, as a member of the

EU, an individual binding target to cut CO_2 emissions by 39% from non-ETS sectors[31] in 2030 (compared to 2005).

Air quality
The IMO under the UN has designated the Baltic Sea as an Emission Control Area (ECA) under Regulation 14 of MARPOL Convention Annex VI to limit the emission of SO_X (also known as a SECA). This means that the sulphur limit for fuel oil used in SECAs from 1 January 2015 is 0.1%. The regulation has led to a significant reduction of SO_2 emissions in the Baltic Sea since it has come into effect (Johansson & Jalkanen, 2016).

Furthermore, the Baltic Sea has been designated as an Emission Control Area (ECA) from 2021 under Regulation 13 of MARPOL Convention Annex VI to limit the emission of NO_X (also known as a NECA). This means that all vessels built after 2021 are required to reduce NO_X emissions by 80% compared to the present emission level. It is expected that a lengthy period of fleet renewal is needed before the regulation will show full effect.

The EU has adopted the Air Quality Directive[32], including limit values[33] for air pollutants, which also apply as limit values in Denmark (implemented in the Danish Statutory Order on Air Quality[34]). The limit values and critical levels apply over differing periods of time because the observed impacts associated with the various pollutants occur over different exposure times.

The limit values and critical levels for the polluting components mentioned in the introduction are shown in Table 7-2.

Table 7-2 Relevant limit values for the protection of human health according to the Air Quality Directive.

Polluting components	Averaging period	Limit values [μg/m³]
NO_2	1 hour	200, not to be exceeded more than 18 times per calendar year
NO_2	Calendar year	40
SO_2	1 hour	350, not to be exceeded more than 24 times per calendar year
SO_2	24 hours	125, not to be exceeded more than 3 times per calendar year
$PM_{2.5}$	Calendar year	25 (20)*
PM_{10}	24 hours	50, not to be exceeded more than 35 times per calendar year
PM_{10}	Calendar year	40

* Number in parentheses is a proposed limit value for 2020.

Baseline

Existing CO_2 emissions and emissions of air pollutants related to the offshore part of the project mainly originate from vessels operating in the Baltic Sea. Table 7-3 shows an overview of emissions from vessels in the Baltic Sea in 2016 and the total annual emissions in Denmark in 2016 for comparison.

[31] Non-ETS sectors are not a part of the EU Emissions trading system (ETS). The non-ETS sectors includes e.g. transportation, agriculture and heating.
[32] Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe.

[33] Limit values are in the Air Quality Directive defined as: *"(…) a level fixed on the basis of scientific knowledge, with the aim of avoiding, preventing or reducing harmful effects on human health and/or the environment as a whole, to be attained within a given period and not to be exceeded once attained".*

[34] Statuary order no. 1472 of 12 December 2017 on assessment and control of the air quality.

Table 7-3 Total emissions from all vessels in the Baltic Sea in 2016 (Johansson & Jalkanen, 2017) and total annual emissions in Denmark in 2016 (Aarhus University, 2018b).

Polluting components	Emissions from vessels in the Baltic Sea [tonnes]	Total emissions in Denmark [tonnes]
CO_2	14,700,000	37,117,000
NO_X	318,000	115,000
SO_X	10,000	-
SO_2	-	10,000
$PM_{2.5}$	9,000	21,000
PM_{10}	-	31,000
PM (TSP)	-	91,000

The CO_2 emissions from vessels from the Baltic Sea correspond to 4,792,000 tonnes of fuel (Johansson & Jalkanen, 2017).

The emissions from the Baltic Sea are mingling with the onshore emissions in a complex way and pollutant concentrations will vary depending on many factors like season and prevailing weather systems. Models are used to describe the processes and calculate average concentrations. Results from model calculations for the Danish part of the Baltic Sea are shown in Table 7-4.

Table 7-4 Modelled concentrations of NO_X and SO_2 in the Danish part of the Baltic Sea in 2016 (Ellermann et al, 2018).

Polluting components	Averaging period	Modelled concentrations in Danish part of the Baltic Sea, 2016 [µg/m³]
NO_X	Calendar year	6 - 10
SO_2	Calendar year and winter	0.25 – 1.50

Impact assessment and transboundary impact

The only potential impact from the project on climate and air quality is emissions to air, which can have an effect both during construction and operation (Table 7-5).

Table 7-5 Potential impact on climate and air quality, offshore.

Potential impact	Construction	Operation
Emissions to air	X	X

Emissions to air

The main emissions from the offshore part of project during construction relate to the combustion of fossil fuels from the various vessels operating in the Baltic Sea as part of the pipe-lay activities. During operation, emissions relate to the combustion of fossil fuels from survey and maintenance vessels.

Emissions to air from the offshore part of the project include both CO_2 emissions having an impact on climate and polluting components having an impact on air quality.

CO_2 emissions

In Table 7-6, the CO_2 emissions from construction and operation of the offshore part of project and from material production is presented. For operation, the results are shown per year on average during estimated operation time (50 years). CO_2 emissions from material production cover the two main materials, steel and concrete, used for the pipes and tunnel elements.

Table 7-6 CO_2 emissions from offshore construction and operation (pr. year in average for an operation time of 50 years). The numbers include landfall and nearshore construction and pre-commissioning in DK and PL.

Activity	CO_2 emissions DK* [tonnes]	Total CO_2 emissions Baltic Sea [tonnes]
Construction activities (offshore, nearshore, landfall, pre-commissioning)	124,400	248,570
Material production (steel and concrete)	181,800	361,613
Construction, total	**306,200**	**610,183**
Operation (per year on average)	53	106

*Danish share of the alignment in the Baltic Sea including disputed area

The sensitivity of the climate as a receptor is considered high because of its potential impact on ecosystems in general. CO_2 emissions have a negative, secondary, transboundary and irreversible impact on climate.

CO_2 emissions from operation are considered negligible, as the yearly emissions constitute less than 0.003‰ of the total emissions from vessels in the Baltic Sea and even less of the total annual Danish CO_2 emissions. However, the CO_2 emissions from construction are considerably higher than from operation and account for approximately 0.8% of the total annual Danish CO_2 emissions in 2016 and for approximately 2.1% of CO_2 emissions from vessels in the Baltic Sea. As the duration is short-term, it is considered as a minor impact and thus, not significant.

Table 7-7 Impact significance on climate, offshore.

	Sensitivity	Magnitude of impact			Severity of impact	Significance
		Intensity	Scale	Duration		
Emissions to air (CO_2 emissions, construction)	High	Medium	Transboundary	Short-term	Minor	Not significant
Emissions to air (CO_2 emissions, operation)	High	Minor	Transboundary	Long-term	Negligible	Not significant

The CO_2 emissions from the total Baltic Pipe project in Denmark are assessed jointly in the document "Environmental Impact Assessment – Introduction and overall conclusion".

Polluting components

In Table 7-8, the emissions of polluting components from the construction and operation of the offshore part of the project are presented.

Table 7-8 Polluting components from offshore construction and operation.

	Air emissions [tonnes]				
	NO_X	SO_2	PM (TSP)	PM_{10}	$PM_{2,5}$
Construction (offshore)	3,400	80	150	150	150
Operation (pr. year in average)	1	0	0	0	0

In the estimates, it has not been taken into account that the Baltic Sea has been designated as a NECA area, implying that all vessels built after 2021 are required to reduce NO_X emissions by 80% compared to the present emission level. This means that the NO_X level will potentially be lower, especially during operation. The ships and fuel used as part of the construction activities for the Baltic Pipe project will be required to comply with to legislation in force, and this will include the legislation as a result of the designated NECA and SECA areas.

The sensitivity of the offshore air quality is assessed as low, as the background level is low and there are good spreading conditions. The above calculated air emissions cover all construction activities offshore and will therefore be emitted in very low amounts along the pipeline route during the construction period. The intensity is assessed as minor during construction and with no impact during operation. The scale is mainly local but can also be regional. The severity of the impact is assessed as minor during construction and negligible during operation. Significant transboundary impact can be excluded.

Table 7-9 Impact significance on air quality, offshore.

	Sensitivity	Magnitude of impact			Severity of impact	Significance
		Intensity	Scale	Duration		
Emissions to air (polluting components, construction)	Low	Minor	Local to regional	Short-term	Minor	Not significant
Emissions to air (polluting components, operation)	Low	No impact	Local to regional	Long-term	Negligible	Not significant

Conclusion on transboundary impact

The potential impacts on climate and air quality resulting from construction and operational activities of the proposed pipeline within Danish waters are summarized in Table 7-10.

Table 7-10 Overall impact significance for climate and air quality.

Potential impact	Severity of impact	Significance	Transboundary
Emissions to air (CO_2 emissions, construction)	Minor	Not significant	Yes
Emissions to air (CO_2 emissions, operation)	Negligible	Not significant	Yes
Emissions to air (polluting components, construction)	Minor	Not significant	Yes
Emissions to air (polluting components, operation)	Negligible	Not significant	Yes

Impacts on human health because of increased air emissions from the project can be excluded both in the national and transboundary context.

7.3 Biological environment

In this section, the baseline conditions for the potentially impacted receptors are described and the potential transboundary impacts on the biological environment are assessed.

7.3.1 Fish

Baseline

The fish community in the Baltic Sea is greatly influenced by the hydrological uniqueness of the sea. The sea is semi-enclosed and surrounded by a large drainage basin. The ecosystem of the Baltic Sea is recognized by its lower biodiversity of both plants and animal species compared to more regular seas with normal (33-37 PSU) salinity (Ojaveer *et al.*, 2017). The water is too fresh for most marine species and too salty for most freshwater species. Approximately 100 fish species (excluding the Kattegat) are adapted to the Baltic Sea ecosystems (Ojaveer *et al.*, 2017). Almost all these species can be found in the southwestern part of the Baltic Sea.

The Arkona Basin and the Bornholm Basin have approximately 110 and 105 species of fish and lamprey, respectively. Of the 110 species registered in the Arkona Basin, 22 different orders are present (HELCOM, 2012), of which Perciformes (26.4%), Gadiformes (12.7%) and Cypriniformes (10.9%) dominate. The composition of orders in the Bornholm Basin is similar to the Arkona Basin, with Perciformes (22.9%), Cypriniformes (18.1%) and Gadiformes (10.5%) dominating (HELCOM, 2012). The perciformes order, meaning "perch-like", contains freshwater species such as perch (*Perca fluviatilis*), pikeperch (*Sander lucioperca*) and ruffe (*Gymnocephalus cernua*), which naturally prefer less saline waters i.e. mostly the coastal areas, but also marine species such as greater sandeel (*Hyperoplus lanceolatus*), mackerel (*Scomber scombrus*) and the invasive round goby (*Neogobius melanostomus*). The gadiformes order includes the most commercially important species in the Baltic Sea for the Danish fleet, i.e. cod (*Gadus morhua*), but in general, most of the registered fish of this order are noted as temporally occurring with no reproduction, e.g. haddock (*Melanogrammus aeglefinus*), pollack (*Pollachius pollachius*) and hake (*Merluccius merluccius*). Lastly, there are the ray-finned fishes i.e. cypriniformes, which include bream (*Abramis brama*), roach (*Rutilus rutilus*) and the silver bream (*Blicca bjoerkna*).

According to the HELCOM checklist for Baltic Sea fish and lamprey species, 35% and 37% of the species show regular reproduction in the Arkona Basin and Bornholm Basin, respectively

(HELCOM, 2012). Among them are species such as herring (*Clupea harengus*), sprat (*Sprattus sprattus*), cod, flounder (*Platichthys flesus*) and plaice (*Pleuronectes platessa*). The aforementioned species are important to the marine food web and commercial fisheries in the Baltic Sea.

Fish play an important role in the Baltic Sea, as they are an essential link between planktonic production and higher trophic level predators. Forage fish are planktivorous pelagic species that transform the major part of zooplankton production into food available at higher trophic levels (Engelhard *et al.*, 2013). Breeding success, condition and reproductive capacity of predators are linked to fish as a food source for marine birds, mammals and fish predators. Decreases in the abundance of forage fish may alter the food web, especially in a wasp-waist type ecosystem such as the Baltic Sea, where a few forage fish dominate the intermediate trophic level. Alterations in abundance or distribution of these species can have large implications for higher trophic levels. During the last thirty years, such changes have occurred with restructuring of the ecosystem, as the biomass of sprat has increased significantly because of the drop in its main predator, the cod (Eero *et al.*, 2012, Casini *et al.*, 2014).

The HELCOM Red List of Baltic Sea species in danger of becoming extinct is a threat assessment that includes fish species. The list follows the red list criteria of the International Union for Conservation of Nature (IUCN). As for the Arkona and Bornholm Basin, the eel is the only fish with regular occurrence which is listed as critically endangered on the HELCOM Red List of Baltic Sea species (HELCOM, 2012). Historically, there has been a decline in the population over the last three decades, and only 1-5% of the former population arrives in Europe today. In the Baltic Sea, the eel fishery consists of fishing for yellow eel (growing phase) and silver eel (migrating phase). In the period from 2010 to 2015, Danish fisheries landed 32.05 tonnes of eel.

Aside from the eel, there are other species in the area surrounding the Baltic Pipe pipeline that are listed on the HELCOM and IUCN Red Lists. As the majority of these species are temporally occurring or listed with IUCN status of Vulnerable, they are judged as being of relatively low importance and will not be dealt with further.

Commercially important species

Commercial fishing is carried out in large parts of the Baltic Sea by all countries in the region. The fisheries target both marine and freshwater species, but approximately 95% of the total fish catch in terms of biomass consists of cod, sprat and herring (ICES, 2017). The catches are used for both human consumption and industrial use. The Baltic Sea fisheries also target demersal species, such as plaice and flounder, along with migratory species, such as trout and salmon. The following section includes a stock definition for the commercially important species e.g. cod, sprat, herring, plaice and flounder. Commercial fisheries as a receptor is dealt with in Section 7.4.2.

<u>Cod</u>

Cod is a demersal species found throughout the Baltic Sea. Since 2003, the cod stock in the Baltic Sea has been managed as two separate stocks i.e. the western and eastern Baltic cod. The stock is divided as there is evidence supporting a phenotypic and genetic difference between the two populations. In the Arkona Basin, there is co-existence among the western and eastern stock. Studies suggest that the cod exhibit natal homing for spawning i.e. they spawn in the same place almost every year, and a difference of approximately 4 months in the timing of peak spawning season between the two stocks may add to the separation between the stocks. The abundance of cod has increased lately, and recent studies show that a large part of cod in the ICES sub-division (SD) 24 is genetically eastern cod (ICES, 2015).

Figure 7-2 shows cod spawning and nursery areas in the southwestern part of the Baltic Sea. The reproductive cycle for the western Baltic cod starts in late October and spawning begins approximately 4 months after (see Table 7-11). The spawning period is from the end of February to the beginning of June, and the main spawning season is from March to April (ICES, 2015). Male cod tend to stay longer in the spawning area and reach maturity earlier than females. Salinity > 15 PSU is a requirement for fertilization to occur, and greater than 20 PSU ensures the buoyancy of the eggs (ICES, 2015). Spawning of the eastern stock differs, as it is confined to deeper areas where salinities are sufficiently high to allow egg fertilisation and buoyancy i.e. 12-14 PSU. Historically, the eastern Baltic cod has had a spawning period that extended from March to September, but in the 2000s, spawning has continued until as late as October/November (Köster *et al.*, 2016).

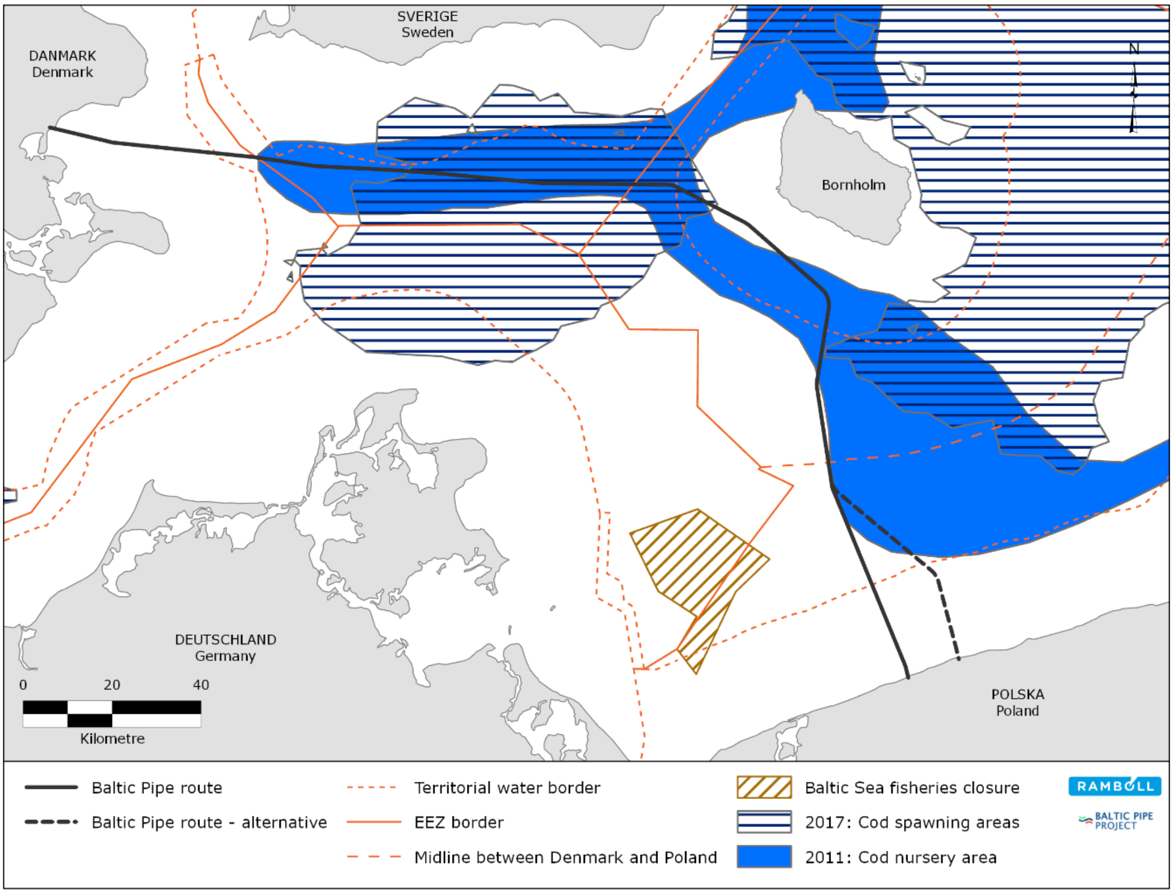

Figure 7-2 Cod spawning and nursery areas in the southwestern part of the Baltic Sea. The map also includes cod-related and general fisheries closures.

<u>Sprat</u>

Sprat is a pelagic species. They are widely distributed in the open sea areas of the Baltic Sea, but high concentrations of young-of-the-year are found in coastal areas (see Figure 7-3). The latter occurs in the autumn and first quarter of the year. Some years juvenile herring tend to stay in the same areas as sprat, and shoals occur often in both open sea and coastal areas (ICES, 2008).

Sprat in the Baltic Sea are near the northern limit of the species' geographic distribution. Therefore, lower temperatures are detrimental to their production and survival in the Baltic Sea, and laboratory experiments have shown that cold water prevents the hatching of sprat eggs (ICES, 2008). In the Baltic Sea, the water temperature has increased over the last years. The effects of warm temperature on sprat biology has resulted in higher egg and larval survival, faster growth rates in larvae and adults, higher food supplies for larvae and adults, and increased and/or earlier egg production (faster gonadal development due to higher temperature and food supply) (ICES, 2008, Voss *et al.*, 2012). Historically, the peak spawning time for sprat in the Baltic Sea occurred in May (see Table 7-11). However, due to inter-annual variability in temperatures, the timing of reproduction has changed. Spawning occurs from January to July (Muus & Nielsen, 1998). During the summer, the sprat spawning activity decreases, and they begin to migrate out of the deep basin towards shallow feeding grounds.

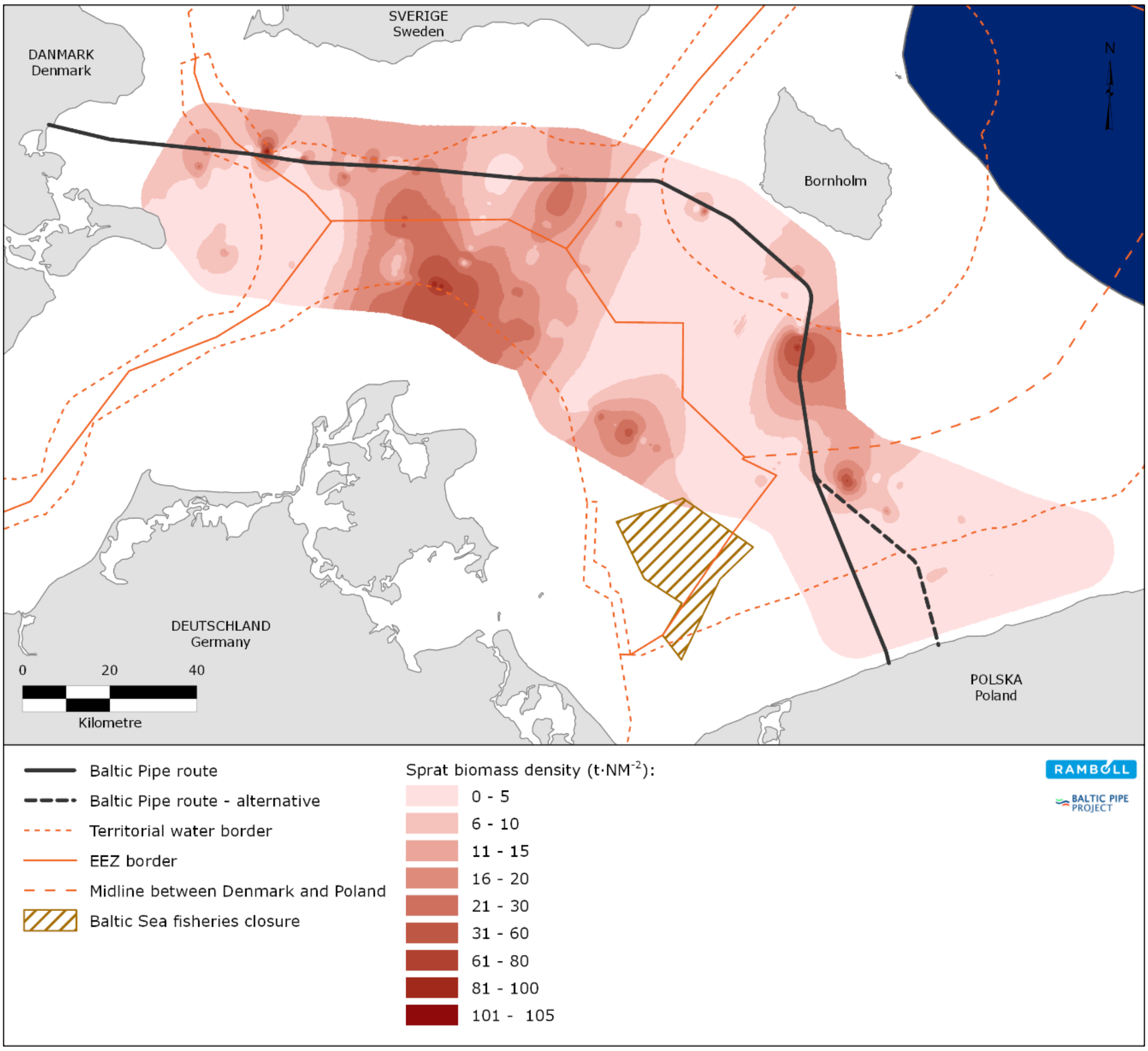

Figure 7-3 Surface biomass density for sprat [t·NM^{-2}], based on hydroacoustic surveys undertaken by the R/V Baltica (project area, January 2018). The map also includes general fisheries closures.

<u>Herring</u>

Herring is a pelagic species that is distributed throughout the Baltic Sea. In management, two populations are identified, the western Baltic spring-spawners and the central Baltic herring, where mixing occurs in the Arkona Basin (HELCOM, 2008). The western Baltic spring-spawners are migratory, travelling to more saline waters in the summer and then returning to the Kattegat and the Sound to overwinter before moving to spawning areas on the German Baltic coast in March-May (see Table 7-11). Herring spawning and nursery areas are typically located nearshore and such areas are particularly vulnerable to anthropogenic influences, including extraction of raw materials i.e. sand and gravel (Figure 7-4). The central Baltic stock comprises mainly a spring spawning herring population in the Bornholm Basin in April-May. Spring spawning occurs at the coast with a temporal gradient from south to north. When spawning is completed, the spawning individuals migrate to the deep basins to feed. There are no major important spawning grounds in the Arkona Basin for herring.

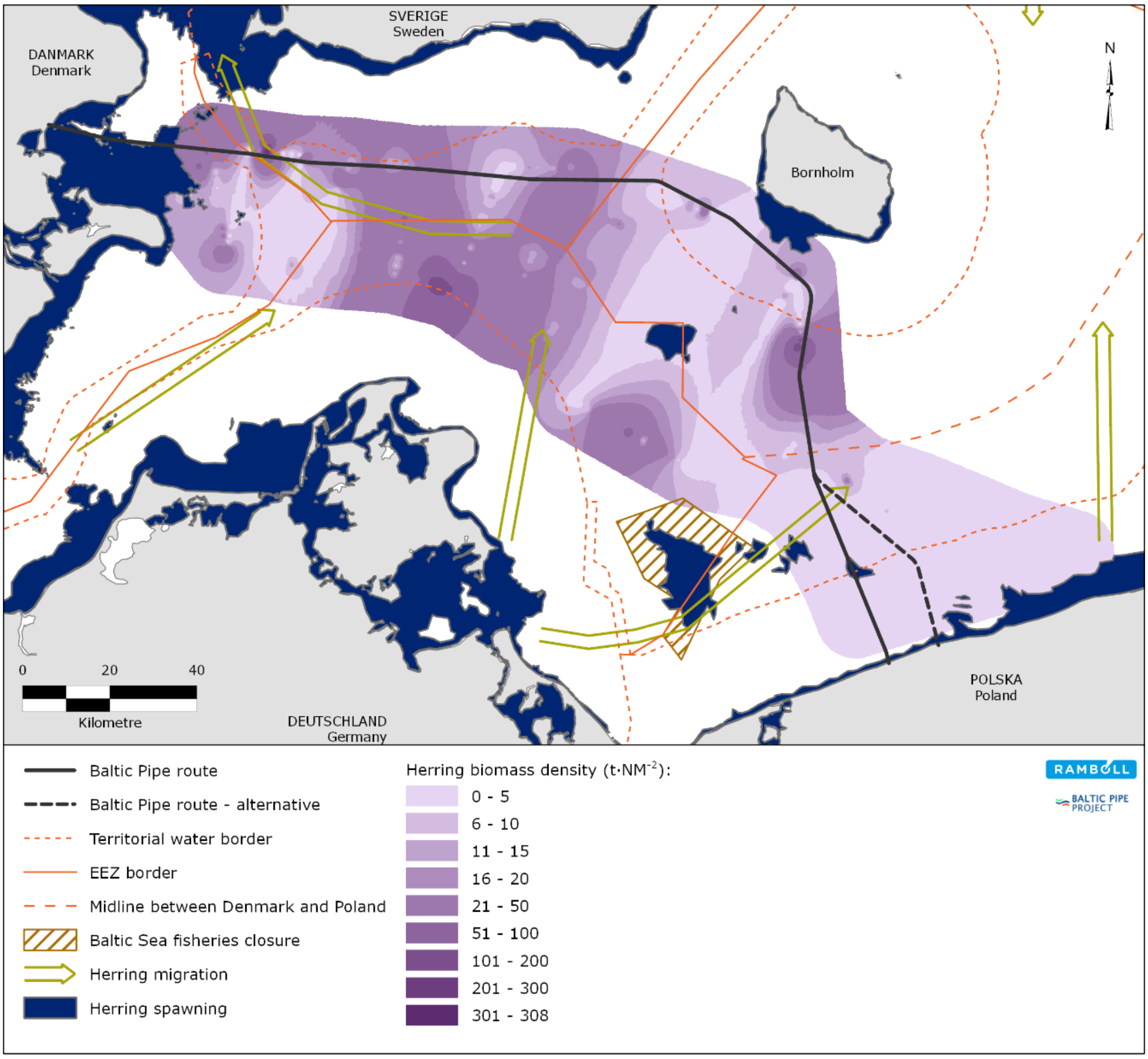

Figure 7-4 Herring spawning areas and migration patterns in the southwestern part of the Baltic Sea. The map also includes general fisheries closures and surface biomass density for herring [t·NM^{-2}] (project area, January 2018).

Plaice

Plaice is an important species in European waters that has been exploited for centuries. Plaice is a demersal species. The distribution of plaice in the Baltic Sea is dependent on salinity and the stock extends from the Gulf of Gdansk to the Gotland area, but is also found sporadically farther north. Plaice spawn in the Arkona Basin and the Bornholm Basin, and the nursery areas are located in shallow waters down to 10 m depth (ICES, 2014). Juveniles are located in shallow coastal waters and outer estuaries. As plaice grow older, they move into deeper water. The abundance of plaice in the southern Baltic Sea is influenced by the migration of plaice from the Kattegat.

Plaice spawn in February-March (see Table 7-11) in the aforementioned basins, and the eggs are pelagic (ICES, 2014). Spawning fails in brackish water if the salinity is below one third of the average sea salinity, as the eggs will sink to the bottom (Muus & Nielsen, 1998). Spawning of marine fishes with pelagic eggs in the Baltic Sea is, due to low saline surface water, restricted to the deep basins.

Flounder

Flounder is the most widely distributed flatfish species in the Baltic Sea. There are two species of flounder in the Baltic Sea, the European flounder and the Baltic flounder (*Platichthys solemdali*), which appear to be nearly identical (Momigliano *et al*., 2018). The two species can be distinguished by two methods, either genetically or by studying their eggs and sperm. The Baltic flounder lays sinking eggs on the seafloor in coastal areas, whereas the European flounder spawn buoyant eggs in deep areas. The Baltic flounder is more abundant in the Gulf of Finland, whilst the distribution of European flounder is centred at the central and southern Baltic Sea. Hence the European flounder is present in the Arkona and Bornholm Basins.

The volume of water suitable for reproduction among the European flounder population in Arkona Basin is driven by salinity above 12 PSU and oxygen concentrations above 2 ml O_2/l. The recruitment success is therefore dependent on hydrological conditions at the spawning grounds i.e. the Arkona Basin and the Bornholm Basin (ICES, 2014). Spawning takes place in March-June (see Table 7-11) and the nursery areas are in shallow coastal waters. The eggs of the European flounder are buoyant, unlike the sinking eggs of the Baltic flounder. The juveniles migrate offshore in the autumn.

Table 7-11 Spawning period for the commercially important species e.g. cod, sprat, herring, plaice, and flounder in the Arkona Basin and Bornholm Basin in the Baltic Sea (ICES, 2014; Bleil & Oeberst, 2012; Köster et al., 2016). E/W indicate main spawning period for eastern and western cod.).

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cod			X^W	X^W	X^{WE}	X^{WE}	X^{WE}	X^E	X^E	X^E		
Sprat	X	X	X	X	X	X	X					
Herring			X	X	X							
Plaice		X	X									
Flounder			X	X	X	X						

Impact assessment and transboundary impact

Relating to the construction and operation of the Baltic Pipe, the potential impacts outlined in Table 7-12 have been identified as relevant for the impact assessment on fish along the pipeline.

Table 7-12 Potential impacts on fish.

Potential impact	Construction	Operation
Physical disturbance of seabed	X	
Suspended sediments	X	
Sedimentation	X	
Underwater noise	X	

Physical disturbance of seabed

Several activities during the construction phase may physically disturb the seabed morphology. Seabed interventions and pipe-lay works comprise trenching, rock installation and DP-vessels/anchor handling, which may cause disturbance and change to the benthic habitats. This impact can potentially disturb spawning and nursery areas.

The sensitivity of fish to physical disturbance of the seabed varies depending on biological circumstances, i.e. the life stage at which the fish is in (egg, larval, fry, juvenile and adult) and whether the fish is spawning (Kjelland *et al*., 2015). Also, the duration and impact magnitude of the physical disturbance is relevant in regard to the sensitivity. Pelagic fish eggs (e.g. cod) that usually concentrate in the halocline due to the low salinity are less susceptible to the physical disturbance of the seabed, whereas benthic fish eggs (e.g. herring) are known to be vulnerable to anthropogenic influences such as raw material extraction (Janßen & Schwarz, 2015; Sundby & Kristiansen, 2015). Despite the disturbance of the seabed, the duration will be temporary and adult fish will return to the area shortly afterwards, making the disturbance of the spawning time and eggs immediate. Therefore, the sensitivity to physical disturbance of the seabed is regarded as low.

There are no known deep benthic spawning areas that will be affected by the physical disturbance of the seabed. This includes the autumn spawning herring in the Arkona Basin, whose spawning grounds are confined to areas of steep coastal slopes or banks with intense vertical mixing of water layers and the demersal-egg spawning herring (i.e. the spring spawning populations) and flounder, which are known to spawn in many coastal areas around the Baltic Sea (Sundby & Kristiansen, 2015; Momigliano *et al*., 2018), which is outside the area of a potential transboundary impact .

Initially, fish will be susceptible to showing avoidance behaviour as a result of the physical disturbance of the seabed (Kjelland *et al*., 2015). However, since the areas surrounding the pipeline are homogenous, the impact will have no spatial influence on the habitat availability (local impact) and the impact is reversible. Once the activity is ceased, fish will return to the area; therefore, the duration is assessed to be short-term despite the fact that the impact is immediate. Therefore, the impact on fish habitats resulting from the construction work is assessed to be of negligible severity.

In summary, the physical disturbance of the seabed is assessed to have no significant impact on fish (Table 7-13). The scale is local, and transboundary impact can be excluded.

Table 7-13 Impact significance on fish from the physical disturbance of seabed during the construction of the pipeline.

	Sensitivity	Magnitude of impact			Severity of impact	Significance
		Intensity	Scale	Duration		
Physical disturbance of seabed	Low	Minor	Local	Short-term	Negligible	Not significant

<u>Suspended sediment</u>
seabed intervention related to the construction works will cause resuspension of sediments to the water column, which may impact fish communities by provoking avoidance, clogging of gills, reduction in feeding ability due to reduced visibility and reduced viability of pelagic fish eggs.

The pipeline sections for which trenching is envisaged are shown in Figure 3-15.

Because an increase in SSC in the water column is a regular feature of the sea (e.g. during stormy events), the vulnerability of fish to resuspended sediment depends entirely on the magnitude, composition and duration of the impact. Demersal fish are, generally, better adapted to elevated SSC and are less sensitive than pelagic species. Pelagic fish eggs are especially sensitive to high SSC, which can lead to egg abrasion. Therefore, the sensitivity is species-specific and can be assessed as high.

Fish avoidance behaviour can potentially be observed among individuals that are within range of the construction site due to the increase of SSC. However, this impact is assessed as short-term because it will take time before the fish resettles the area. The expected avoidance behaviour will also reduce the potential impact of clogging of fish gills. The quantitative knowledge about avoidance thresholds to sediment suspension is limited, but one study found that 3 mg/l resulted in avoidance behaviour in both cod and herring (Westerberg, Rönnbäck & Frimansson, 1996). Also, what is the case for cod will probably also apply to plaice and flounder, which have a similar spawning area and area of distribution for their eggs and larvae (Westerberg, Rönnbäck & Frimansson, 1996).

Sediment may adhere to pelagic eggs, such as cod or sprat eggs, causing them to sink to depths with oxygen deficiency. A critical SSC of 5 mg/l for cod eggs has been reported and yolk-sack larvae show an increased mortality level at a sediment concentration of the order of magnitude 10 mg/l (Westerberg *et al.*, 1996). As Figure 7-2 suggests, the planned Baltic Pipe route crosses a cod spawning area in the Arkona Basin. However, since cod spawning occurs in the water column above the halocline, and the SSC increase primarily takes place in the bottom water, there will be no impact on cod eggs or fry. Turbulent mixing is suppressed by the halocline, meaning that sediment does not diffuse across the layer (Lee & Lam, 2004). Furthermore, the exceedance of threshold concentrations (5 mg/l) from trenching in hours is generally not located in cod spawning areas such as the Arkona Basin, see Figure 7-5.

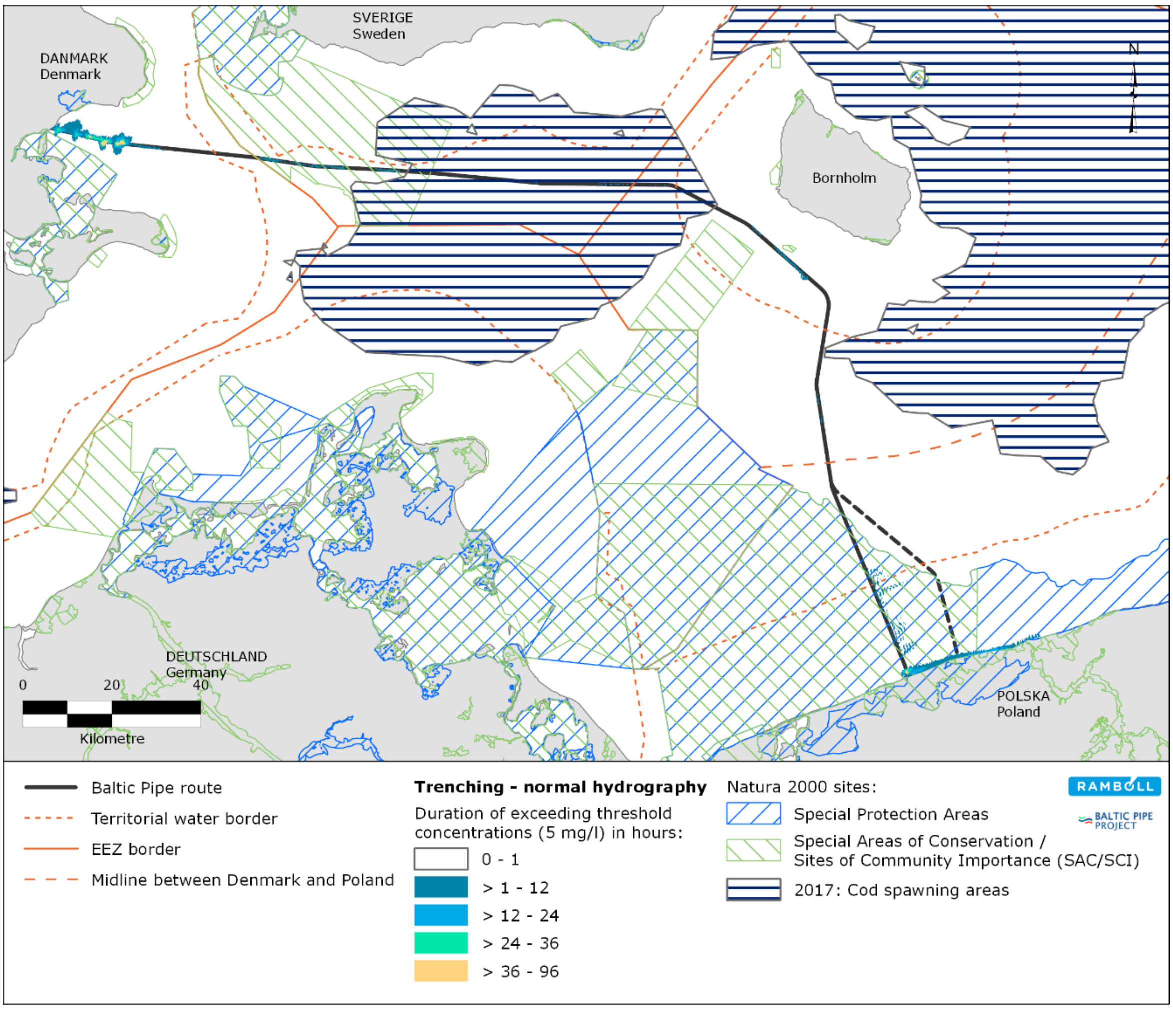

Figure 7-5 Model simulations of exceedances in threshold sediment concentrations from trenching - normal hydrography, and cod spawning areas in the Arkona Basin.

In summary, the impact on fish and fish egg from sediment spill is assessed to have a high sensitivity, as the impact of elevated SSC is species-specific. However, the intensity is minor, as the dispersion caused by sediment spill will be close to natural conditions. The scale is evaluated to be regional i.e. the exceedances in threshold values are usually within a few kilometres of the construction work. The duration of the exceedances of threshold concentrations is on average less than a day.

Minor amounts of sediment spill can cross the border from Denmark to Sweden west of Bornholm, where trenching is also planned on both sides of the border (see Figure 7-5). However, similar to the Danish assessment, the severity of impact is minor, and the impact will not be significant. Significant transboundary impact can be excluded.

Table 7-14 Impact significance on fish from suspended sediment.

	Sensitivity	Magnitude of impact			Severity of impact	Significance
		Intensity	Scale	Duration		
Suspended sediment	High	Minor	Regional	Short-term	Minor	Not significant

<u>Sedimentation</u>
Suspended sediment made available due to construction will re-deposit on the seabed. This sedimentation may potentially affect fish populations by smothering of larvae and eggs. There is no expected impact on pelagic fish from sedimentation.

Like the potential impact of suspended sediment, the magnitude of the impact is closely linked to the quantity, time and spatial scale of the re-sedimentation.

Demersal fish eggs and larvae may be critically covered by sediment (smothering) close to heavy intervention work (trenching areas) (Kjelland *et al*., 2015). Eggs and larvae of demersal spawning species such as herring and the Baltic flounder may be susceptible to smothering by sedimentation. Sedimentation can also influence the available food sources for the fish by burying benthic fauna (Hutchison *et al*., 2016). Despite these potential impacts, the sensitivity is assessed to be medium as the state will revert naturally over time.

However, there will not be any significant impact from sedimentation on fish eggs in either coastal waters or offshore since no important demersal spawning grounds are found along the pipeline. Any potential impact would be within the vicinity of the pipeline. The modelling results have shown that there is a relatively large deposition of sediment at the temporary deposit area and a small area within the vicinity of the exit point for the TBM. The deposition at the temporary deposit area corresponds to approximately 10-20 mm, and in the area close to the exit point of the TBM corresponds to approximately 1 mm. However, as stated above, there are no important demersal spawning grounds in these relatively small areas.

In summary, the magnitude of impact from sedimentation on demersal fish larvae and eggs is assessed as minor due to the immediate duration, local impact and the reversibility of the impact, see Table 7-15. Therefore, it is assessed that there will be no significant impact on fish from sedimentation. Accordingly, transboundary impact can be excluded.

Table 7-15 Impact significance on fish from the sedimentation of re-suspended matter during the construction of the pipeline.

	Sensitivity	Magnitude of impact			Severity of impact	Significance
		Intensity	Scale	Duration		
Sedimentation	Medium	Minor	Local	Immediate	Minor	Not significant

Underwater noise

Anthropogenic underwater noise is potentially a threat to fish, and it has been recognized as an impact that may have implications (Slabbekoorn *et al*., 2010). Fish are exposed to moderate but widespread low-frequency noise, produced by various coastal activities, yet there is little insight into the nature and extent of the impact of sounds on fish (Slabbekoorn *et al*., 2010). Underwater noise may impair the ability of fish to use biologically relevant sound for e.g. acoustic communication, predator avoidance, prey detection and usage of the soundscape (Slabbekoorn *et al*., 2010). In general, there is a lack of studies within this field and the majority of the available studies rely on the use of captive fish (Graham & Cooke, 2008; Celi *et al*., 2016). However, there are indications that fish which are exposed to white noise or simulated boat noise have increased stress hormone (i.e. cortisol) levels (Celi *et al*., 2016). Other studies have shown increased heart rate and motility in relation to noise (Graham & Cooke, 2008). It is not possible to extrapolate such findings to free-swimming fish that are able to leave areas, but it suggests that noise has a potential impact on fish. Such impacts will also be species-specific, as each species has a different hearing ability and dependency on sound (Slabbekoorn *et al*., 2010).

Fish have two sensory systems for detection of water motion, i.e. the inner ear and the lateral line system (Ladich & Schulz-Mirbach, 2016). Generally, fish hear best within 30 – 1,000 Hz, but there are species that can detect sounds up to 3,000 – 5,000 Hz, whereas other species are sensitive to infrasound or ultrasound (Slabbekoorn *et al*., 2010; Ladich & Schulz-Mirbach, 2016). An example of the latter is the European eel, which is fished in Faxe Bugt, and can detect and avoid infrasound (<20 Hz) produced by incoming predators.

The impact of underwater noise on fish can vary significantly, depending on the duration and the received level of the noise (see Table 7-16). Fish are known to respond differently to underwater noise (experimental), which suggests that the reactions are likely dependent on variables such as location, temperature, physiological state, age, body size and shoal/school size (Peng *et al*., 2015).

Table 7-16 Potential impacts of underwater noise on fish.

Potential impact	Description of potential impact
Mortality	Several studies have reported mortality of fish exposed to blasts or other types of high-level sounds (Yelverton *et al.*, 1975; Popper & Hastings, 2009). Blast injuries can occur if munitions clearance takes place, whereas rock installation is incapable of producing noise with this type of impact. International guidance values regarding mortality from noise are described in Table 7-17.
Physical injury	High-level acoustic exposures like blasts can cause physical damage. There are no investigations that have determined whether blasts that do not kill fish have had any impact on physiology (e.g. metabolic rate, stress). This type of impact can only occur in the area of close vicinity to the noise source (Peng, Zhao and Liu, 2015). International guidance values regarding physical injuries from noise are described in Table 7-17.
Permanent threshold shift (PTS)	Permanent threshold shift can be caused by elevated noise resulting in auditory tissue damage. The hearing threshold does not recover after exposure (Andersson *et al*., 2016). PTS values for cod and herring are shown in Table 7-17.

Temporary threshold shift (TTS)	Temporary elevation of the hearing threshold due to noise exposure. Hearing will recover with time, dependent on exposure, repetition rate, sound pressure level (SPL), frequency and health of the fish (Andersson *et al*., 2016). TTS can potentially occur at greater distances. International guidance values for TTS are shown in Table 7-17, including specific values for cod and herring.
Masking of other sounds	Noise above the ambient level could cause masking, interfering with the ability of fish to hear communication signals or other important sounds (Slabbekoorn *et al*., 2010). No threshold values for masking of sounds are available in literature.
Behavioural response	Noise not resulting in PTS and TTS can cause avoidance, flight behaviour, fright response and altered swimming behaviour (Slabbekoorn *et al*., 2010; Andersson *et al*., 2016). International guidance values for behavioural response are shown in Table 7-17, including specific values for cod and herring.

Table 7-17 International guidance values (IGV) for fish and Cod/Herring (CH) (Andersson *et al.*, 2016).

Guidance values for fish and Cod/Herring	Response	Sound Pressure Level (SPL=dB re 1 μPa/SEL=dB re 1 μPa²s)
IGV	Fatal injury	207 dB re 1 μPa²s (SEL)
IGV	Injury with recovery	203 dB re 1 μPa²s (SEL)
IGV	TTS	186 dB re 1 μPa²s (SEL)
Cod/Herring	PTS/TTS	205 dB re 1 μPa (SPL)
Cod/Herring	Mild behavioural response	75 – 125 dB re 1 μPa (SPL)
Cod/Herring	Strong behavioural response	125 – 165 dB re 1 μPa (SPL)
Cod/Herring	Strong escape response	165 dB re 1 μPa (SPL)

Construction activities

Construction activities, such as rock installations, trenching, pipe-lay, anchor handling and ship traffic are characterized as sources of continuous noise. The underwater noise generated from the construction activities is not distinguishable from the ambient noise levels, as the background levels in the Baltic Sea (with large volumes of ship traffic) are relatively high. As a matter of fact, background noise levels of 127 dB re 1 μPa (SPL), which are measured around shipping lanes in the Baltic Sea (Tougaard, 2017), exceed the threshold level for which the IGV assign strong behavioural response (Table 7-17). In addition, behavioural reactions to underwater noise from construction activities such as rock installation and ship traffic will occur near the pipeline and the construction vessels. The duration will be immediate and will cease after the activity has ended. It is not likely that there will be significant impacts on fish.

Unplanned event – munitions clearance

In connection with the risk assessments (Chapter 4), it has been identified that munitions clearance of UXO may pose a risk during the construction phase. Based on the route design strategy, munitions clearance is handled as an *unplanned event*.

Impulsive noise emissions are relevant in relation to potential munitions clearance. The different threshold values are represented in Table 7-17. The potential impact distance for munitions clearance on fish is found in Table 7-18.

Table 7-18 Modelled potential impact distance for munitions clearance on fish (for details on the model, see Ramboll 2018a)

Distance [km]	Faxe Bugt						Bornholm					
Charge size	30 kg TNT				340 kg TNT		340 kg TNT					
Period	Summer		Winter		Summer		Winter		Summer		Winter	
max/avg	max	avg	max	avg	max	avg	max	avg	max	avg	max	avg
Mortality	0.6	0.4	0.6	0.4	0.7	0.5	0.7	0.5	1.5	0.5	1.1	0.5
Injury	0.7	0.5	0.7	0.5	0.8	0.5	0.8	0.5	1.5	0.5	1.2	0.6

In a worst-case scenario where munitions clearance is unavoidable, mortality can occur within a maximum distance of 0.7 km for Faxe Bugt and 1.5 km for Bornholm (Table 7-18). The worst-case scenario for injuries to fish at Bornholm is 1.4 km and the maximum distance for Faxe Bugt is 0.8 km.

It is likely that it will be lethal for shoals or schools of fish that are present within the mentioned distances, when munitions clearances occur. The sensitivity to this impact on an *individual* level is high due to the lethality and irreversibility, and the intensity is large for a regional area. Lastly, the duration of the impact is assessed to be immediate.

On a *population* level, the severity of the impact is minor. Munitions clearances will only present a lethal or injury risk for a very small proportion of larger populations. This means that the structure and function of the populations will remain unaffected.

Regarding behavioural response, fish are known to respond differently to tested noise, which suggests that the reactions are likely dependent on variables such as location, temperature, physiological state, age, body size and shoal/school size. There will most likely be an immediate reaction to munitions clearance and the scale, which also is species dependent, will rangle from local to regional.

Table 7-19 Impact significance on fish from underwater noise (unplanned event - munitions clearance) before mitigation measures.

	Sensitivity	Magnitude of impact			Severity of impact	Significance
		Intensity	Scale	Duration		
Underwater noise (unplanned event - munitions clearance)	High	Large	Local/Regional	Immediate	Minor	Not significant

Mitigation measures
A ship-based sonar survey to identify shoaling or schooling fish in the area should be carried out to assess whether the timing of each munition clearance is suitable or if the detonation should be postponed. This assessment can be helpful in protecting shoals/schools of fish that may be present in the area.

Conclusion on mitigation measures
The mitigation measure will reduce the severity of the impact, as fewer individuals will be affected by the munition clearances. Still, the impact severity is assessed as minor because it is possible that there will be some variation for the respective fish population, but it will be closer to negligible compared to the situation without mitigation measures.

Table 7-20 Impact significance on fish from underwater noise (unplanned event - munitions clearance) after implementation of mitigation measures.

	Sensitivity	Magnitude of impact			Severity of impact	Significance
		Intensity	Scale	Duration		
Underwater noise (unplanned event - munitions clearance)	High	Large	Local/Regional	Immediate	Minor	Not significant

Conclusion on transboundary impact

According to the map of munitions risk areas (Figure 4-7), only the western border between Denmark and Sweden (Arkona Basin) is located within a munitions risk area. At the other two borders crossed by the pipeline (Sweden/Denmark and Denmark/Poland) the probability of munitions finds is very low.

It follows from the assessment above that underwater noise from munitions clearance in Faxe Bugt can cause mortality of fish max. 0.7 km from the blast and injury of fish within 0.8 km. In case munitions clearance takes place right at the border, the impact would be transboundary. The assessment of this transboundary impact is similar to the national assessment, i.e. it is judged that only a very small proportion of a larger population can be affected, and thus the impact is not significant.

Table 7-21 Overall impact significance on fish.

Potential impact	Severity of impact	Significance	Transboundary
Physical disturbance of the seabed	Negligible	Not significant	No
Suspended sediment	Minor	Not significant	No
Sedimentation	Minor	Not significant	No
Underwater noise (Unplanned event)	Minor	Not significant	No

7.3.2 Marine mammals

Baseline

The baseline description on marine mammals is based on literature as well as targeted marine mammal surveys including visual observations from shore, aerial surveys from plane and acoustic monitoring with C-PODs along the planned route and the considered alternatives (Ramboll, 2018j).

Three species of marine mammals are resident in the western part of the Baltic Sea; Grey seal (*Halichoerus grypus*), harbour seal (*Phoca vitulina*) and harbour porpoise (*Phocoena phocoena*). In addition, other marine mammals such as dolphins (e.g. *Stenella coeruleoalba)*, killer whale (*Orcinus orca*), beluga whale (*Delphinapterus leucas*) and more can be observed occasionally in the Baltic Sea, but these species are only rare visitors and will not be dealt with further.

Harbour seal

Harbour seal is the most common seal in Danish waters, with the highest densities in the Skagerrak, Kattegat, and Belt Seas. Further east, within the project area, the population is restricted to only a few colonies. The Baltic Sea population was estimated in 2016 to comprise 1,700 individuals (Hansen, 2018).

The Baltic Sea population can be divided into two subpopulations, referred to as the Kalmarsund and the southern Baltic subpopulation. Within the project area, only the southern Baltic subpopulation is present. Harbour seal colonies can be found at the small island Ægholm and at the north-eastern part of Jungshoved in Faxe Bugt (more than 10.5 km from the planned route), at Saltholm and at Falsterbo (Sweden) (Figure 7-6) (Miljøministeriet, Naturstyrelsen, 2014; Hansen, 2018).

Survey campaigns have been undertaken by observations from shore and as aerial surveys. During the aerial survey campaigns in November, February and March, no harbour seals were observed in Danish waters. Two dead harbour seals were observed during the onshore observations, one in January and one in February.

In general, harbour seals are only swimming at limited distances from their colonies to seek food (less than 30 km, Dietz *et al.*, 2015), though further distances can be observed. Food sources consist mainly of a large variety of fish species, but also squid and crustaceans. The vision of seals is adapted to function equally well under and above water. Seals have whiskers, which have an equally high importance for food search as well as for perception (Denhardt *et al.*, 1998). In addition, hearing is well-adapted to aquatic life.

Seals in general are not considered sensitive to disturbance (Blackwell *et al.*, 2004) except during breeding and moulting. In these periods, the species are sensitive to physical disturbance, especially from disturbance on land near colonies (Galatius, A., 2017). The harbour seal breeds in May/June and moults in August/September (Hansen, 2018), which therefore are the most vulnerable periods. In addition, pups are sensitive to disturbance near colonies in June/July, as they are depending on the resting sites for suckling.

The harbour seal is listed in Annex II and V of the Habitats Directive. The species is included on the designation basis for the Danish Natura 2000 site no. 168 - Havet og kysten mellem Præstø Fjord og Grønsund near the pipeline route. The southern Baltic Sea subpopulation is considered of least concern at the HELCOM Red List and on a national level.

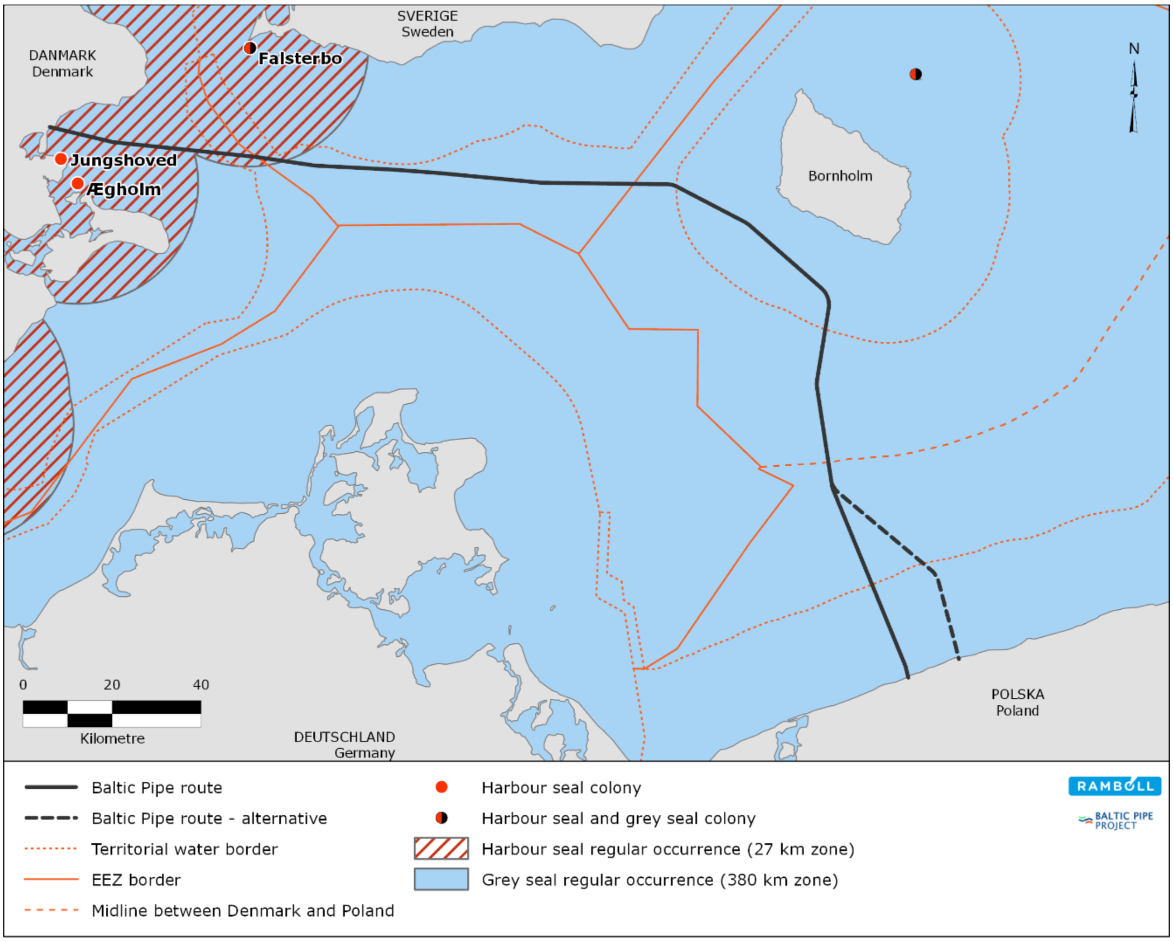

Figure 7-6 Grey and harbour seal colonies and zone of regularly occurrence shown for harbour seal and grey seal (Hansen, 2018, Dietz *et al*., 2015, Teilmann *et al*., 2017). Grey seal occurs in the entire range of the project area, hence marked in blue.

Grey seal

Grey seal can be observed throughout the Baltic Sea. The total size of the Baltic Sea population is estimated to 40,000 individuals. In the Danish part of the Baltic Sea, 589 individuals were counted in 2016 (Hansen, 2018), where the majority (468 individuals) were found at Christiansø north of Bornholm. Colonies, also called haul-out sites, are places for resting, mating, breeding, and moulting. Colonies remain at the same place each year. Grey seal colonies can be found at Saltholm in Øresund and Rødsand at southern Lolland in Denmark and at Falsterbo in Sweden (Figure 7-6). Only Falsterbo has a relatively short distance (more than 25 km) to the Baltic Pipe.

Survey campaigns have been performed as observations from shore and as aerial surveys. During the November campaign, one grey seal was observed in Danish territorial waters southwest of Bornholm. During the two aerial survey campaigns in February and March, no grey seals were observed in Danish waters. There were no observations of grey seal during onshore surveys.

Grey seals travel far between resting spots and foraging sites (up to 380 km have been registered, Dietz *et al.*, 2015). Grey seals feed on a wide variety of fish species. In the Baltic Sea the main food source is herring, but also sprat and Atlantic cod are important food sources. Diving occurs at all water depths within the project area. Vision and hearing have not been researched for grey seals but are generally assumed to resemble the senses for harbour seal.

Grey seals breed at undisturbed haul-out sites in February and March. In Denmark and the remaining part of the project area, Rødsand is the only grey seal breeding site, and only a few pups have been born at this site. Nursing takes place for 2-3 weeks. Moulting takes place on haul-out sites (or sea ice in the northern part of the Baltic Sea) in May/June (Hansen, 2018).

Seals are generally not considered sensitive to disturbance (Blackwell *et al.*, 2004), except during breeding and moulting. In these periods, the species are sensitive to physical disturbance, especially from disturbance on land near colonies (Galatius, A., 2017). As there are no grey seal haul-out sites near the planned pipeline route, grey seal is not considered sensitive to construction activities.

The grey seal is listed in Annex II and V of the Habitats Directive. The species is not included in Danish Natura 2000 sites along the pipeline route. It is considered of least concern at the HELCOM Red List, but as vulnerable on a national level in Denmark. In addition, the grey seal is on Appendix II on the Bonn convention[35].

Harbour porpoise

Harbour porpoise is the only cetacean species that lives in the Baltic Sea. Two populations of harbour porpoise can be found in the Baltic Sea; the Baltic Sea (or Baltic Proper) population and the Belt Sea population. The Baltic Sea population is an endangered population with only very few individuals (500 individuals). This population is only likely to occur during the winter period in the areas of Rønne Banke, as there is a clear distinction between the two populations during the summer period, with a population separation east of Bornholm (Figure 7-7, SAMBAH, 2016). The Belt Sea population size is estimated at approximately 18,500 individuals in 2012 (Sveegaard *et al.*, 2013) and during the SAMBAH study, more than 20,000 individuals were estimated (SAMBAH, 2016). During the summer period (May-October), only the Belt Sea population is expected to be present in the project area, whereas during the winter season (November to April), the presence will be lower but is a mix of the two populations (SAMBAH, 2016). The highest concentration of harbour porpoise can be seen in the western part of the project area. Harbour porpoise distribution can be seen in Figure 7-7. Densities in the project area are generally lower than in other parts of Danish waters (e.g. Storebælt and Lillebælt, Teilmann *et al.*, 2008). Densities range during the period of May – October between 0 and 0.57 individuals/km^2, and during the period November – April between 0 to 0.37 individuals/km^2 (SAMBAH, 2016; Teilmann *et al.*, 2017).

During the aerial campaign of winter 2017/18, one harbour porpoise was observed approximately 25 km east of Møn in November 2017. During the survey campaigns in February and March 2018, no harbour porpoises were observed in Danish waters.

In addition, acoustic monitoring was executed and included the deployment of 10 C-PODs over the entire alignment, whereof 3 C-PODs where deployed within the Danish section of the project area. The survey results for the winter survey confirmed that harbour porpoises are observed in the Danish section of the project area and that there is a density gradient, where the density is higher in the western part of the Arkona Basin than in the eastern part near Bornholm during the

[35] Bonn convention: Convention on the Conservation of Migratory Species of Wild Animals (CMS): The Convention provides a global platform for the conservation and sustainable use of migratory animals and their habitats. It brings together the States through which migratory animals pass (called the Range States) and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.

Migratory species threatened with extinction are listed on Appendix I of the Convention. CMS Parties strive towards strictly protecting these animals, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them. Migratory species that need or would significantly benefit from international co-operation are listed in Appendix II of the Convention.

winter period (Ramboll, 2018j). In general, the harbour porpoise density is very low east of the Arkona Basin, as shown in Figure 7-7 (SAMBAH, 2016).

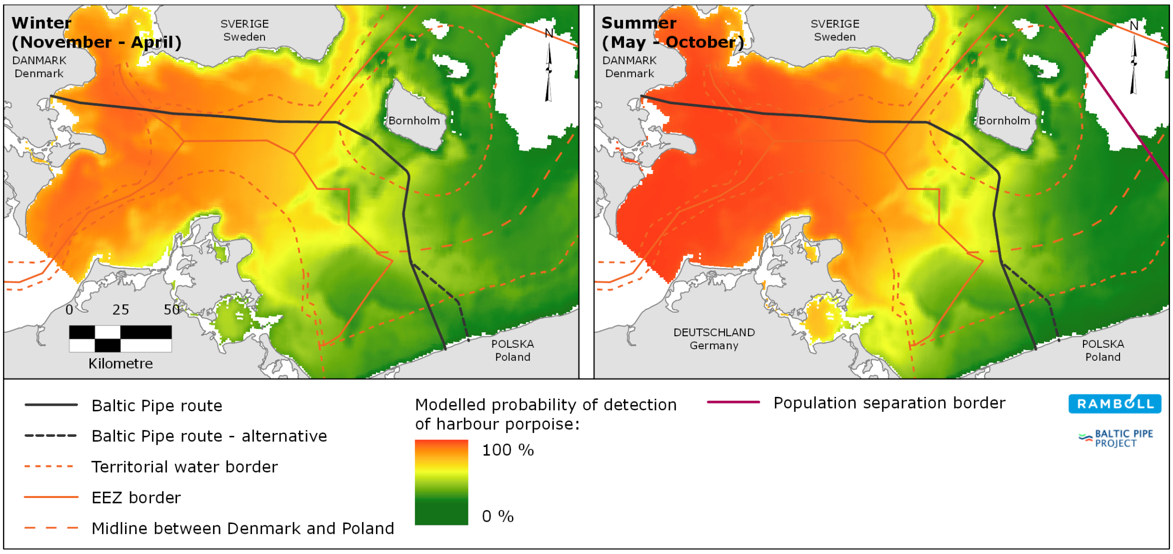

Figure 7-7 Harbour porpoise subpopulations and distribution for the periods November – April and May – October (SAMBAH, 2016). The population separation border marks the boundary at which the Baltic Sea population is not found west of during the summer period.

The main food source for harbour porpoise is various fish species, especially cod, herring, and sprat (Börjesson & Berggren, 2003), but the species is an opportunistic feeder, adapting its feeding conditions towards available prey. Diving depth is usually no more than 50 m, which indicates that harbour porpoise dive at all water depths of the project area.

Harbour porpoises use echo localisation for foraging and navigation and are hence able to navigate and search for prey in complete darkness. Hearing capabilities are a key feature of the species, although harbour porpoises also have good vision underwater.

Harbour porpoise breed from mid-June to late August in the Baltic Sea, where calving takes place in May-June and mating in July-August (SAMBAH, 2016). Females give birth to a single calf and the calf is dependent on its mother the following year. There are no specific breeding areas identified in the Baltic Sea, but areas around the Midsjö Banks in Sweden are considered important (outside project area (SAMBAH, 2016)). It is assumed that the harbour porpoise is especially sensitive during the breeding period, but the calves are considered vulnerable during the lactation period, which lasts 8-11 months.

The species are strictly protected under Annex IV of the Habitats Directive (EU Directive on the Conservation of Natural Habitats and Wild Flora and Fauna - 92/43/EEC). Furthermore, it is included on the Bonn Convention Appendix II[35]. The Baltic Sea population is assessed as Critically Endangered and the Belt Sea population as Vulnerable on the HELCOM Red List.

Impact assessment and transboundary impact

In connection with the construction and operation of the Baltic Pipe, three potential impacts have been identified and are presented in Table 7-22. These impacts are assessed in more detail below.

Table 7-22 Potential impacts on marine mammals.

Potential impact	Construction	Operation
Suspended sediment	X	
Physical disturbance above water	X	
Underwater noise (construction activities, unplanned events)	X	

Suspended sediment

Impacts on marine mammals from increased SSC dispersed from the construction works can be visual impairment and behavioural impacts through avoidance of sediment plumes. However, modelling results show that increased SSC following construction activities only occur locally around the active construction site within a short period of time. All three marine mammal species show a low sensitivity towards increased SSC. Thus, the impact is assessed to be negligible within the Danish project area.

Neither Swedish, German or Polish waters can be negatively affected by sediment plumes originating from the Danish project area. Transboundary effects on marine mammals from increased SSC can therefore be excluded.

Table 7-23 Impact significance on marine mammals from suspended sediment.

	Sensitivity	Magnitude of impact			Severity of impact	Significance
		Intensity	Scale	Duration		
Suspended sediment	Low	Minor	Local	Immediate	Negligible	Not significant

Physical disturbance above water

The physical disturbance from construction related activities above water could potentially disturb seals (but not harbour porpoises), but seals are generally not considered sensitive to disturbance (Blackwell *et al.*, 2004). During periods of breeding and moulting, seals are sensitive to physical disturbance on land near colonies (Galatius, 2017). As the construction activities are not occurring close to colonies (more than 5 km, Figure 7-6), impacts on breeding and moulting seals are not likely to occur.

Neither Swedish, German or Polish waters can be negatively affected by physical disturbance originating from the Danish project area. Transboundary effects on marine mammals from physical disturbance can therefore be excluded.

Table 7-24 Impact significance on marine mammals from physical disturbance above water.

	Sensitivity	Magnitude of impact			Severity of impact	Significance
		Intensity	Scale	Duration		
Physical disturbance above water	Low	Minor	Local	Immediate	Negligible	Not significant

Underwater noise

Potential impacts on marine mammals from underwater noise range from physical injury to behavioural responses (Figure 7-8), characteristics of which are presented in Table 7-25.

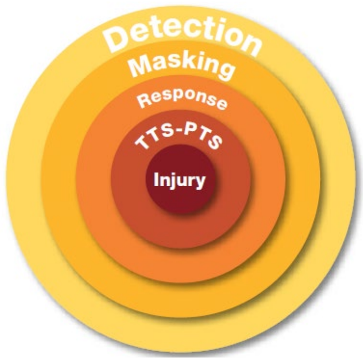

Figure 7-8 Zones of influence at various distances from an underwater noise source (WODA, 2013).

For marine mammals, it applies that the auditory system is the most sensitive organ and the risk of damage on this is higher than the risk of impacts on other organs. Following exposure to loud noise levels, threshold shifts are often observed. Threshold shifts are reductions in hearing sensitivity and can either be permanent or temporary, depending on exposure levels and time. In terms of severity, the impact is gradual from blast injury to TTS (Sveegaard *et al.*, 2017).

Table 7-25 Potential impacts for marine mammals (Yelverton *et al.*, 1973; Southall *et al.*, 2007; Sveegaard *et al.*, 2017).

Potential impact	Description of potential impact
Physical injury (blast injury)	Tissue damage due to the shock wave. Measurements for threshold values have been performed on mammals with ear drums (Yelverton *et al.*, 1973). As the harbour porpoise has no functional ear drum, this measured threshold value does not apply. Risk of tissue damage is measured as the acoustic impulse (Pa·s) 280 Pa·s: No mortality, but moderately severe blast injuries (including ear drum rupture) are frequently observed. Animals are capable of recovery. 140 Pa·s: High risk of minor blast injuries, including ear drum rupture. 70 Pa·s: Low risk of blast injuries. No ear drum rupture. 35 Pa·s: Safe level. Physical injury can be from insignificant bleeding to death of the affected species. Small injuries will recover shortly, and no long-term effects are anticipated. More severe injuries can reduce viability and hinder the ability of reproduction.
Permanent threshold shift – PTS	Permanent hearing loss. Damage to the sensory organ. Hearing threshold does not recover after exposure. As most species are dependent on hearing ability, hearing loss will cause reduced viability and potential death, consequently. The impact severity is dependent on the level of PTS, in which high PTS levels are more severe than small PTS (viability is not reduced significantly). Threshold values for harbour porpoise and seals can be seen in Table 7-28.
Temporary threshold shift – TTS	Temporary hearing loss. The hearing ability will recover with time, ranging from minutes to hours, depending on exposure level. As the impact is relatively short-term, the viability of the marine mammals is not at high risk. Threshold values for harbour porpoise and seals can be seen in Table 7-28.
Avoidance behaviour	Underwater noise, which does not induce TTS or PTS, may still impact marine mammals by altering behaviour, which again can have implications for the long-term survival and reproductive success of the individuals. Avoidance behaviour ranges from panic over flight to disturbance (Skjellerup *et al.*, 2015). Panic behaviour can cause severe impact by inducing by-catch, stranding etc.,

Potential impact	Description of potential impact
	which in turn can cause mortality. Flight and disturbance behaviour can reduce foraging or nursing time, which again can reduce the fitness of the species. No threshold values for construction activities or explosions have been determined in the literature.
Masking of other sounds	Masking is the situation in which project generated noise hinders the detection and identification of other sounds. Masking is relevant in connection with continuous noise (thus, not munitions clearance) and must coincide in time and approximately be within the same frequency band. The impact of masking on marine mammals has not been assessed in the scientific literature. No threshold values for construction activities have been determined in the literature.
Behavioural response	Behavioural responses to noise (other than avoidance behaviour) can include e.g. altered swimming patterns. Behavioural responses are difficult to predict and therefore to assess. No threshold values for construction activities have been determined in the literature.

The sensitivity of marine mammals to underwater noise depends on the type of noise (e.g. level, frequency, single events from explosions vs. continuous noise such as rock installations), the threshold values, the vulnerability over the season (Table 7-26) and the species. In general, seals are considered less sensitive than harbour porpoise to disturbance by underwater noise (Blackwell *et al.*, 2004).

Table 7-26 Vulnerable periods (marked in grey) for marine mammals in the southern Baltic Sea in connections with abundance and key period (breeding, moulting and lactation as specified in the baseline sections).

Species/group	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Harbour porpoise – Belt Sea population[1]												
Harbour porpoise – Baltic Sea population[2]					3	3	3	3	3	3		
Harbour seal												
Grey seal												

[1]Adults are sensitive during the breeding period (June-August). Calves are sensitive 8-11 months after birth.
[2]Very vulnerable population.
[3]Very low abundance (if any present) in the project area (SAMBAH, 2016).

When defining the sensitivity to an activity, a combination of the activity and the seasonality have been taken into consideration.

Construction activities

Construction activities, such as rock installations, trenching, pipe-lay, anchor handling and ship traffic are characterised as continuous noise. The underwater noise generated from the construction activities is not distinguishable from the ambient noise levels, as the background levels in the Baltic Sea, where there are already large volumes of ship traffic, are relatively high. In addition, behavioural reactions to underwater noise from construction activities such as rock installation and ship traffic will occur near the pipeline and the construction vessels. The duration will be immediate and will cease after the activity has ended.

It is not likely that there will be significant impacts on marine mammals.

Neither Swedish, German nor Polish waters can be negatively affected by construction-related underwater noise originating from the Danish project area. Transboundary effects on marine mammals from construction-related underwater noise can therefore be excluded.

Table 7-27 Impact significance on marine mammals from underwater noise from rock installation.

	Sensitivity	Magnitude of impact			Severity of impact	Significance
		Intensity	Scale	Duration		
Underwater noise - construction activities	High	Low	Local	Immediate	Negligible	Not significant

Unplanned events

In connection with the risk assessments (Chapter 4), it has been identified that munitions clearance of UXO may pose a risk during the construction phase. Based on the route design strategy, which aims at avoiding UXOs as far as possible, munitions clearance is handled as an *unplanned event*.

It follows from Chapter 4 that the pipeline route in Danish waters extends through an area in which British minefields were established during world war II (WWII). For the part of the pipeline near the Danish landfall, there is also a risk of encountering shells from the artillery at Stevnsfortet; specifically, small munitions objects with charges of approximately 10 kg TNT each. For the part of the pipeline southwest of Bornholm, there is additionally a risk of encountering chemical munitions (Figure 4-7).

Underwater noise from munitions clearance will potentially generate an impact on marine mammals. In the literature, a set of threshold values has been determined for TTS and PTS (Table 7-25), which are presented in Table 7-28.

Table 7-28 Threshold values for munitions clearance for marine mammals (Southall *et al.*, 2007; Sveegaard *et al.*, 2017).

Species/group	Munitions clearance	
	PTS	TTS
Harbour porpoise	179 dB SEL	164 dB SEL
Seals	179 dB SEL	164 dB SEL

To assess the potential impact from munitions clearance noise propagation models have been applied calculating the expected range, in which impact on marine mammals in the form of PTS/TTS can occur. Details on the modelling methodology, choice of munition type and results of the underwater noise propagation from munitions clearance can be taken from the EIA report (Chapter 5 in Ramboll, 2018a). The propagation is modelled for winter and summer scenarios and for two munition types in Faxe Bugt and one near Bornholm. Modelling of the winter scenario is presented in Figure 7-9 and Figure 7-10. PTS contours represent physical and permanent injury to marine mammals, whereas TTS contours represent the area of TTS and avoidance behaviour.

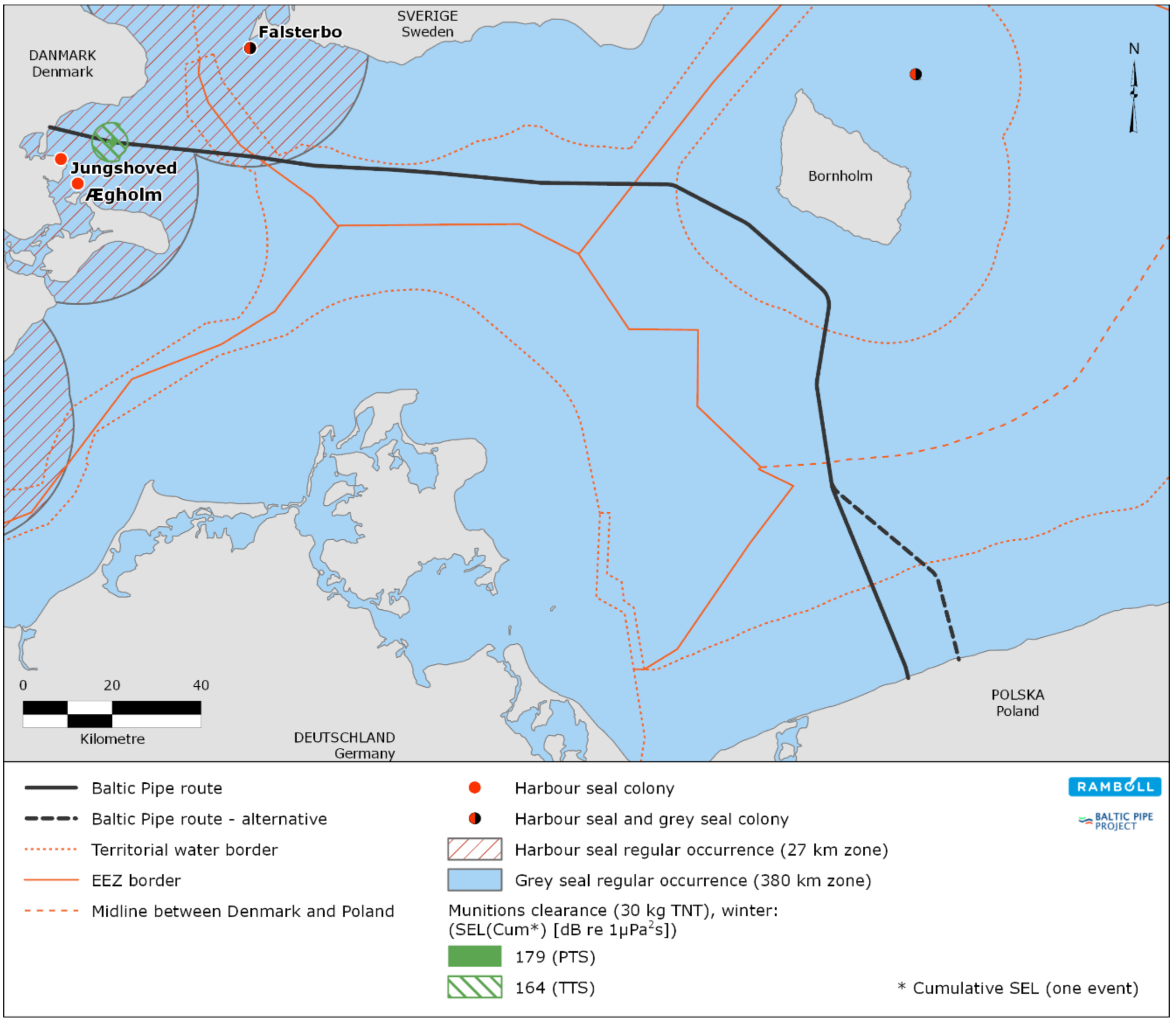

Figure 7-9 TTS and PTS for winter scenario for a 30 kg TNT.

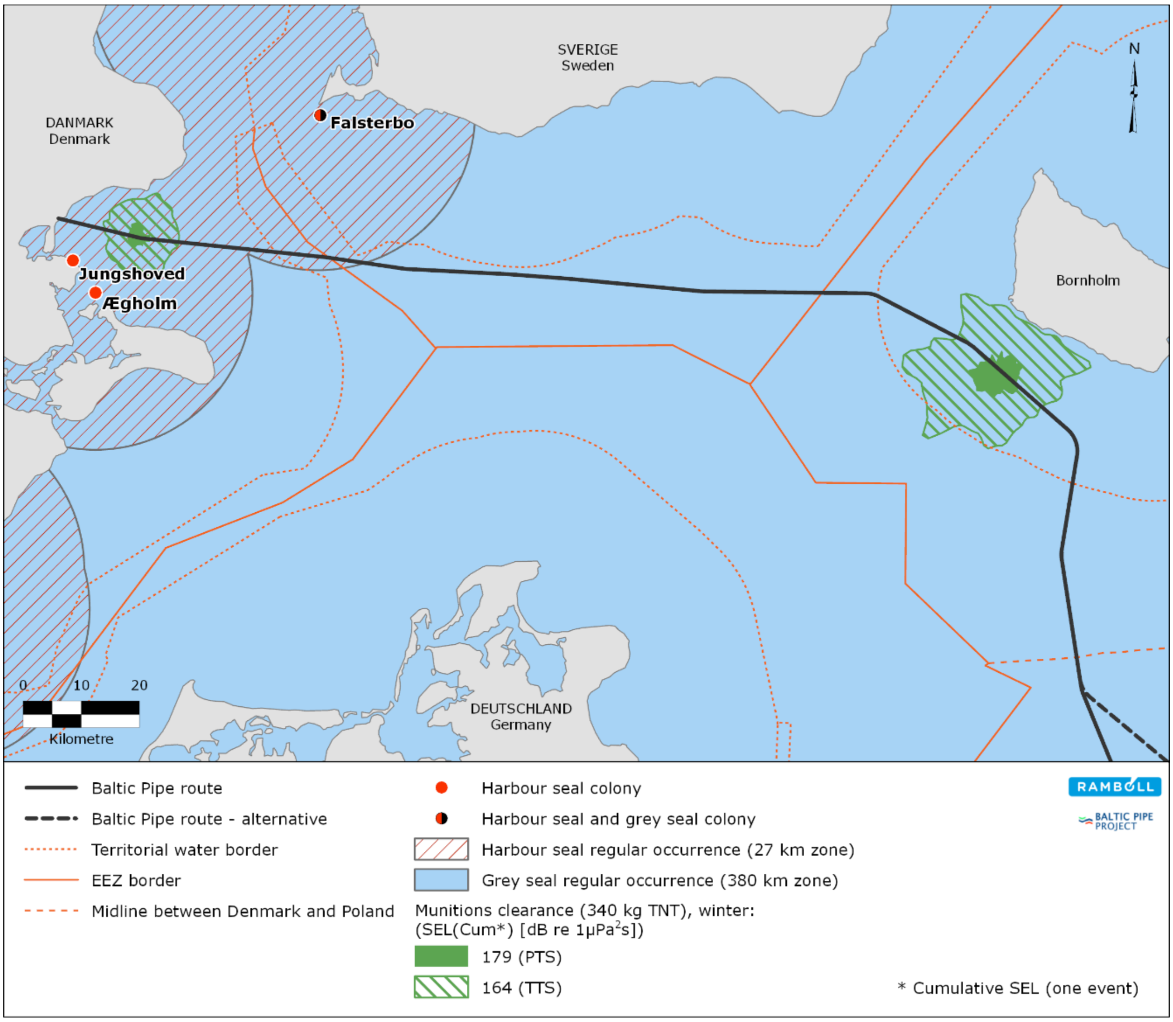

Figure 7-10 TTS and PTS for winter scenario for a 340 kg TNT.

Table 7-29 Potential impact distance for munitions clearance on marine mammals.

Distance [km]	Faxe Bugt								Bornholm			
Charge size	30 kg TNT				340 kg TNT				340 kg TNT			
Period	Summer		Winter		Summer		Winter		Summer		Winter	
max/avg	max	avg	max	avg	max	avg	max	avg	max	avg	max	avg
PTS	1.3	1	1.3	1	2.1	2	2.8	1.8	4.8	3.4	5.2	3.8
TTS	3.6	3.6	4.4	4.1	7.7	5.9	8.3	6.5	17.5	11.8	16.7	12

To assess the impact on marine mammals, it is important to assess the impact both on an individual basis and on a population scale. Impacts can also differ between species and populations. The impacts are assessed below for physical injury/PTS and TTS/avoidance behaviour for harbour porpoises and seals. The assessments are done without the use of mitigation measures (which is a hypothetical scenario as some or all of the suggested mitigation measures must be implemented) and with mitigation measures. Assessments without mitigation measures are done without considerations on season of construction works.

Physical injury and PTS

Harbour porpoise

The sensitivity of individual harbour porpoise of both populations to injury and PTS is high, as the impact is permanent and will most likely cause lowered fitness and potentially death as a consequence.

If munitions clearance is unavoidable in Faxe Bugt and/or near Bornholm, and based on a worst-case scenario, a risk of PTS would be present in a maximum distance of 2.8 km in Faxe Bugt and 5.2 km near Bornholm (Table 7-29). This means that if harbour porpoises are present in this area, the risk of injury and permanent hearing damage is likely to occur. The impact magnitude is high on an *individual* basis, as the intensity of the impact is large, and impact is long-term. The impact severity is major.

On a *population* level, the impact is different. For the Belt Sea population, the impact is not likely to be as severe, as only a few individuals out of a large population are likely to be impacted, and hence the impact on the structure and viability of the population will only be minor. The impact severity is assessed to be minor. The opposite is the case for the Baltic Sea (Baltic Proper) population. If individuals from this very small and endangered population (< 500 individuals) are severely impacted, the impact magnitude on the population will also be high, as the viability of the population will be influenced. Taking a precautionary approach (not considering that the density of the species is low), the impact severity is assessed as major.

In the case that munitions clearance is to occur near the border of Sweden/Denmark or Poland/Denmark, a transboundary impact with the same impact severity (major) can occur in Swedish or Polish waters. Due to distance of the Baltic Pipe route to the German border (>9.4 km), no transboundary impact with regard to PTS on harbour porpoises can be provoked there.

Seal

The sensitivity for individuals of seals to injury and PTS is high, as the impact is permanent and will most likely cause lowered fitness and potentially death as a consequence, similarly to harbour porpoise.

The impact range is identical as for harbour porpoise (Table 7-29), see section above.

On an *individual* scale, the risk of injury and PTS is present with a range of 2.8 km during the winter for both harbour seal and grey seal (in Faxe Bugt), and 5.2 km for grey seal near Bornholm (harbour seal is not present, Figure 7-6). The impact magnitude is high on an *individual* basis as the intensity of the impact is large and impact long-term. The impact severity is assessed as major.

On a *population* level, the impact is not likely to be as severe, as only a few individuals out of a large population are likely to be impacted, and hence the impact severity on the structure of the populations will be minor.

In the case that munitions clearance is to occur near the border of Sweden/Denmark or Poland/Denmark, a transboundary impact with the same impact severity (minor) can occur in Swedish or Polish waters. Due to distance of the Baltic Pipe route to the German border (>9.4 km), no transboundary impact with regard to PTS on seals can be provoked there.

TTS and avoidance behaviour

The sensitivity to TTS and avoidance is low for both harbour porpoise (both populations) and seals, as the impact will cease immediately (i.e. within minutes to hours) after the blast.

If munitions clearance is unavoidable in Faxe Bugt and/or near Bornholm, and based on a worst-case scenario, a risk of TTS and avoidance reactions would be present in a maximum distance of 8.3 km in Faxe Bugt and 17.5 km near Bornholm (Table 7-29). It is expected that marine mammals will be able to hear explosions at a very large distance (beyond the TTS zone) and are expected to react strongly within the TTS zone. Even though the intensity is high leading to a strong behavioural reaction and a risk of TTS, the impact magnitude is assessed low as the hearing ability and the reaction pattern will revert to normal after the impact has ceased. The impact severity will hence be minor and not significant for all species.

In the case the munitions clearance is to occur near the border of Sweden/Denmark, Germany/Denmark or Poland/Denmark, a transboundary impact with the same impact severity (minor) can occur in Swedish, German or Polish waters.

Table 7-30 National Danish and transboundary impact significance on marine mammals from underwater noise from munitions clearance – unplanned event - before mitigation. PTS: Blast injury/PTS; TTS: TTS and avoidance behaviour.

Underwater noise - Munitions clearance			Magnitude of impact					Severity of impact	Signifi-cance
			Sensi-tivity	Inten-sity	Scale	Duration		
Harbour porpoise	Baltic Sea	PTS	High	High	Regional	Long-term	Individual: Major Population: Major	Individual: Significant Population: Significant
		TTS	Low	High	Regional	Imme-diate	Minor	Not significant
	Belt Sea	PTS	High	High	Regional	Long-term	Individual: Major Population: Minor	Individual: Significant Population: Not significant
		TTS	Low	High	Regional	Immediate	Minor	Not significant
Seal		PTS	High	High	Regional	Long-term	Individual: Major Population: Minor	Individual: Significant Population: Not significant
		TTS	Low	High	Regional	Immediate	Minor	Not significant

Mitigation measures

To reduce the impact from blast injury and PTS on individuals and at population level of the two populations of harbour porpoises and for the two species of seal, mitigation measures will be applied. The use of visual monitoring by a marine mammal observer and seal scarers are common measures to reduce the impact from underwater noise. In addition, the choice of season for munitions clearance can reduce the potential impact for the endangered Baltic Sea population of harbour porpoise.

Overall, the UXO specific marine mammal mitigation plan (MMMP) includes mitigation measures such as the use of marine mammal observers (MMOs), Passive Acoustic Monitoring (PAM) and acoustic deterrent devices.

Visual observations and PAM

Visual monitoring by MMOs will be undertaken from the source vessel (on a suitable viewing platform). Visual monitoring should be restricted to periods of good visibility during daylight hours, as visibility decreases during poor weather or lighting conditions. If marine mammals are present prior to planned munitions clearance, the detonation should be postponed. Visual observations prior to munitions clearance do not guarantee that marine mammals are not affected, as marine mammals may stay below the surface and hence remain undetected for long periods. However, a visual survey prior to clearance can help to protect animals, which are sighted. Acknowledged guidelines from JNCC should be applied as good practice for visual observation methodologies (JNCC, 2010; JNCC, 2017). PAMs are hydrophones deployed into the water column, and the detected sounds are processed using specialised software. PAM will be implemented as a supplement to the visual observations done by the MMO.

Seal scarer
Seal scarers or seal scramers are acoustic deterrent devices, which can be used to deter seals and harbour porpoises from e.g. construction activities, fishing gear etc. The range, or the efficiency of the devices depends on the type of scarer and the setup. Harbour porpoises react more stronglyr to seal scarers than seals (Hermannsen *et al,* 2015).

A review done by Centre for Environment and Energy for the Danish Energy Agency has summarised the deterrence range from several studies of scarers and has found that for harbour porpoises the most efficient seal scarer (Lofitech) has a range of 350-7,500 m. According to the review, all animals were deterred within 350 m, most animals at a range of 1-2,000 m, and the maximum reaction range was 7,500 m (Hermannsen *et al,* 2015).

A setup like the one suggested for Nord Stream 2 are suggested to be used for the Baltic Pipe project (Figure 7-11).

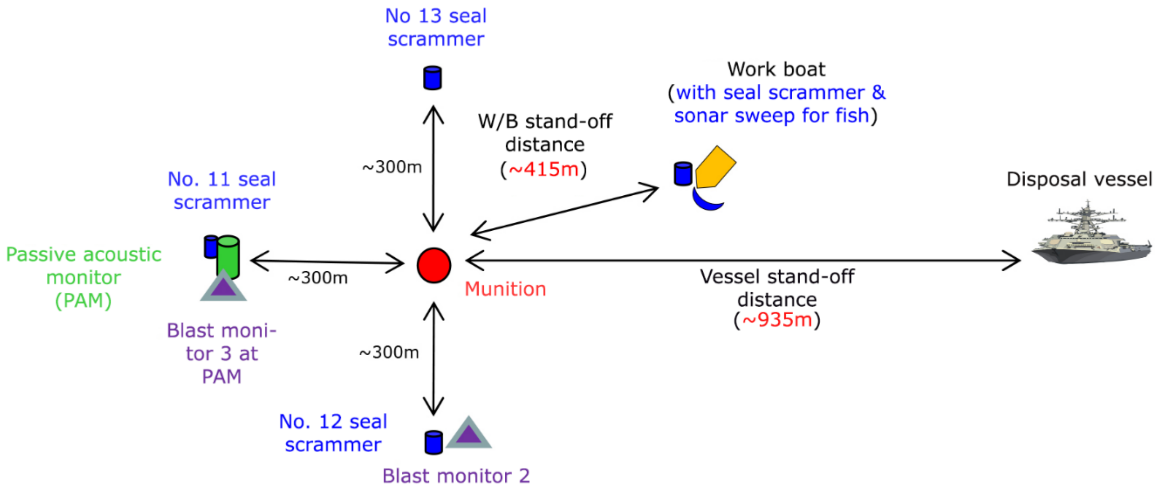

Figure 7-11 Setup for monitoring and mitigation equipment typically used during munitions clearance for the Nord Stream pipeline, from Rambøll (2017).

Application of seal scarers can reduce the risk of severe blast injury (non-recoverable injury, Table 7-25) to a negligible level, as no animals (harbour porpoises and seals) will be close to the detonation site.

For harbour porpoises, the PTS zone will also be reduced, as seal scarers are efficient to a distance of 1-2 km. Within Faxe Bugt the use of seal scarer will be very efficient. For a small detonation (30 kg TNT), the impact magnitude will be minor, and the severity will be negligible, as all harbour porpoises most likely will be scared out of the PTS zone.

For the large detonations (340 kg TNT), a PTS zone will remain as the seal scarer may not entirely deter all harbour porpoises within the zone. As the sound pressure level decrease exponentially from the munition site and as the severity of PTS decreases gradually (Table 7-25), it is assessed that severe PTS will be reduced to *minor to moderately severe injuries*, which corresponds to survivable injuries (Table 7-25). In Faxe Bugt the use of seal scarer is most efficient, compared to the area near Bornholm, due to the difference in noise propagation at the two sites. On the other hand, the density of harbour porpoises is higher in Faxe Bugt than farther to the east, so the risk of impacting individuals is higher in Faxe Bugt than near Bornholm. Therefore overall, the impact magnitude is assessed to be at the same level at the two sites.

As the most severe cases of PTS is reduced to a minor to moderately severe injury, the impact magnitude is assessed as medium and the severity as moderate for harbour porpoises on an *individual* level for both populations, but the impact as not significant, as the individuals can survive.

The impact severity on a *population* level of the Belt Sea population is assessed as minor, as only a few individuals out of a large population are likely to be impacted. Impact significance is assessed as not significant.

The impact severity on a *population* level of the Baltic Sea population is assessed as minor and not significant, as the likelihood of a PTS impact is very small due to the very low density of this population in the Arkona Basin.

Seals may not be deterred due to their curious behaviour, but seals may seek to the surface due to the noise from seal scarers. In this way their heads remain out of the water and they are hence protected from hearing damages. The risk of blast injury and PTS is hence reduced. The impact magnitude is therefore assessed as medium and the severity as moderate for seals on an *individual* level. The impact severity on a *population* level is still assessed as minor.

Acoustic devices are hence the most effective to reduce the risk of PTS, as TTS goes beyond the efficiency of seal scarers. The assessment conclusions for TTS therefore remain unchanged.

Seasonality
To avoid impact on the endangered Baltic Sea harbour porpoise population, munitions clearance could be done during the summer period, if reasonable practically. If this measure is added as a mitigation measure, the risk of impact (blast injury, PTS and TTS) for the Baltic Sea population is considered negligible, due to the insignificant density of the species during the summer period. It should be emphasized that seasonality as mitigation measure is only functional for the Baltic Sea population.

Conclusion on mitigation measures
A combination of the three proposed mitigation measures will significantly reduce the impact on harbour porpoises and seals. The most efficient is the protection of the endangered Baltic Sea population, for which impact can be avoided if munitions clearance only takes place during the summer period (May-October), and can be implemented if reasonable practically. It should be emphasised that the use of MMO, PAM and seal scarers must be implemented to protect marine mammals present in the area.

The impact on individual animals can be reduced to a negligible impact severity for blast injury, a moderate severity for PTS on an *individual* level, a minor impact severity on a *population* level and a minor impact severity for TTS and behavioural responses (Table 7-31).

Table 7-31 Impact significance on marine mammals from underwater noise from munitions clearance (unplanned event) - after mitigation. PTS: Blast injury/PTS; TTS: TTS and avoidance behaviour.

Underwater noise - Munitions clearance			Sensitivity	Magnitude of impact			Severity of impact	Significance
				Intensity	Scale	Duration		
Harbour porpoise	Baltic Sea	PTS	High	Low	Regional	Long-term	Negligible*	Not significant
		TTS	High	Low	Regional	Immediate	Negligible*	Not significant
	Belt Sea	PTS	High	Medium	Regional	Long-term	Individual: Moderate Population: Minor	Individual: Not significant Population: Not significant
		TTS	Low	High	Regional	Immediate	Minor	Not significant
Seal		PTS	High	Medium	Regional	Long-term	Individual: Moderate Population: Minor	Individual: Not significant Population: Not significant
		TTS	Low	High	Regional	Immediate	Minor	Not significant

*The species will present in the area in insignificant numbers during the summer period, hence the severity of impact is assessed as negligible.

Conclusion on transboundary impact

According to the map of munitions risk areas (Figure 4-7), only the border between Denmark and Sweden in the Arkona Basin is located within a munitions risk area. At the other two borders crossed by the pipeline (Sweden/Denmark and Denmark/Poland), the probability of finding munitions is very low.

It follows from the assessment above, that underwater noise from munitions clearance without application of mitigation measures can lead to blast injury or PTS for very few individuals of harbour porpoises. In relation to the endangered Baltic Sea (Baltic Proper) population, which is only present in the project area in the winter season, this may cause a significant impact, and the severity of the impact would be assessed as major without mitigation measures. The same significant impact could be provoked across borders when munitions clearance is sufficiently close to these borders.

A similar assessment is made for the harbour seal and grey seal, which can potentially be injured by munitions clearance. However, the severity of the impact on a population level is assessed to be minor, since the populations of these species are relatively large, there are no sensitive areas near the pipeline route (haul out sites) and the probability that seals are present far offshore is low. The same is the case regarding the transboundary impact on Sweden, i.e. transboundary impact is not significant for seals.

There is no significant transboundary impact predicted from underwater noise in German waters, neither on harbour porpoise nor on seals.

By applying the three above-mentioned mitigation measures, transboundary impacts on marine mammals are reduced in the following ways:

- Restricting munitions clearance to the summer season ensures that impact on the endangered Baltic Sea population is negligible;

- Applying seal scarers, visual observations and PAM prior to munitions clearance significantly reduces the likelihood of blast injury or PTS as well as the severity of the remaining PTS for harbour porpoise and seals.

It can be concluded that transboundary impact on individual animals can be reduced to negligible impact severity for blast injury; moderate severity for PTS on an *individual* level and minor impact severity on *population* level; and minor impact severity for TTS and behavioural response.

Table 7-32 Overall national Danish and transboundary impact significance on marine mammals after implemented mitigation measures. Impacts are concluded on populations for planned events.

Potential impact	Severity of impact	Significance	Transboundary
Suspended sediment	Negligible	Not significant	No
Physical disturbance above water	Negligible	Not significant	No
Underwater noise - construction activities	Negligible	Not significant	No
Underwater noise – unplanned event	Minor	Not significant	Yes

7.3.3 Annex IV species

In this section, the baseline for Annex IV species in the area is described and the impact from the project is assessed. The impacts described below can potentially be relevant in the transboundary context when project activities take place close to the borders to Sweden and Poland.

Baseline

The harbour porpoise (*P. phocoena*) is the only Annex IV species found in the Danish offshore section of the Baltic Sea. Details about this small marine mammal, its distribution, and key biological features are described in Section 7.3.2.

Assessments of impacts on Annex IV species will be performed regarding the deliberate killing and the ecological functionality in breeding and resting areas; as such, breeding and resting areas are specified below.

It can be seen in Figure 7-7 in Section 7.3.2 that within the Danish section of the Baltic Sea, the highest probability of detecting harbour porpoises is found in the westernmost part (SAMBAH, 2016). No specific areas of reproduction are known for harbour porpoises within the project area. Harbour porpoises are continuously swimming and have no specific resting sites. Two populations of harbour porpoise can be found in the western Baltic Sea; the Belt Sea population, which is present year-round in the Arkona Basin, and the Baltic Sea population, which is present in the Arkona Basin during the winter period (November to April) (SAMBAH, 2016).

Impact assessment

The methodology for the impact assessment for Annex IV species is described in Section 6.3.

In accordance with the Habitats Directive, the following is prohibited for strictly protected species (emphasis added):

- *All forms of deliberate capture and keeping and deliberate killing;*
- Deliberate damage to or destruction of breeding or resting sites;
- *Deliberate disturbance of wild fauna particularly during the period of breeding, rearing and hibernation, in so far as disturbance would be significant in relation to the objectives of this Convention;*
- Deliberate destruction or taking of eggs from the wild or keeping these eggs even if empty;

- Possession of and internal trade in these animals, alive or dead, including stuffed animals and any readily recognisable part or derivative thereof, where this would contribute to the effectiveness of the provisions of this Article.

Planned project activities will not cause intentional or deliberate capture or killing of harbour porpoises. Hence, an assessment is not relevant for the planned project activities.

Deliberate disturbance of wild fauna, as listed above, can be of concern with respect to the planned pipeline, as activities from the construction and operation of the pipeline may cause disturbance. The remaining prohibited actions listed above are not a concern for this project.

A key issue in the assessments for Annex IV species is the ecological functionality of breeding and resting areas. Ecological functionality means the ability of the population to reach or sustain a viable population size, with the potential to reach or maintain favourable conservation status within the entire range of the species, hence the maintenance of the breeding and resting areas. Thus, Article 12(1)(d) of the Habitats Directive ensures that such sites and areas are not damaged or destroyed by human activities.

Potential impacts on harbour porpoises have been identified in the marine mammals section of this report (Section 7.3.2), and only negligible and not significant impacts have been identified for the planned project activities. In addition, there are no specific breeding areas identified in the Baltic Sea, although areas around the Midsjö Banks in Sweden are considered important (SAMBAH, 2016). The Midsjö Bank in Sweden is outside of the project area (the distance from pipeline is more than 120 km).

Based on this, it is not likely that there will be significant impact on the two harbour porpoise populations and the ecological functionality of the species will therefore not be impaired. All impacts are local, and transboundary impact on harbour porpoise can be excluded.

Unplanned events – munitions clearance
Underwater noise from the *unplanned event* of potential munitions clearance has been addressed in Section 7.3.2 and it has identified that impacts can occur on harbour porpoises.

Deliberate killing
The assessment for munitions clearance including visual observations, PAM and seal scarers as mitigation measures concludes that on an *individual* level, there will be a moderate impact on harbour porpoises. Due to the reduced risk of blast injury and severe PTS, the impact is assessed as not significant for harbour porpoises both at the individual and population levels, and as such, the project will not lead to the deliberate killing of specimens.

Deliberate disturbance and impact on ecological functionality
Munitions clearance will be temporary, and as key breeding sites for harbour porpoises are outside the zone of potential impact (the maximum distance at which animals may experience TTS from underwater noise is 17.5 km, west of Bornholm, Figure 7-6 and Section 7.3.2), and because there are no significant impacts on a population level (when seal scarers are applied as a mitigation measure), it is not likely that there will be significant impact on the two harbour porpoise populations. The ecological functionality of the species will therefore not be impaired.

Conclusion on transboundary impact
The described, project impacts have been assessed in relation to the prohibitions of Article 12(1)(a)-(d) Habitats Directive (see Table 7-1). It is concluded that project activities will neither lead to the deliberate killing of harbour porpoises nor will they cause significant disturbance or

destroy breeding or resting areas important to this species. The ecological functionality of the population is therefore not affected, and the actual and future conservation status is not influenced by project activities. Transboundary impact on harbour porpoise can be excluded.

7.3.4 Natura 2000

The alignment of the Baltic Pipe either crosses or passes nearby Natura 2000 sites in the Baltic Sea. In accordance with the prescribed methodology (see Section 6.2), a screening has been conducted to identify those Natura 2000 sites, for which a significant impact cannot be excluded with certainty and for which an appropriate assessment needed to be prepared. As shown in Figure 7-12, the only Natura 2000 sites directly crossed by the pipeline route are situated in Sweden and Poland. For these sites, appropriate assessments have been performed as part of the national EIA procedures in Sweden and Poland. None of the Danish Natura 2000 sites are crossed by the pipeline route, and the screening does not reveal further Natura 2000 sites at which a significant impact is likely to occur. The screening is summarized below in Table 7-33.

With regard to potential transboundary impact, i.e. impact on Swedish, German or Polish Natura 2000 sites from activities executed in the Danish waters, only the Swedish site "Sydvästskånes utsjövatten" (SE0430187) is close enough to be within the potential impact range from the Danish activities. However, trenching will not occur in Danish waters near the Swedish border (see Figure 3-15). Sediment dispersion from pipe-lay activities will be negligible, and significant impacts from dispersed suspended sediment are not likely to occur.

Underwater noise from construction activities can potentially impact marine mammals. As the level of noise from construction activities will be within the same levels of or less than the already existing underwater noise levels in the Arkona Basin, impacts due to underwater noise from construction activities are not likely to be significant. It is therefore concluded that no transboundary impact will occur on Natura 2000 sites.

As there are no significant impacts on any of the Danish Natura 2000 sites or significant transboundary impacts on adjacent Natura 2000 sites, the coherence of the Natura 2000 network will not be compromised.

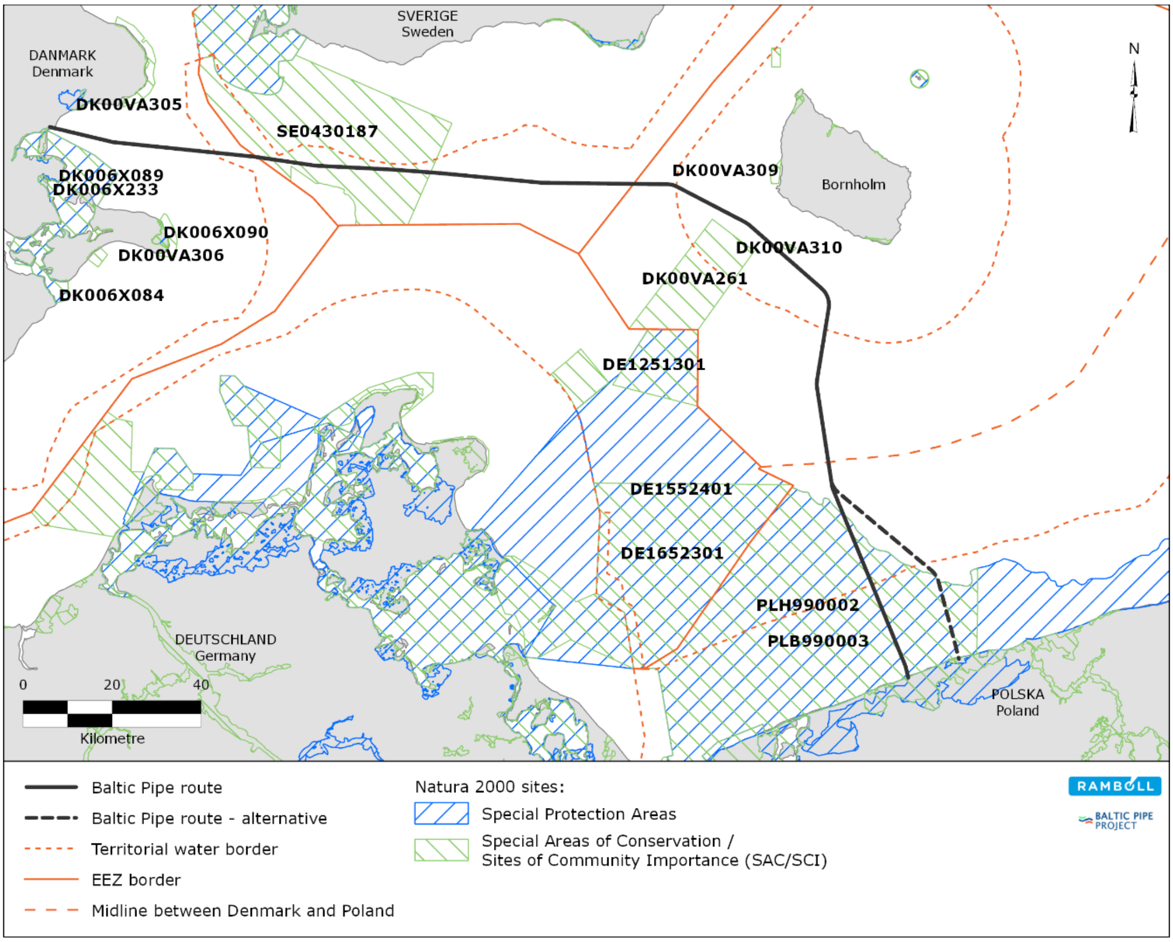

Figure 7-12 Natura 2000 sites along the planned Baltic Pipe route. EU Natura 2000 codes are presented on the map.

Table 7-33 Summary of Natura 2000 screening (Ramboll, 2018i; SMDI, 2017). The screening includes transboundary effects in the Natura 2000 sites of Sweden, Germany and Poland

Natura 2000 site (national #)	Potential impact	Conclusion
"Stevns Rev" #206 (H206 - SAC DK00VA305)	Construction: - Suspended sediment/ sedimentation Operation: - None	Due to the distance between potential sediment dispersion from construction activities and Stevns Rev, a significant impact on Natura 2000 sites is not likely to occur. It is concluded that potential impacts from the Baltic Pipe project, alone or in combination with other projects and plans, are not likely to have significant effects on the Natura 2000 site.
"Havet og kysten mellem Præstø Fjord og Grønsund" #168 (H147 - SAC DK006X233 F84 - SPA DK006X089	Construction: - Suspended sediment/ sedimentation - Physical disturbance above water - Underwater noise	Modelling results have shown that the construction related sediment spill will be very limited and there will be no concentrations of sediment in the Natura 2000 site, which can have a significant impact on the designation basis of the Natura 2000 site. As construction works will occur more than 6 km from the nearest harbour seal colony at Jungshoved Nord, disturbance from activities and underwater noise are not likely to have significant impact.

Natura 2000 site (national #)	Potential impact	Conclusion
F89 - SPA DK006X084)	Operation: - None	It is concluded that potential impacts from the Baltic Pipe project, alone or in combination with other projects and plans, are not likely to have significant effects on the Natura 2000 site.
”Adler Grund og Rønne Banke” #261 (H261 - SAC DK00VA261)	Construction: - Suspended sediment/ sedimentation - Disturbance Operation: - None	An increase in SSC will be limited to the local area around the construction works, where the increase in concentration will be measurable. Model results have shown only very limited exceedance in SSC due to trenching activities. Impacts on the designated habitats of Adler Grund and Rønne Banke are not likely to occur. It is concluded that potential impacts from the Baltic Pipe project, alone or in combination with other projects and plans, are not likely to have significant effects on the Natura 2000 site.
”Bakkebrædt og Bakkegrund” #212 (H212 - SAC DK00VA310)	Construction: - Suspended sediment/ sedimentation Operation: - None	Due to the distance of a potential sediment dispersion and the distance from construction activities to Bakkebrædt og Bakkegrund, a significant impact on Natura 2000 sites is not likely to occur. It is concluded that potential impacts from the Baltic Pipe project, alone or in combination with other plans and projects, are not likely to have significant effects on the Natura 2000 site.
“Sydvästskånes utsjövatten” SCI #SE0430187	Construction: - Physical destruction /footprint - Suspended sediment/ sedimentation - Physical disturbance above water	The distance between this Natura 2000 site and the Danish construction site will be more than 2 km. In combination with the limited duration and range of increased suspended sediment concentration, it is not likely that the sediment spill during construction will have a significant impact on the Natura 2000 site. As the level of noise from construction activities will be within the same level of (or less) than the background noise level in the Arkona Basin, impacts due to underwater noise from construction activities are not likely to be significant. Underwater noise from munitions clearance in the Danish part can exceed the threshold level for PTS up to 0.8 km inside the area. Since the affected zone is rather small only very few individual animals can be affected. Significant impact on the populations of harbour porpoise grey seal and harbour seal can be excluded. In addition, with the use of seal scarers, this impact can be fully mitigated. Underwater noise from munitions clearance in the Danish part can exceed the threshold level for TTS up to 6.3 km inside the area. The effect is only temporary and ceases immediately after the blast. Significant impact on the populations of harbour porpoise grey seal and harbour seal can be excluded. In addition, with the use of seal scarers, this impact can be fully mitigated. It is concluded that potential transboundary impacts from the Baltic Pipe project, alone or in combination with other projects and plans, are not likely to have significant effects on the Natura 2000 site. Since the pipeline route is crossing this Natura 2000 site, a Swedish Natura 2000 appropriate assessment will be prepared for the activities occurring in Swedish waters.
”Pommersche Bucht mit Oderbank” SCI #DE1652-301	Construction: - Suspended sediment/ sedimentation - Underwater noise Operation:	The distance between this Natura 2000 site and the Danish construction site will be more than 9 km. In combination with the limited duration and range of increased SSC, it is not likely that the sediment spill during construction will have a significant impact on the Natura 2000 site. As the level of noise from construction activities will be within the same level of or less than the background noise level in the Arkona

Natura 2000 site (national #)	Potential impact	Conclusion
	- None	Basin, impacts due to underwater noise from construction activities are not likely to be significant. The Danish part of the pipeline route near this Natura 2000 site is not located within the risk areas for UXOs or CWAs; thus, no munitions clearing is expected. It is concluded that potential transboundary impacts from the Baltic Pipe project, alone or in combination with other projects and plans, are not likely to have significant effects on the Natura 2000 site.
"Ostoja na Zatoce Pomorskiej" SCI #PLH990002	Construction: - Suspended sediment/ sedimentation - Underwater noise Operation: - None	The distance between this Natura 2000 site and the Danish construction site will be more than 9 km. In combination with the limited duration and range of increased suspended sediment concentration, it is not likely that the sediment spill during construction will have a significant impact on the Natura 2000 site. The Danish part of the pipeline route near this Natura 2000 site is not located within the risk areas for UXOs or CWAs, thus no munitions clearing is expected. It is concluded that potential transboundary impacts from the Baltic Pipe project, alone or in combination with other projects and plans, are not likely to have significant effects on the Natura 2000 site. Since the pipeline route crosses this Natura 2000 site, a Polish Natura 2000 appropriate assessment will be prepared for the activities occurring in Polish waters.
"Zatoka Pomorska" SPA #PLB990003	Construction: - Suspended sediment/ sedimentation - Underwater noise Operation: - None	The distance between this Natura 2000 site and the Danish construction site will be more than 9 km. In combination with the limited duration and range of increased suspended sediment concentration, it is not likely that the sediment spill during construction will have a significant impact on the Natura 2000 site. The Danish part of the pipeline route near this Natura 2000 site is not located within the risk areas for UXOs or CWAs, thus no munitions clearing is expected. It is concluded that potential transboundary impacts from the Baltic Pipe project, alone or in combination with other projects and plans, are not likely to have significant effects on the Natura 2000 site. Since the pipeline route crosses this Natura 2000 site, a Polish Natura 2000 appropriate assessment will be prepared for the activities occurring in Polish waters.

7.4 Socio-economic environment

In this section, the baseline conditions for the potentially impacted receptors are described and the potential transboundary impacts on the socio-economic environment are assessed.

7.4.1 Shipping and shipping lanes

The Baltic Sea constitutes one of the most intensely trafficked seas in the world and accounts for approximately 15% of the world's cargo transportation. Ship traffic from the North Sea enters the Baltic Sea either via the Kadet Channel, located between Denmark and Germany, or through the Sound between Denmark and Sweden. The marine ship traffic industry is considered to be of high importance given that it has a high economic value and is a key contributor to the economy at the national and international levels.

Baseline

It is not possible to design a pipeline route from Denmark to Poland that avoids all shipping lanes. However, the planned route has been designed to minimise the route length over which there are a high number of ship passages. The traffic intensity in the southwestern Baltic Sea, based on Automated Identification System (AIS) data from 2016, is shown in Figure 7-13.

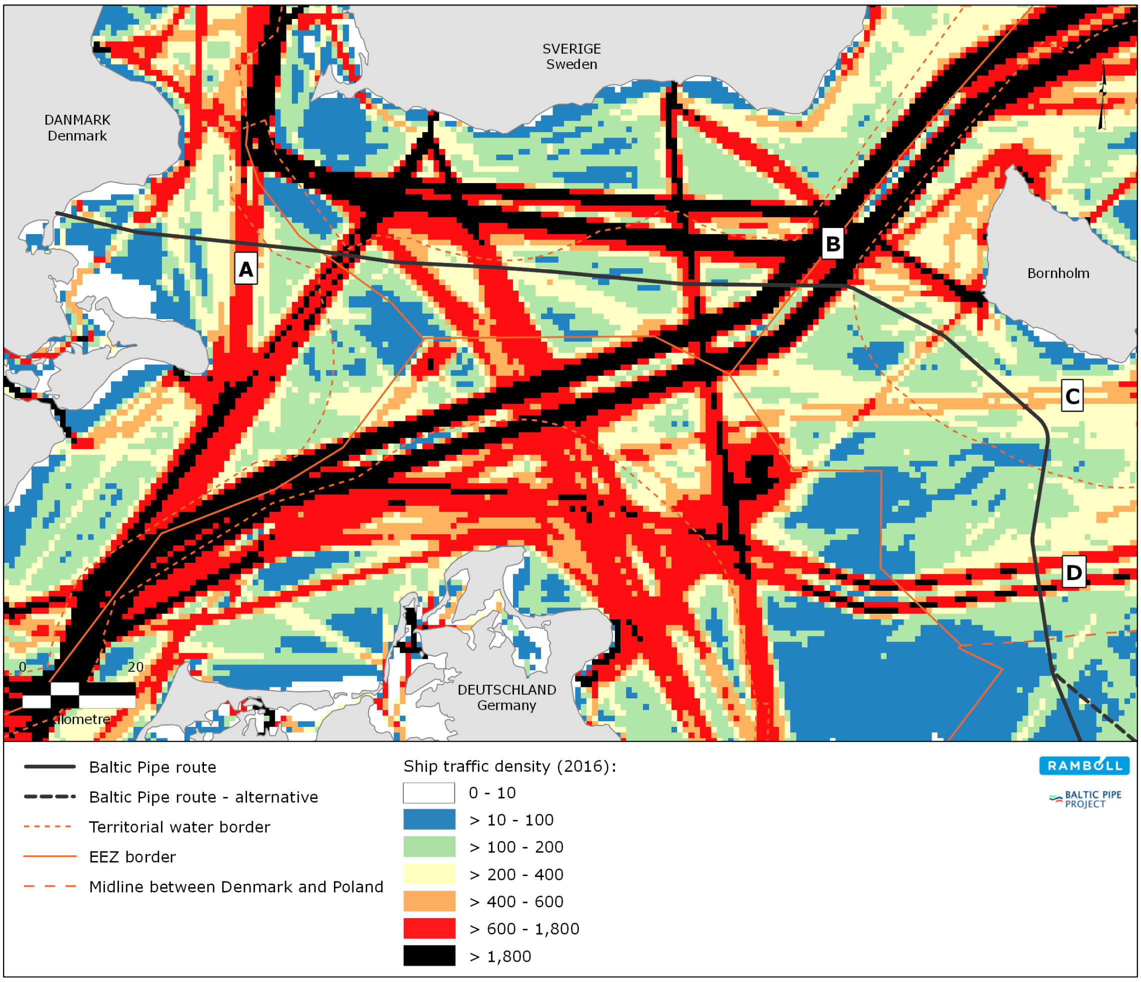

Figure 7-13 Ship traffic intensity in the southwestern Baltic Sea, based on AIS data (Danish Maritime Authority, 2016), and the four identified shipping lanes A, B, C and D.

As can be seen from Figure 7-13, most ship traffic in the southwestern part of the Baltic Sea follows pre-designated routes that are in accordance with traffic separation schemes (TSSs). In Danish waters, the planned pipeline route crosses four shipping lanes, as described in Table 7-34[36].

[36] These shipping lanes have been identified as part of the risk assessment (Ramboll, 2018f).

Table 7-34 Shipping lanes crossed by the planned pipeline in Danish waters based on AIS data (Danish Maritime Authority, 2016).

Shipping lane	Route description	Ship traffic intensity in 2016[37]	Forecasted ship traffic in 2032
Lane A	This shipping lane is the primary route through the Sound passing through the TSS Falsterborev, located off the coast of Stevns within the Swedish and Danish EEZs. Lane A is primarily used for cargo (33%) and passenger transport (25%). The Malmö-Lübeck ferry service operates in the area and crosses the planned pipeline route.	5,143 passages	6,344 passages
Lane B	This shipping lane is the main entrance to/exits from the Baltic Sea through the Femern Belt. It is used by all ships travelling along the main routes in the Baltic Sea and is, therefore, the most intensively trafficked shipping lane in the Baltic Sea. The shipping lane passes through the TSS Bornholmsgat, west of Bornholm within the Swedish and Danish EEZs. The planned pipeline crosses this shipping lane south of the TSS Bornholmsgat, where ships travelling through the Sound via the southern coast of Sweden separate from this shipping lane. Cargo vessels (53%) and tankers (23%) represent more than two thirds of the ship traffic currently using Lane B.	27,587 passages	34,029 passages
Lane C	This shipping lane passes south of Bornholm and merges with shipping lane D west of Bornholm within German waters. When travelling eastward, the main destination on this route is Klaipeda Port in Lithuania. Lane C is primarily used by passenger ships (20%) and smaller cargo vessels (51%) that are able to cross the shallow Rønne Banke.	1,902 passages	2,346 passages
Lane D	This shipping lane is used by ships passing to/from Gdynia and Gdansk in Poland, Kaliningrad in Russia and Klaipeda in Lithuania, and passes through TSS Adlergrund. The route merges with shipping lane B within the German EEZ and north of Rügen. Lane D is primarily used by cargo vessels (62%). Out of the four shipping lanes crossed by the planned pipeline, this is the shipping lane used by most fishing vessels (14% of the ship movements are fishing vessels).	6,342 passages	7,824 passages

[37] Number of ships sailing in the shipping lane in 2016 at the point where the pipeline crosses the shipping lane.

As can be seen from the figure Figure 7-13 and Table 7-34, shipping lane B passing north of Bornholm through the TSS Bornholmsgat is, with an annual movement of 27,587 passages in 2016, the largest shipping lane crossed by the planned pipeline. The other three shipping lanes crossed in Danish waters are significantly smaller, ranging from approximately 2,000 to 6,500 ship movements per year. The planned pipeline will cross all shipping lanes at a minimum water depth of 20 m to reduce the risk of ships grounding on the pipeline system.

Impact assessment and transboundary impact
The assessment in the Espoo context extends the meaning of "transboundary impact" in a way, that all significant impact compromising the safety and easiness of navigation in the Baltic Sea would constitute an international impact, even though it cannot be assigned to one single affected country.
The construction of the Baltic Pipe project may interfere with ship traffic within Danish waters both during construction and operation. See Table 7-35 for an overview of the potential impacts.

Table 7-35 Potential impacts on shipping and shipping lanes.

Potential impact	Construction	Operation
Safety zones	X	X
Restriction zone		X

The following sources of impacts have been screened out:

- **Physical disturbance above water (construction):** Increased ship traffic caused by project-related vessels not requiring safety zones can be screened out, as these ships will sail at normal speed and obey the same navigation regulations as commercial ships and will, therefore, be of negligible impact.
- **Presence of the pipeline on the seabed (operation):** No shipping lanes will be crossed within Danish waters shallower than 20 m, and to protect the pipeline from anchor drop and drag, the pipeline will be trenched and backfilled within all shipping lanes. On the entire alignment the pipeline will be buried into the seabed in areas with less than 20m water depth, so there will be no pipeline related obstacles in shallow waters. Potential impacts from the presence of the pipeline can therefore be screened out, as no restrictions to ship movements are expected.
- **Restriction zone (operation):** The impact from a permanent restriction zone of 200 m on either side of the pipeline can be screened out, as anchoring is already prohibited within shipping lanes.

<u>Safety zones</u>

Construction
The establishment of temporary safety zones around the pipe-lay vessels, and safety zones of other vessels of limited manoeuvrability (e.g. ploughing vessel and rock installation vessel), is a source of potential impact during construction of the planned pipeline. It is expected that the safety zone around the anchor lay barge will have a radius of 1,000 – 1,500 m, while the safety zone around the DP pipe-lay vessel will have a radius of approximately 1,000 m. For all other vessels with restricted manoeuvrability, a safety zone of 500 m will be implemented. No non-project related vessels will be permitted to enter the vessel safety zones, and vessels will therefore need to plan their route around the safety zones during construction activities. The waters around the shipping lanes crossed by the planned route are sufficiently deep, which is needed for many of the ships using the shipping lanes in order to not become grounded, and it is

expected that ships can navigate around the construction vessels. Therefore, the sensitivity is assessed to be low.

In cooperation with the contractor and the Danish Maritime Authority, the developer will announce the planned periods of construction activities.

The impact from the establishment of the safety zones will be local, immediate and with low intensity, as no permanent changes occur. Combined with a low sensitivity, this impact is assessed to be of minor severity and not significant overall.

Operation
During the operational phase, planned inspections and maintenance activities will be carried out along the pipeline with a low frequency (e.g. 1-2 times a year during the first years and once every 5 years thereafter). The vessels carrying out the inspections will also have a safety zone imposed in which all other ships will be prohibited from entering. The inspection/maintenance vessels are smaller and move faster than pipe-lay vessels and will, therefore, only require a safety zone with a radius of 500 m. The impact from the establishment of this safety zone will be local, immediate and with low intensity. Combined with the low sensitivity, this impact is assessed to be of negligible severity and therefore not significant overall, Table 7-36.

Table 7-36 Impact significance on shipping and shipping lanes from safety zone during construction and operation.

	Sensitivity	Magnitude of impact			Severity of impact	Significance
		Intensity	Scale	Duration		
Safety zones (construction)	Low	Low	Local	Immediate	Minor	Not significant
Safety zones (operation)	Low	Low	Local	Immediate	Negligible	Not significant

Conclusion on transboundary impact
The potential impacts on shipping and shipping lanes resulting from the construction and operation of the planned pipeline within Danish waters are summarized in Table 7-37. Overall disturbance of internationally important shipping lanes will be short term and spatially restricted, and significant impact can be excluded.

Table 7-37 Overall impact significance for shipping and shipping lanes.

Potential impact	Severity of impact	Significance	Transboundary
Safety zone (construction)	Minor	Not significant	No
Safety zone (operation)	Negligible	Not significant	No

7.4.2 Commercial fisheries

Baseline
Commercial fishing is carried out in large parts of the Baltic Sea by all countries in the region. The fisheries target both marine and freshwater species, but approximately 95% of the total fish catch in terms of biomass consists of cod, sprat and herring (ICES, 2017). For a detailed biological description of the important commercial fish species, please consult Section 7.3.1. The composition of the catch is to some extent determined by the salinity, as there is a change in the

distribution from marine species to freshwater species from south to north in the Baltic Sea (Leppäranta & Myrberg, 2009). The catches are used for both human consumption and industrial use. The Baltic Sea fisheries also target demersal species, such as plaice and flounder, along with migratory species, such as trout and salmon. Species of freshwater origin that are commercially exploited in the Baltic Sea include pike, pikeperch, perch and whitefish. Lastly, the Baltic fisheries also catch eel, but it is prohibited to fish for eel of an overall length of 12 cm or more in union waters, including the Baltic Sea, for a consecutive three-month period to be determined by each member state during autumn and winter. This is the time at which eels are migrating and, therefore, are most vulnerable. Denmark has determined this period to be 1. November 2018 - 31. January 2019[38]. The period will be updated on a yearly basis.

The greatest spatial resolution of available fishery data for the Baltic Sea is provided in ICES rectangles (~ 30 x 30 NM). The rectangles are used for the gridding of data to make simplified analysis and visualization. In the Baltic Sea region, fishing vessels longer than 8 m are obliged to complete a logbook. The logbook contains fishing information on quoted fish species (date, gear used, ICES rectangle and landings in kg). These data are used to provide an overview of the spatial distribution of the catches on a species level and the amount that is landed. The fisheries that are distributed along the Baltic Pipe are found within the ICES SDs 24 and 25. The SDs contain 13 and 17 ICES rectangles, respectively. It is relevant to analyse landings data for ICES rectangles that are located along the Baltic Pipe route and adjacent to those, i.e. 36G4, 37G2, 37G3, 37G4, 37G5, 38G2, 38G3, 38G4, 38G5, 39G2, 39G3, 39G4 and 39G5, see Figure 7-14.

[38] Danish Fisheries Agency at https://fiskeristyrelsen.dk/erhvervsfiskeri/aal/

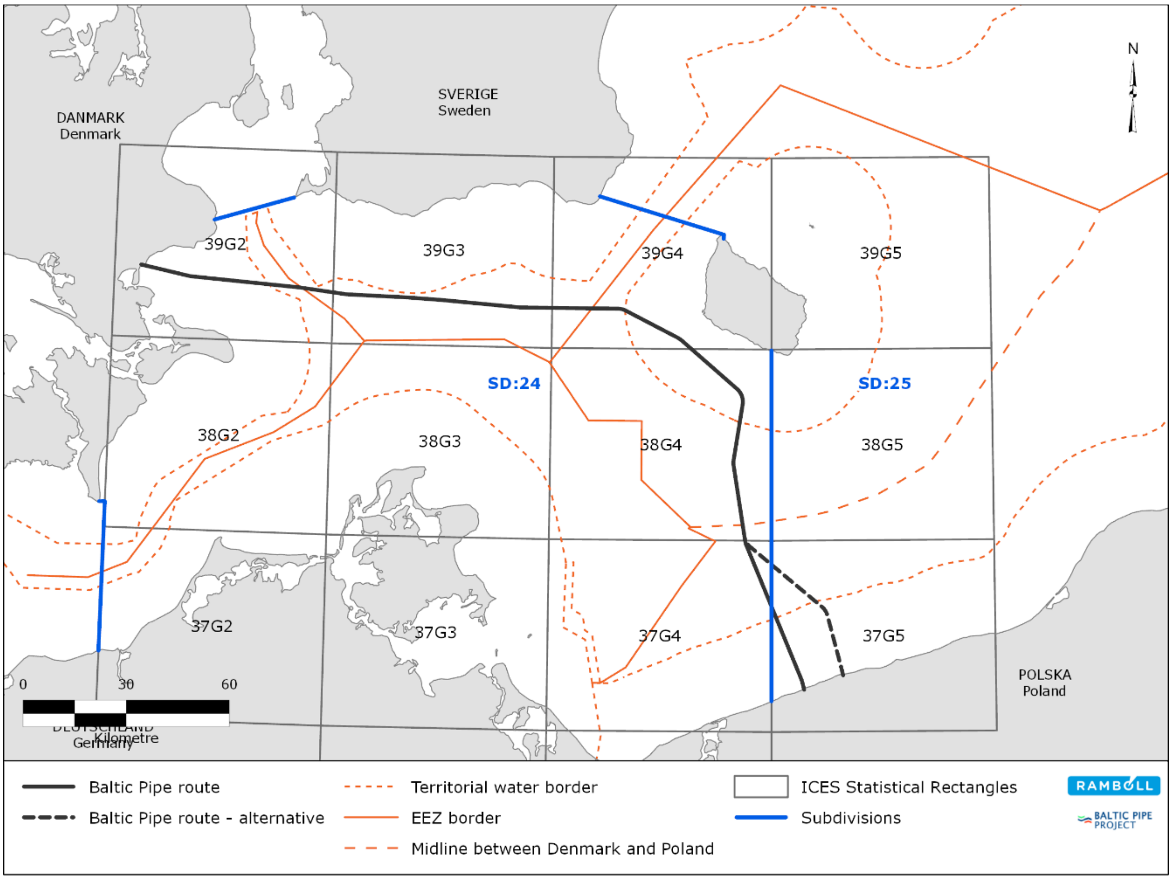

Figure 7-14 ICES rectangles in SDs 24 and 25, which encompass the Arkona and Bornholm Basins, respectively.

Vessel monitoring system (VMS) data are collected from HELCOM for bottom-contacting gear and midwater trawl fisheries. The VMS data have greater spatial resolution than the ICES rectangles and describe the fishing effort, i.e. hours per c-square (grid 0.05 x 0.05 degrees).

<u>Fishing techniques</u>
Commercial fishers use a variety of fishing techniques, which are adapted to the characteristics of the species they target. The characteristics of the target species determine to a large extent the technological characteristics affecting catchability, e.g. for fisheries that target a pelagic schooling fish, the detection of the fish schools with fish finders is more critical than the actual catching process. For demersal species that have a less heterogeneous distribution, detection is less important, as catchability is mainly driven by the area swept (Eigaard *et al.*, 2014).

Pelagic trawl and seine
Pelagic trawl and seine fisheries target a mixture of herring and sprat. The catches vary with season and area, and are used for consumption, fishmeal, and oil production. Trawlers using mesh sizes smaller than 32 mm fish for industrial purposes, whereas meshes above 32 mm are mostly used to fish for human consumption. The main proportion of sprat catches is taken by pelagic single and pair trawling. Fishing for sprat is carried out year-round, with the main fishing season in the first half of the year. There are currently three types of fleets: small cutters (17-24 m length) with an engine power of up to 300 h.p., medium-size cutters (25-27 m length) with an engine power of up to 570 h.p., and large vessels (>40 m length) with an engine power of 1050 h.p (ICES, 2013).

Demersal trawl and seine

Demersal trawls and, to a lesser degree, seines, are the most common gear types in the southwestern part of the Baltic Sea. These mobile contacting gear types primarily target cod, as indicated in Table 7-38. Flatfish is often caught as bycatch when fishing for cod, but in certain periods and areas, demersal trawlers may target flatfish. Occasionally, small-meshed demersal trawls are used to catch herring and sprat.

Gillnet

Gillnets are used to catch fish in a wide range of habitats. They are generally considered a shallow-water gear. However, bottom sets can be used at depths exceeding 50 m (Hubert *et al.*, 2012). They are widely used in offshore fisheries targeting cod, flatfish, and herring. In coastal fisheries, gillnets are set to catch a mix of marine and freshwater species, i.e. cod, flatfish, herring, whitefish, pikeperch, perch, and pike. Drift nets have been prohibited since 2008, and the European Union has limited the length of gear depending on the vessel size and the immersion time.

Other gear types

For commercial fisheries, the following types of gear contribute with relatively small catches by weight to the Danish fisheries:

- Longlines are used to target cod, salmon and sea trout. After the prohibition of drift nets in 2008, longlines have become an important gear type in the offshore salmon fishery.
- There is a wide range of traps used for trap net fisheries, where the type of trap net used depends on the targeted species, e.g. herring, salmon, whitefish, and eel.
- Generally, fyke nets and trap nets are set in shallow water not much deeper than the height of the first frame or hoop. However, they can be set in water greater than 10 m deep (Hubert *et al.*, 2012).

An overview of the number of Danish commercial fishing vessels (≥ 8 m) over time can be seen in Figure 7-15.

ICES rectangles	Bottom trawl						Gill nets						Other gear						Pelagic trawl						Seine nets					
	2010	2011	2012	2013	2014	2015	2010	2011	2012	2013	2014	2015	2010	2011	2012	2013	2014	2015	2010	2011	2012	2013	2014	2015	2010	2011	2012	2013	2014	2015
36G4			1	1																										
37G2	3	2	3		1	1		1		1	1					1		1	3			2	2	6	6	3	8	5	5	8
37G3																			1											
37G4		1	1		1															3	1									
37G5				2	1	3								1	1			1	1	2	4	2		1						
38G2	32	39	35	15	22	21	27	27	29	18	17	16	17	15	13	9	11	13	5	4	9	13	14	5	12	12	11	10	10	9
38G3	37	42	55	27	20	16	2					1	1	2				2	2	2	12	15	10	7	8	4	5	4	3	4
38G4	77	48	62	47	40	27	8	6	5	8	6	2	11	13	10	8	9	6	2	7	9	8	9	6	3	1	3	1		
38G5	92	75	74	65	49	48	11	8	6	6	7	3	20	15	9	9	8	7	36	41	36	22	15	7	1	1				
39G2	25	34	19	11	13	13	19	20	24	23	14	16	18	14	12	12	13	10	6	7	11	14	11	13						
39G3	33	36	45	22	22	20	4	1					2		1	1	1	2	3	6	7	13	6	7						
39G4	78	59	76	60	49	34	27	16	20	20	17	13	15	17	16	18	16	14	6	14	7	11	9	3						
39G5	108	69	80	64	52	45	25	14	15	8	7	7	27	22	20	12	12	6	57	47	50	35	31	17	1	2	1			

Figure 7-15 Number of commercial fishing vessels ≥ 8 m according to fishing gear and year in ICES areas 36G3, 36G4, 37G2, 37G3, 37G4, 37G5, 38G2, 38G3, 38G4, 38G5, 39G2, 39G3, 39G4 and 39G5.

The Danish fishing fleet

The Danish fishing fleet in the Baltic Sea includes fisheries in the Arkona Basin and the area around Bornholm, see Figure 7-14. The fisheries are carried out with trawls (bottom and pelagic), seine-haul fishing, gillnets and other gear types (including passive gear, i.e. hooks and lines, fish traps, pound nets and fyke nets), as described above (ICES, 2017).

Danish logbook data and statistics

From 2010 to 2015, 45 different species were caught and registered in the ICES rectangles 36G4, 37G2, 37G3, 37G4, 37G5, 38G2, 38G3, 38G4, 38G5, 39G2, 39G3, 39G4, and 39G5. The summed catch for the period was 193,223 tonnes with a mean annual catch of 32,203.79 tonnes. Denmark was responsible for 26% of the total catch by weight in the area. The commercially important species, i.e. cod, herring, flounder, plaice, and sprat amounted to 177,520.3 tonnes in the period, which is equivalent to approximately 92% of the total catch by weight and a sales value of 167.3 million euro (€).

Fishing importance and ratio for countries with fisheries activity within the ICES rectangles adjacent to the Baltic Pipe based on the mean value of catches (€) from 2010 to 2015 for cod, flounder, herring, plaice, and sprat, are shown in Figure 7-16. Sandeel was also highly important to the Danish fleet in the region, as they comprised 6.5% of the total catch by weight in the period.

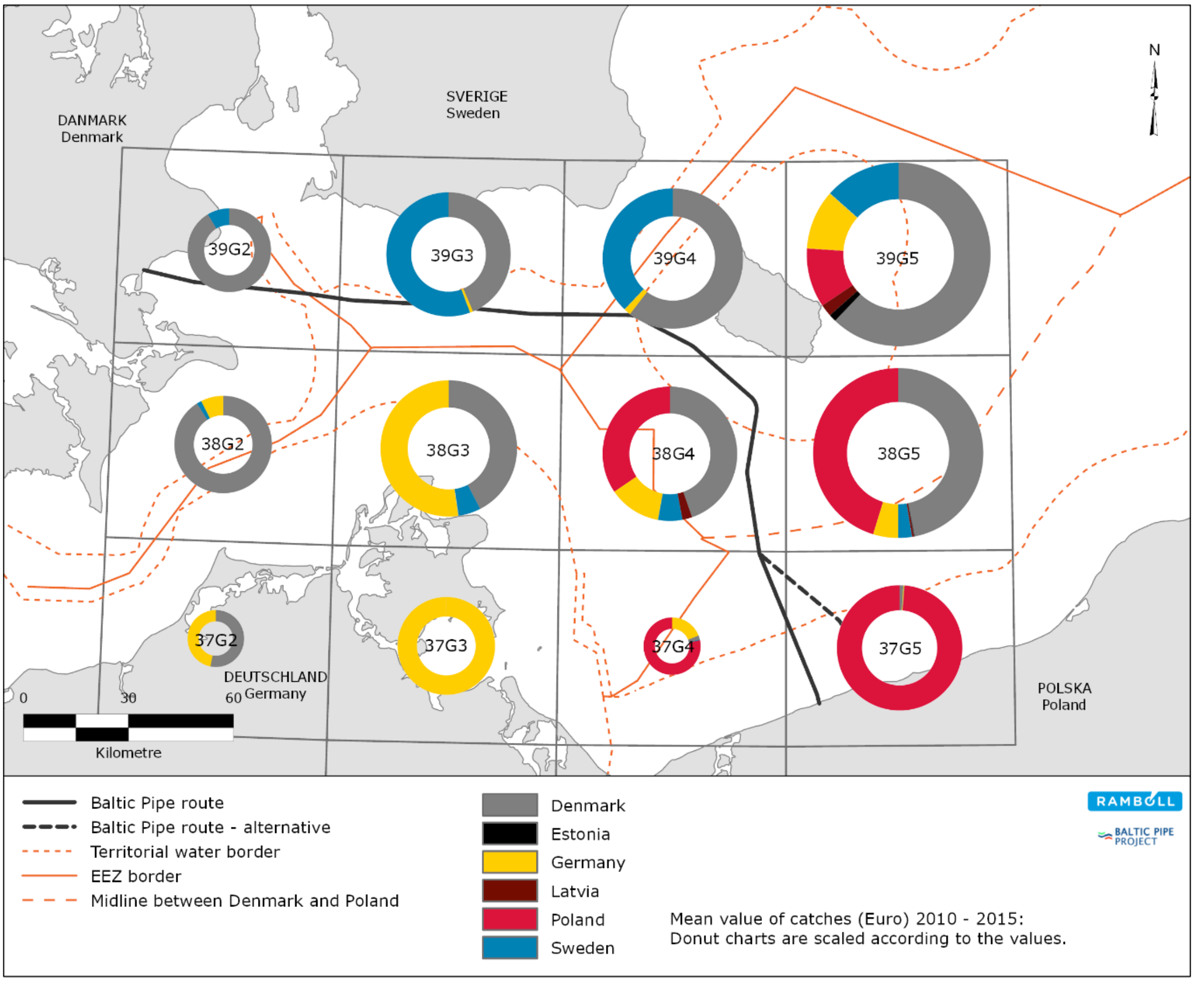

Figure 7-16 Fishing importance and ratio for countries with fisheries activity within the ICES rectangles adjacent to the Baltic Pipe, based on the mean value of catches (€) from 2010 to 2015 for cod, flounder, herring, plaice, and sprat. Data were collected from national fishery authorities for fisheries that operate in subdivision 24 and 25. Finnish data are not included due to data protection, but the summed catch for the period comprises less than <1% when compared to Danish landings.

The logbook data provided to the Ministry of Foreign Affairs of Denmark contained relatively few registrations of crustaceans, cephalopods, cartilaginous and freshwater species compared to the primary catch, which is a composition of marine fish species. In terms of catch by weight, the 10 most important species are marine species, i.e. cod, sprat, herring, sand eel sp., flounder, plaice, whiting, and garfish, except for the anadromous salmon.

Table 7-38 The total quantity (tonnes) of the main species caught by the Danish fishing fleet in the ICES rectangles 36G4, 37G2, 37G3, 37G4, 37G5, 38G2, 38G3, 38G4, 38G5, 39G2, 39G3, 39G4, and 39G5 from 2010 to 2015. Data collected from the Ministry of Foreign Affairs of Denmark.

Species	Scientific name	Quantity (tonnes)
Cod	*Gadus morhua*	68,125.4
Sprat	*Sprattus sprattus*	67,499.1
Herring	*Clupea harengus*	32,372.2
Sandeels sp.	*Ammodytes* sp.	12,552.7
Flounder	*Platichthys flesus*	6,931.3
Plaice	*Pleuronectes platessa*	2,592.1
Whiting	*Merlangius merlangus*	873.5
Salmon	*Salmo salar*	661.9
Garfish	*Belone belone*	538.8

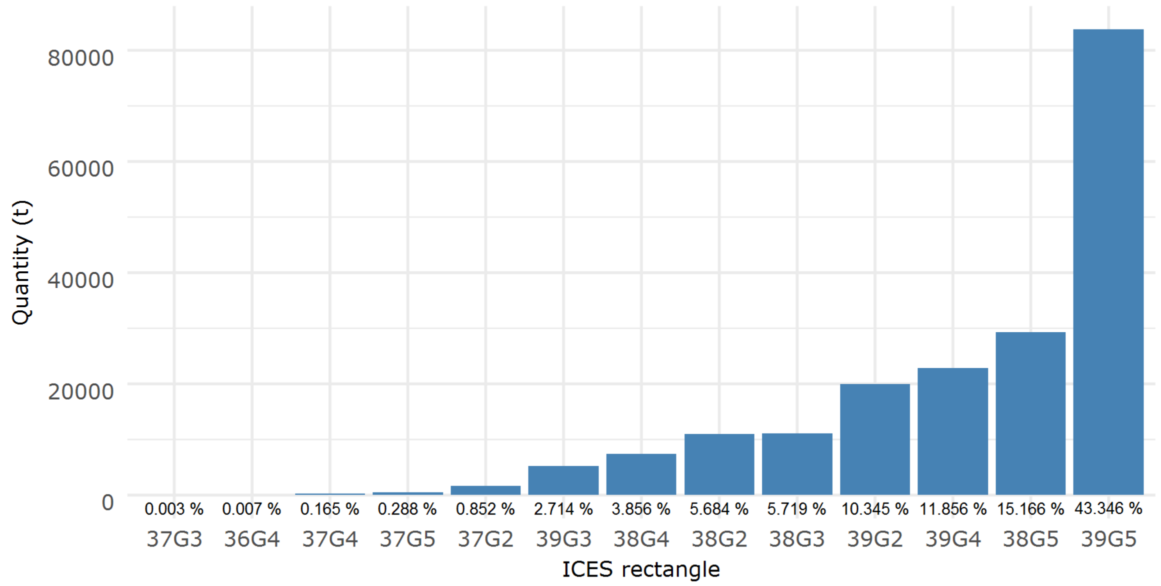

Figure 7-17 Summed quantity (tonnes) of Danish catches in the ICES rectangles 36G4, 37G2, 37G3, 37G4, 37G5, 38G2, 38G3, 38G4, 38G5, 39G2, 39G3, 39G4, and 39G5 from 2010 to 2015. Data collected from the Ministry of Foreign Affairs of Denmark.

As the plotted data from the Danish Ministry of Foreign Affairs suggests (see Figure 7-16, Figure 7-17 and Table 7-39), certain areas are of higher economic interest than others. Three of the four ICES rectangles surrounding Bornholm, i.e. 39G5, 38G5, and 39G4 are, in terms of catch by weight, the most important areas. 39G2, which includes Faxe Bugt, is also an important area for the Danish fishing fleet when looking at quantity (tonnes) as it contributed with 10.3% of the total catch by weight in the period 2010 to 2015.

Table 7-39 Mean annual catch (tonnes) and value (1,000 €) of catch by Denmark during 2010 – 2015 from ICES rectangles that are adjacent to the Baltic Pipe in subdivisions 24 and 25. Data collected from the Ministry of Foreign Affairs of Denmark. Numbers are valid for commercial species (sprat, hering, plaice, cod and flounder)

ICES - rectangle	Catch in tonnes	Value in 1,000 €
36G4	2.1	3.7
37G2	262.4	339.7
37G3	0.9	0.4
37G4	48.6	15.7
37G5	80.9	26.4
38G2	1,459.6	1,739.5
38G3	1,779.0	2,231.7
38G4	940.6	1,482.0
38G5	4,803.6	5,114.5
39G2	1,718.3	1,130.9
39G3	823.7	1,066.1
39G4	3,734.1	4,466.3
39G5	13,932.7	10,275.2

There is a strong correlation between the mean annual catch (tonnes) and the value (€), as 39G5, 38G5, and 39G4 are of the highest importance for both parameters. A combination of central and shore-close ICES rectangles to Denmark i.e. 39G2, 38G2, 39G3, 38G3 and 38G4 are relatively similar in both mean annual catch and value (see Table 7-39).

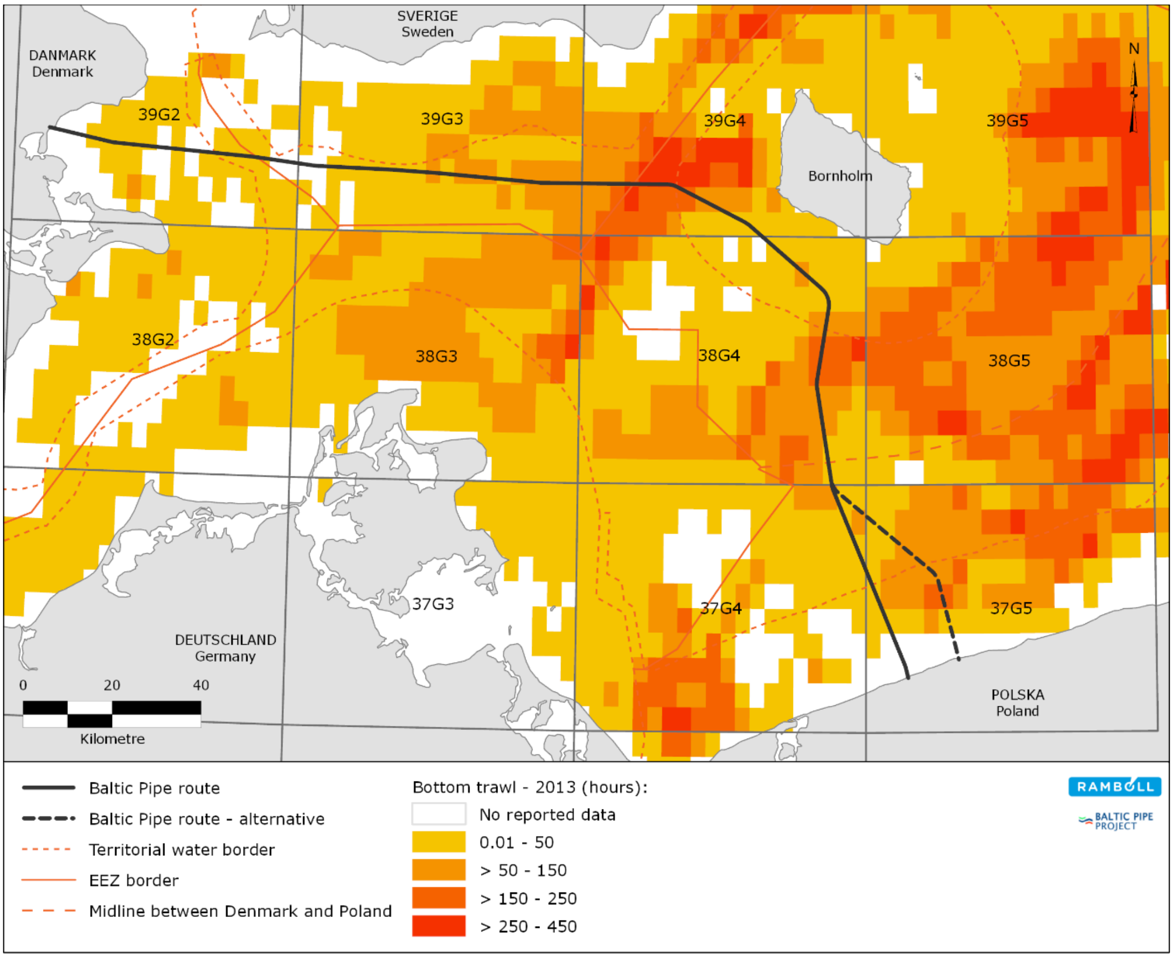

Figure 7-18 Fishing effort in terms of estimated hours per c-square for mobile contacting gear in 2013 based on VMS/logbook data processed by the ICES Working Group on Spatial Fisheries Data (WGSFD) (HELCOM, 2015). The rectangles and codes (ICES rectangles) are used for the gridding of data to make for simplified analysis and visualization.

Figure 7-18 shows the fishing effort for mobile contacting gears in 2013 for HELCOM members, excluding Russia, in the Arkona and Bornholm Basins. Even with the scarcity of data for 38G2, 39G2, 38G4, and 37G4, a pattern emerges, which correlates well with Figure 7-16. As the pipeline will be located on the seabed, it is important to assess the fishing effort for mobile contacting gears such as demersal trawls. As Figure 7-18 includes the fishing effort of other nations than Denmark, it is beneficial to evaluate based on intensity by comparing to Table 7-39, in order to get the full overview of the fisheries in the area.

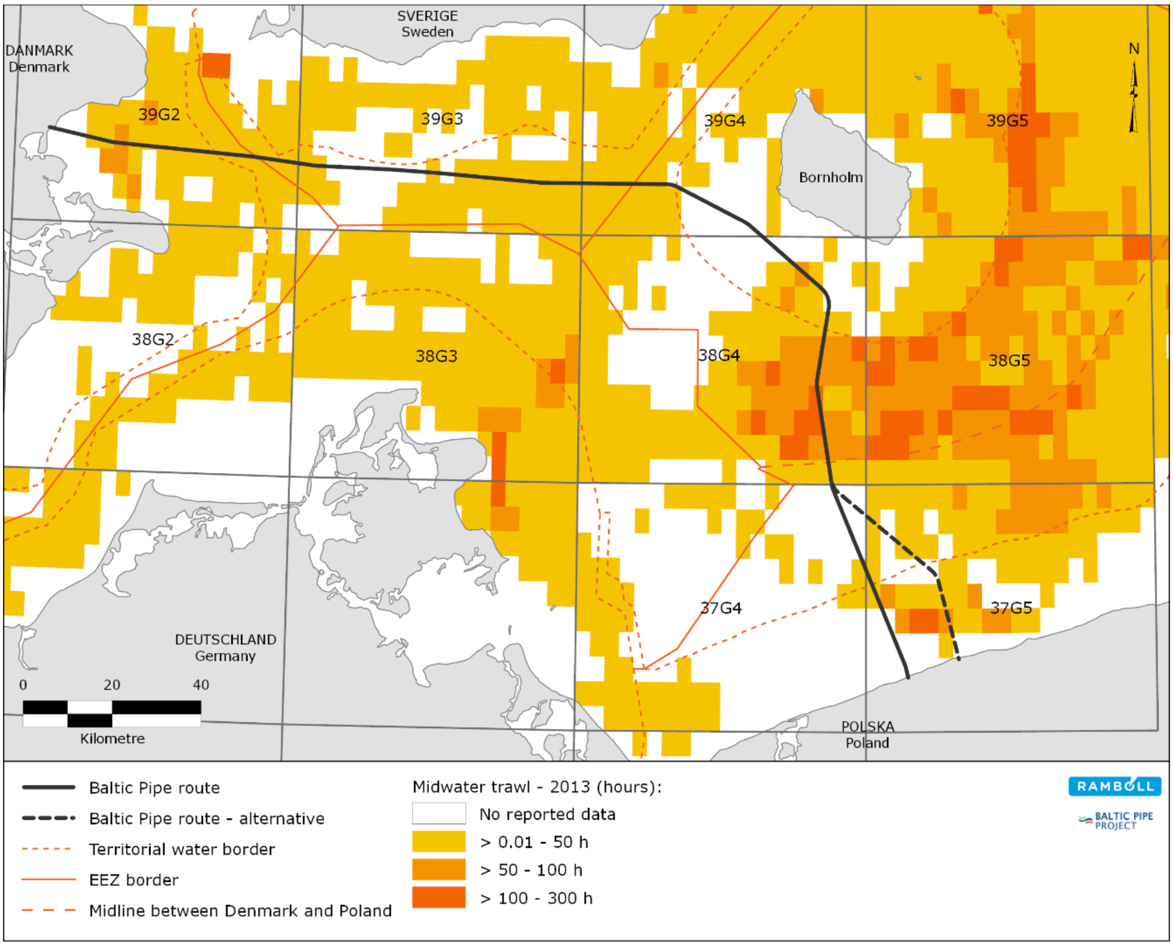

Figure 7-19 Fishing effort in terms of estimated hours per c-square for midwater trawl gear in 2013 based on VMS/logbook data processed by the ICES Working Group on Spatial Fisheries Data (WGSFD) (HELCOM, 2015). The rectangles and codes (ICES rectangles) are used for the gridding of data to make for simplified analysis and visualization.

Figure 7-19 shows the fishing effort for midwater trawl gears in 2013 for HELCOM members, excluding Russia, in the Arkona and Bornholm Basins. Many of the c-squares in Figure 7-19 are reported with no available data. The lack of data is most likely connected with the overall low biomass of sprat and herring in the area that are normally caught by midwater trawling vessels. Midwater trawl effort was less intense than bottom-contacting gears. The year 2013 is assessed to be a representative year for both fishing techniques in the period, as there are little to no changes in the fishing effort pattern in the period 2010 to 2013 where data are available from HELCOM.

Impact assessment and transboundary impact

The Baltic Pipe pipeline can potentially interfere with Danish commercial fisheries during both the construction and operational phases. See Table 7-40 for the potential impacts on commercial fisheries.

Table 7-40 Potential impacts on commercial fisheries.

Potential impact	Construction	Operation
Safety zones	X	X
Restriction zone (around the pipeline)		X
Presence of the pipeline		X
Physical disturbance above water	X	X

Safety zones

Safety zones will be established around the construction vessels. The safety zone will have a radius of 1,000 - 1,500 m around the pipe-lay vessel and accompanying vessels, depending on the use of DPS or anchors and anchor chains. Safety zones will follow the vessels as they move continuously with a speed of 3-4 km per day at water depths of over 20 m, which is where the most high-intensity fishing is carried out. Therefore, impact on commercial fisheries from safety zones will be regional/transboundary and temporary.

As Table 7-39 shows, some of the ICES rectangles are of higher economic mean annual value. The socioeconomic impact that can occur from physical disturbance above water can vary greatly for the individual fisher, as there are differences in the métiers e.g. gear types, target assemblage, mesh sizes, etc. In general, fishermen tend to fish in more than a single ICES rectangle, so it is unlikely that the temporary safety zone will restrict fisheries activity. However, it can alter the catch per unit effort (CPUE) for a short period of time.

In cooperation with the contractor and the Danish Maritime Authority, the developer will announce the planned periods of construction activities. In addition, compensation will be a mitigation measure to reduce the economic impact on fishermen fishing in areas that will temporarily be closed due to the imposition of safety zones.

Table 7-41 Impact significance of safety zones on commercial fisheries.

	Sensitivity	Magnitude of impact			Severity of impact	Significance
		Intensity	Scale	Duration		
Safety zones	Low	Minor	Regional /transboundary	Immediate	Negligible	Not significant

Restriction zone

A restriction zone with a radius of 200 m will be set around the pipeline once it is fully operational. This can have a potential impact on the total fishable area for commercial fisheries and alter the fisheries pattern in the area. There are no nearshore fisheries in spatial conflict with the restriction zone, as the last known fishermen in the area decided to stop fishing activities in 2018. As for demersal trawlers, it is very unlikely that the restriction zone will have any effect, as it will occupy less than 1% of the total fishable area in the Arkona and Bornholm Basins, see Table 7-42.

Table 7-42 Uptake (%) of fishable area by the restriction zones in non-trenched areas for each ICES rectangle.

ICES rectangle	Restriction zone km^2	ICES area [km^2]	Uptake in % of fishable area
39G2	6.11	2,555.98	0.24
39G3	19.08	2,761.98	0.69
39G4	9.35	2,898,98	0.32
38G4	18.36	3,539.98	0.52
37G4	4.80	3,423.98	0.14

Therefore, the effect on CPUE and availability of fishable area is assessed as minor. The intensity of the impact is minor. The restriction zone will be of a local and transboundary scale, because it influences both national and foreign fisheries within a 200 m radius of the pipeline. The duration of the restriction zone is assessed to be long-term. Lastly, the severity of the impact is assessed to be minor and not significant.

Table 7-43 Impact significance of safety zones on commercial fisheries.

	Sensitivity	Magnitude of impact			Severity of impact	Significance
		Intensity	Scale	Duration		
Restriction zone (around the pipeline)	Low	Minor	Local/ transboundary	Long-term	Minor	Not significant

Presence of the pipeline

Where the pipeline is placed directly on the seabed and where rock installations are present, there may be an impact on commercial fisheries, see Section 3.4.2, Figure 3-15. Demersal trawls can be affected by the presence of the pipeline, as their gear can get hooked upon contact with the pipeline. However, hooking is a seldom occurring accidental situation where the trawl equipment becomes stuck under the pipeline created by a span. The seabed is relatively flat where the pipeline will be laid, but in areas where free spans are present and high trawl intensity exists, trawl infill, i.e. rocks will be used to fill potential spans. Demersal trawlers are advised to avoid fishing across the pipeline. It is very unlikely that the presence of the pipeline will restrict fisheries activity, as the fishermen tend to fish in more than a single ICES rectangle, but there will be a need for adaptation in regard to trawl patterns for demersal trawlers. Pelagic trawlers will not be affected by the presence of the pipeline, as the towed net maintains a natural distance to the seabed. Furthermore, the presence of the pipeline will occupy less than 1% of the total fishable area in the Arkona and Bornholm Basins, which will constitute a minor effect on the CPUE and the availability of fishable area, see Table 7-42.

The impact intensity will, therefore, be minor and local/transboundary, because it affects national and foreign fisheries. However, the impact will be long-term. Nevertheless, the severity of the impact is assessed to be minor and therefore not significant.

Table 7-44 Impact significance on commercial fisheries from the presence of the pipeline.

	Sensitivity	Magnitude of impact			Severity of impact	Significance
		Intensity	Scale	Duration		
Presence of pipeline	Low	Minor	Local / transboundary	Long-term	Minor	Not significant

Physical disturbance above water – presence of vessels
The presence of vessels during the construction and operational phases will be conditions that the national and foreign fisheries fleet are already adjusted to, as they are accustomed to the heavy ship traffic that exists in the Baltic Sea under normal circumstances. Therefore, the sensitivity of commercial fisheries is assessed to be low.

Vessels used during both the construction and operational phases may accidentally cut a line of fishing gear, such as longlines and gillnets, which are both considered shallow-water gear. Abandoned, lost, or otherwise discarded fishing gear is a problem of increasing concern, as it may cause environmental impacts and economic loss for the fishermen. Despite this potential impact, there are relatively few fishermen who use these gear types, as shown in Figure 7-15, and the process of pipe-lay in shallow water will be short. The impact is therefore assessed to be of minor intensity. As the vessels will move continuously, the scale is local, and the duration is immediate. Combined with a low sensitivity, the severity of impact is assessed to be negligible and not significant.

Table 7-45 Impact significance on commercial fisheries from the presence of vessels during construction and operation.

	Sensitivity	Magnitude of impact			Severity of impact	Significance
		Intensity	Scale	Duration		
Presence of vessels	Low	Minor	Local/ transboundary	Immediate	Negligible	Not significant

Conclusion on transboundary impact
All Baltic coastal states except Russia are members of the EU, with their fisheries activities being regulated by the EU Common Fisheries Policy. In 2006, the EU and Russia agreed to a bilateral framework fisheries agreement. The Baltic Pipe project will, with its safety zones, restriction zones and presence on the seabed affect the fishable area available to the Baltic coastal states. However, once the pipeline is constructed, it will occupy less than 1% of the total fishable area in the Arkona and Bornholm Basins, see Table 7-42, so even though there will be a transboundary (socio-economic) impact, the impact will not be significant.

In general, the sensitivity of the potential impacts on fisheries is evaluated as low, the intensity minor and scale local/regional. In terms of duration, the imposition of safety zones and the presence of vessels (i.e. physical disturbance above water) have an immediate duration, whereas the presence of the pipeline and the restriction zone around the pipeline are long-term. The severity of each impact is either negligible or minor, and no impacts are evaluated as significant, see Table 7-46.

Table 7-46 Overall impact significance on commercial fisheries.

	Severity of impact	Significance	Transboundary
Safety zones	Negligible	Not significant	Yes
Restriction zones around the pipeline	Minor	Not significant	Yes
Presence of pipeline	Minor	Not significant	Yes
Physical disturbance above water	Negligible	Not significant	Yes

7.4.3 Military practice areas
Military practice areas are an important receptor to assess due to their role in national security and international training, as the Baltic Sea is a strategic area where various types of military

practice areas are maintained. The military practice areas concerned in relation to the Baltic Pipe project are mostly used by NATO and are as such of international importance. In this section, the term "transboundary impact" is therefore extended in the way that it covers any impact on international military exercise areas even though it occurs locally in one of the countries.

Baseline

There are a number of military practice areas within the Danish territorial waters and EEZ along and in the vicinity of the planned route (see Figure 7-20). Temporary practice areas are not included on the map.

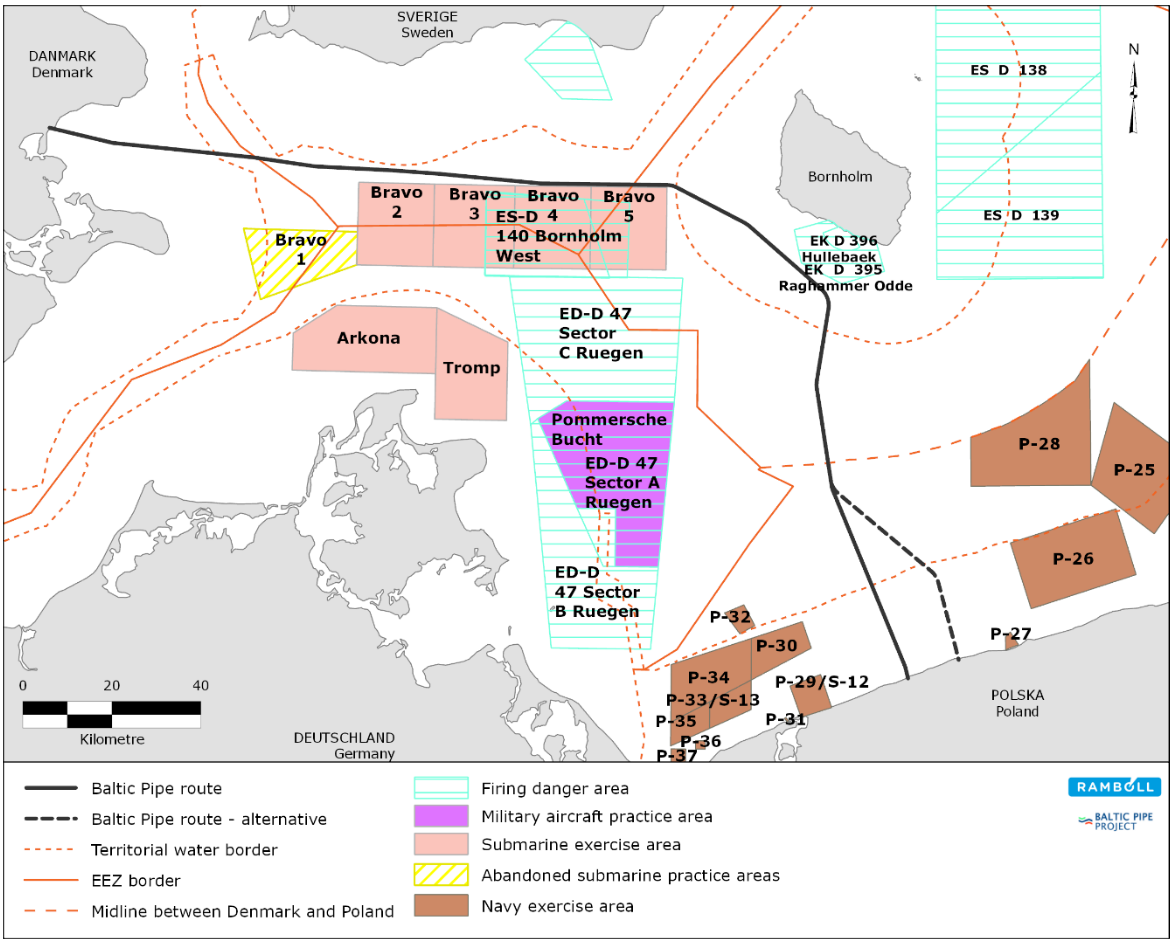

Figure 7-20 Military practice areas in the southern Baltic Sea.

The submarine exercise areas Bravo 2 through Bravo 5 are located along the EEZ borders shared by Germany, Sweden and Denmark (see Figure 7-20). The planned route passes north and east of Bravo 5 within the Danish EEZ west of Bornholm. This submarine exercise area is under the coordination of the German Navy (Submarine Exercise Area Coordinator – SEAC) and is used for NATO training and exercise patrols. Bravo 1 is no longer in use as military training area.

Furthermore, within Danish territorial waters, the firing danger area "EK D 395 Raghammer Odde" is located directly to the southwest of Bornholm, and inside this, the military area "EK D 396 Hullebaek" is located. These firing areas are actively used by the Danish Armed Forces and the Danish Home Guard for live fire practice from Bornholm. These areas are highly active and can be in use 24 hours a day.

Impact assessment and transboundary impact

The construction of the Baltic Pipe pipeline may interfere with the daily activities in military practice areas within Danish, German and Swedish waters. No impacts are anticipated during the operational phase. See Table 7-47 for an overview of the potential sources of impact.

Table 7-47 Potential impact on military practice areas.

Potential impact	Construction	Operation
Safety zones	X	

Safety zones

The establishment of temporary safety zones around the pipe-lay vessels, and safety zones of other vessels of limited manoeuvrability (e.g. ploughing vessel and rock installation vessel), can lead to an impact on the military practice area Bravo 5 during construction of the planned pipeline. It is expected that the safety zone around the anchor lay barge will extend 1,000 - 1,500 m in radius around the vessel, while the safety zone around the DP pipe-lay vessel will be approximately 1,000 m in radius. For all other vessels with restricted manoeuvrability, a safety zone with a radius of 500 m will be implemented. No non-project related vessels will be permitted to enter the safety zones. Since the pipeline will run only 550 m from the northern border of Bravo 5 for a distance of 8 km, some temporary impact from the safety zones can be expected. The pipeline route runs approximately 1.4 km away from one of the corners of the firing danger area "EK D 395 Raghammer Odde", and a 1,500 m safety zone would therefore overlap with this corner of the military area, potentially causing an impact.

The sensitivity of military practice areas to this type of impact is judged to be medium, as the presence of vessels will suspend all military activities in their vicinity and these areas are of high importance to the military as international training areas. However, the pipe-lay vessels are expected to move at a rate of approximately 3 km a day for the 8 km stretch where the route is located adjacent to the northern border of Bravo 5, and the pipe-lay activities will therefore be completed within 3-4 days, depending on weather conditions. Restrictions in the use of the submarine exercise areas will therefore be limited to these 3-4 days. If a safety zone of 1,500 m is required for the construction vessel, then the firing danger area "EK D 395 Raghammer Odde" will be affected for a distance of 300 m along the pipeline route, and the impact will be restricted to a few hours. The planned activities will be coordinated and communicated with the relevant authorities to ensure minimum disruption of military practice activities.

7.5 Cumulative impacts

Cumulative environmental impacts can be defined as effects on the environment, which are caused by the combined results of activities from the present project activity in combination with other ongoing or planned projects.

The respective EIAs of Poland, Sweden and Denmark have identified potential projects for the assessment of cumulative impacts based on:

- The timeframe of the project (both the life cycle and the potential impacts);
- Whether the project is placed within the same geographical area as the Baltic Pipe;
- Whether the impact type is similar to the impacts for the Baltic Pipe or can have an impact on the same receptors as the Baltic Pipe.

Table 7-48 presents an overview of the projects identified in the Danish territorial waters that have been included in the assessment of cumulative impacts. The table is the result of a screening of a bigger number of projects, most of which have been screened out because of their distance to the Baltic Pipe or the small scale of potential impacts. This includes raw material extraction sites and existing or planned subsea cables.

Table 7-48 Offshore projects in the Danish territorial waters included in the assessment of cumulative impacts

Project	Location	Shortest distance to pipeline	Timeframe of project
Raw material extraction sites			
Reserved area*: Krieger's Flak	Krieger's Flak	8.5 km	Sep 2017 - Sep 2027 potentially for a longer period
Common areas**: 520-AA, DA, EA, EB, EC, EF, EG, FA	Faxe Bugt	0.2 km	No specific timing – potentially all year
Common areas: 526-CA, DA, EA, HA, IA, JA	Between Bornholm and Rønne Banke	0.5 km	No specific timing – potentially all year
Offshore wind farms			
Krieger's Flak OWF (DK)	Krieger's Flak	5.3 km	Under construction February 2018-2022
Infrastructure			
Nord Stream (NSP)	South of Bornholm	Crossing	Existing
Nord Stream 2 (NSP2)	Two alternatives; west and south-east of Bornholm	Crossing	Permit for construction not yet obtained in Danish TW

* Extraction reserved for certain purpose

**Extraction open for application

The assessed impacts from the projects mentioned in Table 7-48, which potentially overlap with the Baltic Pipe activities are the following:

- *Suspended sediment (construction (Baltic Pipe) and operation (extraction sites)):* Spill of suspended sediment from extraction activities and construction of the OWF Krieger's Flak as well as from the Baltic Pipe construction and maintenance is very limited in intensity, scale and duration, a significant cumulative impact on environmental receptors is not likely to occur.
- *Physical disturbance above water (ship traffic, noise, light etc.; construction and operation)*: Extraction activities and construction and operational activities of Baltic Pipe can potentially coincide, but as both activities have a low intensity and impacts are limited to the close vicinity of the activities and are of short-term nature, the severity of the cumulative impacts are negligible and are hence not likely to have a significant impact on environmental receptors.
  Ship traffic from construction works at the OWF Krieger's Flak could potentially cumulate with Baltic Pipe construction, but details on activities are not known. As ship traffic will be local for both projects and as ship traffic to/from harbours will travel along already existing ship routes, cumulative impacts are not likely to occur.
  Construction activities from NSP2 will most likely be terminated before commencement of Baltic Pipe construction. However, since no construction plans have been published for the north-western alternative, this evaluation may have to be updated.
- *Underwater noise (construction and operation):* As impacts from construction activities for the Baltic Pipe project are local and immediate, the cumulative impact with extraction sites or the construction of Krieger's Flak is not significant. Hence there will be no significant cumulative impacts.

If munitions clearance (from Baltic Pipe) should become unavoidable and coincides with construction activities such as pile driving for OWF Krieger's Flak, a potential cumulative impact on marine mammals could occur. As the timing of these activities is not known, it is not possible to draw conclusions on the significance of the resulting potential impact.

- *Presence of infrastructure (e.g. pipelines; operation)*:
  During the operational phase, potential cumulative impacts relate to the crossings of the pipelines (NSP and NSP2, if built). Here rock installations will be placed and will create a new structure on the seabed. Impact on the physical-chemical, biological and socio-economic environments have been assessed in the EIA report (Ramboll 2018a, chapter 9). Significant impact is not likely to occur.

7.5.1 Conclusion

Overall, cumulative impacts from existing and planned projects and the planned project activities for the Baltic Pipe project are not likely to be significant for the marine environment. The main reason for this is the local and short-term nature of Baltic Pipe impacts, i.e. overlapping of impacts with other projects can only occur at short distance.

In the transboundary perspective distances between the Baltic Pipe activities in the Danish territorial waters and projects ongoing in Sweden, Germany or Poland become much larger and cumulation of impacts can be ruled out.

8. CLIMATE

The following chapter describes the expected greenhouse gas (GHG) emissions caused by the Baltic Pipe project during operation phase, when the main contribution of GHG emissions is derived from the use of natural gas delivered by the pipeline. The calculated GHG emissions are analyzed in the context of the current and future energy market of Poland and related to the EU climate targets and Paris Treaty.

8.1 Calculation of GHG emissions

The Baltic Pipe is supposed to transport a yearly amount of 10 billion m^3 natural gas to Poland. Its combustion will result in the release of 21.2 million tons of CO_2 equivalents per year including minor contributions of nitrous oxide (N_2O) and non-combusted methane (CH_4). During the planned lifetime of the pipeline of 50 years this sums up to approximately 1.06 billion tons CO_2 eq. (see Table 8-1).

Table 8-1 GHG emission during operation of the Baltic Pipe and emission factors used for calculation (IPCC, 2006), approximate numbers.

	CO_2	CH_4	N_2O	Total
Emission factor (EF) [kg GHG/TJ]	56,100	1	0.1	-
Emissions (yearly) [Mt GHG]	21.2	0.01 (CO_2 eq.)	0.01 (CO_2 eq.)	**21.2** (CO_2 eq.)
Emissions (50 years) [Mt GHG]	1,061	0.53 (CO_2 eq.)	0.50 (CO_2 eq.)	**1,062** (CO_2 eq.)*

*Tentative maximum numbers for exhaustion of the full capacity during entire lifetime

The total CHG emissions in Poland amounted to 398 megatons CO_2 eq. in 2016 (see Table 8-2). In comparison, the emissions generated by the Baltic Pipe gas delivery would account for 5.4 % of the country's total CHG emissions based on the numbers of 2016. Not necessarily all gas delivered by Baltic Pipe must be utilized in Poland. The Baltic Pipe does also establish a north-south corridor for European natural gas, which then can be distributed from Poland to other countries in eastern Europe. However, since Poland's demand is rather large and growing, in this scenario it is assumed that the Polish energy sector absorbs the entire capacity of Baltic Pipe, which may proof different in the future.

Table 8-2 Total main GHG emission in Poland as of 2016 (KOBiZE, 2018)

	CO_2	CH_4	N_2O
Total GHG emissions in 2016 [Mt]	322	47 (CO_2 eq.)	21 (CO_2 eq.)

8.2 Polish energy market

The total primary energy supply (TPES) in Poland is based mainly on fossil fuels. First place belongs to hard coal and lignite, which cover 51 % of the demand. Crude oil also has a significant share of 25 %, while natural gas and renewables comprise 14 and 9 % respectively (see Figure 8-1). In Poland 88 % of electricity is generated from coal, most of it domestic hard coal and lignite.

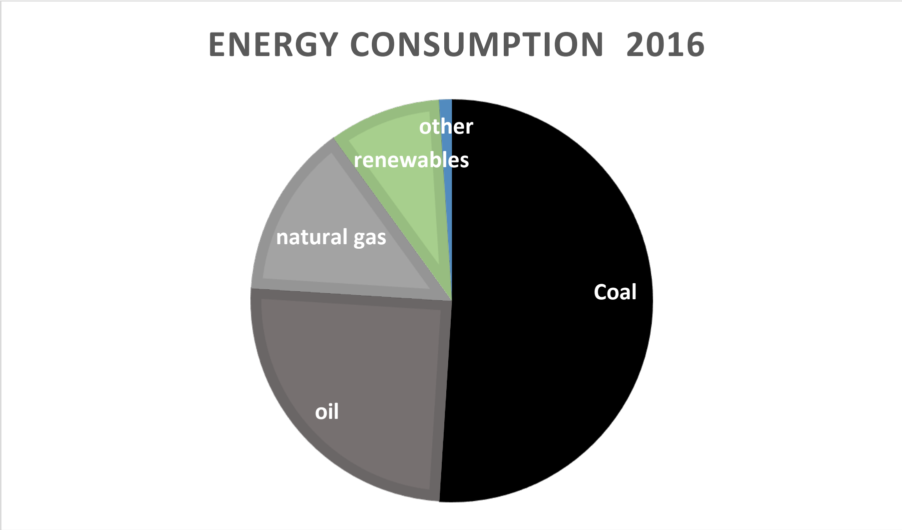

Figure 8-1 Polish energy mix for the total primary energy supply of 2016 (source: European Parliament 2017).

The demand for natural gas currently amounts to 17 billion m^3 per year (year 2018). However, since Poland has experienced continuous economic growth within the last three decades the demand for natural gas and energy in general has been increasing accordingly. It is estimated that the demand for natural gas will be above 20 billion m^3 in the year 2030 (Mościcka-Dendys, 2018).

At the time being Poland can cover about 25 % of the natural gas by domestic production. Poland is therefore depending strongly upon import, traditionally covered by Russia. However, since 2016 a liquid natural gas (LNG) terminal at Swinoujscie has been established and import of LNG mostly from USA and to some extent from Qatar has been increasing in parallel with plans to further extend the LNG capacity. As of 2018 Russian gas comprises 74 % of the natural gas import (see Figure 8-2). Contracts for gas delivery from Russia expire in 2022. According to Poland's gas diversification plans the contracts shall not be extended and the import of natural gas shall be covered by Norwegian gas (Baltic Pipe) and LNG from 2022 on.

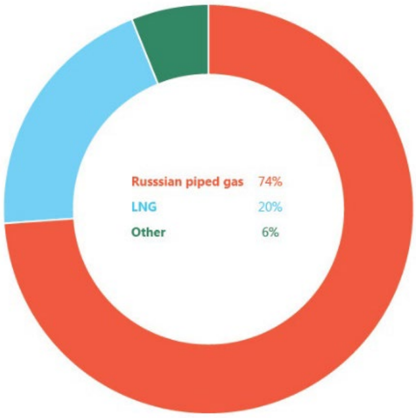

Figure 8-2 Sources of Polish gas imports (Jan-Aug 2018), source: PGNiG, 2018.

8.3 Polish Energy Policy in the light of EU climate and energy framework and Paris Treaty

The EU's nationally determined contribution (NDC) under the Paris Agreement is to reduce greenhouse gas emissions by at least 40% by 2030 compared to 1990, under its wider 2030 climate and energy framework. All key legislation for implementing this target has been adopted by the end of 2018. The 2030 climate and energy framework sets three key targets for the year 2030:

- At least 40% cuts in greenhouse gas emissions (from 1990 levels);
- At least 27% share for renewable energy;
- At least 27% improvement in energy efficiency.

The framework was adopted by EU leaders in October 2014. It builds on the 2020 climate and energy package. It is also in line with the long-term perspective set out in the Roadmap for moving to a competitive low carbon economy in 2050, the Energy Roadmap 2050 and the Transport White Paper.

In 2018 the Ministry of Energy prepared an updated energy policy paper, which currently is in public hearing as draft (Energy Policy of Poland until 2040, EPP2040). The policy defines the strategy and the targets for the country up to the year 2040. In the context of the EU 2030 climate and energy framework EPP2040 formulates the following targets for 2030:

- 60% share of coal in the generation of electricity in 2030,
- 21% Renewable Energy Sources (RES) in gross final energy consumption in 2030,
- Introduction of nuclear energy in 2033,
- Improvement in energy-efficiency by 23% by 2030 relative to 2007,
- Reducing CO2 emissions by 30% by 2030 (in relation to 1990).

EPP2040 elaborates on eight strategy directions addressing different thematic complexes of the energy market (Ministry of Energy, 2018). Within these directions natural gas plays an important role, in particular for the following policy elements and targets:

- Diversification of the gas market (i.e. creating alternatives for Russian gas delivery)
- Restructuring/extending of power capacity utilizing nuclear power and RES (wind and photovoltaic). Establishing gas units and storage technologies as back up for RES.
- Development of gas transmission system and penetration
- Technical development of district heating and modernization of household energy consumption
- Increasing energy efficiency

In order to make the targets of the EPP2040 feasible, a continuous and safe natural gas supply is required. One alternative to the Baltic Pipe would be to increase the LNG capacity beyond existing plans, which would mean the construction of further LNG terminals and belonging infrastructure.

8.4 Climate effect

Delivered gas from Baltic Pipe is planned to replace Russian natural gas deliveries one by one right from the commencement of its operation in 2022. Thus, no incremental GHG emissions are created in the Polish energy production.

In addition, the use of natural gas bares the potential of GHG emission reductions, either directly by replacing coal or oil, or indirectly by enabling establishment of RES and energy efficient technologies, e.g. creating backup for large scale offshore wind power as stipulated in the EPP20140. Besides the Baltic Pipe allows the transport of other types of gases e.g. biogas.

As per today it is speculative to quantify the amount of GHG saved by the Baltic Pipe, since the speed and direction of development in the Polish energy market cannot be foreseen. A scenario presented by Energinet (Energinet, 2018) shows, that the utilization of 10% of the Baltic Pipe capacity (1 billion m^3) for the substitution of coal or oil would result in a reduction of 1.2 – 2.2 megatons of yearly CO_2 emissions depending on the exact use of the gas. The potential, however, is significantly higher.

9. ENVIRONMENTAL MONITORING

9.1 Environmental monitoring in Denmark

In accordance with the Consolidated Act on Environmental Assessment Section 20(1) and Annex 7 and Espoo Convention Article 9(c), a proposal for an environmental programme can be prepared in connection with an EIA if such monitoring is relevant for the project.

The purpose of a monitoring programme is to reduce the environmental impact as much as possible and to ensure that implemented mitigation measures are functioning according to plan. In addition, a monitoring programme can be used to monitor the change to a receptor impacted to some degree by the project.

In the following paragraphs, a proposal for a monitoring programme is presented. The detailed planning and execution of the programme will be established in consultation with the competent authorities. During this dialogue with the authorities monitoring locations, procedures, and periods will be decided.

The proposal for receptors/parameters that could be monitored is based on:

- The impact assessment, hence the potentially significant impacts on receptors caused by the project;
- Experience from similar projects, hence the expected outcome of the project;
- Implementation of mitigation measures, to ensure that these measures are functioning according to plan.

The impact assessment, including the modelling results of sediment spill, show that the project will generate only limited impacts on the marine environment. It is therefore suggested to include offshore monitoring of:

- Sediment spill (water quality/turbidity);
- Reestablishment of the seabed in the temporary footprint area in Faxe Bugt (seabed and eelgrass); and
- The effect of mitigation measures in the event of munitions clearance (observations of marine mammals).

The monitoring set up will be suitable to capture transboundary impacts of sediment spill and underwater noise, if such impact occurs.

9.1.1 Construction

Sediment spill

The purpose of the monitoring will be to survey the concentration and extent of the sediment spill.

A setup for monitoring of the sediment spill during construction should be prepared. This will be to verify the modelled sediment spill and to ensure that the spill does not exceed the expected concentrations during construction. These results will hence validate that the conditions used for the modelling (spill percentage, trenching intensity, amounts etc.) are within the same range as expected and that the basis for the EIA is still valid. Validation of the modelling inputs will in turn support the conclusions of the assessment of impacts on water quality and other receptors.

Unplanned events – effect of mitigation measures in the event of munitions clearance
The monitoring will be executed in accordance with the Marine Mammals Mitigation Plan to ensure that the implemented mitigation measures are sufficient to protect marine mammals from underwater noise impacts arising from munitions clearance.

Monitoring of marine mammals should be implemented by the use of visual observers and passive acoustic monitoring to ensure that seals and harbour porpoises are properly scared out of the zone of physical injury before munitions clearance, hence securing their protection from significant impacts.

9.1.2 Operation

Reestablishment of the seabed in the temporary footprint area in Faxe Bugt
The purpose of the monitoring will be to ensure the restoration of the seabed in the temporary footprint area in Faxe Bugt at the tunnelling pit area and transition zone.

The seabed will be restored after construction works in Faxe Bugt. Monitoring of the seabed by divers can be performed to ensure that the restored seabed areas are suitable for the re-establishment of eelgrass and benthic fauna.

9.1.3 Justification for monitoring programme

Experience from Nord Stream, which is currently the only operational pipeline system in the Baltic Sea, and where an extensive monitoring programme has been completed, has shown that no significant or measurable impacts were observed on fish along the pipeline; benthic fauna; water quality; hydrography; or socio-economic receptors, such as commercial fisheries and marine archaeology (Ramboll O&G/Nord Stream AG, 2011a,b, 2012, 2013, 2014 and 2015). It should be emphasized that Nord Stream consists of two pipelines with a larger pipe diameter. The potential for impact on the seabed is therefore significantly lower for the Baltic Pipe.

10. GAPS AND UNCERTAINTIES

According to the EIA legislation, an EIA report must contain a description of the most important gaps and uncertainties in the data and methods applied for calculating and assessing the environmental impact of the project.

In the following, the gaps and uncertainties are described for the project in general and for the specific models and calculation methods applied. Overall, it is considered that none of the listed gaps and uncertainties will lead to significant changes in the environmental assessments of the Baltic Pipe project for the Danish part within the Baltic Sea. The assessment is considered sufficiently conservative, in particular because experiences from the Nord Stream project have shown that no significant or measurable impacts on the marine environment were observed.

10.1 General uncertainties

There are general uncertainties related to the project design and the baseline data.

10.1.1 Design of the Baltic Pipe project

Deficiencies in the current knowledge base about the project relates primarily to the fact that the entire Baltic Pipe project has not yet been finalised into detail at the time of the finalisation of this EIA, why there may be adjustments or changes in project design and in organising the construction activities, including the applied construction methods. Additionally, further technical studies may be implemented when a more detailed project design becomes available. Therefore, information presented in the EIA about pipeline length, trenching length and location are based on the current design and may be subject to minor changes. Furthermore, all numbers presented in the EIA about e.g. use of materials, rock volumes and emissions from the project are approximate estimates based on the current knowledge at the time of the EIA.

In the EIA report, on this basis, and where there are uncertainties regarding the final project design and methods, a worst-case approach has been applied. This means that the conclusions of the EIA report are sufficiently robust to contain project adjustments in the upcoming detailed design phase.

10.1.2 Baseline data

The baseline has been prepared using desktop studies of scientific literature, technical reports of available data covering the project area (from e.g. authorities), together with field surveys, where results add new information and/or can confirm already existing information. The baseline data are considered sufficient as a basis for the description of the baseline in the EIA and Espoo report and a valid basis for the assessments.

In relation to harbour porpoises, there are gaps in the survey from the second quarter of 2018, which means that the verification of SAMBAH data is limited to the period November to February. This is, however, not considered an important uncertainty, as SAMBAH data are scientifically grounded and highly accepted. Furthermore, SAMBAH data cover the area included in the baseline well.

10.2 Uncertainties of models and calculations

Modelling and calculations have been undertaken for sediment dispersion, underwater noise, airborne noise, air quality and emissions.

10.2.1 Sediment dispersion

The sediment dispersion model is based on a theoretical calculation model supplied with physical input parameters. These input parameters are current fields, spilled originating from the proposed construction methods and physical properties of the spilled material.

Current fields are based on "historical" situations (hindcast) of characteristic hydrographic conditions as they most likely could be under a future construction phase. Actual conditions can be different during the construction of the Baltic Pipe project. The given model results are considered as a realistic extent of the impact, but a specific impact cannot be determined.

As input for the sediment dispersion model, spill percentages from the different types of offshore construction activities applied for the project are defined. The applied spill percentages are based on empirical data and literature studies. However, the actual spill percentage will depend on the equipment used for the task, in combination with the type of seabed.

Physical properties of the sediment main correlates with settling velocity, which again is a matter of grainsize distribution. The samples collected from boreholes were not analysed when the modelling was initiated, and consequently, specific grain size distributions were not available along the route. However, assumptions on the type of seabed material were based on dedicated surveys along the route. This information was transformed into a grain size distribution based on experience. The assessed grain size distributions were biased towards fine sediments which is considered conservative.

10.2.2 Underwater noise

The underwater noise propagation model is based on a theoretical calculation model supplied with physical input parameters such as salinity and temperature data, seabed conditions and bathymetry. If the physical measures are correct, the theoretical results are considered credible, which is the case for the current project. Measurements of underwater noise from munitions clearance, however, may result in varying noise levels due to other physical measures not included in the calculation model, e.g. waves at the surface, partial detonation and/or the munition being embedded in the seabed.

During the gathering of physical measurements for the underwater noise propagation model, it was identified that salinity and temperature data for the position off Bornholm were not present in the available data set. Therefore, measurement data from adjacent sites have been utilized as a qualitatively acceptable replacement.

Information regarding the seabed conditions between about 5 m depth and the pre-Quaternary surface present at approximately 25 m depth at Faxe and 10 m depth off Bornholm has not been possible to gather. Qualitative assumptions have been made for the unknown layers in between the surface conditions and the pre-Quaternary layer.

The quality of the results from the underwater noise propagation model is not considered to be compromised due to the utilization of the above-mentioned assumptions regarding input parameters.

10.2.3 Airborne noise

The noise calculations for airborne noise are associated with some uncertainty. Both the calculation model itself, but also the assumptions about individual noise sources and construction descriptions, are subject to uncertainty. The uncertainty regarding the determination of noise in the construction phase was estimated on the present basis to be ± 5-7 dB. However, it should be emphasized that the assumptions used in this study are generally conservative, i.e. considered worst-case.

10.2.4 Air quality modelling

Modelling of the air quality at the landfall was undertaken with the latest version of the OML model (version 6.2). The OML model is based on historical meteorological data from Kastrup, and thus not on the actual meteorological conditions at the landfall. The modelling results are, however, considered sufficient for assessing the impact from the project, as the OML model is the most well-recognised programme for modelling the spread of air emissions in Denmark.

11. CONCLUSION

Construction and operation of the Baltic Pipe natural gas pipeline in the Baltic Sea is unavoidably associated with impacts on the marine environment. Each impact is characterized by its intensity, range and duration, and the resulting environmental effect depends strongly on the sensitivity of the receptor towards the impact. Based on the results of the Danish environmental impact assessment (EIA report), the Espoo report analyses how far activities in the Danish waters have an impact on receptors in the neighbouring countries Sweden, Germany and Poland. In the following, the main conclusions are summarized for each country.

11.1 Transboundary impact Denmark – Germany

The selected pipeline route does not cross German territorial waters nor the EEZ. The closest distance between the pipeline and German EEZ is about 9 km. Project impacts that can potentially have a long range include sediment dispersion and underwater noise. However, the assessment clearly shows clearly that significant impact on any receptor farther than 9 km from the source of impact can be excluded.

In addition, in this report, the potential impact on international fishery is also discussed in the sense, that fishing restrictions in Danish waters may economically affect the German commercial fisher. It follows from Section 7.4.2 that restrictions will be imposed on only a very small fraction of the available fishing grounds, and furthermore, only a small fraction of the ongoing fishery along the pipeline route is executed by German fishermen. Thus, the impact on the German commercial fishery is minimal.

German Natura 2000 sites in the Baltic Sea are located more than 9 km away from the Danish part of the pipeline route, and thus, transboundary impacts on these sites can be excluded.

The pipeline route has been adjusted in such a way that no military exercise areas are crossed. Thus, no conflict exists with the interests of the German military or NATO.

It is concluded that there are no transboundary impacts from Denmark on Germany.

11.2 Transboundary impact Denmark – Sweden

As the pipeline route crosses the Swedish EEZ, Sweden is both a PoO and AP in the Espoo process. There are two borders between Denmark and Sweden along the pipeline route, between which transboundary impacts can occur; one in the western part of the Arkona Basin and one in the eastern part of the Arkona Basin. Project impacts that can potentially have a long range include sediment dispersion and underwater noise. It follows from the assessment that significant impacts from activities in Danish waters across the borders to Sweden will not occur.

One central point of interest in the assessment was the question of how far away underwater noise from munitions clearance (detonation) could impact the Baltic Sea populations of harbour porpoise, grey seal and harbour seal, as well as fish populations. It was concluded that significant impact can be avoided through implementation of mitigation measures.

The pipeline route crosses the Swedish Natura 2000 site "Sydvästskånes utsjövatten". The potential impact derived from this is assessed in the Swedish EIA report, which is currently under preparation. There are no activities originating in from Denmark, which can have a significant transboundary impact on this site.

The restriction zone around the pipeline for commercial fishery in Danish waters will also affect Swedish fishing activities. It follows from Section 7.4.2 that restrictions will be imposed on only a very small fraction of the available fishing grounds, and thus, the impact on the Swedish commercial fishery is assessed to be not significant.

It is concluded that there are no significant transboundary impacts from Denmark on Sweden.

11.3 Transboundary impact Denmark – Poland

As the pipeline route crosses Polish territorial waters and the EEZ, Poland is both a PoO and AP in the Espoo process. There is one border between Denmark and Poland along the pipeline route, where transboundary impacts may occur. Project impacts that potentially can have a long range include sediment dispersion and underwater noise. It follows from the assessment that significant impacts from activities in Danish waters across the border to Poland will not occur.

One central point of interest in the assessment was the question of how far underwater noise from munitions clearance (detonation) could impact the Baltic Sea populations of harbour porpoise, grey seal and harbour seal, as well as fish populations. It was concluded that significant impact can be avoided through implementation of mitigation measures. In addition, the area around the border between Denmark and Poland is not located within an area of registered munitions finds. Therefore, the probability that munitions will be discovered during the pre-construction survey is considered very low.

The pipeline route crosses the two overlapping Polish Natura 2000 sites "Ostoja na Zatoce Pomorskiej" and "Zatoka Pomorska". The potential impact derived from this is assessed in the Polish EIA report, which is currently under preparation. There are no activities originating in Denmark, which can have significant transboundary impacts on these sites.

The restriction zone around the pipeline for commercial fishery in Danish waters will also affect Polish fishing activities. It follows from Section 7.4.2 that restrictions will be imposed on only a very small fraction of the available fishing grounds, and thus, the impact on the Polish commercial fishery is assessed to be not significant.

It is concluded that there are no significant transboundary impacts from Denmark on Poland.

11.4 Baltic Pipe entire route throughout the Baltic Sea

In section 7.5 it has been stated that cumulative impacts in relation to other plans and projects in the Baltic Sea region could be ruled out. In principle, given the size of the Baltic Pipe project, cumulative impacts can also arise within the project itself when all impacts of the three countries are superimposed.

The potential for such cumulative impact depends on:

- The timeframe of the construction in the different sections of the project;
- Whether the impact type in the one section is similar to the impacts for the remaining sections of can have an impact on the same receptors.

Analysing the envisaged timeframe for the construction works (see Chapter 3) it is revealed that only landfall construction in the nearshore areas in Denmark and Poland will occur simultaneously. Both activities cause small scale disturbance of nearshore habitats. However, the nearshore habitats are different in Poland and Denmark, and none of the potential impacts will be of a transboundary character. Cumulative impacts on equal receptors can be excluded.

Offshore construction is planned as a continuous process starting from the nearshore section in either Denmark or Poland terminating at the other nearshore section.

Significant impacts on environmental receptors from short-term potential impacts such as sediment dispersion, underwater noise, presence of vessels etc. have not been identified in Denmark and are hence not foreseen for Sweden and Poland as the impact intensity will be of same character. As impacts will not occur simultaneously the impact is not likely to be cumulative.

Long-term or permanent impacts, such as seabed intervention work and presence of pipeline can have a local impact on environmental receptors, which is assessed not significant in the Danish EIA. By considering the entire route the absolute size of the impact is scaled up. However, as the reference area is equally scaled up, the significance is not changed, and cumulative impacts on the environment from the project as a whole can be excluded.

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