# Chapter 9

## Impact Assessment and Mitigation Measures

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# 9 Impact Assessment and Mitigation Measures

## 9.1 Introduction

This chapter identifies and assesses the predicted, cumulative and unplanned environmental impacts associated with the Nord Stream Project together with a description of mitigation measures intended. Impacts are assessed following the implementation of mitigation measures that form part of the Project design as well as any additional measures considered necessary by this assessment. Impacts were identified as per the scoping and impact identification process**,** which followed a systematic approach of detailing:

- The technical, spatial and temporal scope of the EIA
- All the interactions between Project activities and the receiving environment
- All the predicted, cumulative and unplanned impacts associated with the Project

The technical scope of the EIA is defined as including the resources/receptors as presented in **Table 9.1**.

**Table 9.1 Environmental and social/socioeconomic resources and receptors associated with the Nord Stream Project**

| Environment | Resource or Receptor |
|---|---|
| Physical environment | Physical processes |
| | Water column |
| | Seabed |
| | Atmosphere |
| Biological environment | Plankton |
| | Marine benthos |
| | Fish |
| | Sea birds |
| | Marine mammals |
| | Nature conservation areas |
| Social and socioeconomic environment | Fisheries |
| | Shipping and navigation |
| | Tourism and recreation |
| | Cultural heritage |
| | Offshore industry |
| | Military operations |

The spatial scope of the EIA depends on the respective resource/receptor and is detailed where relevant. However, the pipelines' route has been divided into five Ecological Sub-Regions (ESRs) as defined in **Chapter 8** and summarised as follows:

- ESR I – Portovaya Bay
  - KP 0 – 22.1
- ESR II – The Gulf of Finland
  - KP 22.1 – 318.4
- ESR III – Baltic Proper
  - KP 318.4 – 745.9
  - KP 945.0 – 1046.4
  - KP 1057.4 – 1070.8
- ESR IV – The southern sandbanks

  - KP 745.9 – 945.0
  - KP 1046.4 – 1057.4
  - KP 1070.8 – 1198.1
- ESR V – Greifswalder Bodden
  - KP 1198.1 – 1222.7

There is no sharp transition from one ESR to another (i.e. from one kilometer point (KP) to another), since the key parameters defining the ESRs are continuous variables. Impacts upon the physical and biological environment are assessed within the boundaries of each ESR in **Sections 9.3 – 9.7** while impacts on the social and socioeconomic environment are assessed at the Baltic Sea level in **Section 9.8**. Transboundary impacts are described and assessed in **Chapter 11**.

The temporal scope of the EIA is restricted to the four main phases of the Project:

- Construction phase
- Pre-commissioning and commissioning phase
- Operational phase
- Decommissioning phase

Predicted impacts during construction, pre-commissioning and commissioning, and operation are assessed as per each resource/receptor while those predicted for the decommissioning phase are presented as a separate section of the chapter (**Section 9.11**). Impacts during construction and pre-commissioning and commissioning are considered in terms of the proposed construction schedule detailed in **Chapter 4**. The impacts attributable to both pipelines are considered as per **Box 9.1**.

**Box 9.1 Assessing the impacts of two pipelines**

The northwest pipeline will be laid prior to the southeast pipeline, except at each of the two landfalls, where the two pipelines will be installed simultaneously. This assessment considers the construction and pre-commissioning and commissioning based impacts associated with the sequential pipe-laying and seabed intervention works for the two pipelines, taking consideration of their respective construction schedules, as set out in **Chapter 4**. With regard to operational phase, this assessment considers the overall impacts attributable to the presence of the two almost parallel pipelines on the sea floor for the duration of their operational life.

Cumulative impacts arising from other third party activities and unplanned impacts (resulting from non-routine scenarios) are assessed as separate sections of this chapter, as per the relevant resource/receptor (**Sections 9.9** and **9.10**).

Impacts are characterised and assessed with the input of the following information sources:

- The Nord Stream national Environmental Impact Assessments for Germany, Denmark Sweden, Finland and Russia
- Project memos compiled by Ramboll (Denmark) and the Swedish Environmental Research Institute (IVL **–** Sweden)
- Modelling results as generated by Ramboll (Denmark) and the Institute for Applied Ecology (IfAÖ **–** Germany)
- Atlas maps as compiled by Ramboll
- Specialist investigations carried out by environmental laboratories in Germany, Denmark, Sweden and Finland as commissioned by Ramboll (Denmark)
- Previous experience of the environmental consultants ERM (UK), IVL (Sweden), IfAÖ (Germany), PeterGaz (Russia), and Ramboll (Denmark and Finland)
- Published and grey literature

Potential impacts are assessed in terms of the methodology presented in **Chapter 7** following implementation of mitigation measures that form part of the Project design as well as any additional measures that are considered necessary. Where it is deemed that a topic area requires additional classification, amendments to the methodology are presented together with an explanation, e.g. sensitivity criteria for a resource or receptor. Unplanned impacts are assessed as per the methodology presented in **Section 7.4.8**

## 9.2 Sources of Impacts

A range of activities associated with the Project will result in impacts on the receiving environment. The identified sources of impact are described in this section.

### 9.2.1 Construction Phase

**Seabed Preparation**

Seabed preparation is concerned with all activities that are required to ensure that the pipelines' corridor is free from obstruction and suitable for either pipe-laying directly on the seabed or necessary seabed intervention works, both pre and post pipe-laying. Seabed preparation activities associated with the Project include:

- Munitions clearance
- Boulder removal
- Wreck removal

Seabed intervention works form part of seabed preparation, however they are discussed separately.

A description of the seabed preparation activities, and their effects on the environment, is given below.

*Munitions clearance*

Avoiding known munitions dump sites was an important criterion for the proposed route selection. However, munitions clearance will be required at a limited number of locations along the pipelines' route prior to pipe-laying. It is envisaged that munitions clearance will be performed in two phase, firstly along the security corridor, followed by selected mentions within the anchor corridor. During WWI and WWII both the Gulf of Finland and the coast of Sweden were heavily defended by munitions. The placement of munitions on the seabed was not, however, entirely restricted to these areas but also extended to other parts of the Baltic Sea. Many minefields have been cleared, but some munitions remain on the seabed. Other munitions (such as depth bombs, torpedoes and grenades) are also present throughout the Baltic Sea. Due to the potential risks involved in triggering a device during the construction phase, the pipelines' route has been optimised to ensure that any munitions clearance will be kept to a minimum. Whilst the exact location of munitions along the route is confidential, it has been confirmed that a total of 31 of these are present within the Gulf of Finland and one is located off the coast of Sweden. Munitions surveys are presently ongoing in Russia, and may reveal further munitions present on the seabed in Russian waters.

Nord Stream is currently developing a method statement for munitions clearance. Munitions clearance requires the safe detonation of the munitions. Physically removing the ordnance affecting the pipelines' route has been addressed by the munitions experts and they have concluded that this method would incur greater risk.

Safe and proven clearance methods will be used, similar to those previously used to dispose of munitions in the Baltic Sea. Over the last decade or so, the collective navies of the Baltic States have developed methods that are both safe and effective for the clearance of mines and other explosive underwater ordnance. These methods have also been used by national navies around the world to dispose of ordnance.

The clearance will be conducted in accordance with a clearance plan that will be developed in conjunction with relevant national authorities. The clearance plan will include clear risk assessed procedures for the technical performance of the work, together with the monitoring plan to minimise impact to receptors, including marine mammals, fish and birds.

The technical procedure of the munitions clearance will address:

- Identification and implementation of demarcation zones and assurance of safe shipping movements for all vessels in the surrounding area
- Pre-detonation inspections: ROV based verification survey using high resolution cameras to record the seabed conditions and the surrounding environment including presence of existing infrastructure, cultural heritage, anthropogenic debris (e.g. barrels) and other munitions will be used
- Munitions classification: all munitions will be identified and confirmed (type, model and amount of explosive material based on historical data)
- Disposal: this method involves placing a small charge next to the identified live or suspected live ordnance on the seabed using a small Remotely Operated Vehicle. These charges are then detonated acoustically from a surface support ship located at a safe distance from the target
- Post detonation survey: to verify successful detonation and if necessary remove any remaining large residual items of metal that are still present in the area and which could create further pipeline installation difficulties. ROV utilising manipulators and special baskets will also carry out this operation

Potential impacts associated with munitions clearance include:

- Increase in turbidity
- Release of contaminants
- Release of nutrients
- Noise and vibration (caused by clearance/explosions)

- Emission of pollutant gases
- Physical alteration of the seabed
- Physical loss of seabed habitats
- Smothering (marine benthos)
- Impacts from increased vessel traffic (see “Construction and support vessel movement” under “Offshore pipe-laying”)
- Restriction on navigation for fishing vessels
- Restriction on navigation for shipping vessels
- Damage to shipwrecks
- Damage to existing cables on the seabed
- Restrictions to future offshore developments

*Boulder removal*

The majority of the pipelines’ route has been optimised so as to avoid areas where extensive boulder removal is required. However, in certain areas along the pipelines’ route in the German EEZ, and around the Russian landfall, some boulder removal will be required to ensure a suitable base for the pipelines and to allow for construction activities.

Potential impacts associated with boulder removal include:

- Increase in turbidity
- Release of contaminants
- Release of nutrients
- Noise and vibration
- Emission of pollutant gases (support vessels)
- Physical alteration of the seabed
- Physical loss of seabed habitats

- Impacts from increased vessel traffic (see “Construction and support vessel movement” under “Offshore pipe-laying”)

*Wreck removal*

The pipelines’ route has been optimised where possible so as to avoid impacts on shipwrecks. However, the pipelines’ route through the Greifswalder Bodden (ESR V) runs alongside two wrecks that form part of the Schiffssperre. The removal and salvaging of one of these wrecks is currently under consideration to ensure its preservation.

Potential impacts associated with wreck removal include:

- Increase in turbidity
- Release of contaminants
- Release of nutrients
- Noise and vibration
- Emission of pollutant gases (support vessels)
- Physical alteration of the seabed
- Physical loss of seabed habitats
- Impacts from increased vessel traffic (see “Construction and support vessel movement” under “Offshore pipe-laying”)
- Damage to shipwrecks

**Seabed Intervention Works**

Seabed intervention works are activities that are necessary to prepare certain sections of the pipelines’ route that do not provide an ideal base for the pipelines. Seabed intervention works ensure that the pipelines can rest in a position, on or below the seabed surface, which guarantees their stability and structural integrity.

Events which are likely to compromise the stability of the pipelines include the following:

- Excessive movement of the pipelines
- Stress/fatigue due to free-span development (sections of the pipelines that are unsupported by sediment) caused by an uneven seabed

- Impacts from shipping traffic
- Impacts from waves and underwater currents
- Near-shore and offshore dredging
- Impacts from fishing gear (such as contact with trawls)

To protect the pipelines from damage from such events, the following seabed intervention works will be necessary at certain points along the pipelines' route:

- Dredging (pre-lay)
- Trenching (post-lay)
- Rock placement
- Installation of support structures
- Sheet piling (by vibration)

A description of the seabed intervention works, and their effects on the environment, is given below.

*Dredging (pre-lay) and trenching (post-lay)*

Trenching of the pipelines in the seabed will be carried out, to ensure dynamic stability, such that the pipelines can be protected from excessive movement from waves or subsea currents. Pre-lay trenching is required in some areas along the pipelines' route to create a trench for the pipelines prior to pipe-laying, with subsequent backfill of sediment in some places. Near-shore pre-lay trenching (dredging) will only be required in the shallow water areas near the landfall sites in Russia and Germany. Pipeline burial is required in these areas at a greater depth than for the deep water sections, of the route. Trenches will be excavated by dredging before the pipelines are laid. The excavated soil will be temporarily stored on the side of the trench or further away in a designated area, before being returned to the trench (backfilling) following pipe-laying.

Offshore post-lay trenching will be carried out further from the landfall sites, by a pipeline plough on the seabed. Each pipeline will be lifted onto the plough and supported on rollers at the front and rear ends of the plough. The plough will then be pulled by one to three tugboats, which are connected via towlines, to create a trench below the supported pipeline. In places where it is necessary for the pipelines to be covered prior to the start of pipeline operation, removed material will either be backfilled (in sections where the pipelines are to be buried completely), or used to cover the pipelines thus creating mounds (in sections where the pipelines are to be partly buried in the seabed).

Along most of the trenched sections, mounds of excavated earth will be left at the sides of the pipelines to allow currents and gravity to level the mounds over time. Post-lay trenching is the environmentally and economically preferred method of trenching, and will therefore be the most commonly used trenching method along the pipelines.

Potential impacts associated with dredging and post-lay trenching include:

- Increase in turbidity
- Release of contaminants
- Release of nutrients
- Noise and vibration caused by excavation, backfilling and use of machinery
- Emission of pollutant gases (support vessels)
- Physical alteration of the seabed
- Physical loss of seabed habitats
- Smothering (marine benthos)
- Changes to plankton dynamics
- Impacts from increased vessel traffic (see “Construction and support vessel movement” under “Offshore pipe-laying”)
- Visual/physical disturbance
- Damage to shipwrecks
- Damage to existing cables on the seabed
- Restrictions to future offshore developments

*Rock placement*

Rock placement will be necessary in certain places to ensure the long-term integrity of the pipelines and to achieve buckling stability. Rock placement is the local addition of coarse gravel and small stones to reshape the seabed and provide a continuous support substrate for the pipelines. Rock placement may also be complemented by the installation of concrete mattresses at select locations. The gravel and stones will be transported by ship to the specific locations where rock placement is required, before being loaded into a fall pipe by conveyors on the ship. The rock material will then be deposited on the seabed via the fall pipe. The lowest part of the fall pipe will be equipped with nozzles to allow precise shaping of each gravel support.

The following types of structure will be formed through rock placement:

- Gravel supports for free-span correction (pre-lay and post-lay)
- Post-lay gravel cover as additional stabilisation of the pipelines after pipe-laying
- Gravel basement at locations where major pipe sections are welded together (hyperbaric tie-in points)
- Gravel supports for cable crossings
- Post-lay gravel cover to protect the pipelines from dropped and dragged anchors and ship groundings

The gravel used in rock placement will be chemically and mechanically stable for the entire life of the pipelines, and will not contain any contaminants, such as heavy metals, that could dissolve in the brackish water environment of the Baltic Sea. The gravel shall, furthermore, have no significant iron content and shall be free from clay, silt, chalk, vegetation, or other toxic substances. The preferred type of gravel will be unweathered basalt, gabbro or granite, which is to be extracted from land-based quarries in Finland and/or Norway. The average diameter of the gravel will be approximately 60 mm although this may vary from 16 to 125 mm.

Potential impacts associated with rock placement include:

- Increase in turbidity
- Release of contaminants
- Release of nutrients
- Noise and vibration generated underwater by gravel falling out of the fall pipe
- Emission of pollutant gases (support vessels)
- Physical alteration of the seabed
- Physical loss of seabed habitats
- Smothering (marine benthos)

- Changes to plankton dynamics
- Introduction of secondary habitats by changing soft sediment substrates
- Impacts from increased vessel traffic (see “Construction and support vessel movement” under “Offshore pipe-laying”)

*Installation of support structures*

The installation of support structures will be necessary at specific locations along the pipelines’ route to avoid free spans in areas where the bearing capacity of the soil does not allow for the use of gravel (rock placement).

In most circumstances, the geotechnical problems associated with soft clay or a sloping seabed can be solved by additional rock placement as counter-fill. However, under certain conditions, such as when the natural seabed has a very low bearing capacity, the quantity of gravel required as counter-fill to achieve stability becomes prohibitively large. Furthermore, at certain locations, the load of the gravel required for stability would exceed the bearing capacity of the soil below. In these circumstances, a support structure will be required, the core of which may then be covered by a thinner gravel layer. Any necessary support structures will be lowered to the seabed by means of a crane vessel.

Potential impacts associated with support structures include:

- Increase in turbidity
- Release of contaminants
- Release of nutrients
- Noise and vibration generated by the installation of the support structure
- Emission of pollutant gases (support vessels)
- Physical alteration of the seabed
- Physical loss of seabed habitats
- Smothering (marine benthos)
- Introduction of secondary habitats
- Impacts from increased vessel traffic (see “Construction and support vessel movement” under “Offshore pipe-laying”)

*Sheet piling (by vibration)*

A cofferdam is to be built at the German landfall that will extend offshore. The cofferdam will be constructed with sheet piles, which are interlocked forming a stable and continuous wall. The cofferdam will provide a stable base and a means of access for dredging equipment. In addition, the cofferdam will restrict the level of interaction between the dredging works and surrounding environment, limiting damage to the environment. Vibration will be used for lowering the sheet piles.

Potential impacts associated with sheet piling include:

- Increase in turbidity
- Release of contaminants
- Release of nutrients
- Noise and vibration caused by lowering sheet piles
- Emission of pollutant gases
- Physical alteration of the seabed
- Physical loss of seabed habitats
- Impacts from increased vessel traffic (see “Construction and support vessel movement” under “Offshore pipe-laying”)

**Offshore Pipe-laying**

Offshore pipe-laying will be performed as a conventional S-lay. The individual pipeline sections will be delivered to the pipe-laying vessel, where they will be assembled into a continuous pipe string and lowered to the seabed. The pipelines will be exposed to different forces during the installation, which must be controlled by the pipe-laying vessel. Such forces will mainly result from hydrostatic pressure, tension and bending of the pipelines.

Activities associated with offshore pipe-laying are as follows:

- Pipe-laying
- Anchor handling
- Pipeline tie-ins
- Construction and support vessel movement

A description of these various activities, and their effects on the environment, is given below.

*Pipe-laying*

The process onboard the pipe-laying vessel will comprise the following general steps, as described in **Chapter 4**, which will take place in a continuous cycle:

- Welding of the pipe
- Non-destructive testing (NDT) of welds
- Field joint preparation
- Laying on seabed

Onboard the pipe-laying vessel, the welding of new pipe sections into a continuous pipe string will be performed as either a semi- or fully automated welding process. When the joining process is complete, the vessel will be moved forward a distance corresponding to the length of one or two pipe sections (12.2 or 24.4 m). Following this move, a new pipe section will be added to the pipe string as described above. As the lay vessel moves forward, the continuous pipe string will exit at the rear end of the vessel into the water and slowly be lowered to the seabed.

Potential impacts associated with pipe-laying include:

- Increase in turbidity
- Release of contaminants
- Release of nutrients
- Noise and vibration
- Emission of pollutant gases (vessel movement)
- Physical loss of seabed habitats
- Impacts from increased vessel traffic (see “Construction and support vessel movement” under “Offshore Pipe-laying”)
- Damage to shipwrecks
- Damage to existing cables on the seabed
- Restriction to future offshore developments

*Anchor handling*

A Dynamically Positioned Vessel (DPV) will be used to lay pipeline one (northwest pipeline) from KP 7.5 to KP 300. A DPV may also be used to lay pipeline two (southeast pipeline) from KP 7.5 to KP 300, depending on availability. In areas where DPVs are not being used, pipe-laying vessels will be kept in position by 12 anchors. These anchors are relocated as required by between two and four large (130-200 m) anchor handling vessels.

Potential impacts associated with anchor handling include:

- Increase in turbidity
- Release of contaminants
- Release of nutrients
- Noise and vibration
- Emission of pollutant gases (vessel movement)
- Physical alteration of the seabed
- Damage to shipwrecks
- Damage to existing cables on the seabed
- Restriction to future offshore developments

*Pipeline tie-ins*

The pipelines will be connected in three places by means of pipeline tie-ins. One tie-in will be an above water tie-in, where the water depth is shallow (at KP 1195.9). At this location the pipelines will be lifted to the water surface for tie-in. The other two tie-ins will be hyperbaric tie-ins on the seabed at KP 300 and KP 675.

Potential impacts associated with above water tie-ins include:

- Increase in turbidity
- Release of contaminants
- Release of nutrients
- Noise and vibration
- Emission of pollutant gases (vessel movement)

- Impacts from increased vessel traffic (see “Construction and support vessel movement” under “Offshore Pipe-laying”)

Following pipeline tie-in works, the remaining three sections will undergo pressure testing during pre-commissioning. Once pressure testing is complete, the pipeline sections will be joined by means of hyperbaric tie-in activities at two points (KP 300 and KP 675), as described in **Chapter 4**. Rock placement will take place at tie-in points in order to level the seabed and provide a sturdy base for the pipelines and the tie-in activities. The impacts associated with rock placement are considered under seabed intervention works as they occur prior to tie-in activities.

Potential impacts associated with hyperbaric tie-in activities include:

- Increase in turbidity
- Release of contaminants
- Release of nutrients
- Noise and vibration
- Emissions of pollutant gases (vessel movement)
- Impacts from increased vessel traffic (see “Construction and support vessel movement” under “Offshore pipe-laying”)
- Damage to shipwrecks

*Construction and support vessel movement*

Various construction and support vessels will be present during the construction phase and will operate 24 hours a day.

Potential impacts associated with vessel movements include:

- Emissions of pollutant gases
- Introduction of non-indigenous species (due to the transport and release of ballast water and via biofouling of ship hulls)
- Noise and vibration
- Visual/physical disturbance
- Ice breaking

- Restriction on navigation for fishing vessels
- Disruption of current fishing patterns
- Restriction on navigation for shipping vessels
- Restriction on navigation for recreational vessels
- Restriction on navigation for naval vessels
- Disruption of military movement
- Exclusion zone around Project vessels

### 9.2.2 Pre-commissioning and Commissioning Phase

Following pipe-laying, pre-commissioning and commissioning activities will prepare the pipelines for operation. Pre-commissioning and commissioning activities will include:

- Seawater intake
- Pipeline flooding, cleaning, gauging and pressure testing
- Pressure-test water discharge
- Pipeline drying
- Pipeline commissioning

A description of the activities during the pre-commissioning and commissioning phase, and their effects on the environment, is given below.

**Seawater intake**

The seawater to be used in pipeline flooding and pressure testing will be sourced from a depth of 10 m below the sea surface near the Russian landfall and pumped onshore to a temporary holding facility.

Potential impacts associated with seawater intake include:

- Noise and vibration
- Physical damage to fish eggs and larvae

- Removal of larvae
- Emissions of pollutant gases from pumps

**Pipeline flooding, cleaning, gauging and pressure testing**

To prevent corrosion, additives such as sodium bisulphite ($NaHSO_3$ – an oxygen bonding agent) and sodium hydroxide (NaOH – to set a pH value of 9.5 – 10) could be added to the Baltic Sea water used in pressure testing. The corrosiveness of the Baltic Sea water is currently being investigated. On the basis of these studies, a decision will be made on the suitability of these additives, and as to whether additives are to be used at all.

Additives that are typically used in pressure-test water treatment already exist in seawater and are harmless to the marine environment at natural concentrations. Such additives rapidly break down in the environment though hydrolysis, oxidation, photo degradation and biodegradation.

The pipelines will be cleaned internally by “pigs”. A volume of water will be introduced ahead of the first cleaning pig. The movement of the pigs will be caused by the water used for pressure testing, which pushes the pigs through the pipelines. The integrity of the offshore pipeline sections can be ensured by pressure testing. To carry out this testing, the pipelines will be filled with water and allowed to stabilise at a controlled pressure and temperature. After the stabilisation period, the pressure is increased up to the required hydro-test pressure, by injecting more water into the pipelines. The pressure and the temperature are then monitored over a 24 hour holding period.

Potential impacts associated with pipeline flooding, cleaning, gauging and pressure testing include:

- Noise and vibration caused by water and pig movement within the pipelines
- Emission of pollutant gases by the pumps
- Visual/physical disturbance due to associated vessel movements

**Pressure-test water discharge**

Following pressure testing, the pressure-test water will be discharged by means of dewatering pigs with sealing discs that are sent through the pipelines to push out the water. Dewatering will occur from west to east along the pipelines from the German landfall to the Russian landfall, using compressed air from a temporary compressor station in Lubmin. The water from the pipelines will be discharged into the sea through the temporary discharge line at the Russian landfall. Water will be discharged at a depth of approximately 10 m below the sea surface.

Potential impacts associated with pressure-test water discharge include:

- Noise and vibration (caused by water flow in the pipelines, compressor noise and the discharge of pressure-test water)
- Emission of pollutant gases (by the compressors)
- Change in water quality

**Pipeline drying**

Any remaining water in the pipelines will be removed by means of dry air sourced from a temporary compressor station in Lubmin.

Potential impacts associated with pipeline drying include:

- Noise and vibration (caused by compressor)
- Emission of pollutant gases (from the compressor)

**Pipeline commissioning**

During commissioning, natural gas will be introduced to the pipelines. In order to create a buffer between the natural gas and the air within the pipelines, inert nitrogen gas will be injected prior to the natural gas.

Potential impacts associated with pipeline commissioning include:

- Noise and vibration (caused by gas movement within the pipelines)

### 9.2.3 Operational Phase

The pipelines are expected to be in operation for 50 years. The scale of pipeline-related activities during operation will be far less than those required during the construction phase. However, certain activities can have an impact on the environment. These activities include:

- Routine inspections and maintenance
- Pipeline presence

**Routine inspections and maintenance**

Pipeline inspections will take place both internally and externally. Internal inspections will be carried out using inspection “pigs”. Pigs, individually or in ‘trains’ will enter the pipelines from the inlet point at the Russian landfall site and will be driven through the pipelines by a gas medium. The frequency with which these inspections will be required will depend on the quality of gas fed into the pipeline system, and will be adjusted by Nord Stream as necessary. External inspection surveys will be conducted from a survey vessel equipped with different types of sensors, such as cameras and scanners, for inspecting the general condition of the pipelines and the support medium (seabed). The equipment is normally mounted on Remotely Operated Vehicles (ROV).

Maintenance work on the seabed (rock placement sites, support structures etc) may also be required during the first year once the pipelines have settled. Maintenance during the operational phase is expected to be minimal.

Potential impacts associated with inspections and routine maintenance works include:

- Noise and vibration (caused by survey vessels)
- Increase in turbidity
- Release of contaminants
- Release of nutrients
- Emissions of pollutant gases
- Introduction of non-indigenous species due to the transport and release of ballast water
- Visual/physical disturbance
- Impacts from increased vessel traffic (see “Construction and support vessel movement” under “Offshore Pipe-laying”)
- Disruption of current fishing patterns
- Restriction on navigation for fishing vessels
- Damage to shipwrecks
- Restriction on navigation for shipping vessels
- Restriction on navigation for recreational vessels
- Restriction on navigation for naval vessels

**Pipeline presence**

The presence of the pipelines on the seabed, and the flow of gas through it, may have an impact on the environment. Potential impacts associated with pipeline presence on the seabed include:

- Noise and vibration (caused by gas movement in the pipelines)
- Physical alteration of the seabed
- Physical loss of seabed habitats
- Introduction of secondary habitats
- Change in underwater current flow
- Temperature change (due to gas flow within the pipelines)
- Release of pollutants from anti-corrosion anodes
- Disruption of current fishing patterns
- Damage to fishing equipment
- Restrictions to future offshore developments
- Damage to pipelines

The impacts from all three phases are assessed for each of the five Ecological Sub-Regions (ESRs) identified in **Chapter 8.**

### 9.2.4 Cumulative Impacts

The potential for cumulative impacts arising from the Nord Stream Project in conjunction with other third party activities in the Baltic Sea is considered. These impacts include:

- Cumulative impacts from third party static developments
- Cumulative impacts on shipping and navigation
- Cumulative impacts on $CO_2$ emissions

### 9.2.5 Unplanned Events

In addition to the potential effects of construction and operational activities, which are tightly controlled, environmental and social impacts may arise from unforeseen accidental events. These events are referred to as “unplanned events”.

The nature of the Project is such that there is an inherent risk that an unplanned event may occur during the Project life cycle, which could impact upon the receiving environment. Potential unplanned events that are considered in **Section 9.10** include accidental:

- Fuel/oil spills
- Disturbance of munitions
- Pipeline failure

A description of the impacts associated with each of these events and their effects on the natural and social/socioeconomic environment is given below.

**Fuel/oil spills**

Fuel spills could occur during all phases of the Project, due to malfunction or failure of equipment during bunkering, refuelling operations of working vessels or oil spills due to accidental damage to a vessel (either third party or construction). Potential impacts from fuel/oil spills are discussed in **Section 9.10.2**.

**Disturbance of munitions**

The pipelines' route will be cleared of conventional munitions where possible, prior to construction of the Project and identified chemical munitions will be left in situ as they are not found in the immediate vicinity of the pipelines' route. However, there is a very small possibility that munitions present in the Baltic Sea may go undetected and may therefore be disturbed unintentionally. Potential impacts from disturbance of munitions are discussed in **Section 9.10.3**.

**Pipeline failure**

Pipelines can be damaged, such as from dents or buckling of a pipeline or from ship traffic related interference which may result in pipeline failure. Pipeline failure occurs when a pipeline is unable to work under normal conditions; the most extreme case would result in pipeline rupture, which can occur if there is significant damage to a pipeline, with a subsequent release of gas. Potential impacts from pipeline failure are discussed in **Section 9.10.4**.

### 9.2.6 Decommissioning Phase

Although the nature of the decommissioning process is not yet known, at present it is thought that the pipelines will either be removed or left on the seabed.

Leaving the pipelines in place will involve the following types of activities:

- Pipeline cleaning by flushing with water
- Water-filling
- Sealing

Removal of the pipelines from the seabed will involve the following types of activities:

- Seabed intervention works
- Anchor handling
- Pipe removal
- Vessel movement

The impacts of these activities will not be assessed in detail since it is not possible to predict these at this time, given the 50-year lifespan of the Project.

## 9.3 Ecological Sub – Region I

### 9.3.1 Introduction

ESR I is small (**Figure 9.1**) and extends 22.1 km south westwards from the Russian landfall in Portovaya Bay. The waters in this area are shallow, and salinity is very low. There is no halocline in ESR I. In winter, until April / May, the area is almost entirely ice-covered. Dissolved oxygen levels in the waters are low, but the waters are not oxygen deficient. The water is relatively free from heavy metal contamination and harmful organic impurities, with lead and mercury being the only metal present in high enough concentrations within the sediment of ESR I to exceed the upper OSPAR EAC levels. The seabed largely consists of sand sediments over a crystalline basement, meaning there are relatively high levels of sedimentation and re-deposition in this ESR and a low suspended solid content in the water column. The low salinity means relatively few marine species are found in this ESR. There is, however, a high abundance of benthic-feeding sea birds towards the landfall site in ESR I, with important populations of breeding and feeding waders and sea birds, including international migrant populations. ESR I is also an important area for grey seals. Grey seal pupping takes place on pack ice in February and March. ESR I is demarcated by the following KPs: KP 0 – 22.1.

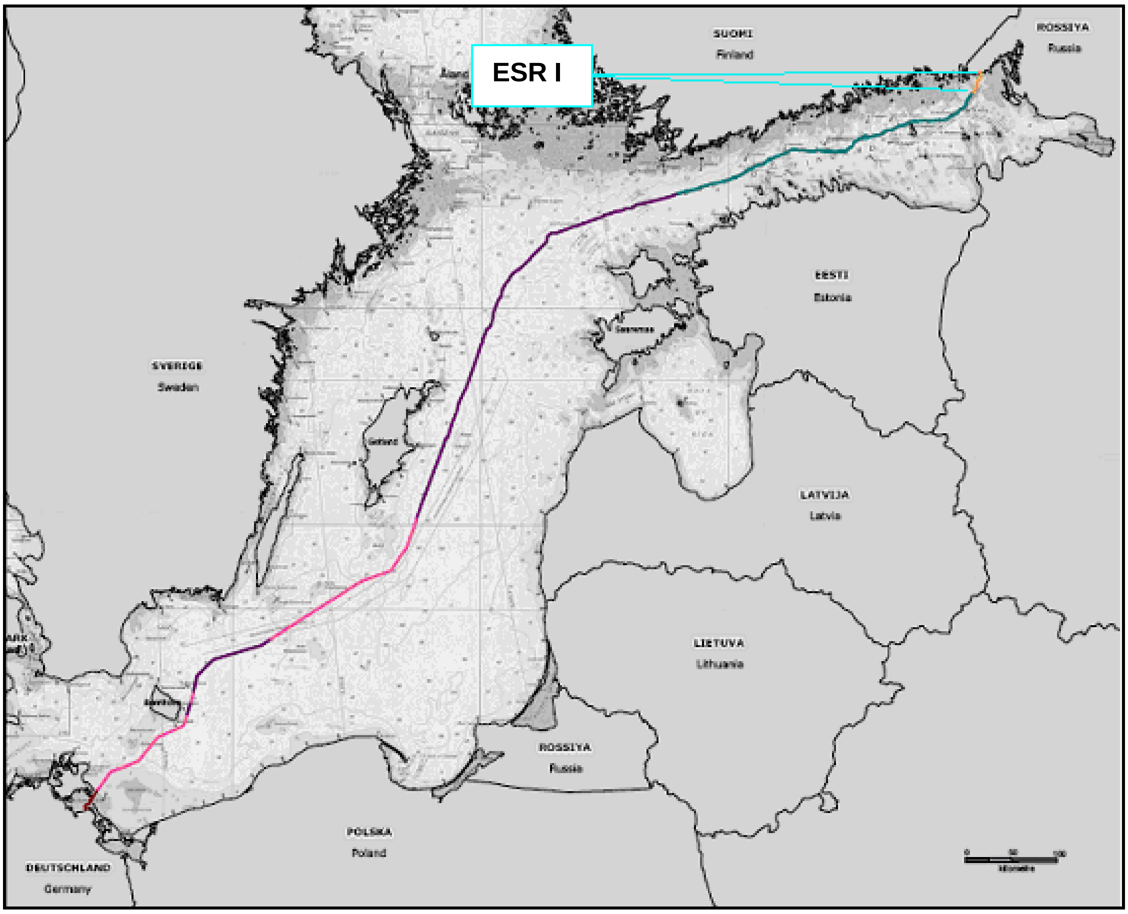


**Figure 9.1 ESR I (in orange) in terms of the pipelines' route**

Predicted impacts in ESR I will occur as a result of the following activities identified during the three initial phases of the Project. These include the following:

**Construction phase**

Seabed preparation activities:

- Munitions clearance

Seabed intervention works:

- Dredging
- Rock placement
- Installation of support structures

Offshore pipe-laying:

- Pipe-laying
- Anchor handling
- Construction and support vessel movement

**Pre-commissioning and commissioning phase**

- Seawater intake
- Pipeline flooding, cleaning, gauging and pressure testing
- Pressure-test water discharge
- Pipeline drying
- Pipeline commissioning

**Operational phase**

- Routine inspections and maintenance
- Pipeline presence

The predicted impacts are identified and assessed as per each resource/receptor in the physical and biological environment. Impacts that are deemed to be of significance when they occur are assessed in full by means of the methodology presented in **Chapter 7**. Impacts that are deemed to be insignificant based upon previous knowledge and experience in similar projects are described but not assessed in detail.

A summary table showing the significant impacts for ESR I is shown at the end of this section (**Table 9.22**).

### 9.3.2 Physical Environment – Physical Processes

**Overview**

This section identifies and assesses the potential impacts on the coastal waters' physical processes in ESR I in terms of the methodology presented in **Chapter 7**.

The physical processes in the Baltic Sea are considered in this report to be the underwater currents occurring as a result of forces exerted on the water column due to the rotation of the earth, the wind, the temperature and salinity of the water column and the gravitational pull of the moon. The movement of these currents is also influenced by the bathymetry of the seabed, freshwater runoff and the shape of the shoreline. The circulation pattern of these currents is particularly complex in the Gulf of Finland, as described in **Section 8.5.2** with meso scale eddy currents occurring in this region.

The main activities in ESR I that are expected to impact on physical processes will occur during the operational phase. There are no expected impacts on the physical processes during the construction or the pre-commissioning and commissioning phase in ESR I since impacts are only likely to occur as a result of the long-term presence of the pipelines on the seabed.

Activities and the associated impacts that are assessed in this section are as follows:

*Operational phase*

- Pipeline presence resulting in:
    - change in underwater current flow

**Impacts during the Operational Phase**

The presence of the pipelines on the seabed in the Gulf of Finland has the potential to alter the composition, strength and direction of the currents. Similarly, currents can be altered due to the effect of a temperature difference between the pipelines and the surrounding water.

*Change in underwater current flow*

Where prevailing currents intersect the pipelines they will be forced to rise. The current field in ESR I is quite complex and is characterised by meso scale eddies due to bathymetrical variations. The pipelines are most likely to impact on current movements in coastal areas, however, within ESR I the pipelines are to be installed within a trench that will extend 1.8 km from the Russian landfall and buried, therefore the possibility of pipeline-generated turbulence being generated, and a significant impact to physical processes, is eliminated. Further offshore, disruption to current movement may occur on a meso scale, but the extent of this is expected to be very small. The height of the pipelines above the seabed will be no more than 1.5 m, and will therefore have little or no impact on the existing current field within ESR I. Moreover, the outflow in the northern part of the Gulf of Finland is not detectable until approximately 20 – 30 km offshore since currents in this coastal area are slowed down by friction(1). Therefore, the effect of pipeline presence on the composition, strength and direction of the currents in ESR I is expected to be **insignificant**.

(1) Andrejev, O. *et al*. 2004. Mean circulation and water exchange in the Gulf of Finland – A study based on three-dimensional modelling. Boreal Environmental Research. 9.

Temperature change can also change underwater current flow. The temperature of the water may be marginally raised in the area immediately adjacent to the pipelines, as described in **Section 9.3.3**. However, since the change in temperature will not be detectable further than 1 m from the pipelines, and since the pipelines will be located in a trench for a length of 1.8 km in ESR I and buried (further reducing heat transfer to the water column), the effect of increased temperature on the water from the pipelines in this section will be **insignificant**.

**Impacts summary**

The impacts on physical processes identified and assessed in ESR I are summarised in **Table 9.2**.

**Table 9.2 ESR I impact summary table for physical processes**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Physical Processes - Ecological Sub-Region** | Change in underwater current flow | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.3.3 Physical Environment – Water column

**Overview**

Following the undertaking of a scoping and impact identification exercise, numerous interactions between the Project and the water column in ESR I have been identified, which could give rise to potential impacts. This section identifies and assesses the potential impacts on the water column in ESR I during the construction, pre-commissioning and commissioning, and operational phases of the Project in terms of the methodology presented in **Chapter 7**.

The characteristics of the water column are not constant throughout the Baltic Sea and differ depending on location as well as depth. Accordingly, the significance of the associated Project impacts on the water column may also differ along the pipelines' route. The quality of the water column is dictated by its salinity and oxygen levels as well as by the concentrations of suspended solids, nutrients, heavy metals, organic pollutants, plankton and biological components. Full details as to the water quality in ESR I are presented in **Section 8.7.1**. Essentially the water column is important for all ecosystems in terms of supporting function and structure but is very resistant to change in terms of its interaction with the Project. In most cases, the water column will rapidly revert back to a pre-impact status once specific activities, such as those during construction, cease. This would depend on the magnitude of the impact and its persistence. As per the sensitivity criteria for the physical environment as detailed in **Section 7.4.4**, the water column has been awarded a **low** value/sensitivity throughout the Baltic Sea.

The main activities that are expected to impact on the water column are those that take place during the construction phase. The re-suspension and spreading of sediments by seabed intervention works is expected to impart the largest impact upon the water column. Accordingly, the characteristics of seabed sediments play a major role in determining the level of impact. Limited impacts are expected in ESR I from the discharge of pressure-test water during pre-commissioning. Impacts during the operational phases are expected to be minimal in comparison to construction. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Re-suspension and spreading of sediments from munitions clearance, boulder removal, seabed intervention works pipe-laying and anchor handling resulting in:
    - Increase in turbidity
- Re-suspension and spreading of sediments from munitions clearance and seabed intervention works resulting in:

- Release of contaminants

- Re-suspension and spreading of sediments from seabed intervention works resulting in:
  - Release of nutrients

*Pre-commissioning and commissioning phase*

- Pressure-test water discharge resulting in:
  - Change in water quality

*Operational phase*

- Pipeline presence resulting in:
  - Temperature change
  - Release of pollutants from anti-corrosion anodes

**Impacts during the Construction Phase**

Impacts upon the water column during the construction phase are limited to the re-suspension and spreading of sediments resulting in an increase in turbidity and the release of contaminants and nutrients as a result of munitions clearance, boulder removal, seabed intervention works, pipe-laying and anchor handling.

*Increase in turbidity*

Construction works on the seabed will also result in the disturbance and subsequent re-suspension of sediments, together with the associated compounds such as nutrients and contaminants, which may be present. This would increase the turbidity levels as well as the concentrations of these substances in the water column. Activities that are expected to disturb the seabed include boulder removal, seabed intervention works, pipe-laying and anchor handling. Seabed intervention works are expected to generate the most re-suspended sediment while boulder removal, pipe-laying and anchor handling are expected to contribute very little. The amount of sediment disturbed is highly dependent on the methods and equipment used during the pipelines' installation phase as well as the extent of the construction works. The degree to which sediments are generally prone to suspension is linked to the fines content and how consolidated the sediment is. Sediments are re-suspended for a period of time before being deposited (sedimentation). It should be noted that seabed intervention works are restricted to specific areas as depicted on **Atlas Maps PR-3A** and **PR-3B**. As such the associated level of impact would not extend along the entire pipelines' route in ESR I.

For the most part, the pipelines' route through ESR I is in the shallow waters of the Baltic Sea. The landfall area has depths up to 14 m. Currents and waves (depending on strength and presence) along the seabed and landfall area will increase the distance to which suspended sediments would be transported laterally as well as the time period for which sediments remain in suspension. Existing turbidity levels are generally higher in the landfall area than offshore.

Prior to construction it is envisaged that munitions clearance will take place within the pipelines' corridor. Route optimisation has ensured that most munitions will be avoided. Surveys of the pipelines' route in Russian waters are currently ongoing and thus the exact locations of munitions have not been confirmed. Munitions that may impact upon the pipelines will require clearing by means of explosives. The clearance of munitions has the potential to re-suspend and spread sediments and contaminants as they are generally in place on or submerged within the seabed.

Modelling of the spread and sedimentation of sediments and the release of contaminants as a result of munitions clearance has been carried for munitions clearance sites in the Finnish EEZ by means of a general numerical particle analysis model (Mike 3 PA)[(1)] . The Mike 3 PA model incorporates specific hydrodynamic data to assess the transport of dissolved and suspended substances. The amount of re-suspension and spreading of sediment is dependent upon the amount and type of detonation explosives and the residual explosive in the munitions, the seabed type and the extent of underwater currents near the seabed. The same model, albeit with different input variables, has been used in the assessment of seabed intervention works locations. As the exact numbers and locations of the munitions to be cleared in the Russian EEZ have not been confirmed, no modelling has taken place as yet. As such, the Espoo Report has considered the modelling performed in Finland and has used it as a basis for assuming that similar impacts would occur in the Russian EEZ.

The clearance of munitions is expected to result in the formation of a crater on the seabed and the re-suspension of sediment throughout the water column. On average, munitions clearance in the Finnish EEZ results in re-suspended sediment with a concentration above 1 mg/l within 1-2 km, with a maximum in some locations of 5 km, of the disturbance area for 13 hours. A concentration above 10 mg/l is expected to last for 4 hours on average and close to the clearance site. Sedimentation is limited and rarely exceeds 0.1 kg/m$^2$. The impacts in the Finnish EEZ are expected to be similar to those that would occur in the Russian EEZ and thus in ESR I. Therefore, due to the limited extent and duration of increased turbidity levels and the fact that munitions clearance will only occur at specific points (when confirmed) on the pipelines' route it is expected that the impact (**negative** and **direct**) on the water column in ESR I will be of **regional** scale (above background levels) and of **short-term** duration (sedimentation rate). Impacts will be **reversible** within a few days as sediment settles to the seabed. Intensity is **low**

(1) Nord Stream AG & Ramboll. 2008. Memo 4.3A-12 - Spreading of sediment and contaminants from clearing of munitions.

as no major change in structure and function is expected. Impact magnitude is **low**. Therefore impact significance is expected to be **minor**. The landfall area typically has high levels of turbidity due to current and wave action.

During construction, boulders in ESR I that may interfere with the construction activities are to be removed. The removal of boulders may result in a very **local** increase in turbidity. However, re-suspended sediment is not expected to increase the current turbidity levels, which are generally quite high, and thus this impact is regarded as being **insignificant**.

The re-suspension and spreading of sediments is expected to be greatest during seabed intervention works that include dredging (landfall only and 1.8 km in extent) and rock placement. Modelling of the spread and sedimentation of sediments and contaminants during works in the seabed in ESR I has been carried out by using a general numerical particle analysis model (Mike 3 PA) for locations along the pipelines' route where pre-lay dredging and pre and post-lay rock placement will take place. The Mike 3 PA model incorporates specific hydrodynamic data to assess the transport of dissolved and suspended substances. It is accepted that an approximate 100 m corridor on either side of the pipelines will be reserved for construction activities. As such, only particles that are eligible for transport beyond 100 m from pipelines are considered in modelling. The Mike 3 PA model involves numerous inputs in relation to the type of seabed intervention works. The initial input for sediment modelling is the expected spill rate for the various activities. The spill rate for dredging (7 kg/s) was determined by the average dredging speed, the nominal volume of displaced sediment, the percentage spill (10 %) and the density of the spilled sediment. The spill rate for rock placement (1 kg/s) was determined by the placement rate, rock volume and falling velocity (kinetic energy converted to potential energy on impact). Sediments are released at a height of 2 m above the seabed for dredging and rock placement. For dredging at the landfall suspended sediment is expected to be very close to the sea surface. The distance a particle travels is governed by particle grain size, flocculation, grain size fractions, hindered settling in high concentration areas, water properties, grain size distribution and settling velocity. The different types of seabed intervention works and types of sediments for ESR I are detailed in **Table 9.3**.

**Table 9.3 Seabed intervention works (both pipelines) and sediments types for Ecological Sub-Region I**

| Area | Seabed Intervention Works | Sediment Types |
|---|---|---|
| Russian landfall area | Dredging | Sand and silt/mud |
| Offshore (>KP 1.8) | Rock placement | Predominantly mud and hard clay |

The areas and average duration of re-suspended sediment concentration > 1 mg/l for ESR I are shown on **Atlas Map MO 25** for normal weather. An excess concentration of 1 mg/l (the model used a background concentration of 0 mg/l) will hardly be visible in the water since normal concentrations in the Baltic Sea are typically in the range of 1 – 4 mg/l during normal weather and even higher during stormy conditions. As such, the sediment clouds shown on the **Atlas Maps** may be regarded as the maximum extent of the sediment spreading (for normal weather conditions). Sedimentation for ESR I in terms of the amount of sediment deposited on a square metre of seabed is depicted on **Atlas Map MO 26**.

For dredging at the Russian landfall, modelled re-suspended sediment with a concentration above 1 mg/l is expected within 3 km to the east and 1 km to the west (extent restricted by the boundaries of Portovaya Bay) of the disturbance area (total area - 35.6 $km^2$) for approximately 12 hours. A concentration above 10 mg/l (a value where avoidance reactions of some fish species can be observed) is expected to last for 13 hours over an area of 5.6 $km^2$. Sedimentation is modelled to be greater than 10.0 $kg/m^2$ up to 220 m from the source and from 0.1 to 1 $kg/m^2$ up to 400 m away. 1.0 $kg/m^2$ is equivalent to 1 mm of sediment over a square metre. Very high levels of sedimentation are expected within 200 m from the disturbance area.

For rock placement beyond KP 1.8 (end point of dredging), modelled re-suspended sediment with a concentration above 1 mg/l is expected within 1.5 km of the disturbance area for approximately 12 hours. A concentration above 10 mg/l is expected to last for 5.2 hours close to the disturbance area. Sedimentation is modelled to range from 0.1 to 1.0 $kg/m^2$ within 500 m of the source and from 0.01 to 0.1 $kg/m^2$ 1.5 km away.

Re-suspended sediments are expected to remain within 10 vertical metres of the seabed. However, the effect of currents and wave action can mobilise sediments towards the surface in the shallow areas. Sediment re-suspended by dredging activities is expected to reach the surface due to the shallow bathymetry of the landfall. Due to the limited extent and duration of increased turbidity levels and the fact that seabed intervention works will only occur at specific points on the pipelines' route it is expected that the impact (**negative** and **direct**) on the water column in ESR I will be of **regional** scale (above background levels) and of **short-term** duration (sedimentation rate). Impacts will be **reversible** within a few days as sediment settles to the seabed. Intensity is **low** as no major change in structure and function is expected. Impact magnitude is **low**. Therefore impact significance is expected to be **minor**. The landfall area typically has high levels of turbidity due to current and wave action.

Pipe-laying can result in the re-suspension and spreading of sediments due to the current generated in front of the pipelines as they near the seabed as well as from the pressure transfer when the pipelines hit the seabed. The amount of sediment that is expected to be placed into suspension during pipe-laying has been determined by considering the vertical velocity of the descending pipelines, the flow velocity of the water during displacement, the Shields parameter[(1)], which defines the limit at which particles start to move, the upwards flow generated by an increase in pore pressure due to sediment compression and both hard and soft sediment characteristics[(2)]. Along a 1 km stretch of a pipeline it is expected that the amount of suspended sediment, when the pipeline hits the seabed, would be up to 600 kg 1 m above the seabed for soft sediments. During pipe-laying, anchors (anchor handling) will be used to position the pipe-laying vessel. Anchor handling involves the placement and retrieval of 12 anchors on the seabed for every 200 – 600 m of pipeline laid. Anchor placement and retrieval, as well as the anchor cable sweeping across the seabed, will result in the re-suspension of sediments. The amount of sediment that is placed in suspension has been determined by considering similar variables to those used for pipe-laying[(3)]. During both anchor placement and retrieval it is expected that 10-160 kg of sediment will be placed in suspension per anchor. Approximately 100-150 m of anchor cable is expected to lay at rest on the seabed and will sweep across the seabed as the lay vessel moves forward resulting in the release of 400-1600 kg of sediment. Anchor handling results in a suspended sediment concentration >10 mg/l over a very limited area of 0.004-0.016 $km^2$. Even though pipe-laying and anchor handling would extend along the entire pipelines' route in ESR I it is expected that the effects of these activities would compare well to the effects of bottom trawling activities (dragging of trawls along the seabed) as well as normal anchor placement in the Baltic Sea. As such it is expected that these activities will contribute very little to the overall amount of sediment placed into suspension during the construction phase and thus the impact is **insignificant**. A DPV will be used to lay pipeline one (northwest pipeline), and possibly also pipeline two (southeast pipeline), from KP 7.5 to KP 300, depending on availability. An anchor-positioned vessel will be used to lay both pipelines at all other locations along the pipelines' route.

*Release of contaminants*

Contaminants (identified as cadmium, mercury, lead, zinc, copper, arsenic, chromium, nickel, polycyclic aromatic hydrocarbons (PAH) and tributyltin) are typically bonded to the sediment particles in the accumulation (sedimentation) areas of ESR I. In order to evaluate their ability to spread and dissolve in the water column various parameters are required. Contaminant concentrations for the sediments have been determined via various surveys as per **Chapter 8**. In order to cause a toxicological effect a contaminant has to be bioavailable in the water column. Desorption (the fraction of a chemical compound in bound sediment that will desorb during re-suspension) and bioactivity (the fraction of the desorbed chemical compound capable of being taken up by receptors) affect how much of a contaminant becomes bioavailable. Values for desorption have been generalised at 50% for metals and 10% for organic pollutants, while values for bioactivity have been generalised at 25 % for metals and 100% for organic pollutants.

(1) Shields parameter - A dimensionless variable that predicts when the basal shear stress is sufficient that sediment of a particular size will be transported.

(2) Nord Stream AG & Ramboll. 2008. Memo 4.3A-4 – Spreading of sediments during pipeline layout.

(3) Nord Stream AG & Ramboll. 2008. Memo 4.3A-9 – Release of sediments from anchor operation.

A combination of all these values realises a release rate of a contaminant to the water column. The release of contaminants leads to an increased concentration in the water column. In order to quantify a risk the ratio between Predicted No-Effect Concentration (PNEC)[(1),(2),(3),(4),(5)] and the Predicted Environmental Concentration (PEC) is applied (PEC/PNEC). A PEC/PNEC ratio of less than or equal to one suggests that no adverse effects are anticipated while a ratio greater than one suggested that adverse affects may occur. Relative toxicity of a contaminant is seen as a function of the desorbed and bioactive fractions and the predicted no-effect concentration in the water column. Copper and PAHs are seen as the most critical compounds in terms of toxicity.

Both munitions clearance and seabed intervention works will result in the release of contaminants into the water column. As the number, and locations, of munitions that require clearance in the Russian EEZ has not been confirmed no modelling of the release of contaminants has taken place. Modelling has, however, been performed for munitions clearance locations in the Finnish EEZ[(6)]. As such, the Espoo Report has considered the modelling performed in Finland and has used it as a basis for assuming that similar impacts would occur in the Russian EEZ.

For munitions clearance locations in the Finnish EEZ, dissolved copper is modelled and predicted to exceed the PNEC (>0.02 µg/l) up to a distance of 1-3 km from the source during normal weather. The duration for which copper concentrations are expected to be greater than the PNEC is 6 hours. Dissolved PAHs are expected to exceed the PNEC (>0.000009 µg/l) up to a maximum distance of 1-3.5 km from the source during normal weather. The duration for which PAH concentrations are expected to be greater than the PNEC is 7 hours. The impacts in the Finnish EEZ are expected to be similar to those that would occur in the Russian EEZ and thus in ESR I. Therefore, due to the limited extent and duration of increased contaminant concentration levels and the fact that munitions clearance will only occur at specific points on the pipelines' route it is expected that the impact (**negative** and **direct**) of the release of contaminants is

(1) Netherlands Organisation for Applied Scientific Research (TNO). 2004. Update of an evaluation of PNEC values for water produced water according to the revised marine EU-TGD. The Netherlands.

(2) Australian Pesticides and Veterinary Medicines Authority. 2005. The reconsideration of registrations of arsenic timber treatment products (CCA and arsenic trioxide) and their associated labels. Part 2 – Environmental assessment.

(3) European Chemicals Bureau. 2005. European Union Risk Assessment Report Chromium Trioxide, Sodium Chromate, Sodium dichromate, Ammonium Dichromate and Potassium Dichromate.

(4) HLD, 2004. Conoco Phillips Scandinavia AS – Ekofisk Tank Cleaning Feasibility Study for cover of inner and outer annuli – Cover design and execution methods.

(5) Norwegian Oil Industry Association. 2003. A manual for standardised modelling and determination of the environmental impact factor (EIF). Norway.

(6) Nord Stream AG & Ramboll. 2008. Memo 4.3A-12 - Spreading of sediment and contaminants from clearing of munitions.

expected to be **regional** (above the PNEC), of **short-term** duration due to the expected settling of suspended sediment bound contaminants and of **low** intensity as no change is expected in the structure and function of the water column. Impacts will be **reversible** within a few days. Impact magnitude is therefore **low**. As both the impact magnitude and receptor value/sensitivity are **low**, impact significance is expected to be **minor**.

Detailed contaminant modelling has been performed in ESR I for seabed intervention works only.

The spreading of contaminants from seabed intervention works was analysed in terms of the suspended contaminant concentrations quantified by the following measures:

- Total amounts of suspended, desorbed and bioactive contaminants
- Time series at the largest rock placement sites
- Area and average duration of contaminant concentrations > PNEC

The spreading of contaminants was only considered at rock placement areas since dredging areas are typically erosion areas and do not display a significant level of contamination. The spreading of contaminants by pipe-laying and anchor handling is not considered as only a limited amount of sediment is expected to be re-suspended. The maximum concentrations of copper and PAHs for rock placement sites in ESR I are shown on **Atlas Maps MO 50-51**. The locations of the affected areas are highly sensitive to the current speed and direction since the contaminants are treated as dissolved particles that do not settle.

For rock placement, dissolved copper is modelled and predicted to exceed the PNEC (>0.02 µg/l) up to a distance of 1 km from the source during normal weather. The duration for which copper concentrations are expected to be greater than the PNEC is 7.5 hours. Dissolved PAHs are expected to exceed the PNEC (>0.000009 µg/l) up to a maximum distance of 250 m from the source during normal weather. The duration for which PAH concentrations are expected to be greater than the PNEC is 14 hours.

Due the limited extent and duration of increased contaminant concentration levels and the fact that seabed intervention works will only occur at specific points on the pipelines' route it is expected that the impact (**negative** and **direct**) of the release of contaminants is expected to be **regional** (above background levels), of **short-term** duration due to the expected settling of suspended sediment bound contaminants and of **low** intensity as no change is expected in the structure and function of the water column. Impacts will be **reversible** within a few days. Impact magnitude is therefore **low**. As both the impact magnitude and receptor value/sensitivity are **low**, impact significance is expected to be **minor**. Seabed intervention works will not contribute additional contaminants to the Baltic Sea but would be active in their relocation.

During seabed intervention works, any $H_2S$ present in the sediment can be released into the water column after which it would react rapidly with any oxygen in the water forming $H_2SO_4$. This results in reduced oxygen levels in the water column. This effect is expected to be temporary as the exchange of water masses will ensure that the oxygen depleted water will be oxygenated. The impact is expected to be **insignificant**.

Chlorinated dibenzo-p-dioxin (PCDD) and dibenzofuran (PCDF) compounds or 'dioxins' may be present in the sediments of ESR I. Dioxins are practically insoluble in water and therefore are not found in great concentrations in the water column but more likely to accumulate in sediments(1). Dioxins do, however, dissolve easily in lipids and are readily accumulated in fatty tissues of fish and marine benthos. There is the potential that with the disruption of sediments due to munitions clearance, pipe-laying, anchor handling and seabed intervention works, dioxins that have accumulated in the sediments may be released into the water column and thereafter bioaccumulate in marine biota and move up through the food chain eventually affecting human health.

Dioxins that have accumulated in sediment tend to be tightly bonded to sediment particles and desorb quite slowly. As per the modelling results for the re-suspension and spreading of sediment, it is expected that re-suspended sediments will not be distributed throughout water column but will be concentrated within 10 vertical metres of the seabed and will settle over a few days. As most dioxins are bonded to the sediment particles it is therefore assumed that they will behave in the same manner and will settle on the seabed. As such, the impact on the water column is expected to be **insignificant** and only limited bioaccumulation in marine biota is expected.

*Release of nutrients*

A release of nutrients, such as nitrogen and phosphorus, during the re-suspension and spreading of sediments from construction activities could stimulate phytoplankton production, should they reach the photic zone, and thereby increase the biomass. An increase in primary production could also potentially contribute to oxygen consumption by the degradation of organic matter. Due to the shallow nature of ESR I, it is likely that the re-suspension of the spreading of nutrients would result on the release of nutrients into the photic zone.

An assessment into the amount of sediment to be released into the water column as a result of seabed intervention works, the expected nutrient content of the disturbed sediment and expected amount of nitrogen and phosphorus to be released has been conducted for that part of the pipelines' route in the Baltic Proper(2). The Baltic Proper includes the Gulf of Finland and thus ESR I. The Greifswalder Bodden (ESR V) was considered separately. The assessment of the impacts associated with the release of nutrients to the water column in ESR I is considered

(1) Helsinki Commission. 2004. Dioxins in the Baltic Sea.

(2) Swedish Environmental Research Institute (IVL). 2008. Complementary IVL background report - Consequences of nutrients released from seabed intervention works.

in terms of data applicable to the Baltic Proper (ESR I, II, III and IV). Taking into consideration the estimated amount of sediment to be re-suspended in the Baltic Proper (~3 400 000 tonnes) and the typical nutrient concentrations within the sediment, it is expected that 22 000 and 4 000 tonnes of nitrogen and phosphorus will be released respectively [(1)]. The Swedish Environmental Research Institute (IVL) calculated the mass balance for nitrogen and phosphorus inputs[(1),(2)] for the whole of the Baltic Proper thereafter determined the magnitude and duration of an increase in nutrient concentration by means of a model developed in a graphic simulation software package (Stella). Most nutrients within the sediments are typically bound to the individual particles and thus are not directly bioavailable. These particulate forms of nutrients will eventually re-settle on the seabed.

**Figure 9.2** shows a simulation of nitrogen concentration in the Baltic Proper assuming a nitrogen release of 53 000 tonnes from seabed intervention works over a four year period. A small increase in nitrogen concentration in the water column from the reference level of 267 µg/l up to 269 µg/l (an increase of 2 µg/l or less than 1%) is evident. The increase is only just visible on the graph. The nitrogen concentration in the water column is expected to return to background levels within a maximum of 10 years if it is assumed that nitrogen inputs to the Baltic Sea are constant. However, the background levels of nitrogen fluctuate constantly and thus the release of nitrogen and the subsequent increase in concentration in the water column is not expected to be a significant impact.

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(1) Håkanson L. & Bryhn A.C. 2008. Tools and criteria for sustainable coastal ecosystem management – with examples from the Baltic Sea and other aquatic systems. Springer, Heidelberg.

(2) Wulff F.V., Rahm L.A. & Larsson P. (eds.). 2001.A Systems Analysis of the, Baltic Sea. Ecological Studies 148. Springer. Heidelberg.

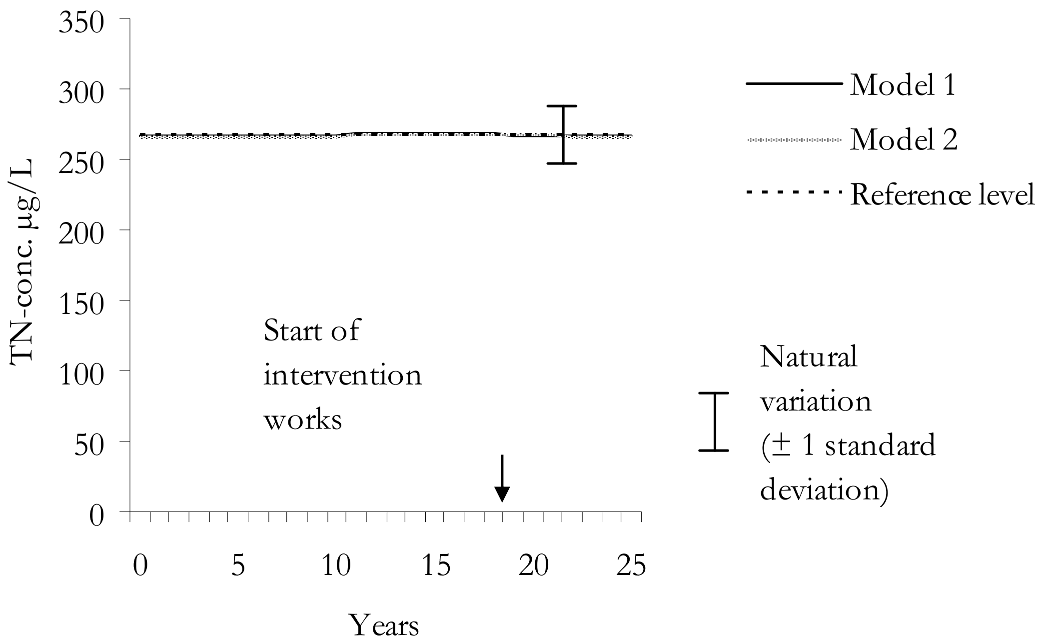


**Figure 9.2** **Simulation of nitrogen concentration in the open water of Baltic Proper assuming a nitrogen release of 53, 000 tonnes from seabed intervention works (13, 000 tonnes per year, from year 10 to 13)**

**Figure 9.3** shows a simulation of phosphorus concentration in the Baltic Proper assuming a phosphorus release of 12 000 tonnes from seabed intervention works over a four year period. A very small increase in phosphorus concentration in the water column from the reference level of 30 µg/l up to 30.7 µg/l (small increase of 0.7µg/l, or 2.3%) is evident. The increase is only just visible on the graph. The phosphorus concentration in the water column is expected to return to background levels within a maximum of 5 years if it's assumed that phosphorus inputs to the Baltic Sea are constant. However, the background levels of phosphorus fluctuate constantly and thus the release of phosphorus and the subsequent increase in concentration in the water column is not expected to be a significant impact.

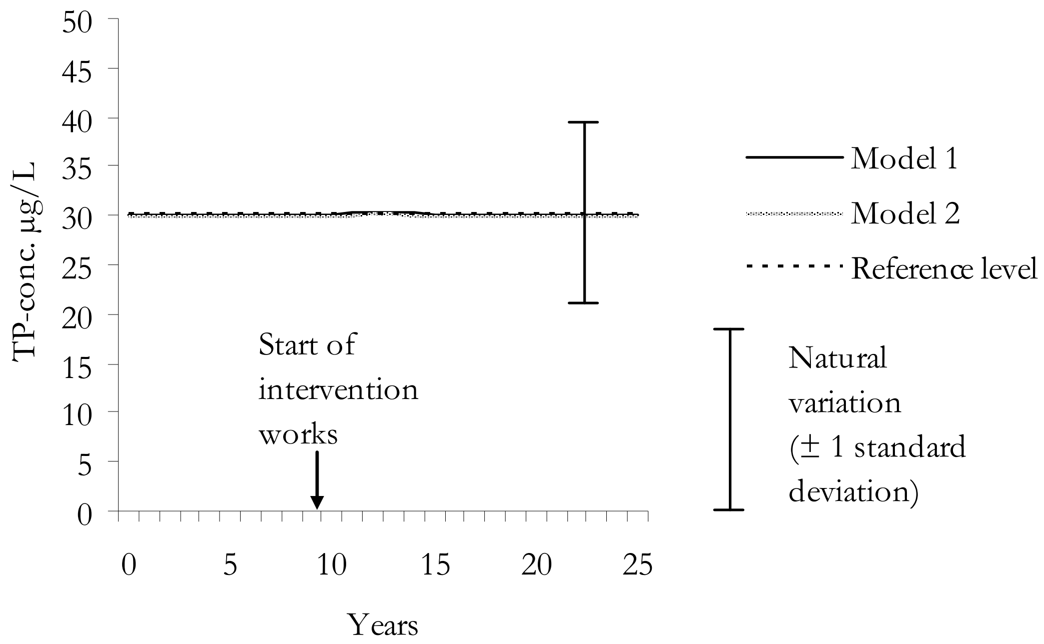


**Figure 9.3 Simulation of phosphorus concentration in the open water of the Baltic Proper assuming a phosphorus release of 12,000 tonnes from seabed intervention works (3,000 tonnes per year, from year 10 to 13)**

Simulations indicate that the likely increase in nutrient concentration resulting from seabed intervention works in the Baltic Proper is small in relation to current nutrient inputs. Accordingly, the release of nutrients into the water column should not generate increases in nutrient concentrations outside the normal range of conditions. Since most of the nutrients in sediments are bound to particles, and will not contribute to primary production, much of the increase in concentration will be reversed as particles settle out. The immediate impact of the release of nutrients would occur during seabed intervention and thus will be of short duration. The release of nutrients will result in an increase in nutrient concentration that would not extend beyond normal conditions[1] and therefore the impact on the water column is assessed to be **insignificant** in ESR I.

**Impacts during the Pre-commissioning and Commissioning Phase**

Impacts upon the water column during the pre-commissioning and commissioning phase are limited to a change in water quality due to the discharge of pressure-test water near the landfall.

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(1) 'Normal conditions' are defined as pre impact status conditions i.e. the existing water column for ESR I prior to commencement of the Project, as detailed in Section 8.7.1.

*Change in water quality*

The impact on the water column from the discharge of pressure-test water depends on which substances are added to the seawater following intake. At present, seawater intake will take place near the Russian landfall and thereafter the seawater will be filtered and treated with caustic soda (NaOH) and an oxygen scavenger (sodium bisulphite - $NaHSO_3$). 1.27 million $m^3$ of pressure-test water will be used and discharged per pipeline.

All substances used in pressure-test water treatment already exist in seawater and are harmless to the marine environment at natural concentrations. On discharge, these substances will rapidly degrade and break down in the water column though hydrolysis, oxidation, photo degradation and biodegradation.

To assess the effects of pressure-test water discharge, parameters have been compared with standards of the European Commission. These quality standards have been described in EU Directives, including 76/160/EU(1) and 2006/113/EC(2) for swimming water and shellfish water, respectively. According to these standards the pH value may not exceed 9 and the mandatory oxygen concentration for shellfish water may not drop below 70% of saturation (approx. 7 mg $O_2$/l). Investigations in the Portovaya Bay show average salinity values from 2.5 ppt to 5.3 ppt and mean temperature in the Gulf of Finland from 8.9°C to 12.4°C. Using average salinity of 3.5 ppt and average temperature 10.6°C the oxygen saturation level is calculated to 10.6 mg $O_2$/l (using Weiss equation for the oxygen/temperature/salinity relationship(3)). According to Russian regulations the “Minimum Allowable Concentration” (MAC) for oxygen is set to at 6 mg$O_2$/l(4). On this basis the acceptable level for oxygen has been set at 7 mg $O_2$/l. In order to reach full acceptable levels of oxygen and pH in the sea the discharged pressure-test water must be diluted with seawater to obtain a minimum oxygen concentration of 7 mg/l and a pH below 8. This necessitates a dilution ratio of 10 which brings about a pH of 7.7, an oxygen level of 7 mg/l and turbidity of 6 mg/l (not visible).

(1) The Council of the European Communities. 1975. Council Directive 76/160/EEC of 8 December 1975 concerning the quality of bathing water.

(2) The European Parliament and the Council of the European Union. 2006. Directive 2006/113/EC of the European parliament and of the council of 12 December 2006 on the quality required of shellfish waters. Official Journal of the European Union.

(3) United States Geological Survey (USGC). 1981. Water quality - New tables of dissolved oxygen saturation values. http://water.usgs.gov/admin/memo/QW/qw81.11.html (accessed October 15, 2008).

(4) PeterGaz. 2006. The north European gas pipeline. Offshore section (The Baltic Sea). Environmental Survey. Part 1. Stage 1. Book 5. Final report. Section 1 Russia’s EEZ and territorial waters. Folder 1.

The impact of pressure-test water discharge on the environment has been assessed by numerical modelling (Cormix model and Mike 3A)[(1)]. Initial results of near-field[(2)] modelling of the extent of dilution indicate sufficient dilution of discharged pressure-test water close to the discharge point (15-40 m). Far-field[(3)] modelling shows that discharged pressure-test water is easily diluted to an acceptable level (>10 ratio) within the Portovaya Bay for conditions both with and without ice. Modelling has concluded that discharged pressure-test water will be diluted by a factor of at least 10 (acceptable) beyond 100 m from the discharge point. A dilution ratio of 50 (effect of discharge will not be detectable) will be evident at the outer perimeter of the Portovaya Bay. The situation in Portovaya Bay is expected to return to normal (dilution factor of 100) within 12-24 hours after the discharge has stopped (during ice free periods).

Based upon the modelled extent and duration of dilution, the impact on water quality (**negative** and **direct**) of the discharge of pressure-test water at the Russian landfall is expected to be **regional**, of **temporary** duration and of **low** intensity. Impact magnitude is therefore **low**. As both the impact magnitude and receptor value/sensitivity are **low**, impact significance is expected to be **minor**. Impacts will be **reversible** within a few days.

### Impacts during the Operational Phase

Impacts upon the water column during the operational phase are limited to the transfer of heat by the movement of natural gas within the pipelines as well as the release of pollutants from anti-corrosion anodes in place on the pipelines.

*Temperature change*

A gas temperature of around 40ºC is expected at the Russian landfall as a result of the natural gas heating during compression. The gas temperature will slowly decrease as the gas expands (Joule-Thomson effect) and due to the exchange of heat with the surrounding environment. The difference in temperature between the gas and the surrounding water column or sediment, may result in a temperature change in the water column.

A Computational Fluid Dynamics (CFD) model, specifically ANSYS CFX Version 11, was used to simulate potential changes in temperature in the surrounding water column and sediment in ESR I[(4)]. A conservative approach was adopted in terms of the input data used:

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(1) Nord Stream AG & Ramboll. 2008. Memo 4.27 - Discharge of test water at Russian coast – environmental assessment.

(2) Near field is defined as the zone where the dilution is dominated by the momentum and buoyancy (negative or positive) from the discharge.

(3) Far field is defined as the zone where the discharge water is embedded in the ambient water and the momentum has dissipated so that the dilution is determined by the ambient water.

(4) Nord Stream AG & Ramboll. 2008. Memo 4.3R - Temperature difference between pipeline and surroundings.

- Inlet gas temperature: 60°C.
- Seawater temperature: -2°C.
- Sediment temperature: 0°C.
- Sea current velocity: 0.1 m/s.

**Figure 9.4** presents a simulation at the Russian landfall for an entrenched pipeline during winter. It is evident that there is an increase in temperature within a 10-20 cm wide zone around the pipeline. Within the first 2-3 cm the temperature in the sediment is expected to increase to 40°C.

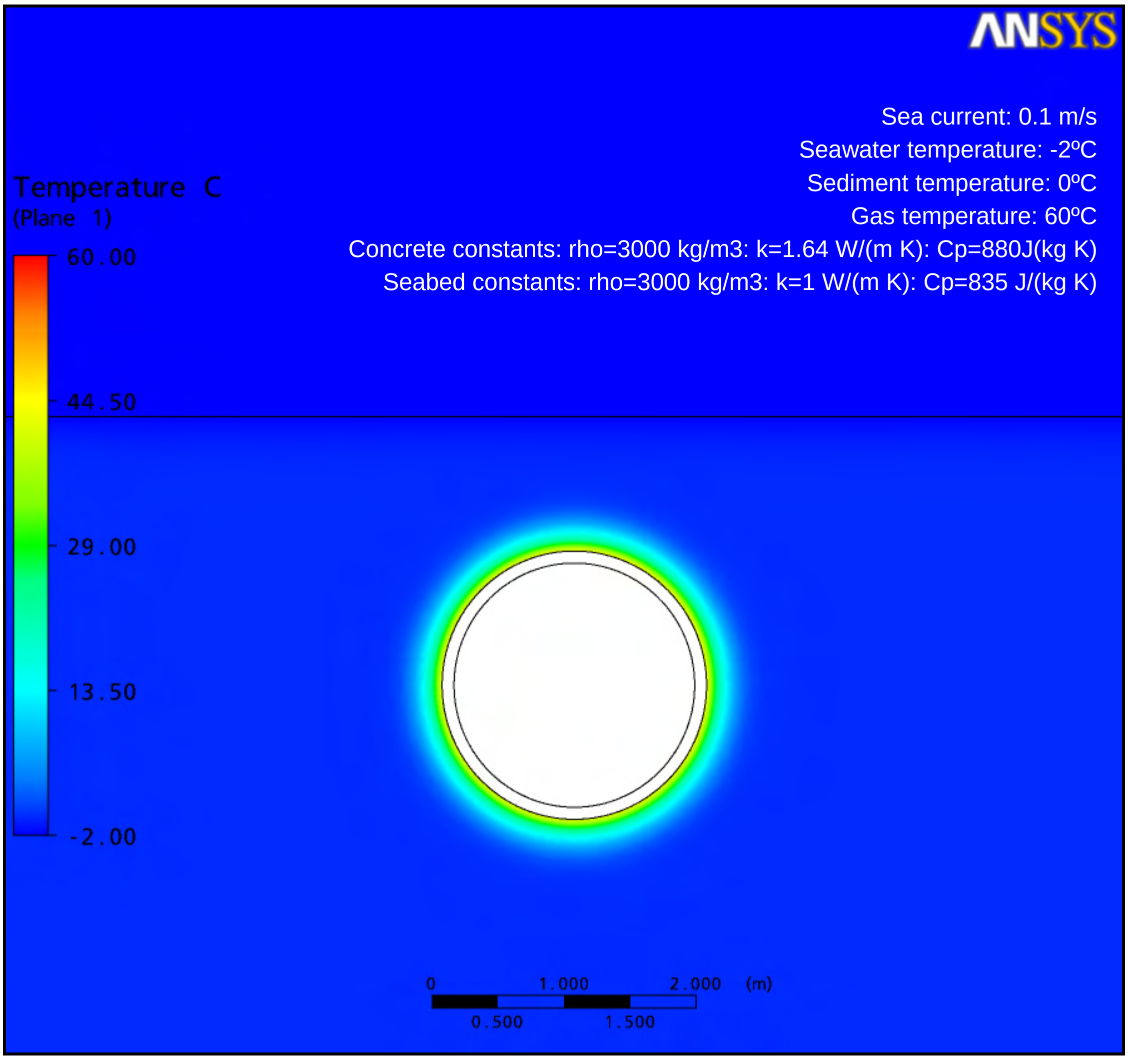


**Figure 9.4 Model showing the temperature effect from a pipeline with 60ºC gas and trenched 1 m into the seabed. The horizontal line represents the seabed**

**Figure 9.5** presents a simulation at the Russian landfall for a pipeline on the seabed during winter. It is evident that there is there is an increase in temperature (0.5°C) in the water near the seabed and on the downstream side of the pipeline. The temperature effect is only detectable from a maximum distance of 0.5-1 m from the pipeline.

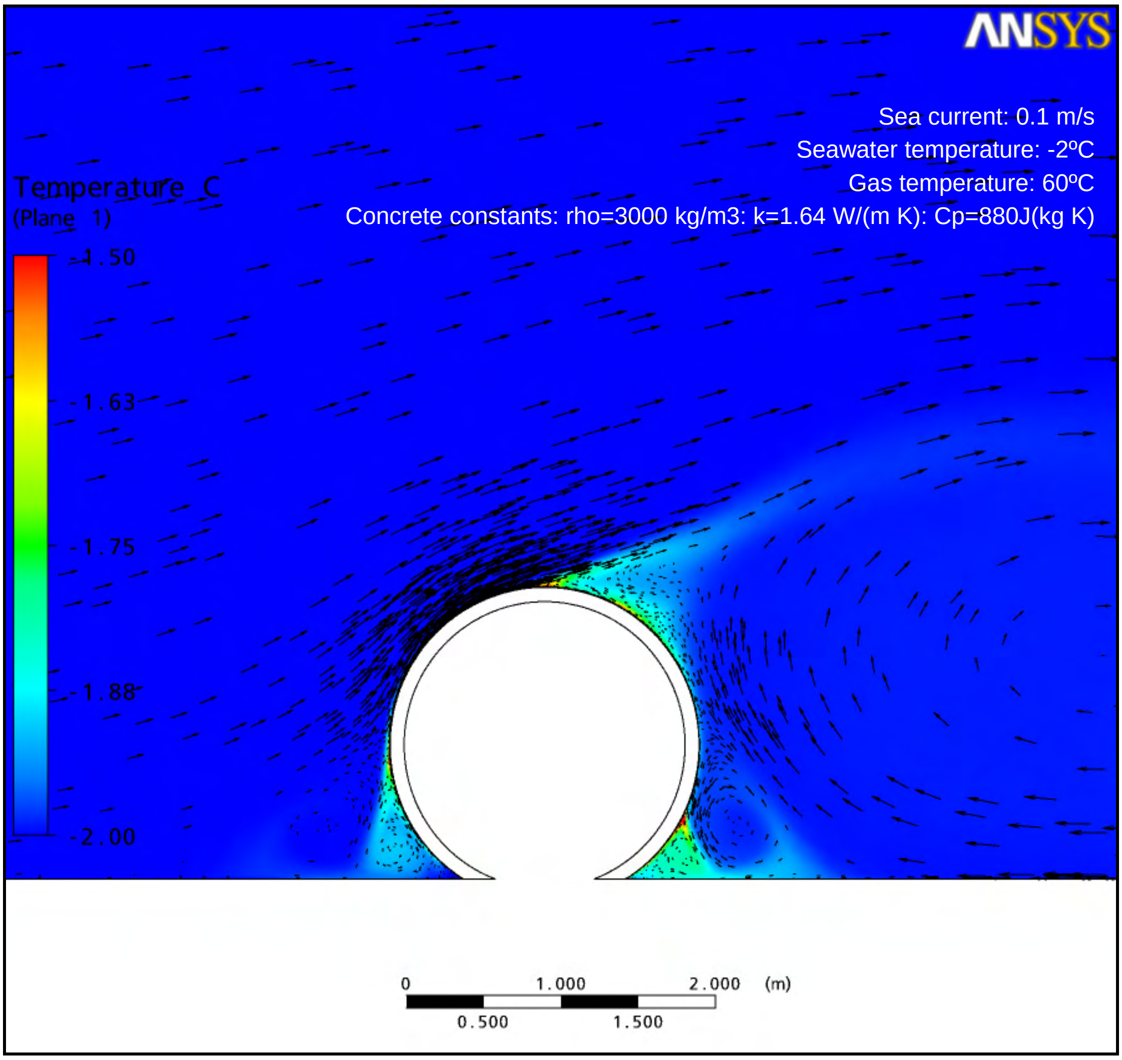


**Figure 9.5 Model showing the temperature effect from a pipeline with 60ºC gas on the seabed**

Taking into consideration that no significant change in temperature is detectable in the water column 1 m from the pipeline based upon the simulations and the fact the pipeline is to be buried within the seabed for the first 1.8 km and thus little interaction will take place with the overlying water column, the impact is deemed to be **insignificant**.

*Release of pollutants from anti-corrosion anodes*

To minimise external corrosion, sacrificial anodes are to be installed at regular intervals along each pipeline. The potential impacts on water quality from pipeline anodes are related to the release of metal ions from the anode material during the lifetime of the pipelines'. Impacts on water quality are only expected in areas where there is a direct interaction between the anode and the water column. The impacts associated with trenched areas are assessed in terms of the seabed in **Section 9.3.4.**

The release rate of metal ions depends on the total amount of anode material, the toxic metal content in the anode material and the attraction of the anodes. The preferred anodes for the Nord Stream pipelines' along most of the route will be made of indium-activated aluminium. In addition, a number of Zinc anodes are considered, particular in the Gulf of Finland where salinity levels are very low. Both the Zinc and Aluminium anodes contain traces of cadmium. Zinc and Cadmium are considered to be toxic and bioaccumulative. The total mass of anodes to be used in the overall pipelines in each of the Ecological Sub-Regions is presented in **Table 9.4**.

**Table 9.4 Total mass of alloy per ecological sub-region for both pipelines**

| | **ESR I 22.1 km** | **ESR II 296.3 km** | **ESR III 542.3 km** | **ESR IV 337.4 km** | **ESR V 24.6 km** | **Total: 1222.7 km** |
|---|---|---|---|---|---|---|
| Aluminium alloy (in tonnes) | 14 | 140 | 2,792 | 3,015 | 160 | 6,220 |
| Zinc alloy (in tonnes) | 238 | 4,279 | 0 | 1,126 | 0 | 5,643 |

The anodes will be spaced 5 to 12 pipe joints apart, corresponding to a distance of 60 to 144 m between anodes. The expected concentrations of metal ions from aluminium and zinc anodes in the water column 1 meter from each pipeline has been calculated and compared with the acceptable levels within the marine environment (see **Table 9.5**)(1). For the calculations of release of metals, a series of conservative assumptions have been made, among these that the anodes are almost fully sacrificed during the design life and that there is little exchange with the surrounding water. Moreover, with a properly applied and undamaged coating the current requirement is close to zero, because only coating damage drains current (metal ions) from the anodes.

(1) Nord Stream AG & Ramboll. 2008. Memo 4.27 - Discharge of test water at Russian coast – environmental assessment.

**Table 9.5 Metal ion concentrations from aluminium and zinc anodes in the water column 1 metre from one of the pipelines compared to water quality criteria**

| | Metals | Release rate (g/hr) | Estimated concentration in the seawater around the pipeline (µg/l) | Background level (µg/kg water) | Acceptable level at sea (µg/l)* |
|---|---|---|---|---|---|
| Aluminium anodes | Aluminium | 0.5014 | 45.75 | - | - |
| | Cadmium | 0.0000 | 0.001 | 0.008 – 0.025 | 0.01 – 0.1 |
| | Copper | 0.0000 | 0.001 | 0.050 – 0.360 | 0.005 – 0.05 |
| | Lead | - | - | 0.01 – 0.02 | 0.5 – 5 |
| | Zinc | 0.0278 | 2.54 | 0.6 – 1.0 | 0.5 - 5 |
| Zinc anodes | Aluminium | 0.00381 | 0.35 | - | - |
| | Cadmium | 0.00009 | 0.008 | 0.008 – 0.025 | 0.01 – 0.1 |
| | Copper | 0.00006 | 0.006 | 0.050 – 0.360 | 0.005 – 0.05 |
| | Lead | 0.00006 | 0.006 | 0.01 – 0.02 | 0.5 – 5 |
| | Zinc | 1.26450 | 115.37 | 0.6 – 1.0 | 0.5 - 5 |

* Ospar Ecotoxicological assessment criteria (EAC) for the North Sea

The OSPAR Ecotoxicological Assessment Criteria (EAC) for the North Sea were adopted for the comparison with acceptable levels (in line with the arguments presented in **Chapter 8**) since no such criteria exist for the Baltic Sea. The release of metals from the aluminium and zinc anodes is lower than the background level (except zinc) and also below the acceptable level in the sea. The content of problematic metals such as cadmium is so low that no effect can be detected. No background values have been confirmed (neither have EAC values established) for aluminium, which is regarded as a non-critical metal. In order to obtain information on the toxicity of aluminium, the US EPA ECOTOX database(1) was consulted. The most sensitive method of toxicity of aluminium in sea water yields a LC50 of 120 µg Al/l for freshwater. An assessment factor of 1000(2) was applied based on the available data. This resulted in a highly conservative water-quality criterion for aluminium of 0.12 µg Al/l. The release of aluminium from the aluminium alloy anodes is expected to result in a concentration of approximately 45.75 µg/l, a factor of 380 higher., this concentration is only expected in close proximity to the pipelines at the anode and due to the effect of currents and water exchange that this concentration will be reduced.

(1) United States Environmental Protection Agency. ECOTOX Database. http://cfpub.epa.gov/ecotox/ (accessed September 20, 2007).

(2) European Commission. 2003. Technical Guidance Document on Risk Assessment Part II. Institute for Health and Consumer Protection. Ispra, Italy.

Based on these calculations, the amount of toxic compounds released is very low and it is concluded that there is no significant risk posed by the release of compounds from aluminium and zinc anodes. As such, the impacts on the water column are deemed to be **insignificant**.

**Impact summary**

The impacts identified and assessed in ESR I on the water column are summarised in **Table 9.6**

.

**Table 9.6 ESR I impact summary table for the water column**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Durat-ion | Intensity | Magnitude | | | |
| Water Column – Ecological Sub-Region I | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Boulder removal | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of contaminants | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | Release of nutrients | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | Change in water quality | Pressure-test water discharge | Negative | Direct | Regional | Temp-orary | Low | Low | Low | Reversible | **Minor** |
| | Temperature change | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of pollutants from anti-corrosion anodes | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.3.4 Physical Environment – Seabed

**Overview**

The seabed in ESR I is predominantly characterised by sandy sediments overlaying Precambrian crystalline basement geology. Sedimentation and re-deposition commonly occur in this ESR. The salinity in ESR I is very low, with minimum salinity levels in spring and summer and maximum levels in autumn and winter. There is no halocline in the shallow waters of ESR I. The heavy metal concentrations recorded at Portovaya Bay indicate that the water is relatively free from heavy metal contamination, with lead and mercury being the only metals present in high enough concentrations within the sediment of ESR I to exceed the upper OSPAR EAC levels (see **Section 8.5.4** and **8.7.2**). The Portovaya Bay area is also relatively free of harmful organic impurities, and the water generally has a higher suspended solid content than the deeper waters.

As described in **Section 8.7.2**, the seabed in ESR I is considered to have a **low** sensitivity throughout, and there are no notable seabed features recorded in this area, such as cold water corals, sea mounts, canyons or areas of sensitive seabed substrate (e.g. cobbles or sand waves). The seabed in this ESR is, however, known to support a number of benthic species as well as fish, birds and marine mammals, and the impacts on these species are assessed below in **Sections 9.3.7– 9.3.10**. The main activities in ESR I, which are expected to impact on the seabed will occur during the construction phase and, to a lesser extent, the pre-commissioning and commissioning, and operational phases.

Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Munitions clearance activities, boulder removal, pipe-laying and anchor handling resulting in:
    - Release of contaminants
- Munitions clearance activities, boulder removal, seabed intervention works, pipe-laying and anchor handling resulting in:
    - Physical alteration of the seabed

*Pre-commissioning and commissioning phase*

- Pressure-test water discharge resulting in:
    - Release of contaminants

- Physical alteration of the seabed

*Operational phase*

- Routine inspections and maintenance and pipeline presence resulting in:
  - Physical alteration of the seabed
- Pipeline presence resulting in:
  - Temperature change
  - Release of pollutants from anti-corrosion anodes

**Impacts during the Construction Phase**

Boulder removal, pipe-laying and anchor handling in ESR I during the construction phase are likely to result in release of contaminants following re-suspension and spreading of sediments. Boulder removal, seabed intervention works, pipe-laying and anchor handing are also likely to cause physical alteration of the seabed, through the spreading of sediments and other disturbance to the existing substrate, and by the introduction of new substrate. Any munitions clearance necessary during seabed preparation in ESR I is also likely to result in the release of contaminants due to re-suspension and spreading of sediments, as well as physical alteration of the seabed.

*Release of contaminants*

The chemical compounds found to be present in the Baltic Sea that have the potential to cause ecotoxicological effects are cadmium, mercury, lead, zinc, copper, arsenic, chromium, nickel, poly-aromatic hydrocarbons (PAH's) and tri-butyl tin(1). Of these, only mercury and cadmium are present in relatively high concentrations within the sediment of ESR I. Since other ESRs have a greater number of chemical compounds present in relatively high concentrations, ESR I is one of the less contaminated ESRs. No contaminants will be added to the seabed as a result of the Project. Since there is not a generally high level of contamination in the sediments of ESR I, and since sediments are not expected to spread more than up to 1 km from the pipelines in ESR I (1 km at rock placement sites), release of contaminants due to munitions clearance, seabed intervention works, anchor handling and pipe-laying is expected to have an **insignificant** impact on the seabed in ESR I.

(1) Nord Stream AG & Ramboll. 2008. Memo 4.3A5 - Spreading of sediments and contaminants during works in the seabed.

*Physical alteration of the seabed*

Physical alteration of the seabed in ESR I is likely to result from the disturbance to the existing substrate due to munitions clearance, boulder removal, dredging, installation of support structures and anchor handling, and the introduction of new substrate through rock placement, installation of support structures and pipe-laying.

The extent of the re-suspension and spreading of sediment and the physical disturbance to the seabed (by the formation of craters) from munitions clearance will depend upon the amount and type of explosive used for clearing and the residual explosive in the device, as well as the seabed type and the extent of underwater currents near the seabed. Sedimentation of re-suspended sediment is limited and thus no impact on the seabed in expected. However, munitions clearance will also result in the formation of craters in the seabed. Based upon the munitions clearance modelling performed in the Finnish EEZ (**Section 9.3.3**) craters with average radii of 4.5 meters are likely in ESR I at munitions clearance sites. This will result in a **negative** and **direct** impact on a **local** scale (<500 m) and of **low** intensity as no major change in structure or function of the seabed is expected. Impacts will be of **short-term** duration and **reversible** as the craters will, overtime, be filled. The magnitude of the impact is **low**. As discussed in **Section 8.7.2**, the seabed is of **low** value/sensitivity and therefore the impact on the seabed in ESR I in terms of physical alteration of the seabed as a result of munitions clearance is considered to be **minor.**

Re-suspension and spreading of sediments in ESR I will occur due to construction activities on the seabed. The type of activity, as well as the sediment type, determines the amount of sediment that is re-suspended. In terms of seabed intervention works in ESR I, boulder removal is not expected to result in significant re-suspension and spreading of sediments, however dredging is likely to generate the most suspended sediment, with an estimated spill rate of approximately 7kg/s, while rock placement would generate less, with an estimated spill rate of 1 kg/s[(1)] . A study of the re-suspension of sediments (**Section 9.3.3**) has concluded that, for the most part, sediments will be deposited over an area up to approximately 5 km from the construction area, although most of the sediment deposition would take place in close proximity to the disturbance point. In ESR I, any notable sedimentation from rock placement (forming a layer over 1 mm) is expected only in very minor areas beyond 100 m from the pipelines, and sedimentation from installation of support structures is also likely to be very small. The impact from dredging will be greater, since a larger area is likely to experience a net sedimentation of more than 1 mm [(1)].

In terms of disturbance to the existing substrate, dredging will also result in the shifting of sediment into mounds on either side of the pipeline trenches. The formation of a trench will not

(1) Nord Stream AG & Ramboll. 2008. Memo 4.3A5 - Spreading of sediments and contaminants during works in the seabed.

create a large amount of disturbance to the structure of the seabed, and these effects will not be permanent once the pipelines are in place within the trenches. The sediments mobilised by the action of currents and waves are likely to refill the trench and reduce mound heights over time, restoring a more even seabed surface. Furthermore, the pipelines' route will avoid potentially sensitive seabed features that may support distinct ecological communities, such as cold water corals, sea mounts, canyons or areas of sensitive seabed substrate (e.g. cobbles or sand waves).

Rock placement and installation of the support structures will also cause physical alteration by the introduction of new substrate. The gravel used in rock placement is coarse grained, and will only affect the seabed in the immediate area where the pipe is laid since it is not likely to drift. Similarly, installation of support structures will only affect the substrate in a highly localised way, in areas where it is laid on the surface of the seabed, or on support structures, rather than in areas where it is buried. The introduction of new substrate will only affect a very small percentage of the Baltic Sea seabed, and will not affect any notable seabed features.

Boulder removal and seabed intervention works are assessed to have a **direct negative** impact on the seabed, which is **reversible** in the long-term, in terms of the structure of the seabed. Impacts act on a **local** to **regional** scale. Impacts are of **long-term** duration. Impact intensity is considered to be **low** as no major change in structure or function is expected. The impact magnitude is **low**. Therefore, due to the **low** value/sensitivity of the seabed the significance of the impacts on the seabed are assessed to be **minor**.

Impacts from pipe-laying are expected to be smaller than those from seabed intervention works, due to the smaller amount of seabed disturbance from this activity. Pipe-laying will only affect the substrate in a localised way, in areas where it is laid on the surface of the seabed, or on artificial supports, rather than in areas where it is buried. The introduction of new substrate will only affect a very small percentage of the Baltic Sea seabed, and will not affect any notable seabed features. Impacts on the seabed morphology from pipe-laying are therefore also deemed to be **insignificant**, as no major change is expected to the seabed in terms of structure and function.

Anchor handling in ESR I is likely to cause physical alteration of the seabed, since controlled positioning of anchors in the seabed will be necessary to ensure that the pipe-laying vessel is kept in position. These anchors are moved as pipe-laying progresses. The sinking of each anchor will involve a dragging action, resulting in the creation of a depression on the seabed and the compression and shifting of sediments. While it is expected that depressions will be refilled due to the redistribution of sediments mobilised by currents and waves, this **negative** impact is expected to cause **local** impacts of **low** intensity. As discussed in **Section 8.7.2**, the seabed is considered to be of **low** value / sensitivity. Impacts will be **short-term** in duration. The magnitude of the impact is considered to be **low**. Impacts will also be **reversible** over time. The

**direct** impact on the seabed in ESR I in terms of physical alteration of the seabed as a result of anchor handling is therefore considered to be **minor.**

**Impacts during the Pre-Commissioning and Commissioning Phase**

Potential impacts on the seabed from the pre-commissioning and commissioning phase in ESR I are limited to release of contaminants and physical alteration of the seabed, due to pressure-test water discharge.

*Release of contaminants*

The release of pressure-test water during pre-commissioning in ESR I is likely to cause some seabed disturbance and re-suspension of sediments, depending on discharge location. However, as discussed above under "*Impacts during the Construction Phase"*, ESR I is one of the less contaminated ESRs. Further, sediment disturbance from the pressure-test water discharge is expected to have a smaller effect on sediment disturbance than activities during the construction phase. Therefore, the release of contaminants from pressure-test water discharge is expected to have an **insignificant** impact on the seabed in ESR I.

*Physical alteration of the seabed*

Physical alteration of the seabed in ESR I may also result from pressure-test water discharge during pre-commissioning in ESR I. Again, this depends on the exact location of the discharge pipe. Impacts during the pre-commissioning and commissioning phase are expected to be smaller than those during the construction phase, due to the smaller amount of seabed disturbance from pressure-test water discharge. Further, as for the construction phase impacts, it is expected that the seabed will quickly reach a state of equilibrium where any depressions are refilled due to the redistribution of sediments mobilised by currents and waves. Impacts on the seabed morphology from pressure-test water discharge are therefore also deemed to be **insignificant**.

**Impacts during the Operational Phase**

Potential impacts on the seabed from the operational phase in ESR I are limited to physical alteration of the seabed due to routine inspections and maintenance and pipeline presence, and temperature change and release of pollutants from anti-corrosion anodes due to pipeline presence.

*Physical alteration of the seabed*

Physical alteration of the seabed may also occur during the operational phase. Routine inspections and maintenance of the pipelines may involve occasional seabed disturbance, but this will occur infrequently and vessel movements will be restricted to the pipelines’ route. Since the larger-scale seabed intervention works during the construction phase are not expected to impact significantly on the seabed, routine inspections and maintenance works are anticipated to have an **insignificant** impact on the seabed in ESR I.

Physical alteration of the seabed during the operational life of the pipelines can manifest as sediment accumulation and seabed erosion (scour) due to pipeline presence. Sediment accumulation along the pipelines is possible following the introduction of the pipelines on the seabed, since pipeline presence will change the flow conditions of sea currents near the pipelines, as discussed in **Section 9.3.2**, and will potentially alter the accumulation zones of fine seabed material around the pipelines, particularly because the seabed in ESR I is sedimentary. However, the average velocity of underwater currents affecting the seabed in ESR I is relatively low and will create a gradual drift of sediments to form a smooth accumulation zone around the pipelines rather than inducing a turbulent movement. In addition, while the sediment accumulation process can exacerbate the erosion in depressions caused by construction work, it can also be expected to partly or completely fill some of the depressions and holes caused during construction, thus acting to counter some of the potential impacts resulting from this process.

Seabed erosion (scour) occurs both naturally, due to wave action, and due to sea currents and removing sediment from below the pipe, causing the pipe to sink into the supporting substrate and leading to release of sediment into the water column. However, a study into the impact of scour(1) concludes that in ESR I, scour will not cause the release of significant amounts of sediment. Models used in these studies assumed that the currents are perpendicular to the pipelines, and that the pipe is laid on a flat seabed without sinking into it. With these conservative assumptions, the generation of scour was shown to be dependent on the speed of the current, occurring only with a steady current of greater than 0.2 m/s; a value which is rarely exceeded in ESR I. It was assessed that scour will not cause release of sufficient amounts of sediment that will cause adverse environmental impacts. For this reason, the presence of the pipelines is anticipated to have an **insignificant** impact on the seabed.

*Temperature change*

As discussed in **Section 9.3.3**, the difference in temperature between the gas and the surrounding water column or sediment may result in a temperature change in the seabed. A simulation for the entrenched pipelines at the Russian landfall during winter showed that there is an increase in temperature within a 10-20cm wide zone around the pipelines, with the temperature in the sediment expected to increase to 40°C within the first 2-3 cm. However, since the pipelines will be buried in the sediment further than 20cm from the seabed surface, marine benthos on the seabed above the pipelines is not likely to be affected by the temperature

(1) Nord Stream AG & Ramboll. 2008. Memo 4.3A2 - Blocking effects of the pipeline on the seabed causing accretion.

increase. Therefore, the impact of temperature change from pipeline presence on the seabed in ESR I is considered to be **insignificant**.

*Release of pollutants from anti-corrosion anodes*

The performance and durability of different sacrificial alloys in the Baltic Sea environmental conditions have been evaluated with dedicated tests conducted by an independent laboratory. In the light of the test results, zinc alloy has been selected for sections of the pipelines' route with very low average salinity, in parts of ESR I, ESR II and ESR IV(1). As discussed in **Section 9.3.3**, the preferred anodes for the Nord Stream pipelines along most of the route will be indium-activated aluminium, since zinc anodes have a higher cadmium and zinc content, which are considered to be toxic and bioaccumulative. For the two pipelines in ESR I, particularly along the sections of pipelines which will be buried, some zinc and chromium is expected to be released into the sediment over the 50-year lifetime of the pipelines. However, burial of the pipelines will reduce the release of compounds to the marine environment(2), and will therefore have a lower impact on the environment than for the sections of the pipelines exposed on the surface of the seabed. The impact of the anodes on the water column itself has been assessed as being insignificant (**Section 9.3.3**); therefore the impact on the seabed is also considered to be **insignificant**.

**Impact Summary**

The impacts on the seabed identified and assessed in ESR I are summarised in **Table 9.7.**

(1) Snamprogetti. 2008. Offshore CP System Sizing.

(2) Nord Stream AG & Ramboll. 2008. Memo 4.3S - Materials.

**Table 9.7 ESR I impact summary table for the seabed**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Seabed - Ecological Sub-Region I | Release of contaminants | Munitions clearance, Boulder removal, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pressure-test water discharge | - | - | - | - | - | - | - | - | **Insignificant** |
| | Physical alteration of the seabed | Munitions clearance | Negative | Direct | Local | Short - term | Low | Low | Low | Reversible | **Minor** |
| | | Boulder removal, Seabed intervention works | Negative | Direct | Local-Regio-nal | Long-term | Low | Low | Low | Reversible | **Minor** |
| | | Pipe-laying | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Anchor handling | Negative | Direct | Local | Short - term | Low | Low | Low | Reversible | **Minor** |
| | | Pressure-test water discharge | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Temperature change | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of pollutants from anti-corrosion anodes | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.3.5 Physical Environment – Atmosphere

**Overview**

The atmosphere is considered to have a **low** sensitivity for reasons described in **Section 8.5.1**. The impacts of pollutant release to the atmosphere are well documented, and operate on a range of scales, from local to transboundary. Transboundary impacts are discussed in **Chapter 11**. The Baltic Sea experiences a seasonal pattern of precipitation and air flow, with intense south-westerly winds throughout the cold season and less intense western and north-westerly winds during the spring and summer months. Therefore, any pollutants released into the atmosphere above the Baltic Sea during the winter season will be rapidly transported towards the eastern part of the Baltic Sea and deposited through precipitation mainly in the coastal and near-coastal regions to the east of the Baltic Sea. Although winds are less intense during the warmer season, rainfall levels are higher, especially in the south-eastern and eastern corners of the region, and these regions are likely to receive a large part of the pollution loads in this period[(1)].

The emissions of key contaminants during each phase of the Project are shown in **Table 9.8**.

(1) Helsinki Commission. Maritime Transport in the Baltic Sea - Draft HELCOM Thematic Assessment in 2006. HELCOM Stakeholder Conference on the Baltic Sea Action Plan Helsinki Finland. 7 March 2006.

**Table 9.8 Predicted emissions of key atmospheric pollutants during all Project phases[1],[2]**

| | Country | Predicted Emissions (tonnes) | | | Predicted emissions relative to annual emissions from the Baltic Sea (%) | | |
|---|---|---|---|---|---|---|---|
| **Phase** | | **$CO_2$** | **$NO_x$** | **$SO_2$** | **$CO_2$** | **$NO_x$** | **$SO_2$** |
| Construction phase | All | 770 000 | 13000 | 3100 | 1.9 | 1.4 | 0.4 |
| Pre-commissioning and commissioning phase | Russia | 30 | 0.05 | <0.01 | <0.1 | <0.1 | <0.1 |
| | Germany | 9900. | 190 | 6.2 | <0.1 | <0.1 | <0.1 |
| | Total | 10000 | 190 | 6.2 | <0.1 | <0.1 | <0.1 |
| Operational phase | All | 53000 | 140 | 110 | 0.1 | <0.1 | <0.1 |
| **Total for all phases** | | **830 000** | **13000** | **3200** | **2.0** | **1.4** | **0.5** |

Values are given to two significant figures.

At a local and regional scale, nitrous oxides (NOx) can have negative effects on human health, including respiratory problems and cancer. However, since the receptors for local to regional scale impacts of pollutants are largely terrestrial (including humans), and the source of these impacts for the Project would be marine, it is considered that there are no local impacts of pollutant emissions (see **Section 8.5.1**). Therefore, it is the impacts on marine and terrestrial receptors at a national and transboundary scale which are expected to occur during the Project, resulting from the construction phase and, to a lesser extent, during the pre-commissioning and commissioning, and operational phases. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Munitions clearance, seabed intervention works and pipe-laying activities resulting in:
    - Emissions of pollutant gases

(1) Nord Stream AG & Ramboll. 2008. Memo 4.3P - Air Emissions.

(2) Patzold, V. 2008. Emission budget for the construction of the Nord Stream gas pipeline through the Baltic Sea.

*Pre-commissioning and commissioning phase*

- Seawater intake, pressure testing, pressure-test water discharge and pipeline drying resulting in:
    - Emissions of pollutant gases

*Operational phase*

- Routine inspections and maintenance resulting in:
    - Emissions of pollutant gases

**Impacts during the Construction Phase**

During the construction phase for ESR I, pollutant emissions associated with munitions clearance, seabed intervention works and pipe-laying activities will potentially contribute to acidification, eutrophication and climate change, with associated negative impacts on marine and terrestrial receptors. Pollutant emissions will only be associated with those aspects of seabed intervention works, which involve fuel combustion in engines on the sea surface. Therefore, emissions during seabed intervention works are likely to arise in ESR I from machinery and vessels associated with dredging and rock placement (transporting gravel to the fall pipe and moving the fall pipe to the required locations). During pipe-laying, emissions will be associated with vessel movement and welding equipment used to join pipeline sections together.

*Emissions of pollutant gases*

At a national scale, emissions of $NO_x$ and $SO_2$ contribute to acidification, which can damage sensitive ecosystems in both terrestrial and marine environments. Due to the low water exchange, the Baltic Sea is more susceptible to the impacts of acidification than many other open water bodies. Also at a national scale, $NO_x$ emissions can contribute to eutrophication due to increased nutrients in water, and this can ultimately lead to oxygen depletion and suffocation of fish and other marine life forms. Eutrophication is one of the most severe environmental problems of the Baltic Sea region. Shipping, road transportation and energy combustion are the main sources of $NO_x$ emissions in the region, and approximately one-quarter of the total nitrogen input into the Baltic Sea comes from airborne nitrogen deposited directly into the sea(1).

At a transboundary scale, release of $CO_2$ and some hydrocarbons from the burning of fossil fuels contribute to the greenhouse effect, and to climate change. It is estimated that shipping may account for 1.8% of the global contribution of $CO_2$ emissions. The main source of

(1) Nord Stream AG & Ramboll. 2008. Memo 4.3P - Air Emissions.

emissions to the atmosphere during the construction phase of the Project will be the diesel and heavy fuel oil used by the construction fleet. The use of such fuels presents a potential risk to human health, due to release of carbon monoxide (CO), nitrogen oxides (NOx), sulphur oxides (SOx), particles including soot particles (PM) and fugitive hydrocarbons (HC) associated with their combustion in engines(1).

In terms of munitions clearance, although there will be a release of a minor amount of toxic gases to the atmosphere from the clearance of munitions on the seabed, the volumes of gases emitted are not expected to cause damage to any ecosystem receptors. The consequence of munitions clearance on the atmosphere is expected to be **insignificant**.

As shown in **Table 9.8**, emissions associated with Project activities are predicted to be most intense during the construction phase, contributing 1.9, 1.4 and 0.44 % to the annual emissions of $CO_2$, $NO_x$ and $SO_2$ respectively for all activities (mainly shipping traffic) in the Baltic Sea. It is not possible to predict with confidence the magnitude of the impact of these emissions on sensitive receptors through their contributions to acidification, eutrophication and climate change. However, since the total pollution load from the construction phase corresponds to less than 1.85 % of the key pollutants emitted from the existing ship traffic in the Baltic Sea every year (1), the scale of these emissions and the duration for which they will be released are both relatively small.

Since the annual release of gaseous pollutants from the Project will be low relative to that of the entire pipelines' route, the contribution from activities in ESR I will be relatively small. However, there will be a **cumulative negative** impact on atmospheric pollutant emission levels from construction activities, operating on a **national** and **transboundary** scale and over a **long-term** duration. The impact of release of pollutant gases and particulate matter emissions, in terms of acidification, eutrophication and climate change, are considered to be **irreversible**, and act on a range of ecosystems. Due to the small contribution of emissions from the Project relative to those from activities in the Baltic Sea as a whole, impact intensity is considered to be **low**. Therefore, the magnitude is considered to be **low**. As described in **Chapter 8**, the value/sensitivity of the atmosphere is considered to be **low**. The significance of this cumulative impact in ESR I, and for the entire pipelines' route, is expected to be **minor**.

**Impacts during the Pre-commissioning and Commissioning Phase**

Seawater intake, pressure testing, pressure-test water discharge and pipeline drying will all involve the use of pumps, which will have associated emissions of pollutant gases.

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(1) Maritime Transport in the Baltic Sea - Draft HELCOM Thematic Assessment in 2006. HELCOM Stakeholder Conference on the Baltic Sea Action Plan Helsinki Finland. 7 March 2006.

*Emissions of pollutant gases*

The amounts of pollutant gases from the pumps used during the pre-commissioning and commissioning phase will be small compared to the construction and operational phases. As shown in **Table 9.8**, emissions associated with pre-commissioning activities in Russia contribute <0.01 % to the annual emissions of $CO_2$, $NO_x$ and $SO_2$ for all activities (mainly shipping traffic) in the Baltic Sea. Almost all these emissions will occur in ESR I and ESR V, with the majority occurring in ESR I. However, due to the small contribution of this phase of the Project to annual emissions in the Baltic Sea, the impact on the atmosphere from these activities is considered to be **insignificant**.

**Impacts during the Operational Phase**

During the operational phase in ESR I, routine inspections and maintenance will have associated pollutant emissions, as for the construction phase, which will also potentially contribute to acidification, eutrophication and climate change, with associated negative impacts on marine and terrestrial receptors.

*Emissions of pollutant gases*

During the operational phase, the sources of impacts on the atmosphere in ESR I will be similar to those during construction (emissions from vessels and machinery associated with routine inspections and maintenance). Venting during routine inspections and maintenance visits will also cause emissions of either natural gas from the pipelines, which is more than 98% methane ($CH_4$), or nitrogen ($N_2$). While nitrogen is an inert gas in the atmosphere and will have no associated negative impacts, methane is a greenhouse gas and its release could contribute further to climate change.

It is not possible to predict with confidence the magnitude of the impact of these emissions on sensitive receptors through their contributions to acidification, eutrophication and climate change. However, as discussed the scale of these emissions and the duration for which they will be released are both relatively small.

For routine inspections and maintenance operations, the magnitude of impacts on the atmosphere will be much lower than for the construction phase, compared to the annual level of emissions from existing ship traffic in the Baltic Sea. As shown in **Table 9.8**, emissions associated with the operational phase of the Project are expected to contribute 0.13, <0.05 and <0.05 % to the annual emissions of $CO_2$, $NO_x$ and $SO_2$ respectively for all activities (mainly shipping traffic) in the Baltic Sea. Therefore, the impact is considered to be **insignificant** for all ESRs.

**Impact Summary**

The impacts on the atmosphere identified and assessed in ESR I are summarised in **Table 9.9**

**Table 9.9 ESR I impact summary table for the atmosphere**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Atmosphere – Ecological Sub-Region I** | Emissions of pollutant gases | Munitions clearance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Seabed intervention works, Pipe-laying | Negative | Cumulative | National – Trans-boundary | Long-term | Low | Low | Low | Irreversible | **Minor** |
| | | Seawater intake, Pressure testing, Pressure-test water discharge, Pipeline drying | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |

## 9.3.6 Biological Environment – Plankton

### Overview

The plankton dynamics in the Baltic Sea vary widely with time and geographical scale. Values/sensitivities for both phytoplankton and zooplankton in ESR I are detailed in **Section 8.7.3** and summarised in **Table 9.10.**

**Table 9.10 Value / sensitivity of plankton in Ecological Sub-Region I**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Plankton** | | | | | | | | | | | | |
| Phytoplankton | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Zooplankton | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |

Given that plankton drift in the water column, there is no potential for the presence of the pipelines on the seabed to change the abundance or distribution of plankton during normal operation of the pipelines in ESR I. Consequently no impacts to plankton populations[(1)] are anticipated during the operational phase.

Project activities and the associated potential impacts that are assessed in this section are as follows:

*Construction phase*

- Re-suspension and spreading of sediments from munitions clearance and seabed intervention works resulting in:
  - Changes to plankton dynamics
- Construction and support vessel movement resulting in:
  - Introduction of non-indigenous species (due to the transport and release of ballast water and via biofouling of ship hulls)

(1) Impacts that have no effect at the population level may reduce the number of offspring of any given genetically distinct population, but this will not have a ‘statistically significant’ effect on stock / population size.

*Pre-commissioning and commissioning phase*

- Seawater intake and pressure-test water discharge resulting in:
  - Changes to plankton dynamics

**Impacts during the Construction Phase**

Impacts on plankton during the construction phase are limited to changes to plankton dynamics and the introduction of non-indigenous species as a result of the re-suspension and spreading of sediments and nutrients from seabed intervention works and discharge of ballast waters.

*Changes to plankton dynamics*

Plankton dynamics are highly variable in the Baltic Sea and occur at a wide scale across the ESRs. Plankton communities vary considerably with time and geographical scale. Munitions clearance and seabed intervention works, including dredging and rock placement, as well as pipe-laying, have the potential to cause an increase in turbidity and subsequently result in the re-suspension of contaminants and nutrients from sediments into the water column.

The re-suspension of contaminants in the water column released from sediments as a result of seabed intervention works has the potential to affect plankton. Contaminants of concern include heavy metals and organic compounds including PAHs. Plankton can take up contaminants such as PAH and accumulate such contaminants in their tissue(1). The potential effects to both zooplankton and phytoplankton are a function of the type of contaminant and the duration of exposure. Heavy metals are generally more soluble than organic compounds, and given the short duration of exposure of the re-suspended contaminants, acute toxicity due to temporary re-suspension of heavy metals is therefore the most likely mechanism by which plankton would be affected. Modelling results for the release of PAHs at rock placement sites in ESR I are illustrated in **Atlas Map MO-51**, and it is predicted that under normal weather conditions, PAHs will exceed the PNEC along the pipelines' route as a result of seabed interventions, for a distance of up to 250 m, for a period of up to approximately 14 hours. There is no conclusive evidence for copper limitation in natural waters, however, copper may at times be toxic to some phytoplankton species(2). Copper concentrations will exceed PNECs in some areas within one kilometre from the seabed intervention works as a result of the re-suspension of sediments.

(1) Kelly, L.D., McGuinness, L.R., Hughes, J. E., Wainright, S.C. 1999. Effects of Phenanthrene on Primary Production of Phytoplankton in Two New Jersey Estuaries. Bulletin of Environmental Contamination and Toxicology. 63.

(2) Stoecker, D.K., Sunda, W.G. and Davis, L.H. 1986. Effects of copper and zinc on two planktonic ciliates. Marine Biology 92.

However, given the short-term duration and regional scale of the elevated metal concentrations (see **Section 9.3.3**), the toxicity effects of contaminants on plankton will be negligible. Any changes to the density of plankton communities due to munitions clearance and seabed intervention works will be undetectable against natural variability as plankton vary considerably in their distribution across ESR I and therefore the impact is assessed to be **insignificant**.

A release of nutrients, particularly nitrogen and phosphorus into the photic zone could increase the risk of eutrophication in ESR I, thereby stimulating phytoplankton production. However, as described in **Section 9.3.3**, the expected amount of nitrogen and phosphorus to be released during the construction phase is insignificant in comparison to the total input of such nutrients into the Baltic Sea. Taking this into consideration any fluctuations in the planktonic community as a result of the Project will not be detectable over the background "normal" fluctuations that occur seasonally. As a result, impacts to plankton in ESR I from seabed intervention works and pipe-laying activities will be **insignificant**.

*Introduction of non-indigenous species*

There is the potential for the plankton community to be impacted if construction vessels cause invasive species to be introduced to the Baltic Sea or cause the spread of already present invasive species within the Baltic Sea itself e.g. from the estuaries and bays of the eastern Baltic to the western Baltic etc. Discharge of ballast water by vessels associated with the construction phase of the Project has the potential to contain non-indigenous, invasive marine organisms. Similarly, the introduction or spreading of invasive species through hull fouling of vessels such as the dredger, or Project equipment and the transport of organisms or fragments of organisms that can reproduce vegetatively may occur. The introduction of invasive marine species to the Baltic Sea has previously been observed, as described in the baseline (**Section 8.6.7**).

The International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention) was held in 2004 and the HELCOM countries have agreed to ratify this convention by 2010, or by 2013 at the latest. The objective of this Convention is to prevent, minimise, and ultimately eliminate the transfer of aquatic organisms and pathogens through the control and management of ships' ballast water and sediments.

HELCOM countries have joined the OSPAR initiative to assist in the ratification, which requires vessels transiting the Atlantic or entering the North-East Atlantic from the West African Coast to conduct ballast water exchange before arriving at the OSPAR area or passing through the OSPAR area and heading to the Baltic Sea. Therefore, the introduction of the BWM Convention into the Baltic Sea states will significantly reduce the spread of non-indigenous, invasive species into and out of the Baltic Sea. It is further noted that the project-induced risk of spreading non-indigenous species into and within the Baltic Sea is very small in comparison to other maritime activities (e.g. fishing, commercial shipping) in the Baltic Sea.

To prevent the transport of non-indigenous species via ballast waters Nord Stream had planned to adhere to the following mitigation measures wherever practically possible:

- Adhere to the OSPAR / HELCOM General Guidance on the Voluntary Interim application of the D1 Ballast Water Exchange Standard in the North-East Atlantic, by all vessels involved in the Project including suppliers and contractors.
- Avoid the discharge of any water into the Baltic Sea which has not been picked up from within the Baltic Sea.
- Discharge ballast waters of Baltic seawater only into the Baltic Sea in areas designated by relevant port states.

To prevent the introduction of invasive organisms into the Baltic and spread throughout the Baltic through hull fouling, careful cleaning of hulls, tanks and drilling and dredging equipment before use will take place wherever practically possible prior to entering the Baltic.

Adoption of these planned mitigation measures will ensure that invasive species are not introduced into the Baltic Sea or transferred from one area of the Baltic to another as a result of the construction of the pipelines. Consequently, the residual impacts of the construction phase on phytoplankton and zooplankton communities in ESR I will be **insignificant**.

**Impacts during the Pre-Commissioning and Commissioning Phase**

During the pre-commissioning and commissioning phase, potential impacts upon plankton are limited to changes to plankton dynamics during seawater intake and pressure-test water discharge.

*Changes to plankton dynamics*

The potential impacts to plankton during the pre-commissioning and commissioning phase are associated with seawater intake and pressure-test water discharge. The impacts of abstracting seawater in ESR I for pre-commissioning activities will not have a detectable effect on plankton communities. Seawater will be discharged back into ESR I following pressure testing. Oxygen levels will reach natural levels in the near vicinity of the discharge in Portovaya Bay. Discharged water in ESR I will be diluted during the pre-commissioning and commissioning phase of the Project. Modelling has concluded that the situation in Portovaya Bay is expected to return to normal or "pre-impact status" (dilution factor of 100) within 12-24 hours after the discharge has stopped (during ice free periods) (see **Section 9.3.3** for further details)[1]. However if ice cover is present it will take up to a few days to reach pre-impact status as water movement is on a

(1) Nord Stream AG & Ramboll. 2008. Memo 4.27 - Discharge of test water at Russian coast – environmental assessment.

smaller scale. The impact on plankton in ESR I during the pre-commissioning and commissioning phase are anticipated to be **insignificant**.

### Impact Summary

The impacts on plankton identified and assessed in ESR I are summarised in **Table 9.11.**

**Table 9.11 ESR I impact summary table for plankton**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Plankton – Ecological Sub-Region I | Changes to plankton dynamics | Munitions clearance, Seabed intervention works, Pipe-laying | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Seawater intake, Pressure-test water discharge | - | - | - | - | - | - | - | - | **Insignificant** |
| | Introduction of non-indigenous species | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.3.7 Biological Environment – Marine Benthos

#### Overview

The baseline in **Section 8.7.4** describes the landfall area in ESR I as supporting approximately 45 species of vascular plants and nine algae species. Surveys of the area found submerged vascular plants to a depth of 2.5 m and the filamentous algae *Cladophora glomerata* was found to a depth of 6 m. Based on these findings, plants and algae are not expected to be found in deeper waters within ESR I. In the shallower waters of ESR I, submerged vascular plants which are dominated by pondweed, and the emergent vascular plants dominated by common reed and bulrush, are common.

In general, the total biomass of zoobenthos within ESR I is very low. This reflects the low abundance and diversity of zoobenthos found during sampling of ESR I as described in **Section 8.7.4**. Zoobenthos at the landfall are dominated by oligochaetes with high numbers of nematodes and crustaceans in evidence. Most of the species present in ESR I are opportunistic species that recover rapidly from disturbance and are tolerant of poor oxygen conditions and fluctuations in salinity.

Following a scoping and impact identification exercise as described in **Chapter 7**, interactions between marine benthos in ESR I and the Nord Stream Project that could give rise to potential impacts have been identified. This section identifies and assesses the potential impacts on marine benthos in ESR I during the construction, pre-commissioning and commissioning, and operational phases of the Project in terms of the methodology presented in **Chapter 7**. Values/sensitivities for marine benthos are detailed in **Chapter 8** and summarised in **Table 9.12.**

**Table 9.12 Value/sensitivity of marine benthos in Ecological Sub-Region I.**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Marine Benthos** | | | | | | | | | | | | |
| **Macroalgae and aquatic vegetation** | | | | | | | | | | | | |
| Filamentous algae | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Emergent vascular plants | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Submerged vascular plants | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| **Zoobenthos** | | | | | | | | | | | | |
| Soft-bottom community | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |

Impacts during the operational and pre-commissioning and commissioning phases are expected to be minimal in comparison to construction. The activities and the related impacts that are assessed in this section are as follows:

*Construction phase*

- Re-suspension and spreading of sediments due to munitions clearance, seabed intervention works, pipe-laying and anchor handling resulting in:
  - Increase in turbidity
  - Release of contaminants
  - Release of nutrients
  - Noise and vibration
  - Physical loss of seabed habitats
- Re-suspension and spreading of sediments due to seabed intervention works (dredging) resulting in:
  - Smothering
- Construction and support vessel movement resulting in:
  - Introduction of non-indigenous species (due to the transport and release of ballast water and via biofouling of ship hulls)

*Pre-commissioning and commissioning phase*

- Seawater intake, pressure testing and pressure-test water discharge resulting in:
  - Noise and vibration
  - Removal of larvae
  - Change in water quality

*Operational Phase*

- Routine inspections and maintenance works and pipeline presence resulting in:
  - Physical alteration of the seabed

- Introduction of secondary habitats
- Temperature change
- Release of pollutants from anti-corrosion anodes

**Impacts during the Construction Phase**

Various impacts can be expected to affect the benthos in ESR I during the construction phase as a result of munitions clearance, seabed intervention works (dredging and rock dumping), installation of support structures, pipe-laying and anchor handling. These include the spreading and re-suspension of sediments causing increased turbidity, release of contaminants, release of nutrients, noise and vibration, physical loss of seabed habitats, and smothering of the benthos.

*Increase in turbidity*

Munitions clearance, dredging, rock placement, installation of support structures, pipe-laying and anchor handling will all cause re-suspension of sediments thereby increasing turbidity in the water column. The physical effects of this impact on the water column are discussed in detail in **Section 9.3.3** and only the effect on marine benthos is discussed here. Re-suspension of sediment from construction activities can create plumes in the water column that eventually settle on the seabed and may cause smothering of the benthos. Depending on the thickness of the deposited material, smothering of benthic flora and fauna can be partial causing increased survival effort, or complete smothering that can lead to death. Heavy sediment loads in the water column can also clog the feeding organs of filter feeding species preventing feeding[(1)] and can decrease light penetration preventing or reducing photosynthesis by benthic flora. The following mitigation measures are planned to address or reduce the significance of the identified potential impacts associated with increased turbidity on benthic fauna:

- The pipelines' proposed route has been chosen and optimised to avoid sensitive seabed areas and protected areas to reduce impacts to benthic fauna.
- Seabed intervention works shall be restricted to the pipelines' corridor only.
- Anchor handling will be kept to a minimum as far as practical. Anchors will not to be dragged through the seabed but rather raised during relocation by tug boats.

The possibility exists that some munitions within the pipelines' corridor within ESR I will need to be removed (surveys are ongoing). Munitions clearance, if required, will take place before construction activities commence, in close consultation with the relevant authorities. In terms of munitions clearance, detailed sediment modelling has not been carried out in the Russian EEZ.

(1) Tait, R.V. & Dipper, F. R. V, 1998. Elements of Marine Ecology: An Introductory Course. Butterworth-Heinemann.

However, these activities have the potential to increase the re-suspension of sediments leading to smothering of benthos. The increase in re-suspension of sediments due to munitions clearance is likely to cause similar impacts to the impacts caused by other construction activities such as rock placement, trenching and pipe-laying (discussed below). The **negative**, **direct** impacts will act on a **regional** scale, impacting benthos in the **short-term** to **long-term** as recovery of the community is dependent on recruitment from the surrounding areas. Most benthic fauna, including non-burrowing species, would be expected to be able to survive even high levels of deposition and therefore the impact would be **reversible.** The intensity of the impact is expected to be **low** as a localised group of individuals will be affected with many individuals expected to survive a certain degree of smothering. The magnitude of the impact is also expected to be **low**. As described above, the value/sensitivity of the benthos communities within ESR I is considered **low** for all communities. The impact significance due to munitions clearance is therefore predicted to be **minor**.

Sediment spread as a result of construction activities has been modelled and described in detail in **Section 9.3.3**. Dredging at the Russian landfall is expected to cause a sediment plume extending up to a few kilometres' width from the pipelines over a length of approximately 2-3 km. The impact from dredging is therefore predicted to affect a **regional** area. However, a dredge-induced deposit in excess of 10 mm deep is only expected to occur within 1 km distance of the pipelines over the first 220 m of the pipelines' route at the landfall. Other construction activities within ESR I such as rock placement are only expected to cause sediment spread within a few 100 metres from the pipelines (covering a total area of 2 $km^2$). As for the impact of munitions clearance, most benthic fauna would be expected to be able to survive deposition from dredging and other construction activities, meaning that the impact would be **negative**, **direct** and **reversible** and would operate in the **short-term** to **long-term**, depending on rates of recruitment from the surrounding areas. As most benthic species are predicted to be able to survive even high levels of deposition from dredging and other construction activities, the intensity of the impact is expected to be **low**. The magnitude of the impact is expected to be **low.** Since the value/sensitivity of the benthos communities within ESR I is considered **low,** the overall impact significance due to dredging, rock placement, installation of support structures, pipe-laying and anchor handling, is predicted to be **minor**.

*Release of contaminants*

Munitions clearance, seabed intervention works, pipe-laying and anchor handling will cause disturbance to the seabed as detailed in **Section 9.3.3**. In areas where the sediments are contaminated with heavy metals and organic contaminants there is a potential for these contaminants to be released into the water column. These contaminants have the potential to cause toxic effects to fauna on the seabed within ESR I upon direct contact and may have an indirect effect on the benthos from contamination of the water column, particularly on suspension feeders. As described in **Section 9.3.3**, up to 50% of sediment re-suspended will release organic contaminants, although much of this contaminant load is bonded to the suspended matter and will settle on the seabed. Upon ingestion, benthic fauna may bioaccumulate some of these contaminants resulting in increased concentrations within the organisms, potentially leading to harmful effects.

The mitigation measures described to minimise impacts from suspended sediment will reduce the significance of potential impacts caused by contamination of the seabed and water column as a result of seabed disturbance. The residual impact from contaminants released from disturbed sediments to the benthos once these mitigation measures have been implemented is expected to be **negative**, **direct** to the seabed and **indirect** through the water column. The concentration of contaminants in the water column will decrease with time reducing the potential for harmful levels of contaminants to accumulate within the organisms. The impact will be **local, long-term** and **reversible** as particle-bound contaminants will be present in the surface layers of the sediment for many years but the population will eventually recover once the contaminants become increasingly immobilised and toxicity of the sediment is reduced. The impact of contaminants on **low** value/sensitivity benthic flora and fauna within ESR I will have a **low** intensity, as changes are expected to be at the limit of detection and will affect a group of localised individuals. The impact will be of **low** magnitude. The impact significance is expected to be **minor**.

*Release of nutrients*

Seabed intervention works are expected to release nutrients from disturbed sediment. The amount of nutrients expected to be released from the construction of the Nord Stream Project has been determined with the use of a mass balance model. Further details of this model are provided in **Section 9.3.3**. An increase of 1% of nitrogen and 2% of phosphorus is expected compared to background inputs to the Baltic Sea. These increases are considered insignificant. On a local scale, the impact of enhanced nutrient concentrations may be more significant in coastal areas such as in ESR I. However, detailed information on present baseline nutrient levels in this area and the predicted increase in nutrient levels within ESR I are not available. Based on the information available for nutrient levels released into the Baltic Sea as a whole, this impact is expected to have an **insignificant** impact within ESR I.

*Noise and vibration*

During munitions clearance, a shockwave will result, originating from the location of the device that is cleared. The shockwave may disrupt sensitive benthic fauna, particularly large mobile species. Information on the distance a shockwave can travel as a result of munitions clearance is not available but is likely to have a **local** impact. The effect is expected to be **direct**, **negative** and **reversible**. The impact would be likely to be **temporary** as the shockwave will quickly lose power with distance and time. This is likely to lead to a **low** to **medium** intensity impact since benthos is expected to receive low level tissue damage. As the size of the resulting shockwave from munitions clearance is unknown, it is difficult to assess the magnitude of the impact;

however it is considered likely to be a **low** magnitude impact, which would affect a **low** value/sensitivity receptor. The overall significance of the impact of noise and vibration from munitions clearance on marine benthos in ESR I is therefore expected to be **minor**.

Noise is also likely to result from seabed intervention works, pipe-laying and anchor handling. As most benthic fauna along the pipelines' route are not sensitive to noise, they are therefore unlikely to be affected by construction noise. However, some invertebrates have been known to respond to noise and vibration in the water[(1),(2)]. Vessel noise is not expected to have an impact on benthic invertebrates and noise and vibration from rock placement is not expected to have an impact outside of the impact area that will cause habitat loss and smothering. The loudest sources of noise during construction will be during dredging with frequencies between 0.020 and 1 kHz, with a peak of approximately 2 kHz. The majority of this noise is below the published hearing frequency of invertebrates that have been studied. The common lobster *Homarus gammarus* has a hearing range of 0.1 to 3 kHz [(1)] . This study by Horridge showed that the threshold of hearing was 110 dB at 0.5 kHz. There is no conclusive evidence to be able to determine whether benthic species may be impacted by noise from construction activities but it is unlikely that they are susceptible to noise. The impact of seabed intervention works, pipe-laying and anchor handling on benthos in terms of noise and vibration is therefore considered to be **insignificant.**

*Physical loss of seabed habitats*

Munitions clearance, dredging, rock placement, installation of support structures and pipe-laying will result in a physical loss of seabed and potential destruction of benthos within the pipelines' corridor. Anchor handling can also cause scarring of the seabed and destruction of benthos.

Munitions clearance will result in physical disturbance to the seabed and loss of benthos habitats that will be **negative** and **direct**. The impacts are likely to affect an area within 500 m of the pipelines' corridor and it will therefore be **local** impact. The loss of habitat from the munitions clearance is likely to be **short-term** and **reversible.** The intensity of the impact is **medium** as localised habitat and associated benthos will be destroyed but not to the extent that the whole population will be affected[(3)]. The magnitude of the impact will be **low** as only a small proportion of the benthic community in ESR I is expected to be affected. As marine benthos is of **low** value/sensitivity, overall this impact is expected to be of **minor** significance.

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(1) Horridge, G.A. 1996. Some recently discovered underwater vibration receptors in invertebrates. In: Barnes, H. (ed.). Some Contemporary Studies in Marine Science. George Allen and Unwin Ltd. London.

(2) Lovell, J.M., Findlay, M.M., Moate, R.M. & Yan, H.Y. 2005. The hearing ability of the prawn *Palaemon serratus*. Comparative Biochemistry and Physiology. Part A. 140.

(3) Impacts that have no effect at the population level may reduce the number of offspring of any given genetically distinct population, but this will not have a 'statistically significant' effect on population size.

Dredging in ESR I will involve the construction of embankments from 0.5 m above sea level to a water depth of approximately 2 m. It is expected that this will cause similar impacts in terms of habitat loss and physical disturbance of the sediment to the dredging itself, although the disturbance from dredging will be greater and is predicted to have the largest impact on habitat loss of all the construction activities within ESR I. The embankments will be constructed in the intertidal and shallow water area of ESR I. The size of the footprint of the embankments is approximately 10,000 $m^3$ which will result in a loss of habitat and physical disturbance of the benthos that will be **negative** and **direct**. The blocking of the alongshore sediment transport may have a **negative** and **indirect** effect as existing communities on either side of the embankments are subjected to accreting and erosive action of the seabed. The impacts are likely to affect an area within 500 m of the pipelines' corridor and can therefore be classified as a **local** impact. The loss of habitat from the embankments is expected to be **short-term** and **reversible** as the embankments will be removed following construction. The intensity of the impact is **medium** as the habitat and its associated benthos within the footprint will be destroyed but not to the extent that the whole population will be affected. The introduction of embankments at the landfall is likely to cause a change to the benthos in a local area; however a **low** magnitude impact is expected to occur as only a small proportion of the benthic community in ESR I is expected to be affected. As stated above, the macroalgae, vascular plants and benthic fauna are of **low** value/sensitivity. Overall this impact is expected to be of **minor** significance. This impact is expected to be of lesser significance to the benthos than other construction activities.

Several areas of rock placement totalling approximately 534,000 $m^3$ of material and one support structure will also be required along some stretches of the pipelines' route within ESR I. However these are expected to have a relatively small footprint in discrete locations along the route in comparison to the installation corridor footprint. Physical loss of the seabed and potential destruction of fauna within the pipelines' corridor will be a **negative** and **direct** effect of rock placement and installation of support structures. The impact is expected to be **local**, **short-term** and **reversible**. It is expected to have a **medium** intensity as habitat will be lost and benthos may be destroyed within these discrete locations but the rest of the population will not be affected. It will have a **low** magnitude impact since the impact is expected to be of a lesser magnitude than dredging at the landfall and is likely to affect a specific group of localised individuals within a population of benthic fauna of **low** value/sensitivity. The overall significance is therefore predicted to be **minor**.

Pipe-laying at the landfall will be conducted using a winch on land and the pipe-laying vessel. The dragging of the pipelines from the pipe-laying vessel onshore is expected to cause a **short-term** loss of habitat. The pipelines at the shoreline of the Russian landfall will be backfilled. In time, it is anticipated that the sediments will be re-colonised by benthic species along the pipelines' route. For example, ephemeral macroalgae such as *Cladophora glomerata* are known for their rapid proliferation (see **Section 8.7.4**) and benthic fauna living in soft-bottom environments such as ESR I are known to readily recover following disturbance. The loss of habitat during pipe-laying will have a **negative** and **direct** effect on a small area causing a **local** impact. This impact is expected to be **reversible** with time (as the benthos is expected to recolonise in approximately 2 to 3 years). As for the dredging and embankment construction, the intensity of the impact is likely to be **medium** as the benthos will be affected within the footprint of dredging activities but the rest of the population will not be affected. The impact is predicted to have a **low** magnitude impact to a **low** sensitivity receptor resulting in an impact of **minor** significance.

Further offshore, pipe-laying will result in a physical loss of seabed and potential destruction of fauna within the pipelines' corridor. Macrophytes and algae are not expected to be found in waters deeper than 6 m. They are, therefore, not considered further. The installation corridor for each pipeline will be approximately 15 m wide and pipe-laying is expected to occur at a rate of 2 to 3 km a day. Pipe-laying will have a **negative** and **direct** effect on the benthic fauna within the pipelines' corridor. This impact is expected to be **local** as only the pipelines' corridor is expected to lose benthic habitats. It is also **short-term** as the benthos communities are expected to recover. The impact is **reversible** with time. The impact will have a **medium** intensity as the habitat will be lost and fauna may be destroyed within the footprint of pipe-laying activities but the whole population will not be affected. The impact from pipe-laying at the Russian landfall in ESR I will be of a **low** magnitude as only a specific group of localised individuals within a population are likely to be affected. The benthos is considered to be of **low** value/sensitivity and the overall impact is expected to be of **minor** significance.

It is likely that there will be some anchor handling within ESR I although, as described above, it is also possible that a DPV will be used, negating the need for anchors. The following assessment describes the potential impacts and their significance if anchor handling is conducted within ESR I. The potential area of the seabed that may be impacted from anchor-handling is expected to be sizeable as there will be a footprint from anchoring along the entire length of the pipelines' corridor. A conservative estimate of the physical impact area of each 25 tonne anchor is approximately 20 $m^2$, which includes anchor dragging. Anchoring will be restricted to a corridor up to 1 to 2 km on either side of the pipelines. During pipe stringing, the lay barge will proceed along the pipelines' corridor in discrete movements of approximately 1 km between stringing operations. At each stopping point, the barge will be anchored prior to re-commencing the stringing operation. 12 anchors will be in use to stabilise the lay barge into position. These anchors will be lifted and manoeuvred by tug boats. This means that approximately 240 $m^2$ of the seabed (within the 1 km anchor corridor) will be physically impacted by the anchors at any one time. The number of anchor movements will determine the total area of benthic habitat that is affected. Anchors have the potential to damage and destroy fauna within each 20 $m^2$ impact area. However, ESR I is regularly disturbed by natural processes. In winter the region is often covered by ice which gouges the seabed destroying the benthos. In summer and autumn, storms also occur, which can disturb the shallow seabed. The benthos within ESR I is therefore subject to regular disturbance and is expected to recover quickly once seabed disturbance during construction activities and anchor handling has ceased.

The following mitigation measures are planned to address or reduce the significance of the identified potential impacts associated with physical loss of the seabed and impacts from anchor handling on the benthos:

- The pipelines’ proposed route has been chosen and optimised to avoid sensitive seabed areas and protected areas to reduce impacts to benthic fauna
- Anchor handling will be kept as to a minimum as far as practically possible. Anchors will not be dragged through the seabed but rather raised during relocation

The loss of seabed habitat after mitigation of anchor handling is expected to be **negative** and **direct** but limited to discrete, **local** areas. The impact from anchor handling is expected to be **short-term** as recolonisation of the area is expected after construction activities cease. The intensity of impact is **low** as the impact is expected to have a comparable effect on benthos and their habitats to that arising from naturally recurring ice gouging and storm events. This impact is **reversible** with time (approximately 2 to 3 years). The impact magnitude is **low** as the loss of habitat will affect a specific group of localised individuals within a population. As benthos has a **low** sensitivity in ESR I, the overall impact significance is therefore expected to be **minor** to benthic flora and fauna.

*Smothering*

Dredging will create spoil material that can blanket the surrounding area. Smothering of benthic flora and fauna can be partial, causing increased survival effort, or complete smothering that can lead to death. This is of particular concern for sessile fauna.

The following mitigation measures are planned to address or reduce the significance of the identified potential impacts associated with increased sedimentation on benthic fauna:

- The proposed pipelines’ route has been chosen and optimised to avoid sensitive seabed areas and protected areas to reduce impacts to benthic fauna
- Seabed intervention works shall be restricted to the pipelines’ corridor only

No specific mitigation measures are possible at the landfall area. Dredging in the intertidal area may form piles of soft sediment at the edge of the trench. The pile may slump laterally, covering an area of seabed and smothering fauna with hypoxic sediments. The residual risk of smothering of benthos as a result of lateral slumping of sediments after mitigation measures have been implemented is **negative** and **direct**. At the landfall, where dredging will take place, the disturbance to sediments will be greater than in deep waters that require minimal seabed intervention works. The impact at the landfall is therefore expected to be greater than in deeper waters. Macroalgae were only found to a depth of 6 m during surveys and are expected to be primarily found within the landfall and shallower areas of ESR I. The benthic flora and fauna at the landfall are considered to be of **low** value/sensitivity. Laterally slumped material is expected to be mobilised only over relatively short distances and is therefore predicted to have a **local** impact. The effect of smothering on the benthos as a result of construction activities is expected to have a **short-term** to **long-term** effect depending on the thickness of deposited material. Many benthic species may survive a thin layer of sediments (< 10 mm), but will succumb underneath thicker layers of anoxic sediment. Eventually, the area is expected to recover due to recolonisation by individuals migrating from other areas. The intensity of this impact is expected to be **medium** as smothered fauna will suffer from the depletion of oxygen and the presence of toxic hydrogen sulphide ($H_2S$) naturally found in these sediments but not to the extent that the entire benthic population is compromised. This impact is expected to have a **low** magnitude as the impact is expected to affect individuals within the pipeline footprints only. The overall impact significance is therefore expected to be a **minor**. This impact is **reversible** as the effects will be limited in time because the area is expected to be colonised by new individuals from other benthic communities.

In the deeper areas of ESR I, the impact from pipe-laying activities is also predicted to have a **short-term** to **long-term** effect on the benthos. The impact is also expected to be on the **local** scale and of **medium** intensity. The impact from pipe-laying may affect a portion of the benthic population but is unlikely to affect the long-term integrity of the population. The magnitude is therefore predicted to be **low**. The overall significance for this impact within the deeper areas of ESR I is predicted to be **minor**.

*Introduction of non-indigenous species*

Aside from the risk of introduction of invasive plankton species through ballast water (see **Section 9.3.6**), it is possible that invasive species enter the Baltic system through biofouling of the ship hull of the vessels involved in the construction. Biofouling primarily transports species that have attached life stages typical of many benthic communities, or species associated with these communities. The use of antifouling paints limits the settling of potential fouling species on the ship hull, tanks and drilling and dredging equipment.

To prevent the introduction of invasive organisms into the ESR I through hull fouling, careful cleaning of hulls, tanks and drilling and dredging equipment before use will take place wherever practically possible prior to entering the Baltic. The spread from formerly introduced species in one part of the Baltic (e.g. from ports in the western Baltic part) to another yet unaffected area by the project, is considered to be negligible in comparison to existing maritime activities (e.g. fishing, commercial shipping) in the area. Chances of successful settlement of invasive species is further reduced by the fact that different marshalling yards are used for the supply to the pipelay vessel which only service specific sections of the pipelines (those within shortest distance of the pipeline route). The differences in salinity, depth and limited oxygen between the various ESRs of the Baltic Sea also constrain the spread of the invasive freshwater species that are known to have settled in ESR I, and reduce the survival of potentially invasive marine species in ESR I that may have successfully settled in ESR IV and V.

From the aforementioned it follows that the unintentional introduction of invasive species into the Baltic Sea or from one area of the Baltic to another poses a negligible risk. Consequently, the residual impacts of the construction phase on benthic communities in ESR I will be **insignificant**.

**Impacts during the Pre-Commissioning and Commissioning Phase**

The pipelines will be flooded with seawater before being put into operation, in order to test their integrity (as detailed in **Section 9.2.2**). Seawater (1.27 million $m^3$ per pipeline) will be extracted at the Russian landfall site at a water depth of approximately 10 m, filtered, and treated before use with an oxygen scavenger (to prevent corrosion) and caustic soda (to prevent anaerobic growth). The waste water from this process will be discharged at the original intake location, following pressure testing.

During the pre-commissioning and commissioning phase potential impacts upon benthos include an increase in noise and vibration, the removal of larvae and a change in water quality associated with the seawater intake, system pressure testing and pressure-test water discharge.

*Noise and vibration*

The intake of seawater during pipeline flooding, subsequent discharge of pressure-test water, and input of natural gas during commissioning will lead to an increase in noise and vibration in the local area around the Russian landfall site. During the system pressure testing, pressure will be increased up to the required hydro-test pressure. This operation will involve injecting more water into the pipelines until the required holding pressure is achieved, and then a 24 hour holding period, where pressure and temperature are monitored.

As mentioned in the **Impacts during the Construction Phase** section, most benthic fauna are not sensitive to noise, however, some invertebrates, such as the common lobster *Homarus gammarus,* are sensitive to noise and vibration. The movement of water during pipeline flooding and pressure testing will generate some noise and vibration, which is expected to be on a similar level to that of normal gas movement within the pipelines and much less than noise produced during dredging. Therefore, noise and vibration generated during the pre-commissioning and commissioning phase are expected to have an **insignificant** impact on marine benthos in ESR I.

*Removal of larvae*

As described above, the pipelines will be flooded during pre-commissioning by seawater intake from the area near the Russian landfall. Planktonic larvae of benthic species will be sucked into the pipelines, potentially leading to a localised decrease in recruitment. However, as plankton are so abundant, a decrease in recruitment is very unlikely. Seawater intake is therefore expected to have an **insignificant** impact on larval recruitment of marine benthos and is not considered further.

*Change in water quality*

Discharge of the pressure-test water will occur at the Russian landfall site at the original intake location and depth as described in **Section 9.3.3**. The discharged water will have been treated with an oxygen scavenger, to eliminate oxygen corrosion, and with caustic soda, to prevent anaerobic growth within the pipelines. Caustic soda dissolves quickly in seawater and is therefore expected to have no effect on the benthos. All the other treatment products are naturally occurring compounds that already exist at low levels in seawater and have been successfully used in similar pipeline projects. Numerical dilution and dispersion models have confirmed that the effect of oxygen depletion and increased pH will be localised to a maximum range of 20 – 50 m around the point of discharge and will be easily diluted by the surrounding seawater. Therefore the impact of the discharged water on water quality and consequently marine benthos is assessed as **insignificant**.

**Impacts during the Operational Phase**

During the operational phase, physical alteration of the seabed as a result of routine inspections and maintenance work and pipeline presence, temperature change in the marine environment and the release of pollutants from anti-corrosion anodes due to pipeline presence have the potential to impact benthos within ESR I.

*Physical alteration the seabed*

Routine inspections of the pipelines will occur infrequently and vessel movements will be restricted to the pipelines' route. This is anticipated to result in low levels of disturbance to the seabed and is expected to have an **insignificant** impact on the benthos. Any repair or improvement works may result in a localised disturbance resulting in a direct loss of flora and fauna and smothering of benthos due to re-suspension of the sediment. This impact is expected to be **negative** and **direct** incurring a **local** and **short-term** effect as these activities are only expected to affect a small area for a limited period of time. The impact is likely to have a **medium** intensity. It is, however, likely to be of **low** magnitude as only a limited number of **low** value/sensitivity individuals are expected to be impacted. The impact significance is therefore **minor**. Impacts are **reversible** since impacted areas are expected to be recolonised within a few years.

*Introduction of secondary habitats*

The physical presence of the pipelines may alter the composition and abundance of the benthic community. Solid surfaces that are placed in marine environments often become colonised by marine organisms[1]. Initially, a surface film forms that is subsequently colonised by a variety of micro-organisms. Secondary colonists such as algal spores and the planktonic larvae of barnacles are the next group to become established and form a habitat for tertiary colonists including a wide variety of invertebrate species. The pipelines will form a hard surface in what is a predominantly mixed sand and soft bottom area, which will support a different community of benthos to that of the surrounding seabed. In addition, the hard substrates that are introduced by rock placement and installation of support structures will further increase habitat diversity in the areas of such interventions. There is an added risk that invasive species, previously introduced in the Baltic, will occupy the new habitat. An overall increase in localised biodiversity and abundance may result. A **direct** impact is expected which is likely to be **local** to the pipelines' structure and **long-term** as the benthos are expected to use the pipelines as a habitat for as long as the pipelines are in place. The impact may be **positive** or **negative** depending on the composition of the community that develops as a result of the pipelines' presence. The impact intensity is expected to be **medium** as the impact is likely to be greater than the limit of detection but will not affect the function of the benthos entirely. This impact is **irreversible** unless the pipelines are removed during decommissioning. The impact from the physical presence of the pipelines is expected to be of **low** magnitude as only a localised group of individuals within a **low** value/sensitivity population is expected to be affected resulting in a **minor** significance impact to the benthos.

*Temperature change*

Natural gas flowing through the pipelines will cause an increase in temperature in ESR I. Models of this temperature increase (described in **Section 9.3.3**) indicate that within a few centimetres of each pipeline, water temperature could increase by up to 40°C. However, near the seabed a maximum increase in temperature of 0.5°C is expected. An increase in temperature was only detectable up to 1 m from the pipelines. Based on the results of this model, benthic fauna may be subjected to a 0.5°C increase in temperature within 1 m of the pipelines. However, as the water temperature near Vyborg naturally varies from 0 – 26 °C, a potential increase in water temperature of 0.5°C is not expected to have a significant impact on benthos within ESR I. The potential impact of increased water temperature on benthos within ESR I is therefore considered to be **insignificant**.

(1) Railkin, A.I. 2004. Marine Biofouling: Colonization Processes and Defences. CRC Press. Cambridge.

*Release of pollutants from anti-corrosion anodes*

Within ESR I, aluminium and zinc anodes will be used to protect the pipelines from corrosion. These anodes have the potential to release cadmium and zinc into the water column which has the potential to cause toxicity to the benthos. However, the quantities of toxic material that are expected to be released are extremely low as discussed in **Section 9.3.3** and there are only a small number of anodes within ESR I. As such, the risk of contamination to the benthos from anodes is considered to be **insignificant**.

**Impact Summary**

The impacts identified and assessed in ESR I on the benthos are summarised in **Table 9.13**.

**Table 9.13 Impact summary table for marine benthos in ESR I**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Marine Benthos - Ecological Sub-Region I | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term - Long-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term - Long-term | Low | Low | Low | Reversible | **Minor** |
| | Release of contaminants | Munitions clearance, Seabed intervention works, Pipe-laying, Anchor handling | Negative | Direct and indirect | Local | Long-term | Low | Low | Low | Reversible | **Minor** |
| | Release of nutrients | Seabed intervention works, Pipe-laying | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Munitions clearance | Negative | Direct | Local | Temporary | Low - Medium | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | | Seawater intake, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | Physical loss of seabed habitats | Munitions clearance | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | | Dredging | Negative | Direct and indirect | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | | Rock placement, installation of support structures, Pipe-laying | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| | Smothering | Dredging, Pipe-laying | Negative | Direct | Local | Short-term - Long-term | Medium | Low | Low | Reversible | **Minor** |
| | Introduction of non-indigenous species | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | Removal of larvae | Seawater intake | - | - | - | - | - | - | - | - | **Insignificant** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Change in water quality | Pressure-test water discharge | - | - | - | - | - | - | - | - | **Insignificant** |
| | Physical alteration of the seabed | Routine inspections | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine Maintenance | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | Introduction of secondary habitats | Pipeline presence | Positive or Negative | Direct | Local | Long-term | Medium | Low | Low | Irreversible | **Minor** |
| | Temperature change | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of pollutants from anti corrosion anodes | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

## 9.3.8 Biological Environment – Fish

### Overview

A project of this nature can impact fish through impacts to water quality, changes to the seabed habitats, underwater noise, disturbance caused from the presence of vessels involved in construction and maintenance of the pipelines and release of pressure-test water during pre-commissioning. These activities will take place during the construction and pre-commissioning and commissioning phase. Noise generated from project related activities as well as the re-suspension of sediments by seabed intervention works are predicted to cause the largest impacts to fish. Impacts during the operational phase are expected to be minimal in comparison to those from construction.

The fish community in ESR I is dominated by pelagic freshwater species. Marine species such as cod and sprat do not tend to occur in these waters as they are intolerant to the low salinity, which also prevents successful development of their eggs. Some important fish of commercial value such as common bream (*Abramis brama*) and perch (*Perca fluviatilis*) and Baltic herring (*Clupea harengus*) use the shallow waters of ESR I as spawning and feeding grounds. Fish species of conservation value found in ESR I include three-spined stickleback (*Gasterosteus aculeatus*), nine-spined stickleback (*Pungitius pungitius*), Atlantic salmon (*Salmo salar*), river lamprey (*Lampetra fluviatilis*) and sea trout (*Salmo trutta*).

Values/sensitivities for fish in ESR I are detailed in **Section 8.7.5** and summarised in **Table 9.14**. In some cases, the value/sensitivity of a particular species may be higher or lower and impacts have then been assessed on species-specific basis.

**Table 9.14 Values/sensitivities of fish in Ecological Sub-Region I**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fish** | | | | | | | | | | | | |
| Freshwater fish species | Low | Low | Low | Med | Med | Med | Low | Low | Low | Low | Low | Low |
| Pelagic species | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Diadromous species | Low | Low | Low | Low | Low | High | Low | Low | High | High | High | Low |

**Atlas Map PR-3a** shows the locations of the various seabed intervention works planned for ESR I.The populations of diadromous species present in ESR I (i.e. salmon, sea trout and lamprey) both spawn in rivers and are considered of high sensitivity during their migratory periods.

Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Re-suspension and spreading of sediments from munitions clearance, seabed intervention works, pipe-laying and anchor handling resulting in:
  - Increase in turbidity
  - Release of contaminants
- Munitions-clearance, seabed intervention works and construction and support vessel movement resulting in:
  - Noise and vibration
  - Visual / physical disturbance

*Pre-commissioning and commissioning phase*

- Pipeline flooding, pressure testing and pressure-test water discharge resulting in:
  - Noise and vibration
- Pressure-test water discharge resulting in:
  - Change in water quality

*Operational phase*

- Routine inspections and maintenance works resulting in:
  - Noise and vibration
- Pipeline presence resulting in:
  - Physical alteration of the seabed
  - Temperature change

**Impacts during the Construction Phase**

The main activities that are expected to impact fish in ESR I are those activities that take place during the construction phase. Impacts upon fish during the construction phase are anticipated as a result of munitions clearance, seabed intervention works, pipe-laying, anchor handling and construction and support vessel movement. The impacts anticipated are primarily from an increase in turbidity, release of contaminants (heavy metals and organic pollutants), noise and vibration and physical/visual disturbance.

At the Russian landfall site in ESR I, dredging will take place along 1.8 km of the pipelines' route and will therefore directly affect an area of at least 0.15 $km^2$. The landfall works will be carried out in summer/autumn.

*Increase in turbidity*

Re-suspension of sediments and consequent increases in turbidity will result from munitions clearance, boulder removal, seabed intervention works, pipe-laying and anchor handling.

Munitions clearance, seabed intervention works and pipe-laying will cause an increase in turbidity due to the disturbance of sediments. The greatest impact from these activities is expected to be caused by dredging (see **Atlas Map MO-25**), which will lead to concentrations of suspended sediment exceeding 1 mg/l for over 72 hour in places at a distance of 1 km from the pipelines due partly to the muddy nature of the sediment, and for up to 12 hours at a distance of 7 km from the pipelines. This may potentially cause physiological damage to any fish species and eggs and larvae that are present in the areas of increased turbidity.

Pelagic fish such as roach, bream, ruffe and perch inhabit the shallow coastal waters of < 20 m depth. These areas of ESR I are important spawning areas for both roach and bream when water temperatures reach 10 and 15º C respectively (i.e. in spring and summer). Carp are known to spawn in these shallow waters when water temperatures reach 19 to 21 ºC. As mentioned in the baseline (**Section 8.7.5**), most of the species in ESR I are considered low priority species for conservation action. Furthermore, these fish will move away from areas of increased turbidity until levels return to normal. ESR I is also important for the three-spine stickleback, which is a species of conservation concern that spawns in the coastal waters of ESR I. This species is a migratory fish, but few individuals swim upstream to spawn and many prefer to stay in brackish bays. During the spawning period, males build a nest on the bottom and are very territorial.

The reproductive success of these species will be affected by elevated turbidity as a result of construction works at the sea bottom and will impact spawning in the following ways:

- Re-settling sediment may smother eggs and larvae, as well as prey items
- High suspended sediment concentrations may displace adults away from their natural spawning areas

As mentioned previously, herring and carp spawn in May and June. No construction is to take place in ESR I from April 15th to June 15th in order to reduce or eliminate potential impacts on flora and fauna including fish, their larvae and eggs. Therefore, herring spawning will not be impacted. However, as a result of increased turbidity, eggs spawned late in the season and larvae may be affected. The population size of herring and carp in the area is not likely to be affected(1) as a result of eggs and larvae being disturbed due to immigration of fry from adjacent areas, which remain unaffected by the works. Impacts on these species due to munitions clearance, seabed intervention works and pipe-laying will therefore be **insignificant**.

It should be noted that migratory fish species pass through ESR I and could also potentially be impacted by increased turbidity. One such fish is the river lamprey (*Lampetra fluviatilis*), which is found in high concentrations in the coastal waters near the Serga River. As described in the baseline, the Baltic Sea population is of global importance. River lamprey move from rivers to the sea in spring and reside there until autumn of the following year when they migrate to their spawning rivers. ESR I is an important area for the passage of river lamprey during their migratory period in autumn. However the migration of this species will not be impacted by the increased turbidity as a result of the Project as this euryhaline species is adapted to turbid conditions in rivers. The nine-spine stickleback is also found in ESR I, however this species moves to freshwaters to spawn in spring and in the autumn and subsequently adults and young fish move to deep waters offshore and sometimes even to the less saline parts of the sea. Impacts on spawning of this species due to munitions clearance, seabed intervention works and pipe-laying will be **insignificant** as they do not spawn in ESR I.

Atlantic salmon is not common in ESR I, but may pass through during their spawning migrations, peaking in June. Therefore, there will be an **insignificant** impact on salmon as a result of increased turbidity due to munitions clearance, seabed intervention works and pipe-laying in ESR I.

Boulders and stones in ESR I that may interfere with construction activities are to be removed and replaced. The removal of boulders may result in a very localised increase in turbidity, however re-suspended sediment is not expected to substantially affect current turbidity levels, which are generally quite high, and thus this impact of increased turbidity due to boulder removal on fish is regarded as being **insignificant**.

Throughout the construction phase, anchors from the construction and support vessels will have to be constantly repositioned. This repositioning, along with drifting anchors and chains dragging across the seabed, and the additional impact of ship propellers in these shallow waters, will give rise to increased turbidity. As described above (**Section 9.3.3**), a Dynamically Positioned Vessel (DPV) will be used to lay pipeline one (northwest pipeline) for KP 7.5 to KP 300. A DPV may also be used to lay pipeline two (southeast pipeline) from KP 7.5 to KP 300, depending on availability. Use of the DPV in ESR I will minimise the increase in turbidity resulting from

(1) Impacts that have no effect at the population level may reduce the number of offspring of any given genetically distinct population, but this will not have a ‘statistically significant’ effect on stock / population size.

construction works and anchor handling. The lifting of anchors off the seabed and the repositioning back on the seabed will give rise to limited increased turbidity. However, in comparison to turbidity as a result of fishing and trawl nets, these impacts are considered to be **insignificant**.

*Release of contaminants*

An increase in the concentration of dissolved contaminants in the water column due to the suspension of sediment could, theoretically, raise the concentration of contaminants in the food chain and affect fish spawning and the fish themselves. The potential effects to marine organisms are a function of the type of contaminant and the duration of exposure. Contaminants of concern include heavy metals and organic compounds including PAHs. Heavy metals are generally more soluble than organic compounds, and given the short duration of exposure, acute toxicity due to temporary re-suspension of heavy metals is the most likely mechanism by which eggs and larvae would be affected.

The sediments in ESR I contain elevated levels of heavy metals, with particularly high mercury levels (see **Chapter 8**). Fish exposed to elevated concentrations of contaminants will absorb contaminants through their gills, accumulating it within the liver, stomach, and gall bladder, which can lead to long-term, sub-lethal effects. Adult fish are mobile and generally able to detect heavily contaminated areas(1) or areas of low water quality. Pelagic species in ESR I will be affected by the elevated concentrations of dissolved contaminants. The duration for which PAH concentrations are expected to be greater than the Predicted No-Effect Concentration (PNEC) is 14 hours (see **Section 9.3.3** for further details) at rock placement sites. Once fish move away from the source of contamination they can metabolise the pollutants and cleanse themselves within a few weeks of exposure(2),(3). The period of exposure is therefore short and, in addition, fish are likely to avoid areas of elevated turbidity, where suspended contaminants may occur. Some fish species such as perch and roach use turbidity as a refuge when macrophytes are not present(4) and therefore these species may be subject to higher levels of contaminants as a result. However, munitions clearance and seabed intervention works will result in increased noise and vibration, and therefore fish will move away from the areas of increased turbidity due to increased noise levels.

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(1) International Petroleum Industry Environmental Conservation Association (IPIECA). 2000. Biological Impacts of Oil Pollution - Fisheries. IPIECA Report Series. 8.

(2) Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP). 1993. (IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution). Impact of Oil and Related Chemicals and Wastes on the Marine Environment. GESAMP Reports and Studies. 50.

(3) Heath, A.G. 1995. Water Pollution and Fish Physiology. Second ed. Lewis Publishers. Boca Raton. FL.

(4) Pekcan-Hekim, Z. 2007. Effects of turbidity on feeding and distribution of fish. Doctoral dissertation (article-based). University of Helsinki.

A much greater threat to fish populations is posed from exposure of eggs and larvae to increased contaminants as they can not actively move away from the contaminated areas. High levels of contamination may cause eggs and larvae to experience increased mortality rates, potentially affecting later recruitment to the adult population. Even low concentrations of contaminants can have marked effects on the proportions of eggs which hatch, and on the growth rates and development of larvae. Contamination may eventually lead to mortality and reduction in recruitment to adult populations.

Fish eggs and larvae mostly occur in the upper layers of the water column in ESR I and are less likely to be impacted by increased levels of contaminants due to the re-suspension of sediments in the water column. The disturbance to spawning grounds as a result of construction will not have any significant impact on the overall population dynamics of roach, bream and perch in the Baltic Sea as the pipelines will take up a very small fraction of the spawning grounds available to these species and the numbers of eggs or larvae impacted will have a negligible impact on population size.

Herring is a species that does spawn near the seabed. However, as previously described in the construction phase, this species will not be significantly impacted if caution is taken to avoid construction during the spawning season (May-June).

The following mitigation measures are planned to be carried out where possible, to address or reduce the significance of the identified potential impacts associated with construction works on spawning fish:

- In order to reduce the volume of re-suspended sediments, the pipelines' route has been optimised to reduce the extent of seabed intervention works required

- Anchor handling will be kept to a minimum to reduce sediment disturbance. Anchors will not be dragged through the seabed but rather raised during relocation

Consequently the residual impact of munitions clearance and seabed intervention works resulting in the release of contaminants on fish species during the construction phase is expected to be **negative** and **direct,** on a **local** scale and of **short-term** duration. Impacts are **reversible**. The value/sensitivity of fish is **low** to **high**. However as the re-suspension of sediments and release of contaminants are less likely to affect the upper layers of the water column, these impacts will be of **low** intensity with a **low** magnitude. Impact significance is expected to be **minor** where mitigation measures are applied. In the unlikely event that diadromous species are in close proximity to the pipelines during migratory periods, an increase in contaminants could result in an impact of **moderate** significance, as these fish are highly sensitive at this time.

*Noise and vibration*

A potential impact to fish in ESR I will arise from increased levels of underwater noise and vibration as a result of construction. Elevated underwater noise levels can affect fish by causing tissue damage (including damage to hearing apparatus) and changes in behaviour (including avoidance and attraction).

The nature and magnitude of the impacts of noise on fish vary greatly between species due to their differing hearing abilities and resultant sensitivity to noise. It has been shown that all species of fish are able to hear, but the frequencies that different fish species are able to hear vary significantly from 30 Hz to 4 kHz(1). In ESR I, Baltic herring are the most sensitive species to noise(1). Carp (*Cyprinus carpio)* are hearing specialists and are known to have hearing sensitivities that approach those of herring(2). Perch are regarded as being hearing generalists and are not sensitive to noise(3). Underwater noise and vibration could arise from a number of activities during the construction phase, particularly seabed intervention works, pipe-laying and construction and support vessel movement and operations.

In ESR I, herring is one of the most sensitive species to noise impacts and can hear in an extended range of frequencies of between 30 Hz and 4 kHz with a hearing threshold of 75 decibels (dB) re 1 μPa at 100 Hz(4). Herring are demersal spawners, depositing their eggs on coarse sand, gravel, stones and rock throughout ESR I. Increased noise levels in these areas will impact spawning success rates of Baltic herring if construction is carried out during the spawning season between May and June(5). In ESR I, construction will not be carried out between the 15$^{th}$ April and 15$^{th}$ June in the near shore areas, in water depths of between 3 and 17m, and therefore there will be an **insignificant** impact on herring spawning as a result of noise.

Carp are hearing specialists and their range of best hearing is between 0.5 to 1.0 kHz(6). Carp spawn in ESR I among sedges or other vegetation when water temperatures reach between 19 and 21 ºC in the May/June. The eggs are adhesive and stick to plants. Noise levels associated

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(1) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

(2) Amoser, S., and Ladich, F. 2005. Are hearing sensitivities of freshwater fish adapted to the ambient noise in their habitats? Journal of Experimental Biology. 208.

(3) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

(4) Enger, P.S. 1967. Hearing in Herring. Comparative Biochemistry and Physiology. 22.

(5) Finnish Game and Fisheries Research Institute. Herring (Clupea harengus) http://www.rktl.fi/english/fish/fish_atlas/herring/ (accessed September 29, 2008).

(6) Amoser, S., and Ladich, F. 2005. Are hearing sensitivities of freshwater fish adapted to the ambient noise in their habitats?, Journal of Experimental Biology. 208.

with the Project could potentially impact spawning of carp. However, as for herring, **no impact** is anticipated on carp as no construction will take place in the spawning period.

Salmon respond only to low-frequency tones (below 380 Hz), with best hearing at 160 Hz. The hearing of salmon is poor, with narrow frequency span, a poor ability to discriminate signals from noise and low overall sensitivity(1). Salmon spawn in rivers and hence spawning will not be impacted by noise related activities in ESR I. Salmon migrating and feeding in the area of the pipeline construction activities will be able to move away from any area of excessive noise and vibration. As salmon only respond to low-frequency tones, they will not be impacted by noise during the construction phase.

Tissue damage or death is likely to occur when fish are in the immediate vicinity of loud, sudden noises such as that caused by the explosion of munitions. Surveys of the pipelines' route in Russian waters are currently ongoing and the exact locations of munitions have not been confirmed. The expected level of noise generated is not known but would depend on the amount of explosive used as well as the amount of residual explosive within the device. However, the peak noise levels during such an event are expected to be significantly greater than the hearing thresholds of most fish in the Baltic, including herring and sprat and studies have reported injuries of this species due to noise exposure at sound levels of 153 to 180 dB re 1µPa(2). Ruptures of the swim bladder, haemorrhages and ruptures to internal organs such as the kidneys or the liver in fish may result from munitions clearance(3). Fish with a swim bladder such as cod, herring and sprat are more sensitive than fish that lack swim bladders (e.g. flatfish). However, due to construction and support vessel movement in ESR I, it is expected that some fish will move out of the vicinity of the pipelines prior to munitions clearance. In addition, fish spawing times will be considered during munitions clearance and an acoustic survey will take place prior to clearance to ensure that schools of fish are not present.

The impacts of an explosion, which cause the most harm to fish is caused by the differential rate of transmission of pressure waves(3). Studies have shown that smaller species of fish are more sensitive to explosive charges than larger species(4). A study carried out in the Baltic Sea by the Swedish Defence Research Agency (FOI) showed that following a planned detonation of a mine, at a depth of 70 m, with an explosive charge of 3 tonnes all Baltic herring, sprat and cod

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(1) Hawkins, A. D. and Johnstone, A. D. F. 1978. The hearing of the Atlantic salmon (Salmo salar). Journal of Fish Biology. 13

(2) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

(3) Wright, D.G and Hopky, G.E. 1998. Guidelines for the use of explosives in Canadian fisheries waters. Canadian Technical Report of Fisheries and Aquatic Sciences. 2107.

(4) Yelverton, J.T., Richmond, D.R., Hicks, W., Saunders, K. and Fletcher, E.R. 1975. The relationship between fish size and their response to underwater blast. Topical Report DNA 3677T. Department of Defence, Washington, D.C.

within a 1.5 km radius were instantly killed. Therefore if these species are found in a similar radius, they will die. Salmon and sea trout were affected only within the immediate vicinity of the explosion. An area of water 150 m wide was lifted approximately one metre into the air following the detonation and resulted in increased turbidity(1).

As loud noises usually initiates an avoidance response, some fish in ESR I will move away from the areas of disturbance from vessels associated with munitions clearance and return once munitions clearance has completed. However, displacement of fish away from their usual spawning grounds during the spawning season could have a significant impact on recruitment to the adult population(2). The impacts of noise generated as a result of munitions clearance on fish will be **negative** and **direct** and of **temporary** duration. The impact will be on a **regional** scale around the clearance site. Impact intensity is expected to be **medium** to **high** depending on the fish present in the area impacted from the detonation. Impact magnitude is **medium** and the value/sensitivity ranges from **low** to **high** depending on the species impacted. Impacts may be irreversible at an individual level if tissue damage or hearing loss occurs, however at a population level the impacts are considered to be **reversible**. Therefore, impact significance is expected to be **minor** to **moderate.** It should be noted that munitions clearance is a common activity in the Baltic Sea. Impacts will act on the individual rather than operating at the population level.

Fish may also exhibit behavioural changes in response to lower level intermittent or continuous noise sources, however, these are often hard to detect. Behavioural changes will typically involve a cessation of normal activities and the commencement of avoidance or "startle" behaviour as a result of the detection of sound from marine construction activity. Continued detection of noise activity by fish often results in habituation to the sound, followed by a re-commencement of normal behaviour(3).

As described above, dredging will be carried out in ESR I, however, no trenching will be carried out in this ESR (See **Atlas Map PR-3a**). Dredging is expected to emit similar underwater noise levels to trenching. In terms of trenching (and therefore dredging), studies have shown that fish may be able to detect noise at peak levels of 178 dB at 1 metre from the source at 160 Hz, with

(1) Karlsson, R-M., Almström, H. & R. Berglind. 2004. In Swedish: Environmental effects of underwater explosions – a literature review: FOI- Swedish Defence Research Agency report.

(2) Impacts that have an effect at the population level are likely to reduce the number of offspring of any given genetically distinct population, which may affect future generations.

(3) Knudsen, F.R., Enger, P.S. and Sand, O. 1992. Awareness reactions and avoidance responses to sound in juvenile Atlantic salmon, *Salmo salar* L. Journal of Fish Biology. 40.

an overall source level 185 dB at 1 metre[1] . These studies have shown that fish may be able to detect noise of this frequency and magnitude at distances of more than 10 km [4].

Rock placement is planned to be carried out in ESR I, with around 264,000 to 270,000 $m^3$ of rock being placed along each of the pipelines' route. Noise generated from rock placement is not expected to exceed background noise beyond the immediate vicinity of the works and thus **no impact** on fish is anticipated as a result of this activity being carried out at locations throughout the pipelines' route in ESR I.

The hearing threshold for herring at 160Hz is approximately 76 dB re 1µPa. The peak noise levels during dredging are significantly greater than this threshold. For Clupeids (herring and sprat), injuries have been reported due to noise exposure at sound levels of 153 to 180 dB re 1µPa. Pile driving can generate noise of similar levels to dredging and this has been shown to cause severe injury or mortality of fish in the direct vicinity of the piling (10-12 m)[2]. However, due to the presence and passage of vessels in ESR I, it is expected that fish will move out of the vicinity of the pipelines prior to noise associated with trenching or dredging reaching levels that could cause injury.

As loud noise usually initiates an avoidance response, fish in ESR I will move away from the pipelines while construction is carried out and return once construction has completed. The impacts of noise generated from construction on fish will be **negative, direct, reversible** and **regional**. The impact will be **temporary** and of **low** intensity. Overall the impact will be of **low** magnitude as only the local fish population will be impacted and therefore will be of **minor** significance. Diadromous species are less sensitive to noise (as described above), however during migration an impact of **moderate** significance may occur when these species have a **high** value/sensitivity.

Fish can acclimatise to noise sources and studies have demonstrated the ability of fish to acclimatise to airgun noise with time[3]. The species inhabiting the pipelines' route are already likely to be habituated to vessel noise from other marine traffic as detailed above and the addition of a pipe-laying vessel is unlikely to represent a significant increase in underwater noise. A study of spawning herring in Norway was carried out to investigate the effects of repeated passage (at a distance of 8 – 40 m, in 30 – 40 m of water) of a research vessel with a peak noise level of around 145 dB re 1uPa 1Hz within the range 5 – 500 Hz, had no detectable

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(1) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

(2) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

(3) Chapman, C.J., and Hawkins, A.D. 1969. The importance of sound in fish behaviour in relation to capture by trawls. FAO Fisheries Reports 62 (3).

reaction amongst the spawning herring[1]. The maximum level of noise anticipated from the vessels is 162 dB. This is slightly higher than that of a fishing trawler (158 dB) and lower than that of the large tankers (177 dB) that are known to operate in the Baltic[2]. Impacts on fish as a result of increased vessel noise are deemed to be **insignificant**.

*Visual/physical disturbance*

In the shallow waters of ESR I, dredging will be carried by a backhoe dredger for 1.8 km to depths of up to 14 m. In water depths of greater than 14 m, rock placement will be carried out. These activities will require support vessels. The presence and passage of such vessels including the dredging vessel in ESR I will have an impact on pelagic fish in the area, such as roach (*Rutilus rutilus*), pike (*Esox lucuis*), ruffe (*Gymnocephalus cernuus),* bream and perch as the levels of vessel traffic will be at their highest. However, it is envisaged that fishing activities will be temporarily prohibited around the pipe-laying barge during construction and within the planned protection area around the Russian landfall. Therefore, vessel traffic associated with construction is unlikely to lead to a significant increase over existing background levels. Also, the presence of pipe-laying vessels at any one location along the pipelines' route will be for a short duration, since 2 to 3 km of pipeline will be laid per day. Due to this, the impact of the presence and passage of vessels on fish is therefore anticipated to be **insignificant** within the context of the Baltic Sea as the increased in vessel traffic will be not be noticeable above background numbers of vessels in the area.

**Impacts during the Pre-commissioning and Commissioning Phase**

During the pre-commissioning and commissioning phase potential impacts on fish may result from noise associated with the seawater intake and pressure-test water discharge in ESR I. Physical damage to fish eggs and larvae may also arise. However, as fish are known to move away from disturbances, the intake of pressure-test seawater and dewatering associated with pre-commissioning of the pipelines will result in a temporary displacement of fish present in the immediate vicinity of the intake area.

*Noise and vibration*

Impacts on fish during the pre-commissioning and commissioning phase (pipeline flooding and pressure-test water discharge), and during the commissioning phase as a result of natural gas input to the pipelines, may result as a consequence of underwater noise and vibration. However, these impacts are anticipated to be less significant than those associated with the construction

(1) Skaret, G., Axelsen, B. E., Nottestad, L., Ferno, A. and Johanssen, A. 2005.The behaviour of spawning herring in relation to a survey vessel. ICES Journal of Marine Science. 62.

(2) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

phase, as pre-commissioning activities will be carried out over a much smaller area and over a shorter duration. Impacts are therefore considered to be **insignificant**.

Noise from construction and support vessel movement during the pre-commissioning and commissioning phase of the Project may have some impact on pelagic fish present in the area, such as perch, bream, carp, sea trout, herring, and salmon. As with the construction phase of the Project, this increase in noise due to vessel traffic in ESR I will not be a significant increase over existing background levels and therefore the impact is considered to be **insignificant**.

*Change in Water Quality*

Seawater for pressure testing is to be sourced at a depth of 10 m near to the Russian landfall. This seawater will be filtered and treated with caustic soda (NaOH) and an oxygen scavenger (sodium bisulphite - $NaHSO_3$) prior to filling the pipelines. These substances already exist in seawater and are harmless to the marine environment at natural concentrations. A grid will be used in order to minimise and where possible prevent the intake of eggs, larvae or small fish with the seawater. Approximately 1.27 million $m^3$ of oxygen-deficient pressure-test water per pipeline will be discharged back into the Baltic Sea at the same location as seawater intake on completion of pre-commissioning at a depth of 10 m. Depleted oxygen levels in pressure-test water discharged into ESR I could result in slower development of eggs/larvae and loss of eggs present.

According to Russian regulations the “Minimum Allowable Concentration” (MAC) of oxygen levels in water allowed to be discharged is 6 $mgO_2$/l of seawater(1). To ensure compliance with this standard Nord Stream will ensure, by dilution, that discharged pressure-test waters will have a minimum oxygen concentration of 7 mg/l (see **Section 9.3.3**). Therefore, there will be **no impact** to eggs and larvae development as a result of pressure testing.

### Impacts during the Operational Phase

Impacts that will arise throughout the operational phase are anticipated to result from increased noise and vibration, physical disturbance of the seabed and temperature change due to pipeline presence.

*Noise and vibration*

The noise levels of natural gas movement through a pipeline are known to have frequencies between 0.030 and 0.100 kHz(2), which is at the lowest levels detectable by many fish species. Higher values are predicted in the area closest to the Russian landfall and the compressor. The

(1) PeterGaz. 2006. The north European gas pipeline. Offshore section (The Baltic Sea). Environmental Survey. Part 1. Stage 1. Book 5. Final report. Section 1 Russia’s EEZ and territorial waters. Folder 1. Moscow.

(2) Martec Limited. 2004. Effects of Pipelines/Gathering Lines on Snow crab and Lobster.

limit of hearing detection at the predicted frequency range for gas movement through a pipeline is 77 to 90 dB re 1µPa for cod (Gadus morhua) and 75 to 77 dB re 1µPa for herring[(1)].

Studies were carried out at KP 125 and 675 (in ESR II and III respectively) to determine the total noise level of gas movement in the pipelines at distances of 10, 100 and 1,000 m from the pipelines. No study was carried out in ESR I, however, the results are expected to be similar to that of the levels anticipated in ESR II. The results from the modelling carried out at KP 125 show that herring may be able to detect noise generated by natural gas moving through the pipelines at distances of less than 1 km from the pipelines (see **Section 9.4.8** for further detail). Therefore there is potential for noise to affect the behaviour of this fish species as it is thought to spawn along the pipelines; route and close to shore. The pipelines will be buried for 1.8 km in ESR I, which will thus reduce noise levels emitted from the pipelines. Where they are not buried, the sound pressure levels are unlikely to cause any physical damage and will only result in an initial startle response. After the initial movement away from the noise, the fish will return and may even become habituated to the noise levels if they are continuous over a significant period of time.

In ESR I, herring and carp are particularly sensitive to noise impacts. Other than an initial startle response it is unlikely that any fish species will be adversely affected by the sounds emitted from the pipelines and fish within ESR I that can detect the noise will quickly become habituated to it. Evidence suggests that in fact many species aggregate around pipelines[(2)]. This impact (**negative** and **direct**) will be **local** and of **low** intensity. The magnitude of the impact will be **low**, will affect **low** to **high** sensitivity receptors and will be **reversible**. The impact is therefore considered to be of **minor** to **moderate** significance in the **short-term**. As fish will naturally become acclimatised to the noise over time, it is expected that noise from operation of the pipelines in the long-term would have no impact on the fish and therefore no specific mitigation measures are proposed.

Routine inspections and maintenance works on the pipelines are assumed to have an **insignificant** impact in terms of noise on fish in ESR I, as inspections and works will be infrequent and restricted to the immediate pipelines' route.

*Physical alteration of the seabed*

As the surface area of the seabed taken up by the physical presence of the pipelines will represent less than 0.001% of the total seabed area of the Baltic Sea, the total substrate area of feeding and spawning grounds expected to be impacted is relatively small.

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(1) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

(2) Love, M. S. and York A. 2005. A comparison of the fish assemblages associated with an oil/gas pipeline and adjacent seafloor in the Santa Barbara Channel, southern California Bight. Bulletin of Marine Science. 77(1).

As herring and stickleback are benthic spawners in ESR I, the physical presence of the pipelines on the seabed may cause an obstruction to spawning to these fish. Due to the small area of the substrate that will be impacted by the pipelines' footprint, the impact on feeding and spawning grounds is anticipated to result in **negative** and **direct** residual impacts following mitigation, on a **local** scale of **long-term** duration. These impacts will be of **medium** intensity with a **low** magnitude. Impact significance is expected to be **minor** as these species that spawn in ESR I have a **low** value/sensitivity. Impacts are **irreversible** unless the pipelines are subsequently removed during decommissioning.

A number of sensitive migratory species pass through ESR I particularly European eel *(Anguilla Anguilla)*, stickleback, river lamprey and the Atlantic salmon. The pipelines will be buried in much of ESR I to depths up to 14 m and therefore once construction ceases there will be no physical impact of the pipelines in this area. In the deeper waters of ESR I, there is no potential for the presence of the pipelines on the seabed to act as a barrier to their migration. As such it is anticipated that there will be **no impact** to fish migration due to the presence of the pipelines in ESR I and therefore no mitigation measures are proposed.

Studies have shown that the addition of hard substrates (such as pipelines and materials used during rock placement) into the marine environment may be beneficial to fish populations in certain areas due to an increase in habitat heterogeneity and associated increase in prey availability[(1),(2)]. Due to the relatively shallow waters in ESR I, fish species may derive benefit from greater habitat diversity on the seabed and this may result in aggregations of fish around the pipelines or any artificial structures introduced by the project such as areas of rock from rock placement. Aggregations of commercial fish around the pipelines may lead to increased fishing along the pipelines' route and possibly result in over exploitation of such fish species. A study was carried out along North Sea oil and gas pipelines in the North Sea to determine whether fish in commercial quantities aggregate along the pipeline potentially creating basis for a profitable fishery[(3)] No measurable aggregation effect on commercial fish species along the pipelines was observed in the North Sea. Consequently the impact of artificial habitat creation in ESR I is anticipated to be a long-term but low intensity impact which will be **insignificant** as it will have no adverse effects on fish populations.

Routine inspections and maintenance works on the pipelines may result in localised re-suspension and spreading of sediments should they interact with the seabed. The following mitigation measures are proposed to address or reduce the significance of the identified potential impacts associated with routine inspections and maintenance works during the operational phase on fish:

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(1) Love, M. S. and York A.. 2005. A comparison of the fish assemblages associated with an oil/gas pipeline and adjacent seafloor in the Santa Barbara Channel, southern California Bight. Bulletin of Marine Science. 77(1).

(2) Marine Conservation Society. 2000. Habitats Factsheet: Artificial Reefs.

(3) Statoil. 1998. Tråltest over steinfyllinger på Sleipner kondensatrørledning 06.-14. juli 1998. (In Norwegian only).

- Any seabed intervention work required during operation as a result of necessary maintenance to pipelines will be kept to a minimum

- Disturbance of seabed sediments will be avoided or, in the case of routine maintenance, disturbance of sediments will be minimised

These inspections and works will be infrequent and restricted to the immediate pipelines' route and therefore are anticipated to have an **insignificant** impact on fish. However, should these works be greater than expected, impacts of **minor** significance may result.

*Temperature change*

Modelling has shown that the temperature of the water at the surface of an unburied section of pipeline in the immediate vicinity of the landfall near Vyborg could be up to 0.5 º C greater than the surrounding water temperature. Mixing will ensure that water temperatures will reach equilibrium with surrounding water temperatures at a distance of between 0.5 and 1 m from the pipelines. There will be a temperature increase in the sediment surrounding the trenched part of the pipelines in a 10-20 cm wide zone. For the buried part of the pipelines in ESR I, modelling has shown that the transfer of heat from the pipelines to the sediment and the surrounding seawater is insignificant. However, in the few centimetres surrounding the pipelines, temperatures in the sediments are expected to increase by a maximum of approximately 40ºC(1).

Increased water temperatures have the potential to have an impact on spawning behaviour and on egg development, however as water temperatures will reach equilibrium within 0.5 to 1.0 m of the pipelines in ESR I, **no impact** on fish is anticipated. No specific mitigation measures are proposed.

**Impact Summary**

The impacts identified and assessed in ESR I for fish are summarised in **Table 9.15**.

(1) Nord Stream AG & Ramboll. 2008. Memo 4.3R - Temperature difference between pipeline and surroundings.

**Table 9.15 ESR I impact summary table for fish**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Fish– Ecological Sub-Region I** | Increase in turbidity | Munitions clearance, Seabed intervention works, Pipe-laying | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Boulder removal | | | | | | | | | |
| | | Anchor handling | | | | | | | | | |
| | Release of contaminants | Munitions clearance, Seabed intervention works | Negative | Direct | Local | Short-term | Low | Low | Low-High | Reversible | **Moderate** |
| | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Medium-High | Medium | Low-High | Reversible | **Minor-Moderate** |
| | | Dredging | Negative | Direct | Regional | Temporary | Low | Low | Low-High | Reversible | **Minor-Moderate** |
| | | Rock placement | - | - | - | - | - | - | - | - | **No impact** |
| | | Pipeline flooding, pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | Negative | Direct | Local | Short-term | Low | Low | Low -High | Reversible | **Minor-Moderate** |
| | Visual/ physical disturbance | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | Temperature change | Pipeline presence | - | - | - | - | - | - | - | - | **No impact** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Revers-ibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Physical alteration of the seabed | Pipeline presence | Negative | Direct | Local | Long-term | Medium | Low | Low | Irreversible | **Minor** |
| | | Rock placement, Pipeline presence (addition of hard substrates) | - | - | - | - | - | - | - | - | **Insignificant** |
| | Change in water quality | Pressure-test water discharge | - | - | - | - | - | - | - | - | **No impact** |

## 9.3.9 Biological Environment – Sea Birds

### Overview

Following the undertaking of a scoping and impact identification exercise, interactions between the Project and sea bird populations(1) have been identified, which could give rise to impacts. This section identifies those impacts and assesses their significance on sea birds in ESR I during the construction, pre-commissioning and commissioning, and operational phases.

The significance of the associated Project impacts on the avifauna in ESR I varies along the pipelines' route depending on the ecology of each species (e.g. foraging behaviour, preferred food resources), seasonal aspects and the extent of impacts. Baseline information about the species present and their populations is provided in **Section 8.7.6**. The assessment of impacts on sea birds depends largely on the detail of information available during the preparation of the Espoo Report and can vary throughout the different ESRs along the pipelines' route. Relatively detailed information is available on birds within the Important Bird Areas (IBAs) along the pipelines' route, whereas the offshore areas have largely been assessed based on the analysis of abiotic factors, such as ice cover and water depth, in order to assess the potential for these areas to support populations of sea birds.

The impact assessment focuses mainly on the identification of impacts on internationally protected or rare species or species occurring in large numbers and densities.

The pipelines in ESR I do not cross any IBAs. However, they pass close to five IBAs within the Finnish and Russian EEZ: the Beryozovyye Islands, Dolgy Reef Island and Bolshoy Fiskar Archipelago, the Nature Protection Area Ingermanlandsky, Itäinen Suomenlahti National Park and Kirkon-Vilkkiläntura Bay.

Dolgy Reef Island and Bolshoy Fiskar Archipelago, located 2.9 km to the west, and Beryozovyye Island 17 km to the east of the pipelines' route, are regarded as the most important sites for staging and breeding sea birds in the Russian EEZ. Large numbers of diving ducks (long-tailed duck *Clangula hyemalis*, tufted duck *Aythya fuligula* and common scoter *Melanitta nigra*) and diver (*Gavia* spp.) occur during spring/autumn migration) while breeding populations consist largely of gulls (herring gull *Larus argentatus* and lesser black-backed gull *Larus fuscus fuscus*). Terns such as common tern (*Sterna hirundo*), Arctic tern (*Sterna arctica*), Caspian tern (*Sterna caspia*) and black tern (*Chilonias niger*) occur in smaller numbers. The Nature Protection Area of Ingermanlandsky, to the east and west of the pipelines' route, is located in close proximity to the pipelines. These areas are highly important for shelduck (*Tadorna tadorna*), black guillemot

(1) Impacts that have an effect at the population level are likely to reduce the number of offspring of any given genetically distinct population, which may affect future generations.

(*Cepphus grylle*), common eider (*Somateria mollissima*), ruddy turnstone (*Arenaria interpres*), Caspian tern (*Sterna caspia*) and black-throated diver (*Gavia arctica*).

Species diversity within the area of Itäinen Suomenlahti National Park is similar to that found on Dolgy Reef. Five species of gulls (*Larus* spp.) and three species of terns (Sterna spp.) are found. Further species of note include breeding velvet scoter (*Melanitta fusca*), red-breasted merganser (*Mergus serrator*), lesser black-backed gull (*Larus fuscus fuscus*), Caspian tern (*Sterna caspia*) and black guillemot (*Cepphus grylle*). Caspian tern, common tern (Sterna *hirundo*) and barnacle goose (*Branta leucopsis*) are also listed in Annex I of the EC Birds Directive and are therefore of high ecological value. PeterGaz (2008)(1) also identified nine species of sea birds which are seen as of particular importance due to their protection status; these include bittern (*Botaurus stellaris)*, Bewick's swan (*Cygnus columbianus*) mute swan (*Cygnus olor*), lesser white fronted goose (*Anser erythropus*), shelduck (*Tadorna tadorna*), common eider (*Somateria molissima*), gadwall (*Anas strepera*), common scoter (*Melanitta nigra*) and little tern (*Sterna albifrons*). Values / sensitivities for sea birds in ESR I are detailed in **Chapter 8** and summarised in **Table 9.16**. In some cases, the sensitivity of a particular species may be higher or lower and impacts have then been assessed on a species-specific basis.

**Table 9.16 Values/sensitivities of sea birds in Ecological Sub-Region I**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Birds** | | | | | | | | | | | | |
| Breeding birds | Low | Low | Med | High | High | High | High | High | High | Med | Low | Low |
| Wintering birds | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Migratory birds | Low | Med | High | High | High | Low | Low | Low | High | High | High | Low |

Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Munitions clearance, seabed intervention works, pipe-laying and anchor handling resulting in:

(1) Petergaz. 2008. Nord Stream Offshore Gas Pipeline Project (Russian Sector). Volume 8. Environmental Protection Book 1 – Offshore Section. Part 1 Environmental Impact Assessment Doc. No. 36/07-01- TEO-OOS-0801(1)-S3.

  - Increase in turbidity

- Munitions clearance, seabed intervention works and construction and support vessel movement resulting in:

  - Noise and vibration

  - Visual/physical disturbance

- Seabed intervention works and pipe-laying resulting in:

  - Loss of seabed habitat

*Pre-commissioning and commissioning phase*

- Pipeline flooding during pressure testing and pre-commissioning and commissioning support vessel movement resulting in:

  - Noise and vibration

  - Visual/physical disturbance

*Operational phase*

- Routine inspections and maintenance works and associated vessel movements and pipeline presence resulting in:

  - Noise and vibration

- Routine inspections and maintenance works and associated vessel movements resulting in:

  - Visual/physical disturbance

**Impacts during the Construction Phase**

During the construction phase, munitions clearance, dredging, rock placement, pipe-laying and anchor handling are likely to result in re-suspension and spreading of sediments, noise and vibration, and direct loss of seabed habitat. Construction and support vessel movement may also lead to physical and visual disturbance of sea birds.

*Increase in turbidity*

Increased turbidity can result from munitions clearance, boulder removal, dredging, rock placement, pipe-laying and anchor handling. Sediment plumes and sedimentation may result in negative impacts upon bird foraging habitats, reducing the available food supply, and having an indirect impact due to the temporary displacement of fish. A suspended sediment concentration of 15mg / l or more is considered as being problematic for the eyesight of diving sea birds.

The re-suspension and spreading of sediments is expected to be greatest during munitions clearance and seabed intervention works, which include dredging (landfall only and 1.8 km in extent). As the extent of increased turbidity in excess of 15mg/l is not known, the value of 10 mg/l was used in order to identity the approximate area in which diving birds may be affected. Munitions clearance is expected to result in sporadic sediment plumes. Turbidity concentrations above 10 mg/l are only expected for up to 4 hours in close vicinity of the clearance location. For dredging at the Russian landfall, a concentration above 10 mg/l is expected to last for 13 hours over an area of 5.6 $km^2$ reaching very high levels of sedimentation within 200 metres from the disturbance area. Rock placement causes concentration above 10 mg/l which last for 5.2 hours close to the disturbance area beyond KP 1.8 (see **Section 9.3.3**).

Many species of diving sea birds including those of high ecological value such as divers (*Gavia* spp.) are known to feed by eye sight and increased turbidity may have a direct negative impact upon foraging success of these species. Re-suspended sediments are expected to remain within 10 vertical metres of the seabed surface for seabed intervention works and throughout the water column for munitions clearance. As the water depth in ESR I is predominantly shallow (<10 m) increased turbidity will, apart from smaller proportion of deeper water of up to 20m, affect the majority of sea birds within ESR I, mainly gulls, terns, diving ducks and auks breeding on Dolgy Reef and Bolshoy Fiskar Archipelago and due to the close vicinity of this site. Indirect negative impacts may also be caused by the temporary displacement of fish. However, fish will return within a few days as sediment settles to the seabed.

Increased turbidity due to boulder removal, pipe-laying and anchor handling is not expected to have a significant impact on sea birds since these activities will not cause a significant increase in turbidity (as discussed in **Section 9.3.3**). Further, areas supporting high densities of birds will not be directly crossed by the pipelines; therefore small amounts of increased turbidity are unlikely to affect sea birds and impacts are considered to be **insignificant**.

Impacts from increased turbidity due to munitions clearance and seabed intervention works will be **regional**, of **short-term** duration and of **low** intensity. Impact magnitude is therefore **low**. Birds in ESR I are highly sensitive during the breeding season and spring/autumn migration period due to the large numbers of internationally protected species present during these periods. However, increased turbidity will not affect the long-term distribution and abundance of sea birds in ESR I. The value/sensitivity of species ranges from **low** to **high**. The majority of affected species forage over large ranges and will return once re-suspended sediment has settled, therefore the impact will be **reversible**. Increased turbidity may result in **moderate** significant impacts on foraging terns as these species are listed in Annex I of the EC Birds Directive, and **minor** significant impacts on the majority of gulls, auks and cormorants.

*Noise and vibration*

Noise and vibration impacts on sea birds may be direct due to the short-term displacement of sea birds or indirect due to the displacement of fish and the subsequent redistribution of piscivorous species of birds. Increased levels of underwater noise will be generated during seabed preparation and intervention works including munitions clearance, dredging, rock placement and pipe-laying activities. Increased levels of airborne noise may also be caused by construction and support vessels during the construction phase of the Project.

Comparatively little is known about direct impacts of noise and vibration on sea bird populations. It is generally expected that the extent of visual disturbance impacts is larger than the extent of noise impacts. As construction noise offshore is almost exclusively associated with the presence of vessels, which also result in visual/physical disturbance impacts, it is often impossible to distinguish between impacts caused by increased noise levels and visual/physical impacts caused by the presence of vessels as both impacts occur simultaneously.

The sensitivity of sea birds to noise impacts is species-specific and also appears to depend on the flock size of sea birds. Surveys carried out to the east of Rügen within the German EEZ showed that a number of key species are sensitive to vessel movements and associated noise, particularly diving sea birds such as long-tailed ducks, velvet scoter and divers (*Gavia* spp.)[(1),(2)]. The disturbance distance for noise disturbance from vessels is typically 1 to 2 km for the more sensitive bird species such as divers and scoters, and to a lesser extent cormorants, but other species such as gulls and terns are likely to be less affected[(3),(4)]. Noise impacts can result in various different types of response. In the UK, research on coastal bird species on the Humber Estuary recorded responses including birds being startled or showing a “heads up” response to small scale movements and also birds leaving the affected area altogether. The responses of the birds to the regular noise levels during a study was mostly limited to wildfowl raising their heads, and there was no apparent variation in feeding rates by waders with noise levels of between 55 dB(A) and 84 dB(A)[(5)]. These findings are not dissimilar to those recorded at the

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(1) Kube, J. & H. Skov. 1996. Habitat selection, feeding characteristics, and food consumption of long-tailed ducks, *Clangula hyemalis*, in the southern Baltic Sea. Meereswiss. Ber., Warnemünde. 18: 83-100.

(2) Bellebaum, J., Diederichs, A., Kube, J., Schulz, A. & G. Nehls. 2006. Flucht- und Meidedistanzen überwinternder Seetaucher und Meeresenten gegenüber Schiffen auf See. Ornithologische Rundbrief für Mecklenburg-Vorpommern Orn. Rundbrief Mecklenburg-Vorpommern 45, Sonderheft 1 (Tagungsbd. 5. deutsches See- und Küstenvogelkolloquium).

(3) Ruddock, M. & Whitfield, D.P. 2007. A Review of Disturbance Distances in Selected Bird Species. A report from Natural Research (Projects) Ltd to Scottish Natural Heritage.

(4) Skov, H., Durinck, J., Leopold, M.F. and Tasker, M.L. 2007. A quantitative method for evaluating the importance of marine areas for conservation of birds. Biology Conservation. 36(3).

(5) Institute of Coastal and Estuarine Studies (ICES). 1999. Avifaunal Disturbance Assessment: Flood Defence Works, Salt End. Report to the Environment Agency.

Wadden Sea and Delta area, where flight responses were observed in waterfowl in response to noise levels of over 84 dB(A)[(1)]. These findings are predominantly for coastal species rather than those offshore.

Munitions clearance will result in increased underwater noise levels and above surface noise levels. The greatest level of disturbance is expected to affect birds foraging underwater in the immediate vicinity. The shallow water of the Russian coastline may at times support large numbers of staging birds, especially during the spring/autumn migration. A number of highly sensitive species of waders are known to occur in the local area, including ruff and bar-tailed godwit. The clearance of munitions will be carried out outside the breeding and migration period and will also be carried out during daytime hours because the eastern part of the Gulf of Finland supports night-time roost sites for migrating birds. Increased noise levels may cause the temporary displacement of a small number of birds which will return once these construction activities have ceased. Impacts are therefore **insignificant**.

Of all seabed intervention activities, dredging is likely to have the greatest impact in terms of noise and vibration. Dredging may cause direct and indirect impacts on diving sea birds within the area of the Russian landfall. As assessed in **Section 9.3.8**, dredging will result in the temporary displacement of fish from the area, on a regional scale, which could then affect piscivorous species of sea birds, especially those breeding or staging within the area of Dolgy Reef and Bolshoy Fiskar Archipelago due to the close vicinity to the pipelines. Such species include gulls, terns and divers during the summer breeding season and/or the spring/autumn migration period. Further, the pipelines in ESR I cross a traditional herring spawning site. Surveys carried out in the German EEZ show that herring and their fry may provide an important food resource for many species of diving ducks such as long-tailed ducks, common scoter and velvet scoter. However, construction will not be carried out during the herring spawning season, in order to avoid impacts on fry-feeding sea birds. Impacts on fish during the construction phase, which are mainly associated with dredging activities, may result in the short-term displacement of some species of fish. Long-term impacts on fish are not predicted as the construction of the pipelines will be carried out outside the spawning season. The temporary displacement of fish due to noise and vibration from dredging, and from other seabed intervention works, is considered to have an **insignificant** impact on sea birds.

Noise impacts due to construction and support vessel movement may result in a temporary redistribution of fish with densities nearer to the pipelines' corridor decreasing during the construction phase. However, the generation of underwater noise during vessel movement will be comparable to ordinary shipping noise, and since the majority of fish-feeding species of birds forage over large ranges, they will return once the construction has been completed. Direct and

(1) Smit, C.J. & G.J.M. Visser. 1993. Effects of Disturbance on Shorebirds: A Summary of Existing Knowledge from the Dutch Wadden Sea and Delta Area. WSG Special Report.

indirect noise impacts to sea birds due to other construction activities and associated construction and support vessel movement are therefore considered to be **insignificant**.

*Loss of Seabed Habitat*

Munitions clearance, boulder removal, dredging, rock placement, installation of support structures and pipe-laying will result in a physical loss of seabed and potential destruction of seabed habitat within the pipelines' corridor. The loss of seabed habitat may cause negative impacts on benthic feeding species such as diving ducks and auks, especially within the area of Dolgy Reef, Bolshoy Fiskar Archipelago and the Ingermanlandsky islands due to their close proximity to the pipelines' route. Diving ducks comprise the most numerous group of sea birds within the area of Beryozovyye Island, supporting several hundred thousand long-tailed ducks (*Clangula hyemalis*), black scoter (*Melanitta nigra*) and velvet scoter (*Melanitta fusca*) during the spring/autumn migration period. Smew, a species protected under the EC Birds Directive, is also present although in smaller numbers.

The impact on sea birds due to loss of seabed habitat will be **direct** and **negative** and will affect a 15 m corridor on each side of the pipelines within the offshore areas and within 500 m of the pipelines along the dredged sections at the Russian landfall (see **Section 9.3.7**). Destruction of seabed habitat may also be caused by increased turbidity. Impacts on benthic feeding sea birds are **local** in scale and will not affect the long-term distribution of species of sea birds in ESR I. The loss of benthic habitat is **reversible** and **short-term** and will affect only small numbers of foraging sea birds during the spring/autumn migration period and also during the breeding season. Long-term impacts on sea birds will not result and the impact will not affect the long-term distribution and abundance of sea birds in ESR I. Impact intensity is **low**. Impact magnitude is **low**. The sensitivity of sea birds is **low** to **high,** being high during the spring/autumn migration period and also during the breeding season due to the large number of protected species. The loss of seabed habitat will primarily affect common birds, especially during autumn migration when, amongst others, large numbers of long-tailed ducks, common scoter and velvet scoter migrate through this area. However, the loss of seabed habitat is small in comparison will recover rapidly. The impact significance is **minor** to **moderate**.

*Visual/physical disturbance*

Although no detailed information on munitions present and those that require clearance was available during the preparation of this Espoo Report, some munitions clearance is expected in ESR I, causing physical disturbance to birds rafting or feeding on the water surface, as well as those foraging underwater. The greatest level of disturbance is expected to affect birds foraging underwater in the immediate vicinity of the clearance site. Bird populations in ESR I are particularly sensitive during the breeding season and the spring/autumn migration period, as high numbers of internationally protected species are present at these times and a large number of diving ducks migrate through this area during the spring/autumn migration (primarily long-tailed ducks, tufted ducks, black scoter and velvet scoter). These species forage underwater and may be affected by munitions clearance activities in ESR I.

The impact of munitions clearance, which will be **negative** and **direct**, is expected to act on a **local** scale and be **temporary** in duration. The intensity varies between **low** and **medium** depending on the distance between the bird and the detonation point. The careful timing of munitions clearance activities is very important in ESR I, and these activities will be carried out during daytime hours, in agreement with government and non-governmental organisations relevant to bird conservation, in order to ensure that the level of physical disturbance to sea birds will be kept to a minimum. With these mitigation measures in place, the impact magnitude is considered to be **low**. The sensitivity of species ranges from **low** to **high**. Impacts will be **reversible**. The impact will therefore be of **minor** to **moderate** significance, affecting small numbers of diving ducks. Although still moderate, the impact may be slightly higher if velvet scoter are affected as this species is listed as rare and/or declining in the Baltic Sea. However, if timed carefully, the clearance of munitions will not affect the long-term abundance and distribution of protected or rare birds.

A lower risk of significant impacts is identified for species foraging on the water surface, such as terns and gulls. These species may be disturbed for a very short period of time and will return immediately. The impact of physical disturbance from munitions clearance on these species is therefore expected to be **insignificant**.

Of the other construction phase activities, visual and physical disturbance to sea birds will primarily be caused by construction and support vessel movement during pipe-laying. The zone of influence in which birds react with startle behaviour or flight is not known for all species in ESR I. However, some species are known to react to visual and physical disturbance such as divers (*Gavia* spp.), long-tailed ducks, common scoter and velvet scoter, up to 1 to 2 km from the impact source(1),(2). It also appears to depend on the flock size, with large flocks being generally more sensitive than small flocks. The flight distances of these species generally vary between 470 m and 1,500 m (large and small flocks of long-tailed ducks), as indicated by surveys carried out in the German EEZ(3). Again, this behaviour is species-specific. Some species such as common scoter and divers are known to move away from sources of visual impact, whereas gulls and terns are often attracted by vessels and are likely to move towards pipe-laying vessels leading, again, to the short-term redistribution of birds.

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(1) Ruddock, M. & Whitfield, D.P. 2007. A Review of Disturbance Distances in Selected Bird Species. A report from Natural Research (Projects) Ltd to Scottish Natural Heritage.

(2) Skov, H., Durinck, J., Leopold, M.F. & Tasker, M.L.. 2007. A quantitative method for evaluating the importance of marine areas for conservation of birds. Biology Conservation. 36(3).

(3) Institut für Angewandte Ökologie (IfAÖ). 2009. Umweltverträglichkeitsstudie (UVS) zur Nord Stream Pipeline von der Grenze der deutschen Ausschließlichen Wirtschaftszone (AWZ) bis zum Anlandungspunkt.

The nearest internationally important breeding site to the pipelines' route is Dolgy Reef and Bolshoy Fiskar Archipelago, located 2.9 km to the north-west of the pipelines. This is outside the sensitive zone and it is therefore concluded that breeding birds will not be directly disturbed during the construction phase of the Project. Birds foraging in the vicinity of the pipelines will, however be affected, especially those foraging within the offshore areas to the east of Dolgy Reef and Bolshoy Fiskar Archipelago, due to the close vicinity of these areas to the pipelines. Visual and physical disturbance will primarily affect piscivorous species and benthic feeding birds in the area of the Russian landfall as these species typically forage over large areas. Diving ducks, auks, divers, terns and gulls may therefore be primarily affected for short periods during the pipe-laying process.

Visual and physical disturbance impacts will be **direct** and **negative** as they lead to the **short-term** redistribution of birds, and will be of **local** to **regional** scale depending on the species affected. **Negative**, **indirect** impacts can also occur due to the short-term displacement of fish from the local area, with birds following to feed, during the construction period of the Project. These impacts will only affect piscivorous species such as divers, gulls, terns and fish-feeding ducks such as velvet scoter and common scoter. These species breed within the area of Dolgy Reef and Bolshoy Fiskar Archipelago. Important Bird Areas within the vicinity of the pipelines consist largely of piscivorous species (gulls and terns), and the greatest impact from visual/physical disturbance will affect these species which, unlike other species, are often attracted by vessels.

The intensity of the impact on sea birds from construction and support vessel movement is **low**. The pipelines in the Gulf of Finland follow well established shipping routes with almost 17,000 sailings per year. It is therefore expected that birds already exhibit a degree of habituation to disturbance caused by vessels. Construction of the offshore section of the pipelines in the vicinity of Ingermanlandsky and Dolgy Reef and Bolshoy Fiskar Archipelago will also be carried out outside the birds' breeding season in order to ensure that impacts to breeding birds are kept to a minimum. The magnitude of the impact is **low**. The significance of the impact depends largely on the conservation status of affected bird species**.** Significance ranges from **minor** (common species) to **moderate** (internationally protected species). Several species of note breed within the area of Dolgy Reef and Bolshoy Fiskar Archipelago, Beryozovyye Island and Ingermanlandsky islands including a large number of nationally rare and/or declining species which may occur within the impact area.

Species of **low** value/sensitivity comprise primarily gulls such as herring gull and black-headed gulls. These species may forage within the area of the pipelines. Gulls are often attracted by vessels and may be displaced during the construction period. For these species, impact significance is **minor**. Direct visual and physical impacts to velvet scoter, a species listed in the

HELCOM list of threatened and/or declining species[1], although still of minor significance, may be slightly higher as this species is sensitive to visual impacts and may be displaced within an area of 600 m during the construction period[2]. Impacts on common and rare/declining species of sea birds are of **minor** significance and these species will migrate back once the construction of the pipelines is completed.

Internationally important species of **high** value/sensitivity present within the area comprise red-breasted merganser, lesser black-backed gull, Caspian tern, common tern, Arctic tern and red-throated diver. The majority of these species breed within the IBAs in the Russian and Finnish EEZ while divers also migrate through this area in large numbers. The impact significance is **moderate** for all bird species of **high** value/sensitivity, but may be slightly higher in the case of the red-throated diver, especially during the autumn/spring migration period when several thousand birds migrate through the Gulf of Finland. This species is known to react to visual and physical disturbance impacts with stand off areas of 900 m[3]. However, the short-term disturbance of these species will not affect the long term abundance or distribution of these species and the impact will be **reversible** once the construction has been completed.

Significant impacts on protected coastal species such as Bewick's swan and white-fronted goose as well as common species including a large number of waders and geese are very unlikely due to the distance to the nearest site of international importance for birds which is outside the zone of influence as describe above. Therefore impacts on these species are **insignificant**.

**Impacts during the Pre-Commissioning and Commissioning Phase**

During the pre-commissioning and commissioning phase, potential impacts upon birds may result from noise associated with the seawater intake and pressure-test water discharge in ESR I as well as visual and physical disturbance. Impacts result primarily in the short-term displacement of birds from the local area.

*Noise and vibration*

During the pre-commissioning and commissioning phase of the Project, support vessel movement and underwater noise due to pipeline flooding, pressure-test water discharge and natural gas input during commissioning, as well as construction and support vessel movement, may have some impact on foraging sea birds predominantly during the spring/autumn migration

(1) Helsinki Commission. 2007. HELCOM lists of threatened and/or declining species and biotopes/habitats in the Baltic Sea area. Baltic Sea Environmental Proceedings, No. 113.

(2) Institut für Angewandte Ökologie. 2009. Umweltverträglichkeitsstudie (UVS) zur Nord Stream Pipeline von der Grenze der deutschen Ausschließlichen Wirtschaftszone (AWZ) bis zum Anlandungspunkt.

(3) Institut für Angewandte Ökologie (IfAÖ). 2009. Umweltverträglichkeitsstudie (UVS) zur Nord Stream Pipeline von der Grenze der deutschen Ausschließlichen Wirtschaftszone (AWZ) bis zum Anlandungspunkt.

period and summer breeding season due to increased noise levels. Although the sensitivity of birds is generally high during the breeding season and the spring/autumn migration period generated noise during pressure testing may only affect a limited part of the pipelines closest to the compressor affecting, if any, a very small number of high value bird species. Noise and vibration impacts are therefore expected to be far lower for the pre-commissioning and commissioning phase than for the construction phase. Impacts on sea bird populations are therefore **insignificant**.

*Visual / physical disturbance*

During the pre-commissioning and commissioning phase of the Project, a low level of vessel movement will occur, which may lead to a low level of physical and visual disturbance to sea birds. However, since vessel movement will be on a smaller scale than for the construction phase, for the reasons discussed above under '*noise and vibration*', the impacts associated with vessel movement on sea birds during the pre-commissioning and commissioning phase in ESR I are considered to be **insignificant**.

**Impacts during the Operational Phase**

Impacts on avian fauna are likely to be much lower during the operational phase of the Project than for the construction phase. However, inspections and maintenance vessel movement and pipeline presence are likely to result in low-level noise and vibration. Vessel movement may also lead to low-level physical and visual disturbance to sea birds.

*Noise and vibration*

As outlined in **Section 9.3.8**, it is unlikely that any fish species will be adversely affected by the sounds emitted from the pipelines in the long run, as fish will quickly acclimatise to the noise and therefore there will be no significant impact to fish feeding bird species in ESR I. After the pipelines are laid, the construction-related noise impacts caused by routine inspections and maintenance vessels will hardly be distinguishable from existing background noise levels. Operational impacts due to noise and vibration are therefore considered to be **insignificant** in ESR I.

*Visual/physical disturbance*

Routine inspections and maintenance works and associated vessel movements will be infrequent during the operational phase and impacts are likely to be undetectable over those resulting from the daily shipping movements in the area. Impacts on sea birds due to visual/physical impacts are therefore considered to be **insignificant** in ESR I.

### Impact Summary

The impacts identified and assessed in ESR I on sea birds are summarised in **Table 9.17.**

**Table 9.17 ESR I impact summary table for sea birds**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Sea Birds - Ecological Sub-Region I | Increase in turbidity | Boulder removal, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Munitions clearance, Seabed intervention works | Negative | Direct and indirect | Regional | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Munitions clearance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline flooding, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance, Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Loss of seabed habitat | Munitions clearance, Boulder removal, Seabed intervention works, Pipe laying | Negative | Direct | Local | Short-term | Low | Low | Low - High | Reversible | **Minor-Moderate** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Visual/ physical disturbance | Munitions clearance | Negative | Direct | Local | Temporary | Low - Medium | Low | Low - High | Reversible | **Minor - Moderate** |
| | | Construction and support vessel movement | Negative | Direct and indirect | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| | | Pre-commissioning and commissioning support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |

## 9.3.10 Biological Environment – Marine Mammals

### Overview

Following the undertaking of a scoping and impact identification exercise, several interactions between marine mammals in ESR I and the Project have been identified, which could give rise to potential impacts. This section identifies and assesses the potential impacts on marine mammals in ESR I during the construction, pre-commissioning and commissioning, and operational phases of the Project, in terms of the methodology presented in **Chapter 7**.

As described in **Chapter 8**, there are very few marine mammal species that inhabit the Baltic Sea in contrast to ocean populations. In ESR I, there are two seal species present:

- Ringed seal (*Phoca hispida baltica*)
- Grey seal (*Halichoerus grypus balticus*)

Each of these marine mammals has been described as a threatened and/or declining species of the Baltic Sea by HELCOM. Values/sensitivities for each marine mammal species is presented in detail in **Section 8.7.7** and summarised in **Table 9.18**. The harbour seal and harbour porpoise are only occasionally present within the ESR I Project area. They are common in the coastal areas between Saaremaa and Estonia as well as Sweden (**Atlas Map MA-2** and **MA-5**).

**Table 9.18 Values/sensitivities of marine mammals in Ecological Sub-Region I**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Marine mammals** | | | | | | | | | | | | |
| Ringed seal | Med | High | High | High | High | Med | Med | Med | Med | Med | Med | Med |
| Grey seal | Med | High | High | Med | High | High | Med | Med | Med | Med | Med | Med |

The main activities which are expected to impart an impact on marine mammals are those that take place during the construction phase; impacts during the pre-commissioning and commissioning, and operational phases are expected to be minimal in comparison. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Munitions clearance, seabed intervention works, pipe-laying, anchor handling and construction and support vessel movement resulting in:
  - Noise and vibration
- Re-suspension and spreading of sediments due to munitions clearance, seabed intervention works, pipe-laying and anchor handling resulting in:
  - Increase in turbidity
  - Release of contaminants
- Construction and support vessel movement during winter resulting in:
  - Ice breaking

*Pre-commissioning and commissioning phase*

- Seawater intake and pressure-test water discharge resulting in:
  - Noise and vibration
  - Change in water quality
- Pipeline flooding and pipeline commissioning resulting in:
  - Noise and vibration

*Operational phase*

- Pipeline presence resulting in:
  - Noise and vibration (due to movement of natural gas in the pipelines)
- Routine inspections and maintenance works resulting in:
  - Increase in turbidity
  - Noise and vibration

**Impacts during the Construction Phase**

Impacts on marine mammals during the construction phase are limited to noise and vibration, an increase in turbidity and the release of contaminants due to munitions clearance, boulder removal, seabed intervention works, pipe-laying, anchor handling, and construction and support vessel movement. Ice breaking to facilitate vessel movements will only be implemented should pipe-laying take place during the winter months in the Gulf of Finland. This is not planned as per the construction schedule.

*Increase in turbidity*

An increase in turbidity due to the re-suspension and spreading of sediments during construction may result from munitions clearance, pipe-laying and anchor handling along the entire pipelines' route in ESR I and boulder removal and seabed intervention works such as dredging and rock placement at designated areas. The seabed in ESR I is characterised as being predominantly mud, while the landfall area is sandy. ESR I is primarily a zone of sedimentation. Sediments that are fine in texture are more susceptible to disruption and extended suspension, while the opposite is true for coarse sediments. In the case of mud, sediments are typically fine textured but there is a high level of aggregation and therefore re-suspension levels are expected to be low compared to a silty sediment. Sands are coarse textured and tend to settle rapidly. The extent and duration of an increase in turbidity is detailed under the water column in **Section 9.3.3.** ESR I incorporates coastal areas and it is thus expected that turbidity levels are high and therefore any sediments that are placed into suspension will not contribute significantly to existing levels. Overall, an increase in turbidity levels is expected to be of **short-term** duration (**Section 9.3.3**). As marine mammals use their hearing ability for navigation, as well as for hunting, an increase in turbidity is expected to yield an **insignificant** impact on individuals. Other marine fauna, on which marine mammals would feed, may vacate the construction area due to noise and an increase in turbidity. This may temporality affect feeding areas but the associated impact is expected to be **insignificant** as marine mammals are able to hunt over large distances and would typically avoid the construction areas.

*Release of contaminants*

An increase in contaminant concentration in the water column due to the release of contaminants from the re-suspension and spreading of sediments during munitions clearance, boulder removal, seabed intervention works, pipe-laying and anchor handling could theoretically raise the concentration of contaminants in the food chain and subsequently in mammal tissue. However, it is expected that any contaminants that may be released will remain above the Predicted No-Effect Concentration (PNEC) for **short** periods of time in the immediate (2-4 km) vicinity to seabed intervention sites (**Section 9.3.3**). In general, marine mammals are expected to vacate the construction area due to noise and thus impacts related to the release of contaminants are deemed to be **insignificant** and are not assessed further.

*Noise and vibration*

Noise generation during construction in ESR I is generally as a result of munitions clearance, boulder removal, seabed intervention works (dredging and rock placement), pipe-laying, anchor handling and construction and support vessel movement. All of these activities may impact on marine mammals.

Ringed and grey seals communicate by emitting sounds that pass through the water column. These sounds can be detected across vast distances and may influence the behaviour of these mammals. The hearing ability of the marine mammals in ESR I is detailed in **Section 8.6.6.** An increase in background noise or the introduction of a specific noise sources may affect marine mammals in that they may be prevented from detecting important sounds (masking), their behaviour may be altered, temporary or permanent hearing loss may be experienced or damage to tissue may occur(1),(2). These effects are described below:

- Masking occurs when undesirable noise interferes with a marine animal's ability to detect and process a sound of interest. This is of particular concern when the interfering noise is at frequencies similar to those of biologically important sounds, such as mating calls. The masking effect is also influenced by the duration of the noise. Noise that masks important sounds may have an indirect impact on marine mammals by postponing a reaction to the call. Although there are indications that marine mammals may have the ability to modify their natural sound in order to counteract the masking effect, studies that substantiate such indications are scarce(3). As such, the exact consequences of masking are uncertain. However, no lasting effect on the individual, and far less at a population level(4), is expected.

- Behavioural changes include a reduced amount of time spent at the surface as well as swimming away from the interfering sound. Changes may also impact upon the sounds (calls) made by a marine mammal. This would include louder calls, more calls, longer calls, or a shift in the frequency of the calls. Noise that causes behavioural change may affect

(1) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

(2) Richardson, W.J., Greene, C.R., Malme, C.I., and Thomson, D.H. 1995. Marine Mammals and Noise. Academic Press, San Diego and London.

(3) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

(4) Impacts that have an effect at the population level are likely to reduce the number of offspring of any given genetically distinct population, which may affect future generations.

individual mammals temporarily. However, a behavioural change causes no permanent change to the individual mammal and hence no impact on the population as a whole[1].

- Exposure to sound may cause elevated hearing thresholds or threshold shifts in marine mammals. If the hearing threshold returns to a baseline level, it is known as a temporary hearing loss (THL). If a marine mammal is exposed to repeated shifts in the hearing threshold, permanent hearing loss (PHL) may result. Hearing loss depends on a sound's intensity, frequency and duration. Noise that causes temporary or permanent hearing loss is a serious impact on an individual marine mammal. If a stock of seals is affected by noise that causes hearing damage, the impact may extend to the population level.

- It has been hypothesised that damage to tissue (TD) surrounding the lungs or swim bladder occurs when resonance from loud sounds causes air- or fluid-filled organs to vibrate at very high amplitudes. As the organs vibrate, the tissues surrounding the organs might haemorrhage and become damaged. The damage may explain stranding due to impeded navigational skills. Noise of this magnitude is not expected as a matter of course in the Project but may occur during munitions clearing. Tissue damage may only occur in very close proximity to such noise.

When assessing the potential impacts of man-made noise on marine mammals, it is important to estimate the radius within which such impacts are expected to occur. The sequence of the zones of impact from the source (centre) is depicted in **Figure 9.6**.

(1) Impacts that have no effect at the population level may reduce the number of offspring of any given genetically distinct population, but this will not have a 'statistically significant' effect on stock / population size.

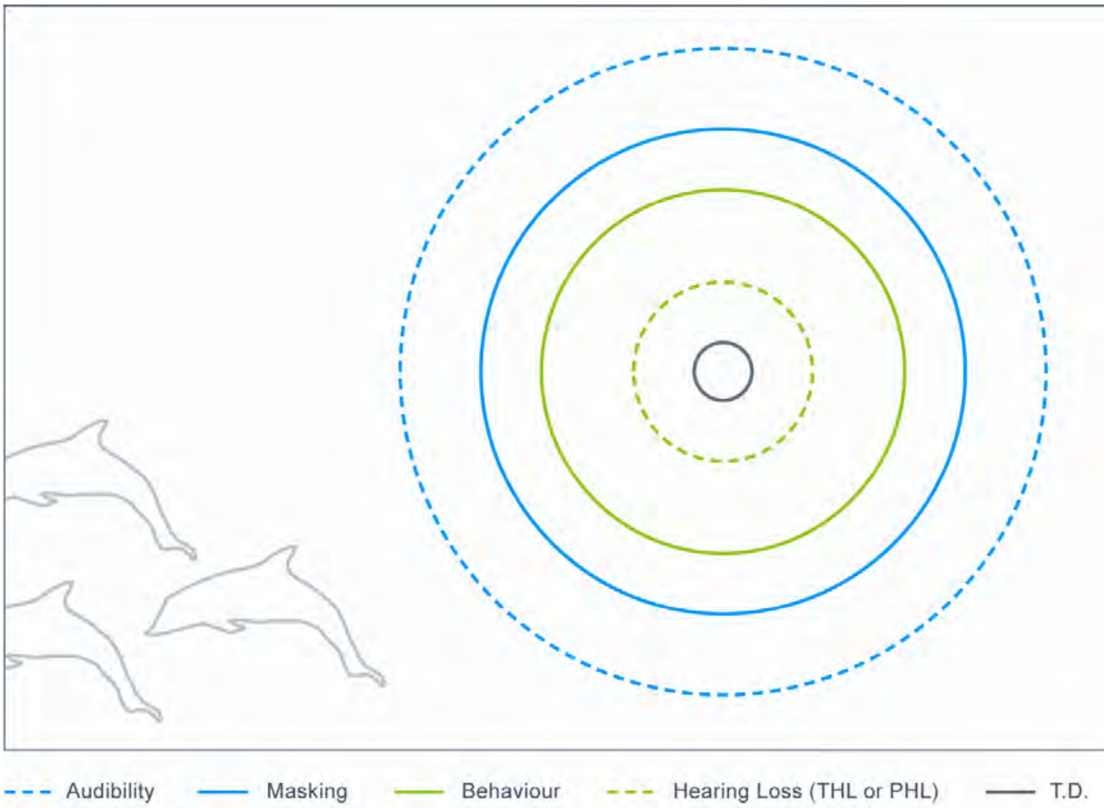


**Figure 9.6 The zones of impact for noise and vibration on marine mammals[(1),(2),(3)]**

Munitions clearance has the potential to cause considerable noise and vibration that would impact negatively on marine mammals. Surveys of the pipelines' route in Russian waters are currently ongoing and thus the exact locations of mines and other ordnance have not been confirmed. Mines/ordnance that may impact upon the pipelines will require clearing by means of explosives in collaboration with the relevant authorities. Noise generated during clearing takes the form of an initial shock pulse followed by a succession of oscillating bubble pulses[(2)]. Pulses at high peak levels have the potential to cause acoustic trauma and tissue damage, should an individual mammal be in close proximity to the blast site[(2),(4)]. The expected level of noise and vibration generated will vary and is dependent on the amount of explosive used as well as the residual explosive within the device. As the impact (**negative** and **direct**) is of **temporary** duration, a slight behavioural change (recognition of the sound and / or swimming away) is

(1) Rassi, P., Alanen A., Kanerva, T., Mannerkoski, I. 2001. Suomen lajien uhanalaisuus.

(2) Richardson, W.J., Greene, C.R., Malme, C.I., and Thomson, D.H. 1995. Marine Mammals and Noise. Academic Press, San Diego and London.

(3) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

(4) Swedish Armed Forces Headquarters. 2007. Environmental effects of underwater explosions.

expected in individual seals that are present within 2-3 km of the clearance site. Due to the presence of vessels during munitions clearance, it is expected that seals would vacate the area and thus no tissue damage or hearing loss is expected. An acoustic survey will take place prior to clearance to ensure that marine mammals (and schools of fish) are not present. In addition, acoustic harassment devices will be employed to reduce the possibility that marine mammals will be present in close proximity to the clearance site. The impact will be on a **regional** scale. Impact intensity is expected to be **medium** to **high** depending on marine mammal presence. Impacts may be irreversible at an individual level if tissue damage or hearing loss occurs, however at a population level the impact is considered to be **reversible**. Impact magnitude is **medium** and value/sensitivity ranges from **medium** to **high** depending on the seasonal breeding habits. Therefore, impact significance is expected to be **moderate**. It should be noted that munitions clearance is a common activity in the Baltic Sea and that most marine mammals would avoid the immediate area due to vessel movement.

Seabed intervention works, which include dredging and rock placement, are restricted to the designated areas along the pipelines' route (**Atlas Maps PR-3a** and **3b**). These activities will generate noise and vibration at a level that exceeds that generated by other construction activities. Dredging noise (frequencies between 0.020 and 1 kHz, with a peak of approximately 0.020-2 kHz) is expected to have a zone of influence (in terms of behaviour change) on seals of approximately 1 km. Noise generated by rock placement will have a negligible impact on seals. This is based upon measurements taken during rock placement by the *Rollingstone*, a dedicated rock placement vessel, in the Yell Sound near the Shetland Islands for the Magnus EOR project where it was found that rock placement generated noise did not exceed background noise(1). In most cases seals would vacate the construction area at the first instance of a foreign sound or change in background noise. Grey seals, which breed in the east of the Gulf of Finland on the ice, could also potentially be affected should construction coincide with the breeding season. The construction schedule, however, dictates that this breeding area will be avoided during the construction period. Ringed seals tend to concentrate in the coastal areas away from the pipelines' route. No seal colonies exist in close proximity to the pipelines' route (< 5 km). Impacts are expected to act on the individual rather than at the population level. Impacts are both **negative** and **direct**, will be on a **regional** scale around the source of impact, of **short-term** duration during construction and of **low-medium** intensity. Impacts are **reversible**. Impact magnitude is **low** and value / sensitivity ranges from **medium** to **high** depending on the seasonal breeding habits. Impact significance is expected to be **minor** to **moderate** (if grey and ringed seals are disrupted during the breeding season).

No direct measurements are available for the noise generated during boulder removal, pipe-laying and anchor handling. The primary source of noise is expected to be the movement of anchors. The presence of heavy machinery on board the pipe-laying vessel is expected to generate low frequencies below 100 Hz. It should be noted that pipe-laying will take place at a

(1) Nedwell, J. and Howell, D. 2004. A review of offshore windfarm related underwater noise sources.

rate of 2-3 km a day and thus the source of noise will move along the pipelines' route and will not remain fixed at one point for an extended period of time. Noise generated is expected to be on a par with normal shipping and fishing activities to which marine mammals have habituated and thus the impact of boulder removal, pipe-laying and anchor handling is expected to be **insignificant**.

Marine mammals can perceive underwater noise generated by vessel movements (0.01-10 kHz with source levels between 130-160 dB), and the use of equipment at sea, a number of kilometres from a source. Such noise has a zone of responsiveness for marine mammals of 200-300 m(1). As the pipelines' route in ESR I is largely within or close to normal shipping lanes it is expected that seals and harbour porpoises in the area have already habituated to the noise and vibration generated by vessel movement and thus the impact is **insignificant**.

*Ice breaking*

ESR I has typical ice coverage of 90 - 100% during normal and even mild winters. Seals (mainly the grey seal) breed offshore on the ice and thus have the potential to be impacted upon should construction activities take place during their breeding season. The pipelines' route does not pass through, and is not adjacent to, any primary breeding areas (**Atlas Maps MA3-4**). However, the possibility still exists that seals may be found in the area. Vessel movements during winter would result in ice breaking in the eastern Gulf of Finland and thus the potential to affect seal breeding habitats could be high. This may result in behavioural changes as well as an increase in seal pup mortality rates(2). Ice breaking is also associated with an increase in noise. The critical time for breeding (giving birth to pups) is from mid-February to mid-March for the ringed seal and between February and March for the grey seal. However, the construction schedule is such that pipe-laying in the Russian landfall area is expected to take place outside these periods and thus the possibility of ice breaking is highly unlikely. In addition, as most of the pipelines' route falls within or very close to normal shipping lanes in the Gulf of Finland and particularly in the grey seal breeding area, it is expected that ice breaking, should it be required, would have a minimal potential for impacts on seals (**Atlas Map SH1**). Seals do not typically dwell in areas where ice breaking is a regular occurrence.

If the construction schedule is followed, no ice breaking will take place and thus there will be **no impact**. However, in the highly unlikely event that ice breaking is required, and if breeding areas are affected, the impact (**negative, direct** and **secondary**) is expected to be **regional** along the pipelines' and vessels' routes, of **short-term** duration and of **medium** intensity. Impact magnitude would be **medium**. Impacts are **reversible** within a few generations in a worst case

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(1) ENERGI E2. 2006. EIA Report - Marine mammals. Horns Rev 2, offshore wind farm.

(2) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

scenario[1]. Impact significance is expected to be **moderate** for both the grey and ringed seals if any ice breaking activities disrupt breeding areas (marine mammals have a **high** value/sensitivity during the breeding season).

**Impacts during the Pre-Commissioning and Commissioning Phase**

The main impacts associated with pre-commissioning and commissioning in ESR I are noise and vibration and a change in water quality due to the intake of seawater and subsequent discharge of pressure-test water. Noise and vibration is also expected during the flooding of the pipelines during pressure testing and the input of gas to the pipelines during commissioning.

*Noise and vibration*

The pipelines will be flooded with seawater taken in at the Russian landfall site. Seawater (1.27 million $m^3$ per pipeline) will be pumped from a temporary supply line installed at a water depth of approximately 10 m to a temporary landfall pumping system. Seawater will either be used untreated or treated with an oxygen scavenger and caustic soda, which will prevent corrosion and anaerobic growth. The intake of seawater together with the discharge of pressure-test water is combined with limited activity and the generation of noise (intake suction noise). This may cause a temporary displacement of marine mammals present in the intake area. Seal colonies are not located in close proximity to the landfall area and thus any impacts are assumed to act at an individual level rather than on populations. Seals are likely to vacate the Project works area during the first indication of an increase in noise. No mitigation measures are required. Impacts due to seawater intake, both **negative** and **direct**, will be on a **regional** scale due to the transmission of sound through the water column but of **short-term** duration during pre-commissioning activities. Impact intensity is **low** as no change in function or structure is expected. Impacts are **reversible**. Impact magnitude is **low** and as result, impact significance is expected to be **minor** to **moderate** (if grey and ringed seals are disrupted during the breeding season).

The movement of pressure-test water in the pipelines during pipeline flooding, pressure-test water discharge and the input of gas during commissioning will generate some noise and vibration. The noise generated is expected to be on par if not slightly higher than normal gas movement within the pipelines (see section on the operational phase impacts). As such, noise generated by the movement of pressure-test water within the pipelines is expected to have an **insignificant** impact on marine mammals in ESR I. No mitigation is required.

*Change in water quality*

The discharge of pressure-test water will occur at the Russian landfall site in the same area used for pressure-test water intake. Approximately 1.27 million $m^3$ of oxygen-deficient pressure-

(1) Worst case scenario’ is hereafter considered to be the maximum possible impact at extreme conditions.

test water per pipeline will be discharged to the Baltic Sea at a depth of 10 m. The noise and the activity associated with pressure-test water discharge may result in the displacement of marine mammals. It may also cause fish to flee; thereby forcing marine mammals to forage elsewhere thus reducing the potential impacts of a change in water quality by reducing marine mammal presence. In both cases, this is of **short-term** duration, as both fish and mammals are likely to return soon after discharge has stopped. Numerical dilution and dispersion models have confirmed that there are no significant environmental impacts on the water column from pressure-test water discharge (**Section 9.3.3**). Impacts, both **negative** and **direct**, will be on a **regional** scale to the spread and dilution of pressure-test water discharge and of **short-term** duration. Impact intensity is **medium**. Impacts are **reversible**. The value/sensitivity ranges from **medium** to **high** depending on the season. Impact magnitude is **low** and therefore impact significance is expected to be **minor** to **moderate** (if grey and ringed seals are disrupted during the breeding season).

**Impacts during the Operational Phase**

Impacts upon marine mammals during the operational phase are limited to noise and vibration from gas movement within the pipelines as well as from routine inspections and maintenance works. An increase in turbidity is expected to coincide with maintenance works should they interact with the seabed.

*Increase in turbidity*

Routine inspections and maintenance works may be required on the pipelines or on the supporting seabed to ensure that the pipelines have a stable base. These works may result in localised re-suspension and spreading of sediments and a subsequent increase in turbidity and release of contaminants. The following mitigation measures will be implemented to reduce the impacts:

- Any seabed intervention work, such as rock placement, required during operation will be kept to a minimum.
- Disturbance of seabed sediments will be kept to a minimum.
- Any surveys will avoid encounters with marine mammals wherever possible.

As these works are not expected to occur on a regular basis and will be localised, the impacts on marine mammals are expected to be **insignificant**.

*Noise and vibration*

Routine inspections would include external inspections of the pipelines by means of ROV and internal inspections using pigs (**Section 9.2.3**). Maintenance works are not expected but may include possible repair works on the pipelines or on the seabed where required. Routine inspections and maintenance works are expected to generate very little noise and are thus assumed to have an **insignificant** impact upon marine mammals and will be restricted to the pipelines' route and be infrequent (i.e. not constant).

A study commissioned for the Project has investigated the noise generated by the movement of gas within the pipelines(1). The study considered the prediction and modelling of noise levels within the pipelines, the transmission of noise through the pipelines' structure and the radiation of noise from the pipelines. It was concluded that the sound pressure 10 metres from the pipelines was highest at approximately 1 kHz for most of the route, while certain sections (landfall areas) displayed higher sound pressures at 0.063-0.25 kHz. In addition, experience gained from gas pipelines in other marine environments, such as the North Sea, suggests that the movement of gas within pipelines does not create substantial noise. An acoustic survey performed on a gas pipeline off the coast of Nova Scotia, Canada, determined that the movement of gas within a pipeline creates low frequency sound (0.030 – 0.100 kHz) that may be detected at a distance of up to 200m from the pipeline(2). These frequencies fall below that detectable by the resident marine mammals. This, coupled with the fact that the pipelines will for the most part be buried in ESR I, thus reducing noise levels, indicates that the operation of the pipelines would have little to no impact on marine mammals at either an individual or population level. On the contrary, the pipelines are expected to become artificial habitats for other marine fauna and may thus become a hunting ground for certain marine mammals. The impact is deemed to be **insignificant** as the frequencies generated fall below that detectable by the resident marine mammals.

**Impact Summary**

The impacts on marine mammals identified and assessed in ESR I are summarised in **Table 9.19**.

(1) Lommer, M. and Lemaire, G. 2008. Ødegaard & Danneskiold-Samsøe A/S. Noise along the Nord Stream pipelines in the Baltic Sea.

(2) Martec Limited. 2004. Effects of Pipelines/Gathering Lines on Snow Crab and Lobster.

**Table 9.19 ESR I impact summary table for marine mammals**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Marine Mammals - Ecological Sub-Region I | Increase in turbidity | Munitions clearance, Boulder removal, Seabed intervention works, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | Insignificant |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of contaminants | Munitions clearance, Boulder removal, Seabed intervention works, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Medium - High | Medium | Medium – High | Reversible | **Moderate** |
| | | Boulder removal, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low - Medium | Low | Medium – High | Reversible | **Minor - Moderate** |
| | | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Seawater intake | Negative | Direct | Regional | Short-term | Low | Low | Medium – High | Reversible | **Minor- Moderate** |
| | | Pipeline flooding, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Ice breaking | Construction and support vessel movement | -/ Negative | -/Direct, Secondary | -/ Regional | -/Short-term | -/Medium | -/Medium | -/High | -/Reversible | **No impact/ Moderate** |
| | Change in water quality | Pressure-test water discharge | Negative | Direct | Regional | Short-term | Medium | Low | Medium – High | Reversible | **Minor-Moderate** |

## 9.3.11 Biological Environment – Nature Conservation Areas

### Overview

This section identifies and assesses the potential impacts on nature conservation areas in ESR I during the construction, pre-commissioning and commissioning, and operational phases of the Project. The impacts on Natura 2000 sites are detailed and assessed in **Chapter 10**.

ESR I is a small region, comprising only 22 km of the Nord Stream pipelines' route. ESR I extends from the Vyborg landfall area through the north-eastern Gulf of Finland. While the pipelines' route does not cross any nature conservation areas in ESR I, it does pass within 0.5 km of a Protected Area in the Russian part of the Baltic Sea: Skala Hally of the Ingermanlandskiy Islands Nature Reserve. In addition to the Ingermanlandskiy Islands Nature Reserve (the route also passes Bolshoy Fiskar at a distance of 3 km), the route passes within 20 km of two other nature conservation areas, as listed in **Table 9.20**.

Protected areas in the Russian part of the Baltic Sea are illustrated on **Atlas Map PA-2**, Ramsar sites are shown on **Atlas Map PA-4** and BSPA and UNESCO sites are shown on **Atlas Map PA-5**.

**Table 9.20 Nature conservation areas within 20 km of the route in ESR I**

| Nature Conservation Area | Designation | Protected Habitats and Species | Distance to Pipelines (km) |
|---|---|---|---|
| Ingermanlandskiy islands – Skala Hally | Protected areas in the Russian part of the Baltic Sea | The designation for Bolshoy Fiskar has been adopted for Skala Hally, due to the proximity to the former. Area designated for:<br>Important breeding colonies of great cormorant (*P. carbo*), black-backed gull (*Larus* spp.), Arctic tern (*S. paradisaea*), Caspian tern (*S. caspia*), great merganser (*M. merganser*), black guillemot (*Cepphus grylle*), eider duck (*S. mollissima*), and razorbill (*A. torda*).<br>Seal haul-out areas: ringed seal (*P. hispida*) and grey seal (*H. grypus*). | 0.5 |
| Ingermanlandskiy islands – Bolshoy Fiskar | Protected areas in the Russian part of the Baltic Sea | Area designated for:<br>Important breeding colonies of Great cormorant (*P. carbo*), black-backed gull (*Larus* spp.), Arctic tern (*S. paradisaea*), Caspian tern (*S. caspia*), great merganser (*M. merganser*), black guillemot (*Cepphus grylle*), eider duck (*S. mollissima*), and razorbill (*A. torda*).<br>Seal haul-out areas: ringed seal (*P. hispida*) and grey seal (*H. grypus*). | 3 |
| Prigranichnyy | Protected areas in the Russian part of the Baltic Sea | Area designated for:<br>Important bird species include black-throated diver (*G. arctica*), barnacle goose (*B. leucopsis*), mute swan (*C. olor*), white-winged scoter (*M. deglandi)*, and white-tailed eagle (*H. albicilla*).<br>Grey seal and ringed seal are also present. | 7 |
| The Beryozovyye Islands | Protected areas in the Russian part of the Baltic Sea, Ramsar | Area designated for:<br>Rare plant species on the islands.<br>Important breeding and staging sites for waterfowl including divers, grebes, swans, geese, dabbling ducks, diving ducks, gulls and terns. Breeding grounds for the ringed seal. Spawning and breeding grounds for fish, incl. Baltic herring. | 15 |

The scope of this assessment is limited to the particular impacts on features for which the nature conservation areas have been designated, including protected habitats in the areas. Impacts on floral and faunal receptors (fish, mammals, sea birds and marine benthos) are assessed in the other sections of the Espoo Report. Where these species are specifically protected by the nature conservation designation, consideration will be given here as to the significance of potential impacts on these species from the installation of the pipelines in ESR I. As nature conservation areas are of national importance, their values/sensitivities are rated as **high** and as such, consideration should be given to any significant impacts which might affect these sites.

All of the nature conservation areas which may be affected by the Project in ESR I are coastal or consist of island archipelagos, and therefore have protected coastal habitats which may be impacted by the development. A number of the sites are important spawning areas for fish species, including the Baltic herring. All of the sites are designated for their important populations of breeding and staging sea and water birds, and/or breeding areas for the grey and ringed seal (as shown in **Table 9.20**)[(1)], which also have the potential to be affected by the construction, pre-commissioning and commissioning, and operational phases of the Project.

The main activities anticipated to affect the nature conservation areas in ESR I are those occurring during the construction phase of the Project, such as seabed intervention works, pipe-laying, and anchor handling. There is also the potential for munitions clearance to take place in ESR I and the impacts of this will be considered as part of the construction phase. Impacts during the pre-commissioning and commissioning and operational phases are expected to be comparatively small, due to the less invasive nature of the activities in these phases, and the smaller scale on which these activities will operate.

Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Re-suspension and spreading of sediments due to munitions clearance, seabed intervention works, pipe-laying and anchor handling resulting in:
    - Increase in turbidity
    - Noise and vibration
    - Physical alteration of the seabed
- Construction and support vessel movement resulting in:
    - Visual/physical disturbance

(1) Nord Stream AG & Ramboll. 2007. Memo 4.3G -Protected Areas.

*Pre-commissioning and commissioning phase*

- Seawater intake, pipeline flooding, pressure testing and pressure-test water discharge resulting in:
    - Noise and vibration
    - Change in water quality
- Construction and support vessel movement resulting in:
    - Visual/physical disturbance

*Operational phase*

- Routine inspections and maintenance works, and associated vessel movement, resulting in:
    - Increase in turbidity
    - Noise and vibration
    - Physical alteration of the seabed
    - Visual/physical disturbance
- Pipeline presence resulting in:
    - Noise and vibration

**Impacts during the Construction Phase**

Potential impacts on nature conservation areas in ESR I during the construction phase include impacts on fauna from noise and vibration and visual/physical disturbance, and turbidity impacts on habitats and fauna due to munitions clearance, seabed intervention works and pipe-laying activities.

*Increase in turbidity*

Munitions clearance may be required in ESR I along the pipelines' route. Surveys are currently being undertaken in Russian waters to identify any munitions along the pipelines' route which will require clearance by use of explosives. Munitions clearance is a common activity in the Gulf of Finland, which has the potential to result in an increase in turbidity due to the re-suspension and spreading of sediments during a blast, the extent of which will depend on the amount and type of explosives used and the amount of residual explosives present in the device. The impact of an increase in turbidity on nature conservation areas will depend on the proximity of the clearance site to the protected area and its designated habitats and species. As the nature conservation areas in ESR I are at least 0.5 km from the pipelines' route, they will not be directly affected by munitions clearance. The Ingermanlandskiy Islands Nature Reserve is partly designated the preservation of grey seal and ringed seal habitat. Insignificant impacts are anticipated on marine mammals as a result of munitions clearance in ESR I. However, impacts may be felt by designated fauna outside the boundary of the protected area, for example if birds such as great cormorants and Caspian tern are foraging outside the designated site and closer to the pipelines' corridor and experience more turbid water for a short period as a result of the munitions clearance. Impacts of increased turbidity on these important habitats for the species for which the conservation areas are designated are expected to be **negative** and **direct**, but are **short-term** and on a **regional** scale (as detailed in **Section 9.3.3)**. Impact intensity is expected to be **low** to **medium** and consequently magnitude is expected to be low to medium as in a worse case scenario, the structures and functions of the conservation areas are affected but their basic structure/function is retained depending on the proximity of the munitions clearance to the nature conservation areas and its protected species. Impacts are **reversible** as sediment settles over a few days. As the overall value/sensitivity of nature conservation areas is **high**, the overall significance of munitions clearance is expected to be **moderate**.

Increases in turbidity in the water column due to the re-suspension and spreading of sediments will also result from seabed intervention works including dredging and rock placement, pipe-laying and anchor handling. As discussed in previous sections, this can potentially cause physiological damage to faunal species such as fish (**Section 9.3.8**), or smothering of important benthic communities (**Section 9.3.7**). ESR I incorporates coastal areas and it is therefore expected that background levels of turbidity will be high and that the expected increase in turbidity will not contribute significantly to existing levels. In addition, impacts will only affect species for a short duration and within a relatively localised area surrounding the pipelines. The areas and average duration of re-suspended sediment concentrations are illustrated on **Atlas Map MO-26** for ESR I. As normal sediment concentrations in the Baltic Sea are typically in the range of 1 – 4 mg / l during normal weather, concentrations over 1 mg / l are regarded as the maximum extent of the sediment spread (as detailed in **Section 9.3.3**). As shown on **Atlas Map MO-26**, for dredging and rock-placement, re-suspended sediment concentrations of above 1 mg/l are only expected to occur up to approximately 1.5 km from the disturbance point for 12 hours, with the majority of sedimentation occurring in close proximity to the works. As all of the nature conservation areas in ESR I (with the exception of Skala Hally) are at least 3 km from the pipelines, the impact of increased turbidity as a result of the re-suspension and spreading of sediments on nature conservation areas in ESR I is therefore considered to be **insignificant**.

As Skala Hally is situated approximately 0.5 km east of the pipelines' route, this nature conservation area will be affected by an increase in turbidity, as it is within the predicted extent of sediment spread as a result of seabed intervention works, pipe-laying and anchor handling. The main impact of an increase of turbidity on Skala Hally would be the temporary displacement of fish from the designated conservation area which are a vital source of food for sea birds and marine mammals. Impacts are expected to be **negative** and **direct**, and on a **regional** level as an increase in turbidity will occur up to 1.5 km from the impact source. The impact will be **short-term** as re-suspended sediment will settle to the seabed within a few days and fish will return to the area. Impact intensity is expected to be **low** as some change in the structure and function of Skala Hally and its inhabitants may occur. Impact magnitude is therefore **low**. Impacts will be **reversible**. As the value/sensitivity of nature conservation areas (and their associated species) is **high**, the overall significance of an increase in turbidity as a result of seabed intervention works for Skala Hally is expected to be **moderate**.

*Noise and vibration*

The activities during construction likely to cause disturbance from noise and vibration are munitions clearance, boulder removal, dredging, rock placement, and construction and support vessel movement, all of which are planned to take place in ESR I. The significance of any noise and vibration impacts on nature conservation areas will depend on the distance between the source of the impact (originating from within the vicinity of the pipelines) and the nature conservation areas and their associated protected species. Potential receptors for impacts from noise and vibration are marine mammals, fish and sea birds. The ringed seal and grey seal are protected in the Ingermanlandskiy Islands, Prigranichnyy, the Beryozovyye Islands and the Eastern Gulf of Finland National Park. Sea birds are protected in all of the nature conservation areas identified in ESR I. Spawning areas for fish, including the Baltic herring, are also protected in the Beryozovyye Islands.

Marine mammals can be affected by noise, due to the masking of mating calls, behavioural changes, hearing damage or, at the highest level, tissue damage. Munitions clearance may be undertaken along the pipelines' corridor in ESR I, which has the potential to cause considerable noise and vibration. Munitions clearance is a common activity in the Gulf of Finland and as part of the Project will be carried out in conjunction with the relevant authorities. As all nature conservation areas (except Skala Hally) are at least 3 km from the pipelines' route, they will not be directly affected by noise associated with munitions clearance. However, impacts may be felt by designated fauna outside the boundary of the protected areas if they range closer to the munitions clearance sites, for example while foraging. Tissue damage or hearing loss as a result of a large explosion is possible in marine mammals and fish, and may occur in foraging birds, but is not predicted to occur as activity during munitions clearance is expected to cause fauna to move away from the immediate vicinity of the blast. The main impact expected is that ringed seal and grey seal, sea birds and noise sensitive fish species such as herring may be temporarily displaced from the vicinity of the munitions clearance area due to the noise and vibration produced (as detailed in **Sections 9.3.8**, **9.3.9** and **9.3.10**). Impacts to conservation areas designated as a result of protected species present are expected to be **negative** and **direct**, but **temporary**. Impacts will occur on a **regional** scale. Impact intensity is expected to be **low** to **medium**, depending on the proximity of the designated fauna to the munitions clearance areas. Similarly, impact magnitude may be **low** to **medium**, depending on the number of individuals affected as the structures and functions of these conservation areas may affected but their basic structure/function is retained. Impacts will be **reversible** as the conservation areas and their associated species will revert to their pre-impact state. As the sensitivity of nature conservation areas (and their protected species) is **high**, impact significance is predicted to be **moderate**.

Boulder removal and rock placement are not expected to generate noise and vibration that would exceed background levels. Therefore the impact from these activities is considered to be **insignificant**.

Dredging is expected to have a zone of influence on seals of approximately 1 km, and general shipping activity is likely to cause behavioural changes in marine mammals at a distance of 0.5 km (as discussed in **Section 9.3.10**). However, all sites (except Skala Hally) are further than 3 km from the noise source at its closest point, and pipe-laying will take place at a rate of 2 – 3 km a day, meaning that the source of noise will move along the pipelines' route and will not remain fixed at one point for an extended period of time. It is also highly unlikely that noise from dredging will reach levels that could cause either hearing damage or tissue damage, and the noise of general shipping activity and preparatory activities prior to dredging are likely to cause marine mammals to move away from the area of the pipelines. Therefore, impacts on marine mammals in the conservation areas in ESR I are expected to be **insignificant**.

As discussed in **Section 9.3.9**, comparatively little is known about the impacts of noise and vibration on birds. Birds in the Baltic Sea are used to the noise of general shipping activities. The disturbance distance for visual and noise disturbance from boats is typically 1 – 2 km for the more sensitive bird species such as divers and scoters and to a lesser extent cormorant, but other species such as gulls and terns are likely to be less affected[(1),(2)]. As the distance between noise and vibration-generating construction activities is 0.5, 3 and 7 km for Skala Hally, Bolshoy Fiskar and Prigranichnyy respectively, impacts on birds are expected to be minor. In addition, noise generated at sea surface-level will be of comparable volume to that for other shipping activity in the Baltic Sea (which the birds will be habituated to). Therefore, it is concluded that noise impacts from construction and support vessel movement on nature conservation areas are expected to be **insignificant** in ESR I.

Fish can also be impacted by noise and vibration and the Baltic herring is thought to be particularly sensitive to noise impacts. Any displacement of fish on which bird species forage can have a temporary influence on sea bird distribution as a result. Fish in ESR I are already likely to be habituated to vessel noise and other activities in the Baltic Sea, due to the large

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(1) Ruddock, M. & Whitfield, D.P. 2007. A Review of Disturbance Distances in Selected Bird Species. A report from Natural Research (Projects) Ltd to Scottish Natural Heritage.

(2) Skov, H., Durinck, J., Leopold, M.F. & Tasker, M.L.. 2007. A quantitative method for evaluating the importance of marine areas for conservation of birds. Biology Conservation, 36 (3).

amount of ship traffic in the sea. Increased noise levels may impact on the spawning success of Baltic herring if construction is carried out during the spawning season. However, due to the distance between the construction work and the nature conservation areas (the closest sites are 0.5 and 3 km and the others range from 7 – 15 km away), noise impacts will be minimal. In addition, as noted in **Section 9.3.8**, construction will not be carried out during the spawning season, so it is considered that the impact on fish in the nature conservation areas as a result of noise and vibration from all sources during the construction phase will be **insignificant**.

*Physical alteration of the seabed*

Physical alteration of the seabed is likely to occur during construction due to munitions clearance, dredging, pipe-laying, and anchor handling. However, since the pipelines do not pass directly through any of the conservation areas in ESR I, physical alteration of the seabed is not expected and impacts on the nature conservation areas are therefore deemed to be **insignificant**.

*Visual/physical disturbance*

Visual or physical disturbance from the movement of vessels during construction may affect sea bird populations that are protected by the nature conservation areas designated in ESR I. All of these nature conservation areas hold important populations of breeding and feeding waders and sea birds, including international migrant populations (as detailed in **Section 9.3.9**). The approximate distance where disturbance is likely varies between species, and depends on the nature of the vessel movement. As detailed above, for the more sensitive species disturbance can arise at 1 – 2 km, whilst other species are much less affected. Pipe-laying is expected to progress at the rate of 2 – 3 km/day, therefore vessel movement will be relatively slow and the risk of disturbing sea birds will be low. Sea birds will also be habituated to vessel movement in this area of the Baltic Sea, as the pipelines follow an established shipping route. As the pipelines' route is at least 0.5 km from the nature conservation areas, the pipe-laying process is unlikely to disturb flocks within the protected areas and the impact of vessel movement on sea birds associated with the nature conservation areas in ESR I is considered to be **insignificant**.

Disturbance to birds protected within the nature conservation areas may also occur when the birds are out of the boundaries of the nature conservation area. The majority of birds are not sensitive to disturbance. Divers, scoters and cormorants, which are present in ESR I, are more sensitive(1). However, studies have shown that birds such as common scoter tend to avoid channels with high frequencies of shipping activity, even when these areas hold a high prey

(1) Garthe, S. and Hüppop, O. 2004. Scaling possible adverse effects of marine wind farms on sea birds: developing and applying a vulnerability index. Journal of Applied Ecology. 41.

biomass[1]. As the pipelines' route follows a shipping channel, these birds are unlikely to be present so the risk of disturbance is low and is considered **insignificant**.

**Impacts during the Pre-commissioning and Commissioning Phase**

Potential impacts upon nature conservation areas in ESR I during the pre-commissioning and commissioning phase are limited to noise and vibration impacts on fauna generated by pipeline flooding, pressure-test water discharge and commissioning, changes in water quality as a result of pressure-test water discharge and the visual or physical disturbance of fauna from vessel movement during the works.

*Noise and vibration*

Noise and vibration generated by the movement of pressure-test water within the pipelines during pipeline flooding and subsequent pressure-test water discharge, as well as gas movement in the pipelines due during commissioning will only cause potential impacts on fauna in the immediate vicinity of the pipelines. Since the pipelines do not directly pass through any of the nature conservation areas in ESR I, noise and vibration impacts are expected to have an **insignificant** impact.

*Change in water quality*

Pressure-test water will be extracted, used for flooding the pipelines and then discharged at the original intake location and depth in the vicinity of the Russian landfall site in Portovaya Bay. Treatment products which remain in the discharged water – an oxygen scavenger and caustic soda – are naturally occurring compounds that already exist at low levels in seawater (as discussed in **Section 9.3.3**). Numerical dilution and dispersion models have confirmed that the effects of these products will be temporary and localised to Portovaya Bay and will be easily diluted by the surrounding seawater. Therefore, discharged water will not affect any of the nature conservation areas in ESR I, due to the distance between the protected sites and the Russian landfall area (none occur within Portovaya Bay) and water quality impacts are expected to be **insignificant**.

*Visual/physical disturbance*

During the pre-commissioning and commissioning phase there will be a low level of vessel movement, primarily associated with pipeline flooding. This may lead to a low level of visual or physical disturbance, but it will be on a much smaller scale than that of the construction phase. For this reason, and because of the reasons discussed above, the disturbance of sea birds in

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(1) Kaiser, M.J., Galanidi, M., Showler, D.A., Elliot, A.J., Caldow, R.W.G., Rees, E.I.S., Stillman, R.A. and Sutherland, W.J. 2006. Distribution and behaviour of Common Scoter Melanitta nigra relative to prey resources and environmental parameters. Ibis 148.

relation to vessel movement will be low and therefore the impacts on nature conservation areas are considered to be **insignificant**.

**Impacts during the Operational Phase**

In general, impacts during the operational phase will be similar to those during the construction phase, but to a much lesser extent. Impacts from natural gas movement due to pipeline presence during the operational phase are limited to noise and vibration. Potential impacts as a result of routine inspections and maintenance are expected to be an increase in turbidity as a result of the re-suspension and spreading of sediments, noise and vibration and physical alteration of the seabed. Inspections and maintenance vessel movement may result in visual or physical disturbance to fauna in the vicinity of the pipelines.

*Increase in turbidity*

Re-suspension and spreading of sediments in the water column is possible in association with routine inspections and maintenance work. Routine inspections are not likely to cause any significant impacts, however maintenance work may require seabed intervention works. The extent of these impacts are likely to be much smaller than for the construction phase, but it is not possible to predict the frequency with which maintenance works will be required, nor the extent of seabed disturbance from these activities. However, due to the distance of all the nature conservation areas from the pipelines, re-suspension and spreading of sediments from routine maintenance works will have an **insignificant** impact on conservation areas in ESR I.

*Noise and vibration*

As for the pre-commissioning and commissioning phase, noise and vibration generated by natural gas movement in the pipelines are expected to have an **insignificant** impact on conservation areas in ESR I since the pipelines pass at least 0.5 km from the nearest nature conservation area (Skala Hally). For the same reason, routine inspections and maintenance work will have an **insignificant** impact on conservation areas in ESR I in terms of noise and vibration.

*Physical alteration of the seabed*

Physical alteration of the seabed is also possible during routine inspections and maintenance work, and again the extent of these impacts will be smaller than for the construction and pre-commissioning and commissioning phases. Since all the nature conservation areas are over 0.5 km from the pipelines, physical alteration of the seabed is expected to have an **insignificant** impact on the conservation areas in ESR I

*Visual/physical disturbance*

There will be a low level of vessel movement associated with routine inspections and maintenance work, which may result in low level visual or physical disturbance to sea birds associated with the nature conservation areas in ESR I. Routine inspections are thought to have a limited impact upon sea birds, especially as vessel movement is common throughout the area. As these works will be infrequent, and on a much smaller scale than that of the construction phase, the impact on birds associated with the nature conservation areas in ESR I is considered to be **insignificant**.

**Impact Summary**

The impacts identified and assessed in ESR I on nature conservation areas are summarised in **Table 9.21**.

**Table 9.21 Impact summary table for nature conservation areas in ESR I**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Nature Conservation Areas - Ecological Sub-Region I | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term | Low - Medium | Low - Medium | High | Reversible | **Moderate** |
| | | Seabed intervention works, Pipe-laying, Anchor handling | - / Negative * | - / Direct* | - / Regional* | - / Short-term* | - / Low* | - / Low* | - / High* | - / Reversible* | **Insignificant / Moderate*** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Low - Medium | Low - Medium | High | Reversible | **Moderate** |
| | | Boulder removal, wreck removal | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Dredging | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline flooding, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Physical alteration of the seabed | Munitions clearance, Dredging, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Change in water | Pressure-test water discharge | - | - | - | - | - | - | - | - | **Insignificant** |

| S - | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | quality | | | | | | | | | | |
| | Visual/ physical disturbance | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |

* Values refer to impacts on the Skala Hally nature conservation area

**Table 9.22 Summary of significant impacts for ESR I**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value / Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Water Column | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | Release of contaminants | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | Change in water quality | Pressure-test water discharge | Negative | Direct | Regional | Temporary | Low | Low | Low | Reversible | **Minor** |
| Seabed | Physical alteration of the seabed | Munitions clearance | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Boulder removal, Seabed intervention works | Negative | Direct | Local-Regional | Long-term | Low | Low | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| Atmosphere | Emissions of pollutant gases | Seabed intervention works, Pipe-laying | Negative | Cumulative | National - Transboundary | Long-term | Low | Low | Low | Irreversible | **Minor** |
| Mari | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term - Long-term | Low | Low | Low | Reversible | **Minor** |

| Impact | Activity | Nature | Type | Impact Magnitude | | | | Value / Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Seabed intervention works | Negative | Direct | Regional | Short-term - Long-term | Low | Low | Low | Reversible | **Minor** |
| Release of contaminants | Munitions clearance, Seabed intervention works, Pipe-laying, Anchor handling | Negative | Direct and indirect | Local | Long-term | Low | Low | Low | Reversible | **Minor** |
| Noise and vibration | Munitions clearance | Negative | Direct | Local | Temporary | Low - Medium | Low | Low | Reversible | **Minor** |
| Physical loss of seabed habitats | Munitions clearance | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | Dredging | Negative | Direct and indirect | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | Rock placement, Installation of support structures, Pipe-laying | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | Anchor handling | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| Smothering | Dredging, Pipe-laying | Negative | Direct | Local | Short-term - Long-term | Medium | Low | Low | Reversible | **Minor** |
| Physical alteration of the seabed | Routine maintenance | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value / Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Fish | Introduction of secondary habitats | Pipeline presence | Positive or Negative | Direct | Local | Long-term | Medium | Low | Low | Irreversible | **Minor** |
| Fish | Release of contaminants | Munitions clearance, Seabed intervention works | Negative | Direct | Local | Short-term | Low | Low | Low-High | Reversible | **Moderate** |
| Fish | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Medium-High | Medium | Low-High | Reversible | **Minor-Moderate** |
| Fish | Noise and vibration | Dredging | Negative | Direct | Regional | Temporary | Low | Low | Low-High | Reversible | **Minor-Moderate** |
| Fish | Noise and vibration | Pipeline presence | Negative | Direct | Local | Short-term | Low | Low | Low -High | Reversible | **Minor-Moderate** |
| Fish | Physical alteration of the seabed | Pipeline presence | Negative | Direct | Local | Long-term | Medium | Low | Low | Irreversible | **Minor** |
| Sea birds | Increase in turbidity | Munitions clearance, Seabed intervention works | Negative | Direct and indirect | Regional | Short-term | Low | Low | Low - High | Reversible | **Minor-Moderate** |
| Sea birds | Loss of seabed habitat | Munitions clearance, Boulder removal, Seabed intervention works, Pipe laying | Negative | Direct | Local | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| Sea birds | Visual / physical | Munitions clearance | Negative | Direct | Local | Temporary | Low - Medium | Low | Low - High | Reversible | **Minor-Moderate** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value / Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | disturbance | Construction and support vessel movement | Negative | Direct and indirect | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor-Moderate** |
| Marine Mammals | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Medium - High | Medium | Medium - High | Reversible | **Moderate** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low - Medium | Low | Medium - High | Reversible | **Minor-Moderate** |
| | | Seawater intake | Negative | Direct | Regional | Short-term | Low | Low | Medium - High | Reversible | **Minor-Moderate** |
| | Ice breaking | Construction and support vessel movement | - / Negative | - / Direct, Secondary | - / Regional | - / Short-term | - / Medium | - / Medium | - / High | - / Reversible | **No impact/ Moderate** |
| | Change in water quality | Pressure-test water discharge | Negative | Direct | Regional | Short-term | Medium | Low | Medium - High | Reversible | **Minor-Moderate** |
| Nature Conservation Areas | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term | Low - Medium | Low - Medium | High | Reversible | **Moderate** |
| | | Seabed intervention works, Pipe-laying, Anchor handling | - / Negative* | - / Direct* | - / Regional* | - / Short-term* | - / Low* | - / Low* | - / High* | - / Reversible* | **Insignificant / Moderate*** |
| | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Low - Medium | Low - Medium | High | Reversible | **Moderate** |

* Values refer to impacts on the Skala Hally nature conservation area

## 9.4 Ecological Sub– Region II

### 9.4.1 Introduction

ESR II comprises some 296 km route (see **Figure 9.7**). Salinity ranges significantly in ESR II from east to west and from surface waters to deep waters, from 0-3 psu in the shallow eastern areas of the Gulf of Finland to 5 - 7 psu in the western Gulf of Finland. In the western reaches of the ESR, a halocline exists for most part of the year at depths of 60 - 70 m, while towards the east, the difference between surface and bottom salinities decreases. The waters below the halocline are predominantly anoxic and the benthos is subsequently largely impoverished. In the shallow parts of the Gulf of Finland, sediment composition is naturally affected by frequent storms occurring throughout the year, and by ice gouging in coastal bays. The deeper parts of the seabed, though rarely affected by storm conditions, consist mostly of unconsolidated silt and sands high in organic matter. The level of sediment contamination observed in the Gulf of Finland reflects many years of anthropogenic influence, including a high loading of pollutants from the Neva estuary. The Gulf of Finland hosts a number of Important Bird Areas (IBA), and is particularly important for seal pupping due to the seasonal presence of ice cover. ESR II is demarcated by the following KPs: KP 22.1 – 318.4.

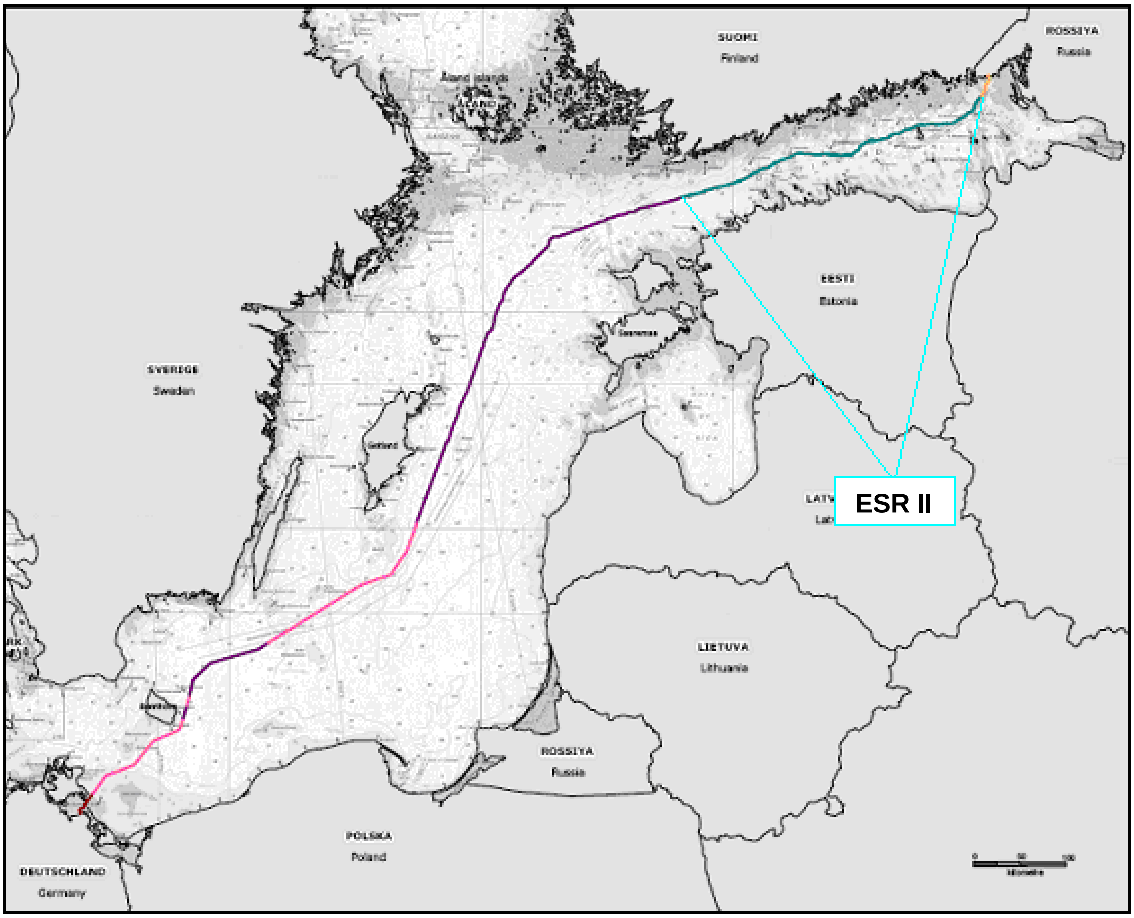


**Figure 9.7 The section of the pipelines' route passing through ESR II (in green)**

Predicted impacts in ESR II will occur as a result of the following activities identified during the three initial phases of the Project. These include the following:

*Construction phase*

Seabed intervention works:

- Munitions clearance
- Rock placement
- Installation of support structures.

Offshore pipe-laying:

- Pipe-laying

- Anchor handling
- Hyperbaric tie-ins
- Construction and support vessel movement

*Pre-commissioning and commissioning phase*

- Pipeline flooding, cleaning, gauging and pressure testing
- Pressure-test water discharge
- Pipeline commissioning

*Operational phase*

- Routine inspections and maintenance
- Pipeline presence

The predicted impacts identified are assessed as per each resource or receptor in the physical and biological environment. Impacts that are deemed to be of significance when they occur are assessed in full by means of the methodology presented in **Chapter 7**. Impacts that are deemed to be insignificant based upon expert knowledge and previous experience in similar projects are described but not assessed in detail.

A summary table showing the significant impacts for ESR II is shown at the end of this section (**Table 9.40**).

### 9.4.2 Physical Environment – Physical Processes

**Overview**

This section identifies and assesses the potential impacts on the deep waters' physical processes in ESR II in terms of the methodology presented in **Chapter 7**.

The physical processes in the Baltic Sea are described in **Section 8.5.2**. The circulation pattern of these currents is particularly complex in the Gulf of Finland, with large eddy currents occurring in this region.

The main activities in ESR II which are expected to impact on physical processes will occur during the operational phase. There are no expected impacts on the physical processes in ESR II arising from the construction or pre-commissioning and commissioning phase since physical processes are only likely to occur as a result of the presence of the pipelines on the seabed, over the long term.

Activities and the associated impacts that are assessed in this section are as follows:

*Operational phase*

- Pipeline presence resulting in change in underwater current flow

**Impacts during the Operational Phase**

As for ESR I, the presence of the pipelines on the seabed has the potential to alter the underwater currents within in ESR II. Where prevailing currents intersect the pipelines they will be forced to rise. This has the potential to alter the composition, strength and direction of the currents. Similarly, currents can be altered as a result of a temperature difference between the pipelines and the surrounding water.

*Change in underwater current flow*

The presence of the pipelines on the seabed in the Gulf of Finland has the potential to alter physical processes such as water mass exchange at the seabed as a result of an increased degree of mixing of new deepwater. Such an increase in the degree of mixing of new deepwater could lead to lower salinity, increased flow rate and increased transport of oxygen, increasing the level of oxygenation in the Gulf of Finland, thereby increasing the deposition of phosphorus in the deepwater, decreasing the effects of eutrophication of the Baltic by a small amount(1).

However, the pipelines in ESR II are located in the main outflow area outside the Finish coastal area, where outflow is quite homogenous from the surface layers down to the depths of 30 m and has a typical speed of 2 – 5 cm/s. At the seabed, where the pipelines will be located and will measure 1.5 m in height, there is a high number of eddies present due to the influence of the bathymetry(2). It is therefore unlikely that the presence of the pipelines will cause any significant changes to the deepwater current system, given the turbulence already caused by the existing eddying effects.

Underwater currents within the study area could also be impacted by minor changes in the water temperature in the vicinity of the pipelines during operation. The temperature balance that

(1) Swedish Meteorological and Hydrological Institute. 2007. Possible effects upon inflowing deep water of a pipeline crossing the flow route in the Arkona and Bornholm Basins. (This study is currently undergoing limited improvements).

(2) Perttilä, M., Kankaanpää, H., Kotilainen, A., Laine, A., Lehtoranta, J., Leivuori, M., Myrberg, K., and Stipa, T. 2006. Implementation of the north European gas pipeline project — data inventory and further need for data for environmental impact.

occurs within the water operates quickly and as such the influence of temperature differences between the natural gas pipelines, the sediment and the water body will be negligible. As a result negative temperature effects are not predicted for the waters surrounding the pipelines. Therefore, the presence of the pipelines will have an **insignificant** impact on the physical processes within ESR II.

### Impacts Summary

The impacts on physical processes identified and assessed in ESR II are summarised in **Table 9.23.**

**Table 9.23 ESR II impact summary table for physical processes**

| Physical Processes - Ecological Sub-Region II | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Change in underwater current flow | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.4.3 Physical Environment – Water Column

**Overview**

Following the undertaking of a scoping and impact identification exercise, numerous interactions between the Project and the water column in ESR II have been identified, which could give rise to potential impacts. This section identifies and assesses the potential impacts on the water column in ESR II during the construction, pre-commissioning and commissioning and operational phases of the Project in terms of the methodology presented in **Chapter 7**.

The characteristics of the water column are not constant throughout the Baltic Sea and differ depending on location as well as depth. Accordingly, the significance of the associated Project impacts on the water column may also differ along the pipelines' route. The quality of the water column is dictated by its salinity and oxygen levels as well as by the concentrations of suspended solids, nutrients, heavy metals, organic pollutants, plankton and biological components. Full details as to the water quality in ESR II are presented in **Chapter 8.8.1.** Essentially the water column is important for all ecosystems in terms of supporting function and structure, but is very resistant to change in terms of its interaction with the Project. In most cases, the water column will rapidly revert back to a pre-impact status once specific activities, such as those during construction, cease. This would depend on the magnitude of the impact and its persistence. As per the sensitivity criteria for the physical environment as detailed in **Chapter 7**, the water column has been awarded a **low** value/sensitivity throughout the Baltic Sea.

The main activities that are expected to impact the water column are those that take place during the construction phase. The re-suspension and spreading of sediments by seabed intervention works is expected to impart the largest impact upon the water column. Accordingly, the characteristics of seabed sediments play a major role in determining the level of impact. No impacts are expected in ESR II during pre-commissioning as the intake of seawater and subsequent discharge of pressure-test water is to occur at the Russian landfall in ESR I and will not affect ESR II. The impacts as a result of hyperbaric tie-ins following pre-commissioning have been included in the construction phase. Impacts during the operational phases are expected to be minimal in comparison to construction. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Re-suspension and spreading of sediments from munitions clearance, seabed intervention works pipe-laying, anchor handling and hyperbaric tie-ins resulting in:
  - Increase in turbidity

- Re-suspension and spreading of sediments from munitions clearance and seabed intervention works resulting in:
  - Release of contaminants
- Re-suspension and spreading of sediments from seabed intervention works resulting in:
  - Release of nutrients

*Operational phase*

- Pipeline presence resulting in:
  - Temperature change
  - Release of pollutants from anti-corrosion anodes

**Impacts during the Construction Phase**

Impacts upon the water column during the construction phase are limited to the re-suspension and spreading of sediments resulting in an increase in turbidity and the release of contaminants and nutrients as a result of munitions clearance, pipe-laying, anchor handling, seabed intervention works and hyperbaric tie-in activities.

*Increase in turbidity*

Construction works on the seabed will result in the disturbance and subsequent re-suspension of sediments, together with the associated compounds such as nutrients and contaminants which may be present. This would increase the turbidity levels as well as the concentrations of these substances in the water column. Activities that are expected to disturb the seabed include munitions clearance, pipe-laying, anchor handling, seabed intervention works and hyperbaric tie-in activities. Seabed intervention works are expected to generate the most re-suspended sediment while munitions clearance, pipe-laying, anchor handling and tie-in activities are expected to contribute very little. The amount of sediment disrupted is highly dependent on the methods and equipment used during the pipelines' installation phase as well as the extent of the construction works. The degree to which sediments are generally prone to suspension is linked to the fines content and how consolidated the sediment is. Sediments are re-suspended for a period of time before being deposited (sedimentation) elsewhere. It should be noted that seabed intervention works are restricted to specific areas as depicted on **Atlas Maps PR-3A** and **PR-3B**. As such, the associated level of impact would not extend along the entire pipelines' route in ESR II.

The pipelines' route through ESR II is at a depth of between 40 and 80 m within the Gulf of Finland. The water column near the seabed in ESR II goes through periods where oxygen is present and through periods of hypoxia and at times a halocline may be present in the deeper sections. When present, the halocline significantly constrains the dispersal of suspended sediments and the associated contaminants and nutrients into the upper water column, as it acts as a lid, inhibiting the bottom-water column from mixing with the water column above the halocline. Certain compounds can, however, diffuse through the halocline. An example would be phosphorus. Currents (depending on strength and presence) along the seabed will increase the distance suspended sediments would be transported laterally below the halocline, as well as the time period for which sediments remain in suspension. In shallow areas and when the halocline is not present, suspended sediment has the potential to impact upon the upper water column. The seabed in ESR II is characterised by areas of sediment with a very high water content, fine particle and organic matter content(1). As a result the upper layers of the seabed are generally soft and susceptible to disturbance. Such disturbance is a regular occurrence during storm events in the Gulf of Finland.

Prior to construction it is envisaged that munitions clearance will take place within the pipelines' corridor. Route optimisation has ensured that most munitions will be avoided. However, 27 munitions have been detected within ESR II that require clearing. Their exact location is currently confidential but all are within Finnish waters. These munitions will require clearing by means of explosives, and this will be carried out in collaboration with the relevant authorities. The clearance of munitions has the potential to re-suspend and spread sediments and contaminants as they are generally in place on or submerged within the seabed.

Modelling of the spread and sedimentation of sediments and the release of contaminants as a result of munitions clearance has been carried for munitions clearance sites in the Finnish EEZ only by means of a general numerical particle analysis model (Mike 3 PA)(2) . No modelling has been performed in the Russian EEZ (a section of which forms part of ESR II) as the exact locations of munitions that require clearance are not known. Similar effects to those for Finnish munitions clearance sites are, however, expected in the Russian EEZ. The Mike 3 PA model incorporates specific hydrodynamic data to assess the transport of dissolved and suspended substances. The amount of re-suspension and spreading of sediment is dependent upon the amount and type of detonation explosives and the residual explosive in the munitions, the seabed type and the extent of underwater currents near the seabed. The same model, albeit with different input variables, has been used in the assessment of seabed intervention works locations.

The clearance of munitions is expected to result in the formation of a crater (average radii of 4.5 m) on the seabed and the re-suspension of sediment throughout the water column. On average, munitions clearance results in re-suspended sediment with a concentration above

(1) Nord Stream AG & Ramboll. 2007. Memo 4.3A-11 - Seabed erosion during storm events in the Gulf of Finland.

(2) Nord Stream AG & Ramboll. 2008. Memo 4.3A-12 - Spreading of sediment and contaminants from clearing of munitions.

1 mg/l within 1-2 km, with a maximum in some locations of 5 km, of the disturbance area for 13 hours. A concentration above 10 mg/l is expected to last for 4 hours on average and close to the clearance site. Sedimentation is limited and rarely exceeds 0.1 kg/m$^2$. Therefore, due to the limited extent and duration of increased turbidity levels and the fact that munitions clearance will only occur at specific points (and when confirmed in the Russian EEZ) on the pipelines' route it is expected that the impact (**negative** and **direct**) on the water column in ESR II will be of **regional** scale (above background levels) and of **short-term** duration (sedimentation rate). Impacts will be **reversible** within a few days as sediment settles to the seabed. Intensity is **low** as no major change in structure and function is expected. Impact magnitude is **low**. Therefore impact significance is expected to be **minor**.

The re-suspension and spreading of sediments is expected to be greatest during seabed intervention works (rock placement). Installation of support structures is complemented with rock placement. Modelling of the spread and sedimentation of sediments and contaminants during works in the seabed in ESR II has been carried out by using a general numerical particle analysis model (Mike 3 PA) for locations along the pipelines' route where pre and post-lay rock placement will take place. The Mike 3 PA model requires numerous inputs in relation to the type of seabed intervention works. The initial input for sediment modelling is the expected spill rate for the various activities. The spill rate for rock placement (1 kg/s) was determined by the placement rate, rock volume and falling velocity (kinetic energy converted to potential energy on impact). Sediments are released at heights of 2 m above the seabed for rock placement. The distance a particle travels is governed by particle grain size, flocculation, grain size fractions, hindered settling in high concentration areas, water properties, grain size distribution and settling velocity. The different types of seabed intervention works and types of sediments for ESR II are detailed in **Table 9.24**.

**Table 9.24 Seabed intervention works (both pipelines) and sediments types for Ecological Sub-Region II**

| Area | Seabed Intervention Works | Main Sediment Types |
|---|---|---|
| Gulf of Finland | Predominantly rock placement with limited support structures. | Glacial clay, glacial till, post glacial mud and sandy mud |

The areas and average duration of re-suspended sediment concentration > 1 mg/l for ESR II are shown on **Atlas Maps MO-12**, **21** and **25**. An excess concentration of 1 mg/l (the model used a background concentration of 0 mg/l) will hardly be visible in the water since normal concentrations in the Gulf of Finland are typically in the range of 1 – 4 mg/l during normal weather. As such, the sediment clouds shown on the Atlas Maps may be regarded as the maximum extent of the sediment spreading (for the applied weather conditions). It should be noted that peak turbidity levels can reach an average of 100 mg/l in the lower layers of the water column during major storm events. This is reduced to 20 mg/l if suspended sediment is spread vertically over the entire water column. Sedimentation for ESR II in terms of the amount of sediment deposited on a square metre of seabed is depicted on **Atlas Maps 13**, **22** and **26**.

For rock placement in the central Gulf of Finland, modelled re-suspended sediment with a concentration above 1 mg/l is expected up to at most 1 km of the disturbance area for approximately 9-10 hours. A concentration above 10 mg/l is expected to last for 4.5-7.5 hours close to the disturbance area. Sedimentation is modelled to range from 0.1 to 1.0 kg/$m^2$ at the source and from 0.01 to 0.1 kg/$m^2$ 900 m away.

For rock placement in the eastern Gulf of Finland near Gogland, modelled re-suspended sediment with a concentration above 1 mg/l is expected within 1.3 km and up to at most 2.6 km of the disturbance area for approximately 12 hours. A concentration above 10 mg/l is expected to last for 5 hours close to the disturbance area. Sedimentation is modelled to range from 0.1 to 1.0 kg/$m^2$ at the source and from 0.01 to 0.1 kg/$m^2$ 1.3 km and at most 2.6 km away.

Due to the limited extent and duration of increased turbidity levels and the fact that seabed intervention works will only occur at specific points on the pipelines' route it is expected that the impact (**negative** and **direct** due to a change in the resource) on the water column in ESR II will be **regional** (above background levels), of a **short-term** duration (sedimentation rate) and of **low** intensity. Impacts will be **reversible** within a few days as sediment settles to the seabed. Impact magnitude is **low**. Impact significance is expected to be **minor (low** sensitivity). When present, the halocline would do much to reduce the vertical extent to which re-suspended sediments are dispersed. It is, however, expected that the increase in turbidity would be limited to the first 10 m of the water column above the seabed.

Pipe-laying can result in the re-suspension and spreading of sediments due to the current generated in front of the pipelines as they near the seabed, as well as from the pressure transfer when the pipelines hit the seabed. The amount of sediment that is expected to be placed into suspension during pipe-laying has been determined by considering the vertical velocity of the descending pipelines, the flow velocity of the water during displacement, the Shields parameter, which defines the limit at which particles start to move, the upwards flow generated by an increase in pore pressure due to sediment compression and both hard and soft sediment characteristics. Along a 1 km stretch of a pipeline it is expected that the amount of suspended sediment, when the pipeline hits the seabed, would be up to 600 kg 1 m above the seabed for soft sediments. During pipe-laying, anchors (anchor handling) will be used to position the pipe-laying vessel. Anchor handling involves the placement and retrieval of 12 anchors on the seabed for every 200 to 600 meters of pipeline laid. Anchor placement and retrieval, as well as the anchor cable sweeping across the seabed, will result in the re-suspension of sediments. The amount of sediment that is placed in suspension has been determined by considering similar variables to those used for pipe-laying. During both anchor placement and retrieval it is expected that 10-160 kg of sediment will be placed in suspension per anchor. Approximately

100-150 m of anchor cable is expected to lay at rest on the seabed and will sweep across the seabed as the lay vessel moves forward resulting in the release of 400-1600 kg of sediment. Anchor handling results in a suspended sediment concentration >10 mg/l over a very limited area of 0.004-0.016 $km^2$. Even though pipe-laying and anchor handling will extend along the entire pipelines' route in ESR II it is expected that the effects of these activities would compare well to the effects of bottom trawling activities (dragging of trawls along the seabed) as well as normal anchor placement in the Baltic Sea. As such, it is expected that these activities would contribute very little to the overall amount of sediment placed into suspension during the construction phase and thus the impact is **insignificant**.

Hyperbaric tie-in activities will take place at a distance of 300 km from the Russian landfall following pre-commissioning. A hyperbaric dry welding habit will be lowered onto a gravel foundation. It is expected that the re-suspension and spreading of sediments and contaminants will be on par if not less than that generated with the laying of the pipelines on the seabed and thus the impact is **insignificant**.

*Release of contaminants*

Contaminants (identified as cadmium, mercury, lead, zinc, copper, arsenic, chromium, nickel, Polycyclic Aromatic Hydrocarbons (PAH) and tributyltin) are typically bonded to the sediment particles in most of ESR II. A contaminant's ability to spread and dissolve in the water column (model) as well as its relative toxicity (in terms of the desorbed and bioactive fractions and the predicted no-effect concentration in the water column) are discussed in **Section 9.3.3** under ESR I. Arsenic has been modelled to exceed the PNEC within 1 km from the pipelines while copper and PAHs have been modelled to display higher toxicity levels above the PNEC value at greater distances.

Both munitions clearance and seabed intervention works will result in the release of contaminants into the water column. The spreading of contaminants by pipe-laying and anchor handling is not considered as only a limited amount of sediment is expected to be re-suspended.

Modelling has been performed for munitions clearance locations in the Finnish EEZ[(1)]. However, as the number, and locations, of munitions that require clearance in the Russian EEZ has not been confirmed no modelling of the release of contaminants has taken place in the Russian section of ESR II. As such, the Espoo Report has considered the modelling performed in Finland and has used it as a basis for assuming that similar impacts would occur in the Russian EEZ.

For munitions clearance locations in the Finnish EEZ, dissolved copper is modelled and predicted to exceed the PNEC (>0.02 µg/l) up to a distance of 1-3 km from the source during

(1) Nord Stream AG & Ramboll. 2008. Memo 4.3A-12 - Spreading of sediment and contaminants from clearing of munitions.

normal weather. The duration for which copper concentrations are expected to be greater than the PNEC is 6 hours. Dissolved PAHs are expected to exceed the PNEC (>0.000009 µg/l) up to a maximum distance of 1-3.5 km from the source during normal weather. The duration for which PAH concentrations are expected to be greater than the PNEC is 7 hours. The impacts in the Russian EEZ are expected to be similar to those that would occur in the Finnish EEZ.

Therefore, due to the limited extent and duration of increased contaminant concentration levels and the fact that munitions clearance will only occur at specific points on the pipelines' route it is expected that the impact (**negative** and **direct**) of the release of contaminants is expected to be **regional** (above the PNEC), of **short-term** duration due to the expected settling of suspended sediment bound contaminants and of **low** intensity as no change is expected in the structure and function of the water column. Impacts will be **reversible** within a few days. Impact magnitude is therefore **low**. As both the impact magnitude and receptor value/sensitivity are **low**, impact significance is expected to be **minor**.

Modelling has been performed for rock placement sites in both the Finnish and Russian EEZ. For rock placement in the central Gulf of Finland, dissolved copper is modelled and predicted to exceed the PNEC (>0.02 µg/l) up to a distance of 1 km from the source during normal weather. The duration for which copper concentrations are expected to be greater than the PNEC is 18 hours. Dissolved PAHs are expected to exceed the PNEC (>0.000009 µg/l) up to a maximum distance of 2.4 km from the source during normal weather. The duration for which PAH concentrations are expected to be greater than the PNEC is 20 hours.

For rock placement in the eastern Gulf of Finland near Gogland, dissolved copper is modelled and predicted to exceed the PNEC (>0.02 µg/l) up to a distance of 1.3 km from the source during normal weather. This extends up to 3.6 km near ESR I. The duration for which copper concentrations are expected to be greater than the PNEC is 14 hours. Dissolved PAHs are not expected to exceed the PNEC (>0.000009 µg/l) near Gogland but would occur up to a distance of 1.5 km from the source near ESR I during normal weather. The duration for which PAH concentrations are expected to be greater than the PNEC is 14 hours.

The maximum concentrations of Cu and SUM16PAH for rock placement sites in ESR II are shown on **Atlas Map MO 34-51**.

Due the limited extent and duration of increased contaminant concentration levels, the fact that seabed intervention works will only occur at specific points on the pipelines' route it is expected that the impact (**negative** and **direct**) of the release of contaminants is expected to be **regional** (above background levels), of **short-term** duration due to the expected settling of suspended sediment bound contaminants and of **low** intensity as no change is expected in the structure and function of the water column. Impact magnitude is therefore **low**. Impacts will be **reversible** within a few days. As both the impact magnitude and receptor value/sensitivity are **low**, impact significance is expected to be **minor**. Seabed intervention works will not contribute additional contaminants to the Baltic Sea but would be active in their relocation.

Some of the sediments within ESR II may be hypoxic and rich in hydrogen sulphide ($H_2S$). During seabed intervention works, $H_2S$ can be released from the sediment after which it would react rapidly with any oxygen in the water forming $H_2SO_4$. This results in reduced oxygen levels in the water column. This effect is expected to be temporary as the exchange of water masses will ensure that the oxygen depleted water will be oxygenated. The impact is expected to be **insignificant**.

Chlorinated dibenzo-p-dioxin (PCDD) and dibenzofuran (PCDF) compounds or 'dioxins' may be present in the sediments of ESR II. Dioxins are persistent organic pollutants that can cause severe, long-term impacts on marine biota such as fish, whole ecosystems and human health[(1)]. The source of dioxins, there presence in the sediments of the Baltic Sea as well as their effects on marine biota and human health are elaborated upon in **Section 9.3.3** under ESR I.

Dioxins that have accumulated in sediment tend to be tightly bonded to sediment particles and desorb quite slowly. As per the modelling results for the re-suspension and spreading of sediment, it is expected that re-suspended sediments will not be distributed throughout water column but will be concentrated within 10 vertical metres of the seabed and will settle over a few days. As most dioxins are bonded to the sediment particles it is therefore assumed that they will behave in the same manner and will settle on the seabed. As such, the impact on the water column is expected to be **insignificant** and only limited bioaccumulation in marine biota is expected.

*Release of nutrients*

A release of nutrients such as nitrogen and phosphorus, during the re-suspension and spreading of sediment as a result of seabed intervention works could stimulate phytoplankton production, should they reach the photic zone, and thereby increase the biomass. An increase in primary production due to the release of nutrients could also potentially contribute to oxygen consumption by degradation of organic matter. A release of oxygen-consuming compounds during trenching or rock-placement may further aggravate situations with local oxygen deficiency at the sea bottom. **Section 9.3.3** summarises the amount of nitrogen and phosphorus expected to be released during seabed intervention works in the Baltic Proper, which includes ESR II. Overall the likely increase in nutrient concentrations resulting from seabed intervention works in the Baltic Proper is small in relation to current nutrient inputs. Accordingly, the release of nutrients into the water column should not generate increases in nutrient concentrations outside the normal range of conditions. Since most of the nutrients in sediments are bound to particles, and will not contribute to primary production, much of the increase in concentration will be reversed as particles settle out. Release of nutrients during seabed intervention works would not be long-term in duration. The release of nutrients will result in an increase in nutrient

(1) Helsinki Commission. 2004. Dioxins in the Baltic Sea.

concentrations that would not extend beyond normal conditions[1] and therefore the impact on the water column is assessed to be **insignificant** in ESR II.

### Impacts during the Operational Phase

Impacts upon the water column during the operational phase are limited to a change in temperature by the movement of natural gas within the pipelines as well as the release of pollutants from anti-corrosion anodes in place on the pipelines.

*Temperature change*

A gas temperature of around 40ºC is expected at the Russian landfall as a result of the natural gas heating during compression. Simulation of temperature for a free-laying pipeline close to the Russian landfall, shows (with seawater temperature of -2ºC) an insignificant temperature increase (maximum 0.5°C) in the water near the seabed and in the water on the downstream side of the pipelines. It is expected that the gas will expand as it moves further away from the Russian landfall and thus decrease in temperature. In ESR II it is expected that the temperature of the gas and the temperature of the water column around each pipeline will reach equilibrium after approximately 150 km. The gas temperature is, however, expected to decrease slowly as it gets close to the German landfall. Overall, the impact on the water column in ESR II is expected to be **insignificant** as no change in water temperature is expected.

*Release of pollutants from anti-corrosion anodes*

To minimise external corrosion, anodes are to be installed at regular intervals along each pipeline. The potential impacts on water quality from pipeline anodes are related to the release of metal ions from the anode material during the lifetime of the pipelines. Various calculations in terms of the expected release of ions and their effect on the water column are described in **Section 9.3.3** under ESR I. Based on these calculations it is concluded that the impact on the water column from the release of pollutants from anti-corrosion anodes due to pipeline presence is **insignificant.**

### Impact Summary

The impacts identified and assessed in ESR II on the water column are summarised in **Table 9.25.**

(1) Normal conditions are defined as pre impact status conditions i.e. the existing water column for ESR II prior to commencement of the Project, as detailed in Section 8.8.1.

**Table 9.25 ESR II impact summary table for the water column**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Water Column – Ecological Sub-Region II** | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Pipe-laying | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Hyperbaric tie-in activities | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of contaminants | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | Release of nutrients | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | Temperature change | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of pollutants from anti-corrosion anodes | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.4.4 Physical Environment – Seabed

**Overview**

The sediment in ESR II is mainly glacial clay, glacial till and post-glacial mud and sandy mud, with zones of sedimentation and zones of non-sedimentation. Natural re-suspension of seabed sediments frequently takes place in this region[(1)]. The seabed is characterised as being shallow in places, with an exposed mineral bed substrate and sandbank habitats, and with comparatively low salinity and comparatively high oxygen levels everywhere except for the deeper water regions (see **Section 8.8.1**). Large areas of ESR II go through periods of anoxia and hypoxia. During periods of anoxia, a halocline may be present and conditions are similar to those of ESR III (see **Section 9.5.3**). The seabed in ESR II supports significant marine fauna and flora.

The seabed in ESR II is considered to have a **low** sensitivity throughout. Although the seabed habitat in this ESR is known to support relatively low numbers of benthic macrophytes, it does support a relatively high diversity of fish species, a number of important bird populations and a number of marine mammals, and the impacts on these species are assessed below in **Sections 9.4.7 - 9.4.10**. However, the seabed is not considered to be particularly sensitive to change.

As for ESR I, the main activities in ESR II which are expected to impact on the seabed will occur during the construction phase and, to a lesser extent, the operational phase. No impacts on the seabed are predicted for the pre-commissioning and commissioning phase. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Munitions clearance, seabed intervention works, pipe-laying activities, anchor handling and hyperbaric tie-in activities, resulting in:
  - Release of contaminants
  - Physical alteration of the seabed

*Operational phase*

- Routine inspections and maintenance work and pipeline presence resulting in:
  - Physical alteration of the seabed

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(1) Nord Stream AG & Ramboll. 2008. Memo 4.3A1 - Assessment of natural seabed erosion caused by high waves / storm in the Gulf of Finland.

- Pipeline presence resulting in:
  - Temperature change
  - Release of pollutants from anti-corrosion anodes

**Impacts during the Construction Phase**

No trenching or dredging will take place in ESR II. Seabed intervention works in ESR II are limited to rock placement and the installation of support structures. However pipe-laying activities and anchor handling will take place during the construction phase, as well hyperbaric tie-in activities. These activities, as well as munitions clearance, are likely to result in the release of contaminants and physical alteration of the seabed.

*Release of contaminants*

Of the potentially ecotoxic chemical compounds in the Baltic Sea (listed in **Section 9.3.4**), copper, nickel and TBT are present in high concentrations in ESR II (see **Section 8.8.2**). It is not likely that there will be large adverse effects on seabed flora and fauna due to the release of contaminants from seabed works in ESR II, since neither munitions clearance, rock placement, installation of support structures, anchor handling, pipe-laying nor hyperbaric tie-in activities are expected to cause sufficient disturbance to the sediment to release contaminants from the lower layers of sediment where they are mostly found. Furthermore, gravel used in rock placement, and the pipelines themselves, will have inert surfaces, as described in **Section 9.2.1**, and neither rock placement nor pipe-laying are expected to cause contamination of the seabed. Therefore, impacts due to release of contaminants on the seabed in ESR II are considered to be **insignificant**.

*Physical alteration of the seabed*

As described in ESR I, the extent of the re-suspension and spreading of sediment, and the physical disturbance to the seabed (by the formation of craters) from munitions clearance will depend upon the amount and type of detonation explosions and the residual explosive in the device, as well as the seabed type and the extent of underwater current in close vicinity to the seabed. Munitions clearance necessary in ESR II prior to construction of the pipelines will cause re-suspension and spreading of sediments in the immediate area of the pipelines and associated sediment spreading over a wider area. Sedimentation of re-suspended sediment is, however, limited and thus no impact on the seabed in expected. Munitions clearance will also result in the formation of craters in the seabed. Based upon the munitions clearance modelling performed in the Finnish EEZ (**Section 9.4.3**) craters with average radii of 4.5 meters are likely in ESR II at munitions clearance sites. This will result in a **negative** and **direct** impact on a **local** scale (<500 m) and of **low** intensity as no major change in structure or function of the seabed is expected. Impacts will be of **short-term** duration and **reversible** as the craters will, overtime, be filled. The magnitude of the impact is **low**. As discussed in **Section 8.8.2**, the seabed is of **low** value/sensitivity and therefore the impact on the seabed in ESR II in terms of physical alteration of the seabed as a result of munitions clearance is considered to be **minor.**

Re-suspension and spreading of sediments in ESR II is likely to occur due to construction activities on the seabed. This includes the introduction of gravel to the seabed during rock placement, and seabed disturbance from installation of support structures and hyperbaric tie-in activities, and creation of depressions during anchor handling. As described in **Sections 9.3.4** and **9.4.3** spill rates for rock placement and anchor handling are relatively low, and sediments will be deposited over an area up to approximately 5 km from the construction area (15 km in rough weather)[(1)]. Installation of support structures and hyperbaric tie-in activities are also expected to have a small impact in terms of sediment spreading, since they are highly localised activities. Support structures will be lowered onto the seabed by crane, further minimising disturbance to the seabed. As for the other ESRs, no major change to the seabed is expected in terms of structure and function, and since seabed intervention works are confined to specific sections of the pipelines' route.

Rock placement, installation of support structures and pipe-laying will also cause physical alteration of the seabed by the introduction of new substrate. As for ESR II, these activities will affect the substrate in a highly localised way, and will only affect a very small percentage of the Baltic Sea surface. There are no known notable seabed features along the pipelines' route in ESR II which will be affected by these activities.

Seabed intervention works are assessed to have a **direct negative** impact on the seabed, which is **reversible** in the long-term, in terms of the structure of the seabed. Impacts act on a **local** scale. Impacts are on the **long-term**. Impact intensity is considered to be **low** as no major change in structure or function is expected. The impact magnitude is **low**. Therefore, due to the **low** value/sensitivity of the seabed the significance of the impacts on the seabed are assessed to be **minor**.

Impacts from pipe-laying are expected to be smaller than those from seabed intervention works, due to the smaller amount of seabed disturbance from this activity. Pipe-laying will only affect the substrate in a localised way, in areas where it is laid on the surface of the seabed, or on artificial supports, rather than in areas where it is buried. The introduction of new substrate will only affect a very small percentage of the Baltic Sea seabed, and will not affect any notable seabed features. Impacts on the seabed morphology from pipe-laying are therefore also deemed to be **insignificant**, as no major change is expected to the seabed in terms of structure and function.

(1) Atlas Maps MO-13 and MO-22

Anchor handling in ESR II is likely to cause physical alteration of the seabed, due to controlled positioning of anchors in the seabed, as described in **Section 9.3.4**. While it is expected that depressions will be refilled due to the redistribution of sediments mobilised by currents and waves, this **negative** impact is expected to cause **local** impacts of **low** intensity. As discussed in **Section 8.8.2**, the seabed is considered to be of **low** value/sensitivity. Impacts will be **short-term** in duration. The magnitude of the impact is considered to be **low**. Impacts will also be **reversible** over time. The **direct** impact on the seabed in ESR II in terms of physical alteration of the seabed as a result of anchor handling is therefore considered to be **minor**.

**Impacts during the Operational Phase**

Impacts on the seabed from the operational phase in ESR II are limited to physical alteration of the seabed due to routine inspections and maintenance and pipeline presence, and temperature change and release of pollutants from anti-corrosion anodes, resulting from pipeline presence.

*Physical alteration of the seabed*

Physical alteration of the seabed may also occur during the operational phase. Routine inspections and maintenance of the pipeline may involve occasional seabed disturbance, but this will occur infrequently and vessel movements will be restricted to the pipelines' route. Since the larger-scale seabed intervention works during the construction phase are not expected to impact significantly on the seabed, routine inspections and maintenance works are anticipated to have an **insignificant** impact on the seabed in ESR II.

In terms of sediment accumulation along the pipelines, this effect is possible following the introduction of the pipelines on the seabed, since their presence will change the flow conditions of sea currents in the pipelines' vicinity, as discussed in **Section 9.4.2**, and will potentially alter the accumulation zones of fine seabed material around the pipelines. However, accumulation zones for fine-grained sediments are low energy zones, which is not the case in ESR II.

Analysis has also concluded that no scouring is foreseen along the pipelines' route in ESR II(1). Therefore, physical alteration of the seabed due to both sediment accumulation and scour is considered to have an **insignificant** impact on the seabed in ESR II.

*Temperature change*

As for ESR I (**Section 9.3.4**) and as discussed in **Section 9.3.3** as part of the assessment of impacts on the water column, the difference in temperature between the gas and the surrounding water column or sediment may result in a temperature change in the seabed. However, the models described in **Section 9.3.3** show that near the Russian landfall site (where

(1) Nord Stream AG & Ramboll. 2008. Memo 4.3A2 - Blocking effects of the pipeline on the seabed causing accretion.

temperature change as a result of pipeline presence will be greatest), a change of temperature of up to 40$^{o}$C will only take place within the sediment up to 20 cm from the pipelines. Further, this impact will reduce further from the Russian landfall site as the gas in the pipelines cools. Since the pipelines will not be buried in ESR II, the only section of seabed to be affected by this temperature increase will be the section immediately below, and up to 20 cm on either side, of the pipelines. Since benthos will not exist directly beneath the pipelines, the only impact to benthos will be along a channel of up to 20 cm either side of each pipeline. Therefore, the impact of temperature change from pipeline presence on the seabed in ESR II is considered to be **insignificant**.

*Release of pollutants from anti-corrosion anodes*

As described in **Section 9.3.3**, zinc alloy anodes have been selected for sections of the pipelines' route with very low average salinity, in parts of ESR II[(1)], with the remaining sections of the route using indium-activated aluminium anodes. For the two pipelines in ESR II, there will be no trenching or dredging of the pipelines, and the release of pollutants from the anodes in these sections will be mostly into the water column directly, with the greatest impact on the marine environment being in terms of the impact on the water column. The impact of the anodes on the water column itself has been assessed as being insignificant (**Section 9.3.3** and **9.4.3**), therefore the impact on the seabed is also considered to be **insignificant**.

**Impact Summary**

The impacts on the seabed identified and assessed in ESR II are summarised in **Table 9.26**

(1) Snamprogetti. 2008. Offshore CP System Sizing.

**Table 9.26 ESR II impact summary table for the seabed**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Seabed - Ecological Sub-Region II | Release of contaminants | Seabed intervention works, Pipe-laying, Anchor handling, Hyperbaric tie-ins | - | - | - | - | - | - | - | - | **Insignificant** |
| | Physical alteration of the seabed | Munitions clearance | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works, Hyperbaric tie-ins | Negative | Direct | Local | Long-term | Low | Low | Low | Reversible | **Minor** |
| | | Pipe-laying | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Temperature change | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of pollutants from anti-corrosion anodes | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.4.5 Physical Environment – Atmosphere

**Overview**

As described in **Section 9.2.1** impacts from pollutant release are most likely to arise from the construction phase and, to a lesser extent, the operational phase. The atmosphere has been given a low sensitivity value as described in **Section 8.5.1**. No impacts on the atmosphere are predicted from the pre-commissioning and commissioning phase. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Seabed intervention works and pipe-laying activities resulting in:
    - Emissions of pollutant gases

*Operational phase*

- Routine inspections and maintenance works resulting in:
    - Emissions of pollutant gases

**Impacts during the Construction Phase**

During the construction phase for ESR II, seabed intervention works and pipe-laying have associated pollutant emissions which will potentially contribute to acidification, eutrophication and climate change, with associated negative impacts on marine and terrestrial receptors, as discussed in **Section 9.3.5**.

As described in **Section 9.3.5**, pollutant emissions will only be associated with those aspects of seabed intervention works, which involve fuel combustion in engines on the sea surface. In ESR II, emissions during seabed intervention works are likely to arise from rock placement machinery, vessel movement and welding equipment used during pipe-laying along the length of ESR II.

*Emissions of pollutant gases*

As for ESR I, pollutant gases and particulate matter emissions from seabed intervention works and pipe-laying activities, due to the diesel and bunker oil used by the construction fleet (both delivery and maintenance vehicles on land and marine traffic), can contribute to acidification, eutrophication and climate change. However, as described in **Section 9.3.5**, and as shown in **Table 9.8**, emissions associated with Project activities are predicted to be most intense during the construction phase, contributing 1.9, 1.4 and 0.44 % to the annual emissions of $CO_2$, $NO_x$ and $SO_2$ respectively for all activities (mainly shipping traffic) in the Baltic Sea.

As for ESR I, and as described in **Section 9.3.5** it is expected that there will be a **cumulative negative** impact on atmospheric $CO_2$ levels from construction activities, operating on a **national** to **transboundary** scale and over a **long-term** duration. Impacts are **irreversible**. As described in **Section 8.5.1**, the atmosphere has a **low** sensitivity. However, since emissions levels relating to the Project are low compared to those from existing shipping traffic, impact intensity is considered to be **low**, impact magnitude is considered to be **low**, and the significance of this impact in ESR II, and for the pipelines' length as a whole, is expected to be **minor**.

**Impacts during the Operational Phase**

During the operational phase in ESR II, routine inspections and maintenance works will have associated pollutant emissions, as for the construction phase, which will also potentially contribute to acidification, eutrophication and climate change, with associated negative impacts on marine and terrestrial receptors.

*Emissions of pollutant gases*

During the operational phase, the type of impacts on the atmosphere in ESR II will be similar to those during construction (emissions from vessels associated with routine inspections and maintenance). As described in **Section 9.3.5**, and as shown in **Table 9.8**, emissions associated with the operational phase of the Project are expected to contribute 0.13, <0.05 and <0.05 % to the annual emissions of $CO_2$, $NO_x$ and $SO_2$ respectively for all activities (mainly shipping traffic) in the Baltic Sea. Emissions associated with routine inspections and maintenance will again be much lower than for those from the construction phase, although they will occur over a longer period. The impact is considered to be **insignificant**.

**Impact Summary**

The impacts on the atmosphere identified and assessed in ESR II are summarised in **Table 9.27**.

**Table 9.27 ESR II impact summary table for the atmosphere**

| Atmosphere - Ecological Sub-Region II | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Revers-ibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Dur-ation | Intensity | Magnitude | | | |
| | Emissions of pollutant gases | Seabed intervention works, Pipe-laying | Negative | Cumul-ative | National - Transboundary | Long-term | Low | Low | Low | Irreversible | **Minor** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.4.6 Biological Environment – Plankton

**Overview**

The plankton dynamics in the Baltic Sea vary widely with time and geographical scale. Values/sensitivities for both phytoplankton and zooplankton in ESR II are detailed in **Chapter 8.8.3** and summarised in **Table 9.28.**

**Table 9.28 Values/sensitivities of plankton in Ecological Sub-Region II**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Plankton** | | | | | | | | | | | | |
| Phytoplankton | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Zooplankton | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |

Given that plankton drift in the water column there is no potential for the Nord Stream Project to change the abundance or distribution of plankton in general in the Gulf of Finland. As described in ESR I potential impacts on plankton as a result of the Project are expected to be **insignificant** in ESR II.

### 9.4.7 Biological Environment – Marine Benthos

**Overview**

In the Gulf of Finland, 93 different macroalgae species are known to exist[1] as detailed in **Chapter 8.8.4**. The upper filamentous zone in the outer archipelago of the eastern Gulf of Finland is dominated by *Cladophora glomerata*. In this area the intermediate zone at approximately 1 – 5 m depth is dominated by bladder wrack (*Fucus vesiculosus*) and the deeper areas are dominated by blanketweed (*Cladophora rupestris*). There are four main groups of macroalgae and vascular plants in ESR II. The filamentous algae which are normally found in shallow water are of **low** sensitivity. Red and brown algae on the other hand are considered to be of **medium** sensitivity as species such as bladder wrack have short dispersal distances and are slow to recover from local extinctions. Both the submerged and emergent vascular plants are considered to be of **low** sensitivity.

(1) Nielsen, R., Kristiansen, A., Mathiesen, L. and Mathiesen, H. 1995. Distributional index of the benthic macroalgae of the Baltic area. In: Acta Botanica Fennica.

Based on survey results described in **Chapter 8.8.4**, the benthic fauna population is thought to be present throughout ESR II where sufficient oxygen levels exist. This community is dominated by opportunistic species of polychaetes, the Baltic Sea telling (*Macoma baltica*), the amphipod *Pontoporeia affinis* and the isopod *Sarduria entomon*. This soft-bottomed community is considered to be of **low** sensitivity.

This section identifies and assesses the potential impacts on marine benthos in ESR II during the construction, pre-commissioning and operational phases of the Project in terms of the methodology presented in **Chapter 7**. Values/sensitivities for marine benthos are detailed in **Chapter 8** and summarised in **Table 9.29.**

**Table 9.29 Values/sensitivities of marine benthos in Ecological Sub-Region II**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Benthos** | | | | | | | | | | | | |
| Macroalgae and aquatic vegetation | | | | | | | | | | | | |
| Filamentous algae | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Red and brown algae | Med | Med | Med | Med | Med | Med | Med | Med | Med | Med | Med | Med |
| Emergent vascular plants | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Submerged vascular plants | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Zoobenthos | | | | | | | | | | | | |
| Soft-bottom community | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |

Impacts during the operational and pre-commissioning and commissioning phases are expected to be minimal in comparison to construction. The activities and the related impacts that are assessed in this section are as follows:

*Construction phase*

- Munitions clearance, seabed intervention works and pipe-laying resulting in:
  - Increase in turbidity
- Munitions clearance, seabed intervention works, pipe-laying and anchor handling resulting in:

- Release of contaminants
- Release of nutrients

- Munitions clearance and rock placement resulting in:
  - Noise and vibration
- Munitions clearance, seabed intervention works, pipe-laying, anchor handling and hyperbaric tie-in activities resulting in:
  - Physical loss of seabed habitats
- Construction and support vessel movement resulting in:
  - Introduction of non-indigenous species (due to the transport and release of ballast water and via biofouling of ship hulls)

*Pre-commissioning and commissioning phase*

- Seawater intake and pressure-test water discharge activities resulting in:
  - Noise and vibration

*Operational phase*

- Routine inspections and maintenance works resulting in:
  - Physical alteration of the seabed
- Pipeline presence resulting in:
  - Introduction of secondary habitats
  - Temperature change
  - Release of pollutants from anti-corrosion anodes

**Impacts during the Construction Phase**

Many of the same impacts described for ESR I are likely to occur within ESR II as a result of munitions clearance, seabed intervention works, pipe-laying and anchor handling. These include the spreading and re-suspension of sediments causing an increase in turbidity, release of contaminants, release of nutrients, noise and vibration, smothering of benthos and the physical loss of seabed habitats.

*Increase in turbidity*

Prior to construction activities commencing, 27 munitions will be cleared in the Gulf of Finland within ESR II in close consultation with the relevant authorities. Munitions clearance will result in the re-suspension and spreading of sediments leading to negative impacts on benthos (**Section 9.4.3**). The **negative**, **direct** impacts will act on a **regional** scale, impacting benthos in the **short-term** to **long-term** as recovery of the community is dependent on recruitment from the surrounding areas. Most benthic fauna, including non-burrowing species, would be expected to be able to survive even high levels of deposition, the impact would be **reversible** and the intensity of the impact is expected to be **low** as a localised group of individuals will be affected with many individuals expected to survive a certain degree of turbidity. The magnitude of the impact is also expected to be **low**. As described above, the sensitivity of the benthos communities within ESR II is considered **low** to **medium** for all communities. The impact significance due to munitions clearance is therefore predicted to be **minor**.

Rock placement, installation of support structures and pipe-laying will cause re-suspension of sediments thereby increasing turbidity in the water column. The physical effects of this impact are discussed in detail in **Section 9.4.3** and only the effect on marine benthos is discussed here. A more detailed description of the impacts resulting from sediment re-suspension is given in **Section 9.3.7**. Sediment spread as a result of construction activities has been modelled and is described detail in **Section 9.4.3**. From this model induced deposits from pipe-laying and installation of support structures are predicted to be less than 0.1 mm anywhere along the pipelines' route within ESR II. The impact will be **negative** and **direct**, although benthos within ESR II is expected to be able to survive these comparatively low levels of deposition. However, if turbidity were to occur during hypoxic periods, the ability of the benthos to survive this impact may decrease. The impact from increased turbidity on the benthic community is predicted to impact an area up to 2 km from the pipelines based on sediment modelling and is therefore a **regional** impact. This impact is **reversible** as the majority of benthos are expected to be able to survive as long as there is sufficient oxygen supply. The benthic community is expected to recover in the **short-term** to **long-term** as new individuals migrate from other areas. Construction activities in ESR II are expected to create less re-suspension of sediments than the construction activities in ESR I. The intensity of this impact in ESR II is therefore **low**. As only a localised group of individuals are expected to be affected the impact magnitude is **low**. The sensitivity of the benthos communities within ESR II is **low** to **medium** and therefore the overall impact significance is **minor**.

*Release of contaminants*

As described in **Section 9.3.7**, construction activities that cause disturbance to seabed sediments can result in the release of contaminants. In ESR II these activities are limited to munitions clearance, rock placement, installation of support structures, pipe-laying and anchor handling. The impact to the benthic community will be **negative** and **direct** through impacts to the seabed and **indirect** through impacts to the water column. The effects are expected to be

**local**. Contaminated sediments are expected to remain on the surface for many years and this is therefore a **long-term** impact. However, sediments contaminated with organic pollutants are expected to degrade making this a **reversible** impact. The impacts to the benthos are expected to be of **low** intensity as the impacts are expected to be at the limit of detection. The magnitude is predicted to be **low** as only a fraction of the population is expected to be affected. The sensitivity of the benthos communities is **low** to **medium** in ESR II and subsequently the overall impact significance is therefore considered to be **minor**.

*Release of nutrients*

Munitions clearance, rock placement, installation of support structures, pipe-laying and anchor handling all have the potential to disturb sediments and thus release nutrients. Details of the mass balance model used to determine the amount of nutrients likely to be released is given in **Section 9.3.3**. In ESR II, the impacts from this release are likely to be more significant in the coastal areas. However, as the pipelines will be laid in the deeper sections of ESR II, and sediment is not expected to spread for more than 2 km, the effects of nutrient release on the benthos is considered to be **insignificant**.

*Noise and vibration*

There will be some munitions clearance within ESR II before construction activities begin. Munitions clearance causes a shockwave that has the potential to impact benthos and in particularly the larger, more mobile benthic species. Details of the size and power of the potential shockwave are not available but it is considered likely that it would cause a **local** impact. Invertebrates are generally thought to have a high tolerance to pressure waves from explosions. A shockwave would cause a **direct**, **negative** and **reversible** impact. The impact is likely to be **temporary** as the shockwave would quickly dissipate with time and distance. The effects are not clear but it is expected there would be a **low** to **medium** intensity impact. The majority of benthos within ESR II is considered to be of **low** sensitivity (see **Table 9.29**) except for the red and blown algae which are considered to be of **medium** sensitivity. However, these algae will not be affected by noise and vibration impacts therefore benthos is considered to have a **low** sensitivity to this impact in ESR II. The details of the size and power of the shockwave are not known but it is expected it will have a **low** magnitude effect on the soft tissue of benthic fauna. The overall impact significance is therefore **minor**.

The majority of benthic fauna along the pipelines' route are not sensitive to noise. However, as discussed in **Section 9.3.7**, some invertebrates have been known to respond to noise and vibration in the water. As no trenching is planned for ESR II the loudest sources of impact from seabed intervention works is expected to be from rock placement. It is unlikely that even noise-sensitive species will be disturbed by this noise source and so the impact is considered to be **insignificant**.

*Physical loss of seabed habitats*

Munitions clearance, rock placement, installation of support structures and pipe-laying will result in a physical loss of seabed and potential destruction of benthos within the pipelines' corridor. Anchor handling can also cause scarring of the seabed and destruction of benthos.

Munitions clearance will result in physical disturbance to the seabed and loss of benthos habitats that will be **negative** and **direct**. The impacts are likely to affect an area within 500 m of the pipelines' corridor and it will therefore be **local** impact. The loss of habitat from the munitions clearance is likely to be **short-term** and **reversible**. The intensity of the impact is **medium** as localised habitat and associated benthos will be destroyed, but not to the extent that the whole population will be affected. The magnitude of the impact will be **low** as only a small proportion of the benthic community in ESR II is expected to be affected. As marine benthos is of **low** to **medium** sensitivity, overall this impact is expected to be of **minor** significance.

A total volume of approximately 944,000 $m^3$ of rock will be placed along the pipelines' route within ESR II to support the pipelines. The footprint of each area of rock placement is likely to cover an area between 8 and 15 m wide across the pipelines, with a maximum of 60 m. The loss of habitat and destruction of benthos as a result of rock placement will be **negative** and **direct**. However, as the impact is expected to be restricted to approximately 15 m from the pipelines it will therefore result in a **local** impact in discrete areas. Habitat loss from rock placement will be permanent**,** but the benthos is expected to recover in the **short-term** as long as there is enough oxygen available, therefore the impact of habitat loss on benthos is considered to be **reversible**. As with the impact from pipe-laying, the intensity of the effect is expected to be **medium**. A **low** magnitude impact is expected which will impact a smaller area than pipe-laying. The benthos within ESR II is considered to be of **low** to **medium** sensitivity (see **Table 9.29**) and thus this impact is expected to be of **minor** significance.

The footprint caused by pipe-laying is a long, narrow strip approximately 1.5 m wide. Each pipeline will be laid at a rate of approximately 2 to 3 km a day. The pipelines will be laid on the surface of the seabed thereby destroying an area of seabed habitat for the benthos within ESR II. However, this area is small in comparison to the total size of ESR II. This impact will be **negative** and **direct**. The impact will occur within the pipelines' corridor and is therefore a **local** impact. Whilst the loss of habitat is permanent, the benthos will recover in the **short-term**. The loss of habitat is expected to cause a **medium** intensity effect as individual fauna may be destroyed and a small area of habitat may be lost, but the population as a whole is not expected to be affected. The impact will be **reversible** provided there is sufficient oxygen for the benthic community to recover in the affected areas. Overall a **low** magnitude impact is expected to occur to the benthos as a result of pipe-laying. The benthos within ESR II is considered to be of **low** to **medium** sensitivity (see **Table 9.29**) and therefore the overall significance for this impact is **minor**.

Anchor handling will be needed along the entire length of the pipelines' corridor within ESR II. The footprint from this impact is potentially considerable as a result. An estimate of the physical impact area of each anchor is given in **Section 9.3.7** but is expected to affect an area of the seabed of approximately 240 $m^2$ in size at any one time. Each time the anchors are repositioned, a new area will be affected. Consequently the total area affected within ESR II will be dependant on the number of anchor movements. A **negative** and **direct** impact will result in the form of physical loss of habitat and potential loss of individual benthic fauna. This impact will be **local** and is likely to have a **short-term** effect as recolonisation is expected once construction activities cease. A **medium** intensity impact is predicted as a relatively small area of habitat will be destroyed and some individuals within the benthic community may be destroyed but will not lead to a permanent change in the structure of the benthic community. A **low** magnitude impact is predicted as only a small portion of the overall benthic community will be affected. This impact is **reversible** with time (approximately 2 to 3 years). Overall this impact is expected to be of **minor** significance as the benthos in ESR II ranges from **low** to **medium** sensitivity.

One hyperbaric tie-in will occur within ESR II and seabed disturbance from tie-in activities has the potential to impact benthos within ESR II. The tie-in will require an offshore welding habitat with a large footprint, causing a temporary physical loss of seabed. The impact is expected to be **negative** and **direct**. The size of the footprint is unknown but it is expected to incur a **local** and **short-term** effect. It is expected to cause a **medium** intensity impact as the benthos and their habitats may be destroyed but the impact will affect a small number of individuals living within the deeper areas of ESR II. Impacts are **reversible**. The loss of habitat and individual benthic fauna will affect a specific group of localised individuals within a population resulting in a **low** magnitude impact. The impact significance is therefore expected to be **minor** as the benthos in ESR II ranges from **low** to **medium** sensitivity.

*Introduction of non-indigenous species*

It is possible that invasive species enter the Baltic system through biofouling of the ship hull of the vessels involved in the construction. This could allow the accidental spread of invasive benthic species into and across the Baltic. The use of antifouling paints, careful cleaning of hulls, tanks and drilling and dredging equipment before use prior to entering the Baltic will limit the potential introduction of invasive species. The risk of intra-Baltic spread of formerly introduced species in one part of the Baltic (e.g. from ports in the western Baltic part) to another area by the project is negligible in comparison to existing maritime activities. Differences in environmental conditions between the various ESRs of the Baltic Sea also constrain the spread of the invasive species from one area to another. The unintentional introduction of invasive species into the Baltic Sea or from one area of the Baltic to another poses a negligible risk. Consequently, the residual impacts of the construction phase on benthic communities in ESR II will be **insignificant**.

### Impacts during the Pre-commissioning and Commissioning Phase

Potential impacts to benthos during the pre-commissioning and commissioning phase in ESR II are limited to noise due to pipeline flooding and pressure-test water discharge, since these activities will involve the movement of water in the pipelines along the route.

*Noise and vibration*

Noise levels in ESR II, as a result of pipeline flooding, pressure-test water discharge and commissioning are expected to be lower than those produced by construction activities and so are considered to be **insignificant**.

### Impacts during the Operational Phase

*Physical alteration of the seabed*

The pipelines will require routine inspections which are expected to cause little or no disturbance to the benthos and are therefore considered **insignificant**. However, routine maintenance works may cause disturbance of the seabed resulting in a direct loss or smothering of the benthos in a **local** area. This impact would be **negative, direct** and **reversible**. Impacts are expected to be **short-term** as the benthic community within ESR II is expected to recover quickly. The impact intensity is considered to be **medium**. Only a small proportion of the benthic community (of **low** to **medium** sensitivity) are predicted to be affected and so this is deemed to be a **low** magnitude impact. Overall the significance of this impact is expected to be **minor.**

*Introduction of secondary habitats*

The physical presence of the pipelines on the seabed has the potential to alter the composition and abundance of the existing benthic community. The majority of ESR II is comprises soft sediment and the introduction of the pipelines will act as a hard substrate for the benthic community. The addition of this hard substrate may encourage a different community of benthos (possibly including invasive species previously introduced) to develop on and around the pipelines which may result in a **direct positive** or **negative** impact depending on the composition of the new benthic community. The effect will be localised to the pipelines and immediate vicinity and is therefore **local**. These changes to the benthic community will be **long-term** and **irreversible** as the pipelines are expected to be used as a habitat for as long as the pipelines remain in situ. A **medium** intensity impact is predicted as the benthic community will be affected above the limit of detection but the structure of the entire benthic population will not be affected. The physical presence of the pipelines acting as a new habitat will affect a localised group of individuals within the larger population and is therefore predicted to be a **low** magnitude impact. The sensitivity of the benthos communities is **low** to **medium** in ESR II and subsequently the overall impact significance is therefore **minor**.

*Temperature change*

A temperature increase is expected in the waters near the landfall in ESR I as a result of natural gas flowing through the pipelines. This change in temperature will be localised and will not extend into ESR II. The potential impact of temperature change in the water column on the benthic community is therefore expected to have **no impact** on benthos in ESR II.

*Release of pollutants from anti-corrosion anodes*

In ESR II, the main anode used will be zinc, although some aluminium anodes will be used in the more saline areas of ESR II in the western Gulf of Finland. These anodes have the potential to release cadmium and zinc to the water column which has the potential to cause toxicity to the benthos. However, as discussed in **Section 9.4.3**, the volume of ions predicted to be released into the water column are insignificant. As such, the impact to the benthos from release of pollutants from anti-corrosion anodes within ESR II due to pipeline presence is considered to be **insignificant**.

**Impact Summary**

The impacts identified and assessed in ESR II on marine benthos are summarised in **Table 9.30.**

**Table 9.30 Impact summary table for marine benthos in ESR II**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Marine Benthos - Ecological Sub-Region II | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term - Long-term | Low | Low | Low - Medium | Reversible | **Minor** |
| | | Rock placement, Installation of Support Structures, Pipe-laying | Negative | Direct | Regional | Short-term - Long-term | Low | Low | Low - Medium | Reversible | **Minor** |
| | Release of contaminants | Munitions clearance, Rock placement, Installation of support structures, Pipe-laying, Anchor handling | Negative | Direct and indirect | Local | Long-term | Low | Low | Low - Medium | Reversible | **Minor** |
| | Release of nutrients | Munitions clearance, Rock placement, Installation of support structures, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Noise and vibration | Munitions clearance | Negative | Direct | Local | Temporary | Low - Medium | Low | Low | Reversible | **Minor** |
| | | Rock placement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline flooding, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | Physical loss of seabed habitats | Munitions clearance | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | | Rock placement | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | | Pipe-laying | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | | Hyperbaric tie-ins | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | Introduction of non-indigenous species | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | Physical alteration of the seabed | Routine inspections | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine maintenance | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | | works | | | | | | | | | |
| | Introduction of secondary habitats | Pipeline presence | Positive or Negative | Direct | Local | Long-term | Medium | Low | Low - Medium | Irreversible | **Minor** |
| | Temperature change | Pipeline presence | - | - | - | - | - | - | - | - | **No impact** |
| | Release of pollutants from anti-corrosion anodes | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.4.8 Biological Environment – Fish

#### Overview

In ESR II the Nord Stream Project has the potential to impact fish during construction, through impacts to water quality, changes to the seabed habitats, underwater noise, disturbance caused from construction and support vessel movement. Impacts to fish may occur during the pre-commissioning, commissioning and operational phases as a result of noise and vibration, the physical alteration of the seabed and temperature change.

Both marine and freshwater species are present in the Gulf of Finland including local pike (*Esox lucius*), roach (*Rutilus rutilus*), ruffe (*Gymnocephalus cernuus*), burbot (*Lota lota*) and white bream (*Abramis bjoerkna*). The coastal waters are also inhabited by sticklebacks (*Gasterosteus aculeatus*, *Pungitius pungitius*), minnow (*Phoxinus phoxinus*), Baltic herring (*Clupea harengus membras*), turbot (*Psetta maxima*) and flounder (*Platichtus flesus*). Cod *(Gadus morhua*) are not common in ESR II. Herring use the shallow coastal waters the Gulf of Finland for spawning. Diadromous species present include the Atlantic salmon (*Salmo salar*), the smelt (*Osmerus eperlanus*) and the river lamprey (*Lampetra fluviatilis*).

Values/sensitivities for fish in ESR II are detailed in **Section 8.8.5** and summarised in **Table 9.31**. In some cases, the sensitivity of a particular species may be higher or lower and impacts have then been assessed on species-specific basis.

**Table 9.31 Values/sensitivities of fish in Ecological Sub-Region II**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fish** | | | | | | | | | | | | |
| Pelagic fish | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Demersal fish | Low | Low | Low | Low | Med | Med | Med | Low | Low | Low | Low | Low |
| Freshwater fish community | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Diadromous species | Low | Low | Low | Low | Low | High | Low | Low | High | High | High | Low |

Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Construction and support vessel movement and the re-suspension and spreading of sediments from munitions clearance, seabed intervention works, pipe-laying, anchor handling and hyperbaric tie-in activities resulting in:

- Increase in turbidity
- Release of contaminants
- Noise and vibration
- Visual/physical disturbance

*Pre-commissioning and commissioning phase*

- Pre-commissioning and commissioning vessel movement resulting in:
  - Noise and vibration

*Operational phase*

- Routine inspections and maintenance works and pipeline presence resulting in:
  - Noise and vibration
  - Physical alteration of the seabed
  - Temperature change

**Impacts during the Construction Phase**

Impacts upon fish during the construction phase are anticipated as a result of munitions clearance, seabed intervention works, pipe-laying, anchor handling and hyperbaric tie-in activities. **Atlas Map PR-3a** shows the locations of the various seabed intervention works planned for ESR II. These impacts associated with these activities are limited to the re-suspension and spreading of sediments resulting in an increase in turbidity and the release of contaminants (heavy metals and organic pollutants). Increased noise and vibration and disturbance caused from vessels have also been identified as potential impacts and are assessed.

*Increase in turbidity*

Re-suspension of sediments and the subsequent increase in turbidity will result from munitions clearance, seabed intervention works, pipe-laying, anchor handling and hyperbaric tie-in activities. The western reaches of ESR II have a temporary halocline at 60 to 80 m (see **Atlas Maps BA- 1** and **WA-1**). Increases in turbidity, as a result of munitions clearance, seabed intervention works and pipe-laying, may potentially cause physiological damage to any fish species, particularly to flatfish such as flounder and turbot (*Psetta maxima*) that are present in the area. Most fish species (including a number of sensitive species such as Atlantic salmon, European eel, herring and shad (*Alosa* sp.)) inhabit waters above the halocline. However, a halocline does not exist throughout the Gulf of Finland.

Modelling was carried out to predict the effects of seabed intervention works on turbidity. Seabed intervention works in ESR II will result in a re-suspension of sediment (see **Atlas Map MO-12** and **MO-13**) with concentrations of suspended sediment exceeding 1 mg/l for over 12-24 hours in places at distances close to the pipelines due partly to the hard clay and muddy nature of the sediment. This may potentially cause physiological damage to any fish species, their eggs and larvae that are present in the areas of increased turbidity, however adult fish will move away from the waters with increased turbidity and the pipelines' route in ESR II does not pass through any known spawning grounds. Impacts from munitions clearance and pipe-laying are expected to have a lower impact still. Therefore the impact of increased turbidity on fish in ESR II due to munitions clearance, seabed intervention works and pipe-laying is expected to be **insignificant**.

Throughout the construction phase, anchors of the support vessels associated with the pipe-laying vessel will have to be constantly repositioned. This and drifting anchors and chains dragging across the seabed and the additional impact of ship propellers in these waters will give rise to increased turbidity. The use of a Dynamically Positioned Vessel (DPV) to lay pipeline one (northwest pipeline) from KP 7.5 to KP 300 (and pipeline two (southeast pipeline), depending on availability) would minimise this potential cause of increased turbidity resulting from construction works and anchor handling. However, in comparison to turbidity as a result of fishing and trawl nets, these impacts are considered to be minimal and therefore **insignificant**.

In ESR II, both pipelines will be tied in by means of a seabed tie-in (hyperbaric) at KP 300 located in the western Gulf of Finland. This location does not lie in or near an important spawning ground. The zone of elevated turbidity will be localised at KP 300 and is expected to be minimal and remain beneath the halocline. Due to the tie-in activities being of a highly localised nature, in addition to the presence of a halocline, the vast majority of species will not be affected by an increase in turbidity and the impact is deemed to be **insignificant**.

*Release of contaminants*

An increase in the concentration of dissolved contaminants in the water column from the disturbance and re-suspension of contaminated sediment could affect fish spawning and fish themselves (see **Section 9.3.8** for details). Contaminants of concern include heavy metals and organic compounds including PAHs. The sediments in ESR II contain high levels of heavy metals (see **Section 8.8.2**).

Adult fish are generally able to detect heavily contaminated areas[(1)] or areas of low water quality. Pelagic species in ESR II will be affected by the elevated concentrations of dissolved

(1) International Petroleum Industry Environmental Conservation Association (IPIECA). 2000. Biological Impacts of Oil Pollution - Fisheries. IPIECA Report Series. 8.

contaminants. However, the period of exposure will be very short and fish are likely to avoid areas of elevated turbidity, where suspended contaminants may occur. These effects are often short lived and once fish move away from the source of contamination they can metabolise the pollutants and cleanse themselves within weeks of exposure[(1)],[(2)]. Some fish species such as perch and roach use turbidity as a refuge when macrophytes are not present[(3)] and may be subject to higher levels of contaminants as a result. However, seabed intervention works will result in increased noise and vibration and consequently fish in the area of the pipelines will move away from these areas which also coincide with areas of increased turbidity minimising exposure to these contaminants. A much greater threat to fish populations is posed from exposure of eggs and larvae to increased contaminants as they can not actively move away from the contaminated areas. However, there are no specific important spawning grounds located in the vicinity of the proposed route in this ESR.

Consequently the impacts of munitions clearance and seabed intervention works resulting in the exposure of fish to contaminants during the construction phase is expected to be **insignificant** as there are no specific spawning grounds located in the vicinity of the proposed route in this ESR.

*Noise and vibration*

One of the main potential impacts to fish in as a result of the Project will be from increased levels of underwater noise and vibration as a result of construction. Underwater noise and vibration could arise from a number of activities during the construction phase, particularly construction vessel engines, pipe-laying operations, seabed intervention works and from the installation of special support structures. Approximately 2 to 3 km of pipeline will be laid per day, thus the daily potential for creation of noise and vibration will be restricted to this immediate area.

The noise frequencies fish species are able to hear, vary significantly between 30 Hz and 4 kHz[(4)]. Of the species in ESR II herring are the most sensitive to noise. The auditory detection limits for flatfish have not been defined but their sensitivity to noise is understood to be

(1) Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP). 1993. (IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution). Impact of Oil and Related Chemicals and Wastes on the Marine Environment. GESAMP Reports and Studies. 50.

(2) Heath, A.G. 1995. Water Pollution and Fish Physiology. Second ed. Lewis Publishers. Boca Raton. FL.

(3) Pekcan-Hekim, Z. 2007. Effects of turbidity on feeding and distribution of fish. Doctoral dissertation (article-based). University of Helsinki. Faculty of Biosciences. Department of Biological and Environmental Sciences, Aquatic Sciences.

(4) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

considerably lower than herring[(1)]. Herring can hear in an extended range of frequencies of between 30 Hz and 4kHz with a hearing threshold of 75 decibels (dB) re 1µPa at 100 Hz[(2)]. As herring do not spawn in ESR II[(3)] their spawning will not be impacted by noise emitted from construction activities.

Salmon respond only to low-frequency tones (below 380 Hz), with best hearing at 160 Hz. The hearing of salmon is poor, with narrow frequency span, poor power to discriminate signals from noise and low overall sensitivity[(4)]. Salmon spawn in rivers and hence spawning will not be impacted by noise related activities in ESR II. Salmon feeding in the area of the pipelines construction activities will be able to move away from any area of excessive noise and vibration.

Surveys of the pipelines' route in the Gulf of Finland have shown that there are at least 27 munitions in ESR II, the exact number of munitions that exist in Russian waters has not been confirmed. Munitions found in the pipelines' route will be cleared prior to construction. Ruptures of the swim bladder, haemorrhages and ruptures to internal organs such as the kidneys or the liver may result as a result of the clearance of conventional munitions[(5)]. As described in **Section 9.3.8** the peak noise levels emitted during such an event are expected to be significantly greater than the hearing thresholds of most fish in the Baltic, including herring and sprat which are present in ESR II. Fish with a swim bladder such as cod, herring and sprat are more sensitive than fish that lack swim bladders (e.g. flatfish).

The impacts of an explosion which cause the most harm to fish is caused by the differential rate of transmission of pressure waves[(6)]. A previous study carried out in the Baltic Sea shows that all Baltic herring and sprat within a 1.5 km radius of a planned detonation were instantly killed[(7)]. Salmon and sea trout were affected only within the immediate vicinity of the explosion.

As loud noise usually initiates an avoidance response, some fish in ESR II will move away from the pipelines as a result of disturbance from vessels associated with munitions clearance and return once munitions clearance has completed. In addition, fish spawing times will be considered during munitions clearance and an acoustic survey will take place prior to clearance

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(1) Enger, P.S. 1967.Hearing in Herring. Comparative Biochemistry and Physiology. 22.

(2) Enger, P.S. 1967.Hearing in Herring. Comparative Biochemistry and Physiology. 22.

(3) Swedish Environmental Research Institute (IVL). 2008. Personal communication.

(4) Hawkins, A. D. and Johnstone, A. D. F. 1978. The hearing of the Atlantic salmon (*Salmo salar*). Journal of Fish Biology. 13.

(5) Wright, D.G and Hopky, G.E. 1998. Guidelines for the use of explosives in Canadian fisheries waters. Canadian Technical Report of Fisheries and Aquatic Sciences. 2107.

(6) Wright, D.G and Hopky, G.E. 1998. Guidelines for the use of explosives in Canadian fisheries waters. Canadian Technical Report of Fisheries and Aquatic Sciences. 2107.

(7) Karlsson, R-M., Almström, H. & Berglind R. 2004. In Swedish: Environmental effects of underwater explosions – a literature review: FOI- Swedish Defence Research Agency report.

to ensure that schools of fish are not present. The impacts of noise generated as a result of munitions clearance on fish will be **negative, direct** and **temporary**. The impact will be on a **regional** scale around the clearance site. Impact intensity is expected to be **medium** to **high** depending on the fish present in the area impacted from the detonation. Impact magnitude is **medium** and value/sensitivity ranges from **low** to **high** depending on the species impacted. Therefore, impact significance is expected to be **minor** to **moderate**. Impacts may be irreversible at an individual level if death, tissue damage or hearing loss occurs, however at a population level the impact is considered to be **reversible**. It should be noted that munitions clearance is a common activity in the Baltic Sea.

In ESR II, the volume of rock to be placed along the two pipelines' route is approximately 944,000m$^3$ in total. Noise generated from rock placement is not expected to exceed background noise and thus **no impact** on fish is anticipated as a result of this particular activity which is carried out at spot locations throughout the pipelines' route in ESR II.

In ESR II, the planned location of the hyperbaric tie-in at KP 300 does not lie in or near an important spawning ground. The mitigation measure planned for fish in ESR II to reduce, minimise and where possible eliminate the impacts of noise emitted from the construction phase of the Project is to ensure wherever possible that equipment to be used during hyperbaric tie-ins is to comply with international standards in terms of noise emissions. Regular maintenance of equipment will be carried out as it is essential to ensure optimal equipment functionality. As loud noise usually initiates an avoidance response, fish in ESR II will move away while the tie-in is carried out and will return once completed. The temporary nature of the noise associated with hyperbaric pipeline tie-ins and the habituation of fish species to background boat traffic suggests that the noise anticipated during the construction phase will have an **insignificant** impact on fish in ESR II.

Fish may exhibit behavioural changes in response to lower level intermittent or continuous noise sources, however, these are often hard to detect. Behavioural changes will typically involve a cessation of normal activities and the commencement of avoidance or "startle" behaviour as a result of the detection of sound from marine construction activity. Continued detection of noise activity by fish often results in habituation to the sound, followed by a re-commencement of normal behaviour(1). Fish can acclimate to noise sources and studies have even demonstrated the ability of fish to acclimatise to airgun noise with time(2). The species inhabiting the pipelines' route are already likely to be habituated to vessel noise from other marine traffic as detailed above and the addition of a pipe-laying vessel is unlikely to represent a significant increase in underwater noise. A study of spawning herring in Norway was carried out to investigate the

(1) Knudsen, F.R., Enger, P.S. and Sand, O. 1992. Awareness reactions and avoidance responses to sound in juvenile Atlantic salmon, *Salmo salar* L. Journal of Fish Biology. 40.

(2) Chapman, C.J., and Hawkins, A.D. 1969. The importance of sound in fish behaviour in relation to capture by trawls. FAO Fisheries Reports 62 (3).

effects of repeated passage (at a distance of 8 – 40 m, in 30 – 40 m of water) of a research vessel with a peak noise level of around 145 dB re 1uPa 1Hz within the range 5 – 500 Hz, found no detectable reaction amongst the spawning herring(1). The maximum level of noise anticipated from the Project vessels is 162 dB, slightly higher than that of the vessel in the Norwegian study. This is slightly higher than that of a fishing trawler (158 dB) and lower than that of the large tankers (177 dB) that are known to operate in the Baltic(2). Impacts on fish as a result of increased vessel noise are deemed to be **insignificant.**

*Visual / physical disturbance*

During the laying of the pipelines, the presence and passage of vessels throughout ESR II may have an impact on pelagic fish present in the area such as herring, sprat, smelt, river lamprey and Atlantic salmon. However, the increase in vessel traffic is unlikely to be a significant increase over existing background levels. The Gulf of Finland is a heavily navigated waterway and vessels associated with commercial shipping and fishing vessels will regularly pass through the Project area (see **Atlas Map SH-1**). As 2 to 3 km of pipeline will be laid per day the presence of pipe-laying vessels at any one location along the pipelines' route will be for a short duration. The addition of the pipe-laying vessel and associated construction support vessel over these short periods will not represent a significant increase, particularly because there will be an exclusion zone imposed on other non-project vessels. Due to this, the impact of the presence and passage of vessels on fish is anticipated to be **insignificant** within the context of the Baltic Sea.

**Impacts during the Pre-commissioning and Commissioning Phase**

During the pre-commissioning and commissioning phase potential impacts upon fish in ESR II are limited to noise and vibration associated with pipeline flooding, pressure-test water discharge and commissioning, and support vessel movement.

*Noise and vibration*

Impacts on fish from pipeline flooding, pressure-test water discharge and commissioning during the pre-commissioning and commissioning phase may result as a consequence of underwater noise and vibration, but these impacts are anticipated to be **insignificant** as noise and vibration levels will be low compared to levels from construction phase activities and as pre-commissioning activities will be carried out over a short duration.

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(1) Skaret, G., Axelsen, B. E., Nottestad, L., Ferno, A. and Johanssen, A. 2005.The behaviour of spawning herring in relation to a survey vessel. ICES Journal of Marine Science. 62.

(2) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

During the pre-commissioning and commissioning phase of the Project, support vessel movement may also have some impact on fish present in the area, such as herring, cod, sprat and salmon. However, as for the construction phase of the Project, this increase in vessel traffic in ESR II will not cause a significant increase in noise and vibration levels over existing background levels and therefore impacts are anticipated to be **insignificant**.

**Impacts during the Operational Phase**

Impacts that will arise throughout the operational phase are anticipated to result from increased noise and vibration, temperature change along the pipelines' route and by physical alteration of the seabed.

*Noise and vibration*

The noise levels of natural gas movement through a pipeline has been known to range between 0.030 and 0.100 kHz, which is at the lowest levels detectable by many fish species. Modelled sound pressure levels within ESR II (predicted for KP 125) at increasing distances from the pipelines are shown in **Table 9.32**(1). High values were predicted at KP 125 which is at the border of the Finnish and Russian EEZ in the Gulf of Finland. The limit of hearing detection at the predicted frequency range for gas movement through a pipeline is 75 to 77 dB re 1µPa for herring(2).

**Table 9.32 Predicted total noise level of gas movement in a pipeline at 10, 100 and 1000 m from the pipeline assuming sound radiation in cylindrical half-space(3)**

| | **KP 125 (Finnish - Russian EEZ Border)** |
|---|---|
| 10 m | 90 dB re 1µPa |
| 100 m | 80 dB re 1µPa |
| 1000 m | 70 dB re 1µPa |

These results show that herring in the Gulf of Finland may be able to detect noise generated by natural gas moving through the pipelines at distances of less than 1 km. As herring spawn in shallow coastal waters, and do not spawn within one kilometre of the pipelines in ESR II there is no potential for noise to affect reproductive success of this fish species. There is no potential for noise from the pipelines during the operational phase to affect these species and subsequently

(1) Lommer, M. and Lemaire, G. 2008. Ødegaard & Danneskiold-Samsøe A/S. Noise along the Nord Stream pipelines in the Baltic Sea.

(2) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

(3) Lommer, M. and Lemaire, G. 2008. Ødegaard & Danneskiold-Samsøe A/S. Noise along the Nord Stream pipelines in the Baltic Sea.

the success of herring spawning. Diadromous fish such as salmon and lamprey do not spawn in ESR II and therefore will not be impacted by noise or vibration.

Other than an initial startle response it is unlikely that any fish species will be adversely affected by the sounds emitted from the pipelines and, as they do with shipping noise, fish within the Gulf of Finland that can detect the noise will quickly become habituated to it. Evidence suggests that in fact many species aggregate around pipelines(1). As fish will naturally become acclimatised to the noise over time it is expected that noise from operation of the pipelines would have no lasting impact on fish and therefore no specific mitigation measures are proposed and is therefore **reversible**. River lamprey and Atlantic salmon are of high value/sensitivity during their migratory periods. These diadromous species migrate along the coastline to their spawning grounds in rivers and therefore will not be impacted by Project related noise in ESR II. The impacts of noise on fish will therefore be a **short-term**, **low** magnitude and intensity impact (**negative** and **direct**) to **low** to **medium** sensitivity receptors and is therefore considered to be of **minor significance**.

Routine inspections and maintenance works on the pipelines are assumed to have an **insignificant** impact in terms of noise on fish in ESR II, as inspections and works will be infrequent and restricted to the immediate pipelines' route.

*Physical alteration of the seabed*

As the surface area of the seabed taken up by the physical presence of the pipelines will represent less than 0.001% of the total seabed area of the Baltic Sea, the total substrate area of feeding and spawning grounds expected to be impacted is relatively small. Also, in ESR II, the proposed pipelines lie at a depth where fish feeding and spawning is scarce.

As a result of the presence of the pipelines, fine substrates may increase in abundance in the softer areas of ESR II such as the Gulf of Finland. Much of the seabed along the proposed pipelines' route in ESR II is nevertheless hard bottomed and therefore will not be impacted. Due to the small area of the substrate that will be impacted by the pipelines' footprint, the impact on feeding grounds is anticipated to be **insignificant**.

A number of sensitive migratory species occur in ESR II particularly European eel, Atlantic salmon, twaite shad (*Alosa fallax*) and allis shad (*Alosa alosa*). However, these species all migrate within the water column and remain in the surface waters and consequently there is no potential for the presence of the pipelines on the seabed to act as a barrier to their migration. As such it is anticipated that there will be **no impact** on fish migration due to the presence of the pipelines in ESR II.

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(1) Love, M. S. and York A.. 2005. A comparison of the fish assemblages associated with an oil/gas pipeline and adjacent seafloor in the Santa Barbara Channel, southern California Bight. Bulletin of Marine Science. 77 (1).

Studies have shown that the addition of hard substrates (such as pipelines and materials used during rock placement) into the marine environment can be beneficial to fish populations in certain areas due to an increase in habitat heterogeneity and associated increase in prey availability[1]. However, as described previously the majority of the fish that inhabit ESR II are pelagic species and therefore will not derive any benefit from greater habitat diversity on the seabed. The introduced hard substrates may be beneficial and may help support a diverse benthic community. Aggregations of fish may occur around the pipelines or any artificial structures introduced by the Project such as areas of rock from rock placement. Aggregations of commercial fish species may lead to increased fishing along the pipelines' route, potentially creating basis for a profitable fishery. This may subsequently result in over exploitation of commercial fish stocks. In a study carried out along pipelines in the North Sea no measurable aggregation effect on commercial fish species was observed[2]. Consequently the impact of artificial habitat creation in ESR II is anticipated to be long-lasting but will be **insignificant** on fish populations.

Routine inspections and maintenance works on the pipelines will be infrequent and restricted to a localised area in the immediate pipelines' route. The following mitigation measures are proposed to ensure the impacts of routine inspections and maintenance works on fish remain insignificant during the operational phase:

- Any seabed intervention work required during the operational phase will be kept to a minimum
- Disturbance of seabed sediments will be avoided during routine inspections and maintenance works or, in the case of repair of the pipelines, disturbance of sediments will be minimised

As these works are not expected to occur on a regular basis, the residual impacts on fish are expected to be **insignificant**.

*Temperature change*

Modelling has shown that the temperature of the water at the surface of an unburied section of pipeline in the immediate vicinity of the landfall at Vyborg (ESR I) could be up to 0.4 ° C greater than the surrounding water temperature. Mixing will ensure that water temperatures will reach equilibrium with surrounding water temperatures at a distance of no more than 0.5 m from the pipeline. These values are likely to be considerably less in ESR II because modelling shows that the temperature of the gas in the pipelines will have dropped by approximately one third by the time the pipelines enter ESR II. The temperature of the gas in the pipelines is expected to reach equilibrium with the surrounding water temperature after approximately 150 km. Therefore, the

(1) Marine Conservation Society. 2000. Habitats Factsheet: Artificial Reefs.

(2) Statoil. 1998. Tråltest over steinfyllinger på Sleipner kondensatrørledning 06.-14. juli 1998. (In Norwegian only).

temperature difference between the pipelines and marine environment may affect fish stocks in the eastern reaches of ESR II, but this is expected to be limited to a very low level of attraction to the pipelines. There are no additional hazards to fish swimming near to the pipelines once they have been installed and therefore this slight change to the distribution of fish in a small section of ESR II is expected to be **insignificant**. No specific mitigation measures are proposed.

**Impact Summary**

The impacts identified and assessed in ESR II for fish are summarised in **Table 9.33**.

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**Table 9.33 ESR II impact summary table for fish**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Fish – Ecological Sub-Region II | Increase in turbidity | Munitions clearance, Seabed intervention works, Pipe-laying | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Hyperbaric tie-ins | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of contaminants | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Munitions clearance | Negative | Direct | Regio-nal | Tempo-rary | Medium - High | Medium | Low- High | Reversible | **Minor-Moderate** |
| | | Rock placement | - | - | - | - | - | - | - | - | **No impact** |
| | | Hyperbaric tie-ins | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline flooding, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | Negative | Direct | Local | Short-term | Low | Low | Low-Medium | Reversible | **Minor** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Physical alteration of the seabed | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Rock placement; Pipeline presence (addition of hard substrate) | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Temperature Change | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Visual/ physical disturbance | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.4.9 Biological Environment – Sea Birds

**Overview**

ESR II does not pass through any national or international sites designated for birds, as described in **Section 8.8.6**, and there will therefore be no direct loss of habitat or other effects on birds within designated sites in the Baltic Sea. The pipelines will, however, pass five Important Bird Areas (IBAs) in the Gulf of Finland.

The pipelines' route also passes within 25 km of the northern coast of the Gulf of Finland, which contains many Natura 2000 sites designated for bird interest including the Pernaja Outer Archipelago, important for populations of Caspian tern (*Sterna caspia*), razorbill (*Alca torda*) and common guillemot (*Uria aalge*). Itäinen Suomenlahti National Park is located approximately 8 km to the north of the Project and is a Natura 2000 site which is important for many species of breeding birds including the mew gull (*Larus canus*), lesser black-backed gull (*Larus fuscus*), Caspian tern (*Sterna caspia*), Arctic tern (*Sterna paradisaea*), razorbill (*Alca torda*) and black guillemot (*Cepphus grylle*). A detailed description of the species present in ESR II is provided in **Section 8.8.6**.

The majority of the route through the western part of the Gulf of Finland does not pass through areas of suitable foraging habitat for the majority of birds breeding within the area. The distance of the pipelines offshore in most areas are, for example, beyond the main foraging ranges of terns. The pipelines in this ESR will also be laid at a water depth in excess of 40 m. Such depths are outside the preferred foraging depths of the majority of benthic feeding diving ducks in the western Gulf of Finland, Kirkkonummi archipelago, Porvoo outer archipelago and Pernaja outer archipelago, as they tend to occur in shallower waters. Activities related to the all phases of the Project may primarily affect sea bird populations on Itäinen Suomenlahti National Park, as this site is located close to the pipelines and within the foraging range of many species that breed in this area. Impacts on coastal species of sea birds are expected to be less significant than for birds with greater foraging ranges, as these species feed predominantly in areas of very shallow water, in the case of waders and dabbling ducks, and are thus unlikely to be affected by the pipelines.

However, gulls and some tern species may be found further away from the breeding colonies as they have larger foraging ranges. Species which may be affected comprise Arctic tern (*Sterna paradisaea*), Caspian tern (*Sterna caspia*), common tern (*Sterna hirundo*) and black guillemot (*Cepphus grylle*). These species are of **high** sensitivity as they are listed in Annex I of the EC Birds Directive. Species of diving ducks including velvet scoter (*Melanitta fusca*) and tufted duck (*Aythya fuligula*) may also be affected, although these will be affected to a lesser extent, as the majority of the pipelines' route is located outside the preferred foraging depth of these species. These species are also relatively common and therefore of **low** sensitivity. Values/sensitivities for sea birds in ESR II are detailed in **Chapter 8** and summarised in **Table 9.34.** In some cases, the sensitivity of a particular species may be higher or lower and impacts have then been assessed on species-specific basis.

**Table 9.34 Values/sensitivities of sea birds in Ecological Sub-Region II**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Birds** | | | | | | | | | | | | |
| Breeding birds | Low | Low | Med | High | High | High | High | High | High | Med | Low | Low |
| Wintering birds | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Migratory birds | Low | Med | High | High | High | Low | Low | Low | High | High | High | Low |

No impact on sea birds in ESR II is expected during the pre-commissioning and commissioning phase as the uptake of seawater and subsequent discharge of pressure-test water is to occur at the Russian landfall in ESR I. Impacts from these activities will occur at a maximum distance of 20 km from the Finnish boundary and therefore impacts such as noise and vibration and visual and physical disturbance will not affect populations of sea birds within ESR II. The zone of influence for sensitive species reached up to 2 km from the impact source and will therefore not experienced by birds in ESR II.

Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Munitions clearance, seabed intervention works including rock placement, pipe-laying, anchor handling, construction and support vessel movement and hyperbaric tie-ins resulting in:
  - Increase in turbidity
  - Noise and vibration
  - Loss of habitat
  - Visual / physical disturbance

*Operational phase*

- Routine inspections and maintenance works resulting in:
  - Noise and vibration
  - increase in turbidity
- Vessel movement resulting in:
  - Visual / physical disturbance

**Impacts during the Construction Phase**

During the construction phase, munitions clearance, trenching, rock placement, pipe-laying and anchor handling are likely to result in increased turbidity, noise and vibration and loss of seabed habitat. Construction and support vessel movement may also lead to physical and visual disturbance to sea birds.

*Increase in turbidity*

Munitions clearance within the Gulf of Finland has the potential to impact upon piscivorous species of birds. As the distance to the nearest area of importance for birds is at least 25 km from the munitions clearance, works this activity is unlikely to pose a risk to sea birds at the colonies. Although it is possible that some birds may still forage underwater closer to the pipelines' route and may be at risk, impacts are considered to be **insignificant** as only single individuals will be temporarily displaced and will return once sediment has settled.

Increased turbidity of the water column is an impact likely to be caused to the greatest extent, during the construction phase by seabed intervention works including rock placement. This can result in creation of sediment plumes and sedimentation impacting on bird feeding and foraging grounds, reducing the available food supply, and having an indirect impact on birds. However, the majority of bird feeding grounds in ESR II will not be affected by re-suspension and spreading of sediments since modelling has shown that sediment is not expected to travel further than 2.4 km from the disturbance point (see **Section 9.4.3**). Further, sediment plumes are expected to remain below the halocline, present over a large part of ESR II, where large schools of fish inhabiting ESR II are unlikely to be found for most of the year due to the anoxic environment the halocline produces. Whilst some birds such as the long-tailed duck can dive to depths as great as 50 m, this is unusual, since the majority of diving birds usually forage at 10-20 m[(1)]. Benthic fauna are also rare at greater depths and therefore it is unlikely that diving birds would feed on benthos within ESR II.

(1) Alerstom, T & Christie, D.A. 1990. Bird Migration. Cambridge University Press.

The Gulf of Finland is also already heavily used by ships, with over 26,000 vessels passing from the Gulf into the Baltic Sea every year (**Atlas Map SH–2**). Since the pipelines within ESR II closely follow areas of the Baltic Sea heavily used by ships, areas in ESR II are unlikely to be important feeding and foraging grounds for sea birds. The presence of a halocline and the distance of the main feeding areas from the pipelines' route will protect the birds' feeding grounds which do exist within ESR II from the effects of re-suspension and spreading of sediments. Therefore, the impact on sea birds due to increased turbidity from seabed intervention works is expected to be **insignificant** in ESR II.

*Noise and vibration*

Noise and vibration impacts on sea birds may be either direct as a result of the short-term displacement of sea birds, or indirect due to the displacement of fish and the subsequent redistribution of piscivorous species of birds.

The sensitivity of sea birds to noise impacts is species-specific and also appears to depend on the flock size of sea birds. Munitions clearance within the Gulf of Finland has the potential to impact upon piscivorous species of birds. The stand off areas of birds foraging under water is, however, largely unknown and the scale of direct effects on birds can therefore not be exactly identified. However, the distance to the nearest area of importance for birds is at least 25 km from the munitions clearance works and therefore is not likely to pose a risk to sea birds at the colonies, due to the distance of these dense populations of sea birds from the detonation point. Although it is possible that some birds may still be foraging underwater closer to the pipelines' route and may be at risk, impacts are considered to be **insignificant**.

Comparatively little is known about direct impacts of noise and vibration on sea bird populations. It is generally considered that the extent of visual disturbance impacts from vessel movement is larger than the extent of noise impacts. As airborne construction noise offshore is almost exclusively associated with the presence of vessels which also result in visual/physical disturbance impacts, it is often impossible to distinguish between impacts caused by increased noise levels and visual/physical impacts caused by the presence of vessels as both impacts occur simultaneously.

As described in **Section 9.3.9**, the sensitivity of sea birds to noise impacts is species-specific and also appears to depend on the flock size of sea birds. Diving sea birds such as long-tailed ducks, velvet scoter and divers (*Gavia* spp.) are particularly sensitive to vessel movements and associated noise(1), at typical distances of 1 to 2 km for the more sensitive bird species such as divers and scoters, and to a lesser extent cormorants, but other species such as gulls and terns

(1) Kube, J. & H. Skov. 1996. Habitat selection, feeding characteristics, and food consumption of long-tailed ducks, *Clangula hyemalis*, in the southern Baltic Sea. Meereswiss. Ber., Warnemünde. 18: 83-100.

are likely to be less affected[1],[2]. Studies on coastal birds have shown that noise impacts can result in various different types of response, including birds being startled or showing a "heads up" response to small scale movements and also birds leaving the affected area altogether[3],[4].

Since the noise and vibration-generating construction activities will take place 8 km from the nearest area of importance for birds (Itäinen Suomenlahti National Park), and because noise generated at sea surface-level will be of comparable volume to that for other shipping activity in the Baltic Sea, it is concluded that direct noise impacts from seabed intervention works, pipe-laying, anchor handling and construction and support vessel movement are expected to be **insignificant** in ESR II.

Underwater noise due to hyperbaric tie-in activities will also occur within areas of deeper water in excess of 50 m (at KP 300). This area is of low importance for sea birds, is well away from the nearest IBA (Tammisaari and Inkoo western archipelago), and is outside the typical foraging range and water depth of diving sea birds. Increased underwater noise is therefore **insignificant**.

*Loss of seabed habitat*

Munitions clearance, seabed intervention works, pipe-laying and anchor handling within ESR II will not be located close to the shallow waters that are regularly inhabited by waterfowl species such as diving ducks and waders. Benthic fauna are rare at greater depths in this ESR. A minor proportion of seabed habitat within areas of shallower water may, however, be lost during the construction of the pipelines affecting a small proportion to the south of Itäinen Suomenlahti National Park. However, the seabed habitat is expected to recover rapidly and the localised loss of seabed habitat is not expected to impact significantly upon benthic-feeding species of birds. Impacts are therefore considered to be **insignificant**.

*Visual/physical disturbance*

Measures described above to reduce the risk of increased noise and vibration effects due to munitions clearance activities on underwater birds will also serve to reduce the risks of physical effects on the birds during munitions clearance. Munitions clearance may, however affect, single individuals of piscivorous sea birds diving in the vicinity of the detonation. As the likelihood that

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(1) Ruddock, M. and Whitfield, D.P. 2007. A Review of Disturbance Distances in Selected Bird Species, A report from Natural Research (Projects) Ltd to Scottish Natural Heritage.

(2) Skov, H., Durinck, J., Leopold, M.F. and Tasker, M.L. 2007. A quantitative method for evaluating the importance of marine areas for conservation of birds. Biology Conservation. 36 (3).

(3) Institute of Coastal and Estuarine Studies (ICES). 1999. Avifaunal Disturbance Assessment: Flood Defence Works, Salt End. Report to the Environment Agency.

(4) Smit, C.J. & Visser G.J.M.. 1993. Effects of Disturbance on Shorebirds: A Summary of Existing Knowledge from the Dutch Wadden Sea and Delta Area. WSG Special Report.

birds are diving in close vicinity to the detonation is very low impacts are considered to be **insignificant**.

Potential visual and physical disturbance to birds from construction and support vessel movement in ESR II is most likely to impact on migrating birds aggregating on open water, post-breeding flocks of moulting birds which are flightless and rafting on open water and birds feeding in open water. Construction activities are not located close to the shallow waters that are regularly inhabited by sea birds in the Baltic Sea, along most of the pipelines' route through ESR II. However, in some places physical and visual disturbance of birds may result from vessels encountering single birds or flocks of birds foraging at sea, during pipeline construction. The distance from which different species of birds are affected by this type of disturbance varies between species (many are less sensitive to boats and some species even follow them), and depends on the nature of a vessel's movement (see **Section 9.3.9**).

The pipe-laying vessels will move slowly, since pipe-laying will progress at a rate of 2 to 3 km a day. Therefore, the risk of construction and support vessels disturbing sitting birds is very low. Furthermore, the pipelines within ESR II closely follow areas of the Baltic Sea heavily used by ships, so the sea birds which use these waters are likely to be accustomed to regular vessel movements in the area surrounding ESR II and will experience little, if any, additional disturbance as a result. While birds may maintain a stand-off distance from the immediate area of construction works, the pipe-laying vessel is unlikely to disturb flocks and the impacts associated with vessel movement on sea birds during the construction phase are considered to be **insignificant** in ESR II.

**Impacts during the Operational Phase**

During the operational phase, inspection and maintenance vessel movement associated with routine inspections and maintenance are likely to result in an increase in turbidity, low-level noise and vibration and low-level physical and visual disturbance to sea birds.

*Increase in turbidity*

Routine inspections and pipeline maintenance works will have limited impact upon sea birds. Increased turbidity in ESR II will occur outside the foraging range of benthic feeding sea birds and remain under the halocline. Impacts will be restricted to the pipelines' route and are expected to be far lower in both magnitude and duration than for the construction phase. Impacts during the operational phase are considered to be **insignificant**.

*Noise and vibration*

Noise generated during routine inspections and maintenance is considered to have a limited impact upon sea birds, since these activities will be restricted to the pipelines' route and will not be long-term. Generated noise is not expected to exceed the current baseline noise levels as routine inspections would only result in a few extra vessel sailings. The impact on birds in terms of noise and vibration is expected to be far lower in both magnitude and duration than for the construction phase, and is considered to be **insignificant** during the operational phase. It is also unlikely that fish species will be adversely affected by the sounds emitted from the pipelines and therefore indirect, negative impacts on birds will not result (see **Section 9.4.8**).

*Visual / physical disturbance*

Routine inspections and maintenance are likely to result in only a few extra vessel sailings. Vessel movements will be restricted to the pipelines' route and any impacts will not be long term. The pipelines follow highly used shipping routes and additional visual/physical impacts are likely to be indistinguishable from background levels. Impacts will be far lower in both magnitude and duration than for the construction phase and for the operational phase are considered to be **insignificant**.

**Impact Summary**

The impacts identified and assessed in ESR II on sea birds are summarised in **Table 9.35.**

**Table 9.35 ESR II impact summary table for sea birds**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Sea Birds - Ecological Sub-Region II | Increase in turbidity | Munitions clearance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Munitions clearance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Seabed intervention works, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Hyperbaric tie-in activities | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Visual/physical disturbance | Munitions clearance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Loss of seabed habitat | Munitions clearance, Seabed intervention works, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |

## 9.4.10 Biological Environment – Marine Mammals

### Overview

Following the undertaking of a scoping and impact identification exercise, several interactions between marine mammals in ESR II and the Project have been identified, which could give rise to potential impacts. This section identifies and assesses the potential impacts on marine mammals in ESR II during the construction, pre-commissioning and commissioning, and operational phases of the Project in terms of the methodology presented in **Chapter 7**.

As described in **Section 8.6.6** there are very few marine mammal species that inhabit the Baltic Sea in contrast to ocean populations. In ESR II, there are three species normally present, one cetacean and two species of seal:

- Harbour porpoise (*Phocoena phocoena*)
- Ringed seal (*Phoca hispida baltica*)
- Grey seal (*Halichoerus grypus balticus*)

Each of these marine mammals has been described as a threatened and/or declining species of the Baltic Sea by HELCOM. Values/sensitivities for each marine mammal are presented in detail in **Section 8.8.7** and summarised in **Table 9.36**. The harbour seal is seldom present in the ESR II as it prefers the coastal area in Sweden and Denmark (**Atlas Map MA-5**).

**Table 9.36 Values/sensitivities of marine mammals in Ecological Sub-Region II.**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Marine mammals** | | | | | | | | | | | | |
| Harbour porpoise | Med | Med | Med | Med | Med | Med | Med | Med | Med | Med | Med | Med |
| Ringed seal | Med | High | High | High | High | Med | Med | Med | Med | Med | Med | Med |
| Grey seal | Med | High | High | Med | High | High | Med | Med | Med | Med | Med | Med |

The main activities, which are expected to impart an impact on marine mammals, include those that take place during the construction phase. Impacts during the pre-commissioning and commissioning, and operational phases are expected to be minimal in comparison. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Munitions clearance, pipe-laying, anchor handling, seabed intervention works, hyperbaric tie-in activities and construction and support vessel movement resulting in:
    - Noise and vibration
- Re-suspension and spreading of sediment due to munitions clearance, pipe-laying, anchor handling, seabed intervention works and hyperbaric tie-in activities resulting in:
    - Increase in turbidity
    - Release of contaminants
- Construction and support vessel movement during winter resulting in:
    - Ice breaking

*Pre-commissioning and commissioning phase*

- The flooding of the pipelines during pressure testing and the commissioning of the pipelines resulting in:
    - Noise and vibration

*Operational phase*

- Pipeline presence resulting in:
    - Noise and vibration (due to movement of natural gas in the pipelines)
- Routine inspections and maintenance works resulting in:
    - Noise and vibration
    - Increase in turbidity

**Impacts during the Construction Phase**

Impacts upon marine mammals during the construction phase are limited to noise and vibration, an increase in turbidity and the release of contaminants due to munitions clearance, pipe-laying, anchor handling, seabed intervention works, hyperbaric tie-in activities and construction and support vessel movement. Ice breaking will occur due to vessel movement should pipe-laying take place during the winter months in the Gulf of Finland.

*Increase in turbidity*

An increase in turbidity due to the re-suspension and spreading of sediments during construction may result due to munitions clearance, rock placement and hyperbaric tie-in activities at designated areas and pipe-laying activities and anchor handling along the entire pipelines' route in ESR II. The extent and duration of an increase in turbidity is detailed under the water column in **Section 9.4.3**. Significant (above background levels) increases in turbidity are expected to be of **short-term** duration and localised to seabed intervention areas. As marine mammals use their hearing ability for navigation, as well as for hunting, an increase in turbidity is deemed to have an **insignificant** impact on individuals. As the water column near the seabed in ESR II goes through periods where oxygen is present and through periods of hypoxia, a halocline may be present. The halocline would affect the abundance of marine fauna in close proximity to the seabed. During periods where oxygen is present high and thus marine fauna will be abundant. An increase in turbidity may result in short-term reduction in marine fauna close to the seabed (Marine Benthos – **Section 9.4.7** and Fish – **Section 9.4.8**), which may affect marine mammal feeding areas. This is expected to have an **insignificant** impact on marine mammals as they would more than likely avoid the construction area due to noise and vibration and would hunt elsewhere. During periods of hypoxia oxygen levels would be low and thus marine fauna will be scarce in close proximity to the seabed. No significant impacts are expected.

*Release of contaminants*

An increase in contaminant concentration in the water column due to the release of contaminants from the re-suspension and spreading of sediments due to munitions clearance, seabed intervention works, pipe-laying and anchor handling could theoretically raise the concentration of contaminants in the food chain and subsequently in mammal tissue. However, it is expected that any contaminants that may be released will only remain above the Predicted No-Effect Concentration (PNEC) for short periods of time in the immediate (1 - 2 km) vicinity of seabed intervention sites (**Section 9.4.3**). Marine mammals would typically avoid the construction area due to noise and vibration. In addition, during periods of hypoxia the likelihood of marine mammals being present along the pipelines' route is low. Overall the impacts due to a release of contaminants on marine mammals are deemed to be **insignificant**.

*Noise and vibration*

Noise and vibration will be generated during construction in ESR II as a result of munitions clearance, seabed intervention work (rock placement), pipe-laying, hyperbaric tie-in activities and construction and support vessel movement. Construction activity noise and vibration may impact on marine mammals.

The ringed and grey seals, as well as the harbour porpoise, communicate by emitting sounds that pass through the water column. These sounds can be detected across considerable distances and construction noise may influence the behaviour of these mammals. An increase in background noise or the introduction of specific sound sources may affect marine mammals in that they may be prevented from detecting important sounds (masking), their behaviour may be influenced, temporary or permanent hearing loss may be experienced or damage to tissue may occur. These potential effects are further elaborated upon in **Section 9.3.10** under ESR I. The hearing ability of the marine mammals in ESR II is detailed in **Section 8.6.6**.

Munitions clearance has the potential to cause considerable noise and vibration that would impact negatively on marine mammals. Munitions have been detected within the area of the pipelines' corridor in ESR II. Their exact location is currently confidential, however it is confirmed that a total of 27 munitions are present within ESR II (Gulf of Finland), as well as any which may be found along the route in Russian waters. These munitions will require clearing by means of explosives in collaboration with the relevant authorities. Noise generated during clearing takes the form of an initial shock pulse followed by a succession of oscillating bubble pulses(1). Pulses at high peak levels have the potential to cause acoustic trauma and tissue damage should an individual mammal be in close proximity to the blast site(2).The expected level of noise and vibration generated will vary and is dependent on the amount of explosive used as well as the residual explosive within the device. As the impact (**negative** and **direct**) is of **temporary** duration, a slight behavioural change (recognition of the sound and / or swimming away) is expected in individual seals that are present within 2-3 km of the clearance site. Harbour porpoises may be affected up to 10 km away. Due to the presence of vessels during munitions clearance, it is expected that seals and the harbour porpoise would vacate the area and thus no tissue damage or hearing loss is expected. An acoustic survey will take place prior to clearance to ensure that marine mammals (and schools of fish) are not present. In addition, acoustic harassment devices will be employed to reduce the possibility that marine mammals will be present in close proximity to the clearance site. The impact will be on a **regional** scale. Impacts may be irreversible at an individual level if tissue damage or hearing loss occurs, however at a population level the impact is considered to be **reversible**. Impact intensity is expected to be **medium** to **high** depending on the marine mammals present. Impact magnitude is **medium**. Since marine mammals have a **medium** to **high** sensitivity in ESR II, impact significance is expected to be **moderate**. It should be noted that munitions clearance is a common activity in the Baltic Sea and that most marine mammals would avoid the immediate area due to vessel movement.

Seabed intervention works, which include rock placement, are restricted to the designated areas along the pipelines' route (**Atlas Maps PR-3a** and **3b**). Based upon measurements taken during rock placement by the *Rollingstone*, a dedicated rock placement vessel, in the Yell Sound near the Shetland Islands for the Magnus EOR project, rock placement generated noise is not

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(1) Richardson, W.J., Greene, C.R., Malme, C.I., and Thomson, D.H. 1995. Marine Mammals and Noise. Academic Press, San Diego and London.

(2) Swedish Armed Forces Headquarters. 2007. Environmental effects of underwater explosions.

expected to exceed background noise and thus will have an **insignificant** impact on marine mammals(1).

No direct measurements are available for the noise generated during pipe-laying on the seabed and anchor handling. The primary source of noise is expected to be the movement of anchors. The presence of heavy machinery on board the pipe-laying vessel is expected to generate low frequencies below 100 Hz. It should be noted that pipe-laying will take place at a rate of 2-3 km a day and thus the source of noise will move along the pipelines' route and will not remain fixed at one point for an extended period of time. Noise generated is expected to be on a par with normal shipping and fishing activities to which marine mammals have habituated and thus the impact of pipe-laying and anchor handling is expected to be **insignificant**.

Hyperbaric tie-in activities will occur on the seabed 300 km from the Russian landfall following pressure testing of the pipelines. These tie-in activities are described in **Chapter 4**. Potential impacts include noise and vibration as well as the disruption of seabed sediments. Tie-in noise has not been measured or modelled but is assumed to be on a par with typical pipe-laying activities, which are not deemed to generate a significant amount of noise. Any noise generated will be of **short** duration and **localised** at the tie-in area. No breeding areas or colonies are in close proximity to these areas (<20 km). In most cases individual marine mammals would vacate the tie-in areas at the first instance of a foreign sound or change in background noise. The impact (noise) of tie-in activities on marine mammals is expected to be **insignificant**.

Marine mammals can perceive underwater noise generated by vessel movements (0.01-10 kHz with source levels between 130-160 dB), and the use of equipment at sea, a number of kilometres from a source. Such noise has a zone of responsiveness for marine mammals of 200-300 m(2). As the pipelines' route in ESR II is largely within or close to normal shipping lanes it is expected that seals and harbour porpoises in the area have already habituated to the noise and vibration generated by vessel movement and thus the impact is **insignificant**.

*Ice breaking*

Sections of the Baltic Sea experience ice cover during the winter months. The Gulf of Finland has typical ice coverage of 90-100 % during normal and even mild winters in its eastern section. Seals (mainly the grey seal) breed offshore on the ice and thus have the potential to be impacted upon should construction activities take place during their breeding season. The pipelines' route passes through and adjacent to primary breeding areas for the grey and ringed seal respectively. Vessel movements during winter would result in ice breaking in the Gulf of Finland and thus the potential to affect seal breeding habitats would be high. This may result in

(1) Nedwell, J. and Howell, D. 2004. A review of offshore windfarm related underwater noise sources.

(2) ENERGI E2. 2006. EIA Report - Marine mammals. Horns Rev 2, offshore wind farm.

behavioural changes as well as an increase in seal pup mortality rates[(1)]. Ice breaking is also associated with an increase in noise. The critical time for breeding (giving birth to pups) is from mid-February to mid-March for the ringed seal and between February and March for the grey seal. However, the construction schedule is such that pipe-laying in the Gulf of Finland is expected to take place outside of these periods and thus the possibility of ice breaking is minimal. In addition, as most of the pipelines' route falls within or very close to normal shipping lanes in the Gulf of Finland and particularly in the grey seal breeding area, it is expected that in the case that ice breaking should be required, the potential for impacts on seals would be minimal (**Atlas Map SH-1**). Seals do not typically dwell in areas where ice breaking is a regular occurrence.

If the construction schedule is followed, no ice breaking will take place and thus there will be **no impact**. However, in the highly unlikely event that ice breaking should be required and if breeding areas are affected, the impact (**negative, direct** and **secondary**) is expected to be **regional** along the pipelines and vessel routes, of **short-term** duration and of **medium** intensity. Impact magnitude is **medium**. Impact significance is expected to be **moderate** for both the grey and ringed seals if the ice breaking activities disrupt breeding areas (**high** sensitivity). Impacts are **reversible** within a few generations in a worst case scenario.

**Impacts during the Pre-commissioning and Commissioning Phase**

The uptake of seawater and subsequent discharge of pressure-test water during pre-commissioning is restricted to the Russian landfall (ESR I). As such, the only activity that will generate an impact in ESR II is pipeline flooding during pressure testing and the input of gas during commissioning. Both activities would result in the generation of noise and vibration.

*Noise and vibration*

The movement of pressure-test water (pipeline flooding) in the pipelines during pressure testing, pressure-test water discharge and the input of gas during commissioning will generate some noise and vibration. The noise generated is expected to be on a par with, if not slightly higher than normal gas movement within the pipelines (see section on the operational phase impacts). As such, generated noise is expected to have an **insignificant** impact on marine mammals in ESR II. No mitigation is required.

**Impacts during the Operational Phase**

Impacts upon marine mammals during the operational phase are limited to noise and vibration from gas movement within the pipelines and from routine inspections and maintenance works.

(1) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

An increase in turbidity is expected to coincide with maintenance works should they interact with the seabed.

*Noise and vibration*

As per the studies[(1),(2)] described under ESR I for marine mammals (**Section 9.3.10**), the noise generated by the movement of gas within the pipelines falls below the levels detectable by the marine mammals (~1 kHz for the harbour porpoise) present in ESR II. As such, it is expected that gas movement in the pipelines would have little to no impact on marine mammals at either an individual or population level. The impact is deemed to be **insignificant**.

Routine inspections would include external inspections of the pipelines by means of ROV and internal inspections using pigs (**Section 9.2.3**). Maintenance works are not expected but may include possible repair works on the pipelines or on the seabed where required. Routine inspections and maintenance works are expected to generate very little noise and are thus assumed to have an **insignificant** impact upon marine mammals and will be restricted to the pipelines' route and be infrequent (i.e. not constant).

*Increase in turbidity*

Maintenance works may be required on the pipelines or on the supporting seabed to ensure that the pipelines have a stable base, as well as routine inspections. These works may result in localised re-suspension and spreading of sediments and a subsequent increase in turbidity and the release of contaminants. The following mitigation measures will be implemented to reduce the impacts:

- Any seabed intervention work, such as rock placement, required during operation will be kept to a minimum
- Disturbance of seabed sediments will be kept to a minimum
- Any surveys will avoid encounters with marine mammals wherever possible

As these works are not expected to occur on a regular basis and will be localised, the impacts on marine mammals are expected to be **insignificant**.

**Impact Summary**

The impacts on marine mammals identified and assessed in ESR II are summarised in **Table 9.37**.

(1) Lommer, M. and Lemaire, G. 2008. Ødegaard & Danneskiold-Samsøe A/S. Noise along the Nord Stream pipelines in the Baltic Sea.

(2) Martec Limited. 2004. Effects of Pipelines/Gathering Lines on Snow Crab and Lobster.

**Table 9.37 ESR II impact summary table for marine mammals**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Marine Mammals - Ecological Sub-Region II | Increase in turbidity | Munitions clearance, Seabed intervention works, Pipe-laying, Anchor handling, Hyperbaric tie-ins | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of contaminants | Munitions clearance, Pipe-laying, Anchor handling, Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Medium - High | Medium | Medium - High | Reversible | **Moderate** |
| | | Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Hyperbaric tie-ins | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline flooding, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Ice breaking | Construction and support vessel movement | -/ Negative | -/Direct, Secondary | -/ Regional | -/Short-term | - /Medium | -/Medium | -/High | -/Reversible | **No impact/ Moderate** |

### 9.4.11 Biological Environment – Nature Conservation Areas

**Overview**

This section identifies and assesses the potential impacts on nature conservation areas in ESR II during the construction, pre-commissioning and commissioning and operational phase of the Project.

As a result of the route optimisation process, the Nord Stream pipelines' route does not cross any nature conservation areas in ESR II as it passes through the Gulf of Finland. However, the route corridor passes within 20 km of three nature conservation areas, excluding Natura 2000 sites which are considered in **Chapter 10**. The nearest nature conservation area, Bolshoy Fiskar of the Ingermanlandskiy Islands, is approximately 4 km north of the pipelines' route. In addition, the route passes within 20 km of two other nature conservation areas, as listed in **Table 9.38** .

Protected areas in the Russian part of the Baltic Sea are illustrated on **Atlas Map PA-2**, Ramsar sites are shown on **Atlas Map PA-4** and UNESCO and BSPA sites are shown on **Atlas Map PA-5**.

**Table 9.38 Nature conservation areas within 20 km of the route in ESR II**

| Nature Conservation Area | Designation | Protected Habitats and Species | Distance to Pipelines (km) |
|---|---|---|---|
| Ingermanlandskiy Islands – Bolshoy Fiskar | Protected areas in the Russian part of the Baltic Sea | Important breeding colonies of Great cormorant (*P. carbo*), black-backed gull (*Larus* spp.), Arctic tern (*S. paradisaea*), Caspian tern (*S. caspia*), great merganser (*M. merganser*), black guillemot (*C. grylle*), eider duck (*S. mollissima*), and razorbill (*A. torda*). Seal haul-out areas: ringed seal (*P. hispida*) and grey seal (*H. grypus*). | 4 |
| Suursaari | Protected areas in the Russian part of the Baltic Sea | No details available. Birds and marine mammals associated with the island are protected under the designation. | 6 |
| Prigranichnyy | Protected areas in the Russian part of the Baltic Sea | Important bird species include black-throated diver (*G. arctica*), barnacle goose (*B. leucopsis*), mute swan (*C. olor*), white-winged scoter (*M. deglandi)*, and white-tailed eagle (*H. albicilla*). Grey seal and ringed seal are also present. | 10 |

The scope of this assessment is limited to the particular impacts on features for which the nature conservation areas have been designated, including protected habitats in the areas. Impacts on floral and faunal receptors (fish, mammals, sea birds and marine benthos) are assessed in their relevant sections of this report. Where these species are specifically protected by the nature conservation designation, consideration will be given here as to the significance of potential impacts on these species from the installation of the pipelines' route in ESR II. As nature conservation areas are of national importance, their values/sensitivities are rated as **high**.

All of the nature conservation areas which may be affected by the Nord Stream pipelines' route in ESR II are coastal or consist of island archipelagos, and therefore have protected coastal habitats which may be impacted by the development. The main habitats of importance are seashore halophilous meadows, rocky or sandy inlets, reefs, coastal lagoons, seashores and open sea areas. All of the sites are designated for their important populations of breeding and staging sea and water birds and/or as breeding or haul-out areas for the grey and ringed seal(1),

(1) Nord Stream AG & Ramboll. 2007. Memo 4.3G -Protected Areas.

and a number of the sites are important spawning areas for fish species, including the Baltic herring. All of these habitats and species have the potential to be affected by the construction, pre-commissioning and commissioning and operation of a pipeline.

The main activities anticipated to affect nature conservation areas in ESR II are those occurring during the construction phase of the Project, such as pipe-laying, anchor handling, hyperbaric tie-in activities and seabed intervention works. Munitions clearance is also expected to occur in ESR II and the impacts of this will be considered as part of the construction phase.

The impacts which are likely to affect these sites are limited to those which can operate away from the source, including noise and vibration, visual/physical disturbance and the re-suspension and spreading of sediments resulting in increased turbidity. Impacts during the pre-commissioning and commissioning and operational phase are expected to be comparatively small, due to the less invasive nature of the activities in these phases, and the smaller scale on which these activities will operate.

Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Munitions clearance, seabed intervention works, pipe-laying, anchor handling, hyperbaric tie-in activities and construction and support vessel movement resulting in:
    - Noise and vibration
- Re-suspension and spreading of sediments due to munitions clearance, seabed intervention works, pipe-laying, anchor handling and hyperbaric tie-in activities resulting in:
    - Increase in turbidity
    - Physical alteration of the seabed
- Construction and support vessel movement resulting in:
    - Visual/physical disturbance

*Pre-commissioning and commissioning phase*

- Pipeline flooding resulting in:
    - Noise and vibration
- Construction and support vessel movement resulting in:
    - Visual/physical disturbance

*Operational phase*

- Routine inspections and maintenance works and construction and support vessel movement resulting in:
    - Increase in turbidity
    - Noise and vibration
    - Physical alteration of the seabed
    - Visual/physical disturbance
- Pipeline presence resulting in:
    - Noise and vibration

**Impacts during the Construction Phase**

Potential impacts upon nature conservation areas in ESR II during the construction phase include impacts on fauna from noise and vibration and visual/physical disturbance, and turbidity impacts on habitats and fauna as a result of seabed intervention works, pipe-laying, anchor handling, hyperbaric tie-in and munitions clearance activities.

*Increase in turbidity*

Increases in turbidity due to the re-suspension and spreading of sediments in the water column are likely to result from munitions clearance, seabed intervention works, hyperbaric tie-in activities, pipe-laying and anchor handling. As discussed in **Section 9.4.8**, this can potentially cause physiological damage to faunal species such as fish or smothering of important benthic communities (**Section 9.4.7**). However, impacts will only affect species for a short duration and within a relatively localised area surrounding the pipelines. The re-suspension and spreading of sediments is expected to be greatest during seabed intervention works, including rock placement, in ESR II.

Munitions clearance is scheduled to take place in the Gulf of Finland prior to the start of construction. While route optimisation has minimised the number of munitions to be affected, it is necessary to clear at least 27 munitions that are situated along the pipelines' route in ESR II, via the use of explosives. Munitions clearance is a common activity in the Gulf of Finland and will be carried out in conjunction with the relevant authorities. Munitions clearance will result in the re-suspension and spreading of sediments on the **regional** scale and will be of **short-term** duration (**Section 9.4.3**) However, all of the nature conservation areas (excluding Natura 2000 sites which are considered in **Chapter 10**) are situated at a considerable distance from the munitions clearance sites in ESR II, with none of the nature conservation areas with 20 km of the pipelines in ESR II being within 20 km of the nearest munitions location. The nearest conservation area to the pipelines in ESR II is 4 km. Due to the distance between the nature conservation areas and their protected species and predicted munitions clearance, the impact of increased turbidity is expected to be **insignificant**.

The areas and average duration of re-suspended sediment concentrations in the Gulf of Finland for rock placement are illustrated on **Atlas Maps MO-12**, **MO-21** and **MO-25**. As normal water concentrations in the Baltic Sea are typically in the range of 1 – 4 mg / l during normal weather, concentrations over 1 mg/l are regarded as the maximum extent of the predicted sediment spread (as detailed in **Section 9.4.3**). As shown on the Atlas Maps, rock placement (which is restricted to specific locations along the route) will result in re-suspended sediment concentrations of above 1 mg at distances up to approximately 1.5 km from the disturbance point for approximately 12 hours, with the majority of sedimentation occurring in much closer proximity to the works. Therefore, as the closest nature conservation area in ESR II is approximately 4 km from the pipelines' route, no nature conservation area or its associated communities such as benthos is expected to be affected by an increase in turbidity due to the re-suspension and spreading of sediments. Impacts from increased turbidity due to seabed intervention works, pipe-laying and anchor handling are considered to be **insignificant**.

The re-suspension of sediments in the water column from hyperbaric tie-in activities is thought to be on a par with that of the pipe-laying process. Therefore, as detailed above, impacts from the re-suspension and spreading of sediments due to hyperbaric tie-in activities are also deemed **insignificant** as the conservation areas lie at a distance too great to be impacted from increased turbidity.

*Noise and vibration*

The activities during construction that are likely to cause noise and vibration disturbance in ESR II are pipe-laying activities, anchor handling, seabed intervention works, munitions clearance, hyperbaric tie-in activities and general shipping activity.

Prior to the laying of the pipelines, munitions clearance will be required along the pipelines' route in ESR II. While route optimisation has minimised the number of munitions to be affected, it will be necessary to clear at least 27 devices along the pipelines' route in ESR II, via the use of explosives. Munitions clearance has the potential to cause considerable noise and vibration, which would impact negatively on fauna in the region, within or outside of the boundaries of the nature conservation areas. However, as all of the nature conservation areas in ESR II (excluding Natura 2000 sites which are considered in **Chapter 10**) are situated at least 20 km from munitions clearance sites, the impact of noise and vibration is expected to be **insignificant**.

Rock placement, which is restricted to specific points along the pipelines' route, is not expected to generate noise that exceeds background levels(1). There are no noise level estimates available for the noise generated during pipe-laying and anchor handling. Noise and vibration impacts associated with hyperbaric tie-in activities are expected to be similar in nature to those for pipe-laying, but smaller in magnitude and duration. The significance of any noise and vibration impacts on nature conservation areas will depend upon the distance between the source of the impact (originating from within the vicinity of the pipelines) and the conservation areas themselves. Potential receptors for impacts from noise and vibration are limited to marine mammals, fish, sea birds and some marine benthos. Of these groups of fauna, all of the nature conservation areas identified in ESR II are designated to protect important sea bird colonies and the grey and ringed seal.

Marine mammals can be affected by noise, due to the masking of mating calls, behavioural changes, hearing damage or, at the highest levels, tissue damage. For example, general shipping activity is likely to cause behavioural changes in marine mammals at a distance of 0.5 km and masking effects may occur within a radius of 0.5 – 2 km from the source (as discussed in **Section 9.4.10**). However, all sites of nature conservation importance are at least 4 km from the noise source at its closest point, and pipe-laying will take place at a rate of 2 – 3 km a day, meaning that the source of noise will move along the pipelines' route and will not remain fixed at one point for an extended period of time. In addition, as the pipelines' route largely follows a busy shipping channel, marine mammals in the areas will be habituated to the noise and vibration of vessel movement, such that impacts on marine mammals in the conservation areas in ESR II are expected to be **insignificant**.

As discussed in **Section 9.4.9**, comparatively little is known about the impacts of noise and vibration on sea birds. However, the noise generated at sea surface level will be of comparable volume to that of other shipping activity in the Baltic Sea, which birds in the region will be habituated to. In addition, pipe-laying will take place at a rate of 2 – 3 km a day, so the source of noise will move along the pipelines' route and will not remain fixed at one point for an extended period of time. The disturbance distance for visual and noise disturbance from boats is typically 1 - 2 km for the more sensitive bird species such as divers and scoters and to a lesser extent cormorant, but other species such as gulls and terns are likely to be less affected(2),(3). As all nature conservation areas are situated at least 4 km from the pipelines' route, and because noise generated will be comparable to that of other shipping activity in the Baltic Sea, it is concluded that noise impacts on sea birds in protected areas are expected to be **insignificant** in ESR II.

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(1) Nedwell, J. and Howell, D. 2004. A review of offshore windfarm related underwater noise sources.

(2) Ruddock, M. & Whitfield, D.P. 2007. A Review of Disturbance Distances in Selected Bird Species, A report from Natural Research (Projects) Ltd to Scottish Natural Heritage.

(3) Skov, H., Durinck, J., Leopold, M.F. and Tasker, M.L. 2007. A quantitative method for evaluating the importance of marine areas for conservation of birds. Biology Conservation. 36 (3).

Fish can also be impacted by noise and vibration and the Baltic herring is thought to be particularly sensitive to noise impacts. In addition, any displacement of fish on which bird species forage can have a temporary influence on sea bird distribution as a result. However, the fish in ESR II are likely to be habituated to vessel noise and other human activities in the Baltic Sea, due to the large volume of ship traffic in the sea. It is possible that increased noise levels may impact on spawning success of the Baltic herring if construction is carried out during the spawning season. However, construction is scheduled to avoid the spawning season, as noted in **Section 9.4.8**. For these reasons and because of the distance between the construction work and the nature conservation areas in ESR II, (ranging from 4 km to 10 km distance), noise impacts will be minimal and it is considered that the impact on fish in nature conservation areas as a result of noise and vibration will be **insignificant**.

*Physical alteration of the seabed*

Physical alteration of the seabed is likely to occur during construction due to munitions clearance, seabed intervention works, pipe-laying, anchor handling and hyperbaric tie-ins. However, since the pipelines do not pass directly through any of the conservation areas in ESR II, and are situated at least 4 km away from the route, physical alteration of the seabed is not expected and impacts on the nature conservation areas are therefore deemed to be **insignificant**.

*Visual/physical disturbance*

Visual or physical disturbance from the movement of vessels during construction may affect sea bird populations that are protected by the nature conservation areas designated in ESR II. All of the nature conservation areas detailed in **Table 9.37** hold important populations of breeding and staging waders and sea birds, including international migrant populations (as detailed in **Section 9.4.9**). The approximate distance at which disturbance occurs varies between species and depends on the nature of the vessel movement. As detailed above, for the more sensitive species disturbance can arise at 1 – 2 km, whilst other species are much less affected. Pipe-laying is expected to progress at the rate of 2 – 3 km per day, therefore vessel movement will be relatively slow and the risk of disturbing sea birds will be low. In addition, since the pipelines' corridor follows an established shipping route, sea birds will also be used to vessel movement in this area of the Baltic Sea. As the pipelines' route is at least 4 km from the nature conservation areas, the pipe-laying process is unlikely to disturb flocks within the protected areas and the impact of vessel movement on sea birds associated with nature conservation areas in ESR II is considered to be **insignificant**.

Disturbance to birds protected within the nature conservation areas may also occur when the birds are out of the boundary of the protected site. The majority of birds are not sensitive to disturbance. Divers, scoters and cormorants, which are protected in many of the nature conservation areas listed in ESR II, are more sensitive(1). However, studies have shown that birds such as the common scoter tend to avoid channels with high frequencies of shipping activity, even when these areas hold a high prey biomass(2). Therefore, as the pipelines' route follows a shipping channel, these birds are unlikely to be present so the risk of disturbance is low and is considered **insignificant**.

**Impacts during the Pre-commissioning and Commissioning Phase**

Potential impacts upon nature conservation areas in ESR II during the pre-commissioning and commissioning phase are limited to noise and vibration impacts on fauna generated by pipeline flooding and the visual or physical disturbance of fauna from vessel movement during the works.

*Noise and vibration*

Noise and vibration generated by the movement of pressure-test water within the pipelines during pipeline flooding and pressure-test water discharge, as well as gas movement in the pipelines during commissioning, will only have potential impacts on fauna in the immediate vicinity of the pipelines. However, as discussed in **Sections 9.4.7**, **9.4.8** and **9.4.10**, the noise and vibration generated will be similar to that of normal gas movement within the pipelines. Impacts on marine benthos, fish species and marine mammals in the immediate area of the pipelines have been shown to be insignificant, therefore noise and vibration during pipeline flooding is also expected to have an **insignificant** impact on species associated with nature conservation areas within ESR II.

*Visual / physical disturbance*

During the pre-commissioning and commissioning phase, there will be a low level of vessel movement. This may lead to a low level of visual or physical disturbance to fauna, but it will be on a much smaller scale than that of the construction phase. For this reason, and because of the reasons discussed above, the disturbance of sea birds in relation to vessel movement will be low and therefore the impacts on nature conservation areas are considered to be **insignificant.**

**Impacts during the Operational Phase**

In general, impacts during the operational phase will be similar to those during the construction phase, but will be less significant. Impacts from gas movement in the pipelines are limited to noise and vibration. Potential impacts as a result of routine inspections and maintenance works

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(1) Garthe, S. and Hüppop, O. 2004. Scaling possible adverse effects of marine wind farms on sea birds: developing and applying a vulnerability index. Journal of Applied Ecology. 41.

(2) Kaiser, M.J., Galanidi, M., Showler, D.A., Elliot, A.J., Caldow, R.W.G., Rees, E.I.S., Stillman, R.A. and Sutherland, W.J. 2006. Distribution and behaviour of Common Scoter Melanitta nigra relative to prey resources and environmental parameters. Ibis 148.

are expected to be an increase in turbidity as a result of the re-suspension and spreading of sediments, noise and vibration and physical alteration of the seabed. Vessel movement may result in visual or physical disturbance to fauna in the vicinity of the pipelines.

*Increase in turbidity*

Re-suspension and spreading of sediments in the water column may result from routine inspections and maintenance work. Maintenance work may require seabed intervention works of some nature. The extent of these impacts are likely to be much smaller than for the construction phase, but it is not possible to predict the frequency with which maintenance works will be required, nor the extent of seabed disturbance from these activities. However, due to the distance of the nature conservation areas from the pipelines, re-suspension and spreading of sediments from routine inspections and maintenance works will have an **insignificant** impact on conservation areas in ESR II.

*Noise and vibration*

As for the pre-commissioning and commissioning phase, noise and vibration generated by natural gas movement in the pipelines is expected to have an **insignificant** impact on conservation areas in ESR II since the pipelines pass at least 4 km from the nearest nature conservation area - the Ingermanlandskiy Islands. In addition, impacts on marine mammals, benthos and fish species in the immediate area of the pipelines have been shown to be insignificant, as discussed in **Sections 9.4.7**, **9.4.8** and **9.4.10**. Similarly, routine inspections and maintenance work will have an **insignificant** impact on conservation areas in ESR II in terms of noise and vibration, as the scale of operations will be far smaller than for the construction phase, which was also considered to have an insignificant impact on nature conservation areas, as discussed above.

*Physical alteration of the seabed*

Physical alteration of the seabed is also possible during routine inspections and maintenance work, and again the extent of these impacts will be smaller than for the construction and pre-commissioning and commissioning phases. Since all the nature conservation areas are over 4 km from the pipelines, physical alteration is expected to have an **insignificant** impact on the conservation areas in ESR II.

*Visual / physical disturbance*

There will be a low level of vessel movement associated with routine inspections and maintenance work which may result in low level visual or physical disturbance to sea birds associated with the nature conservation areas in ESR II. Routine inspections are thought to have limited impact upon sea birds, especially as vessel movement is common throughout the area. As these works will be infrequent, and on a much smaller scale than that of the construction phase, the impact on birds associated with the nature conservation areas in ESR II is considered to be **insignificant**.

**Impact Summary**

The impacts identified and assessed in ESR II on nature conservation areas are summarised in **Table 9.39**.

**Table 9.39 Impact summary table for nature conservation areas in ESR II**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Nature Conservation Areas - Ecological Sub-Region II** | Increase in turbidity | Munitions clearance, Seabed intervention works, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Hyperbaric tie-in activities | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Munitions clearance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipe-laying, Anchor handling, Hyperbaric tie-in activities | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline flooding, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Impact | Activity | Nature | | | |
| | Physical alteration of the seabed | Munitions clearance, Seabed intervention works, Pipe-laying, Anchor handling, Hyperbaric tie-in activities | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Visual/physical disturbance | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |

**Table 9.40 Summary of significant impacts for ESR II**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Water Column** | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | Release of contaminants | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| **Seabed** | Physical alteration of the seabed | Munitions clearance | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Local | Long-term | Low | Low | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| **Atmosphere** | Emissions of pollutant gases | Seabed intervention works, Pipe-laying | Negative | Cumulative | National - Transboundary | Long-term | Low | Low | Low | Irreversible | **Minor** |
| **Marine Benthos huih** | Increase in turbidity | Munitions clearance | Negative | Direct | Local | Short-term - Long-term | Low | Low | Low - Medium | Reversible | **Minor** |
| | | Rock placement, Installation of support structures, Pipe-laying | Negative | Direct | Regional | Short-term - Long-term | Low | Low | Low - Medium | Reversible | **Minor** |

| Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Scale | Duration | Intensity | Magnitude | | | |
| Release of contaminants | Munitions clearance, Rock placement, Installation of support structures, Pipe-laying, Anchor handling | Negative | Direct and indirect | Local | Long-term | Low | Low | Low - Medium | Reversible | **Minor** |
| Noise and Vibration | Munitions clearance | Negative | Direct | Local | Temporary | Low - Medium | Low | Low | Reversible | **Minor** |
| Physical loss of seabed habitats | Munitions clearance | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | Rock placement | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | Pipe-laying | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | Anchor handling | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | Hyperbaric tie-ins | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| Physical alteration of the seabed | Routine maintenance | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| Introduction of secondary habitats | Pipeline presence | Positive or Negative | Direct | Local | Long-term | Medium | Low | Low - Medium | Irreversible | **Minor** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Fish | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Medium-High | Medium | Low-High | Reversible | **Minor-Moderate** |
| | | Pipeline presence | Negative | Direct | Local | Short-term | Low | Low | Low - Medium | Reversible | **Minor** |
| Marine Mammals | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Medium –High | Medium | Medium – High | Reversible | **Moderate** |
| | Ice breaking | Construction and support vessel movement | - / Negative | - / Direct, Secondary | - / Regional | - / Short-term | - / Medium | - / Medium | -/ High | - / Reversible | **No impact / Moderate** |

## 9.5 Ecological Sub– Region III

### 9.5.1 Introduction

ESR III is the largest ESR in the Baltic Sea comprising some 542 km of the pipelines' route (see **Figure 9.8**). The average salinity of ESR III is between 4-8 psu throughout the upper body of the water column, increasing from the east to the west, while the salinity of the deeper water below the halocline (50-70 m) varies from approximately 14 psu in the Eastern Gotland Basin to a maximum of 20 psu in the Bornholm Basin. A permanent halocline lies at a depth of approximately 55-65 m in the central Baltic Proper and 30-40 m in the Bornholm Basin. In general throughout ESR III, concentrations of heavy metals in the water column are low for the Baltic Sea, but high in comparison to other seas. The waters below the halocline are predominantly anoxic and the benthos is subsequently largely impoverished. The weak permanent circulation prevalent in the Baltic Sea results in the relatively low suspended solid concentrations in ESR III. Because of the significant water depths, wave movement is not sufficient to mobilise seabed material. The deep basins of the Bornholm Deep and Gotland Deep are important spawning areas for commercial and conservational species such as cod, flounder and sprat. ESR III is demarcated by the following KPs: KP 318.4 -745.9; KP 945.0 – 1046.4 and KP 1057.4 – 1070.8.

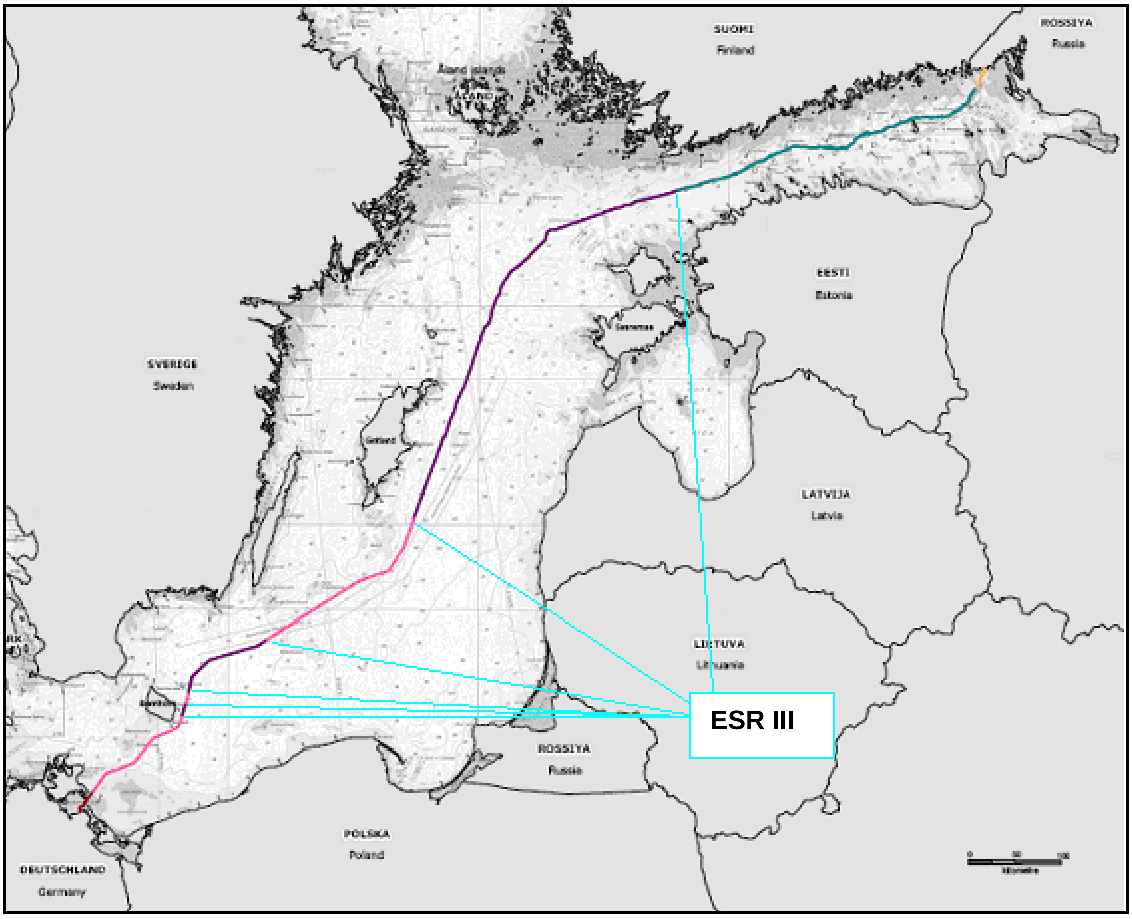


**Figure 9.8 The section of the pipelines' route passing through ESR III (in purple)**

Predicted impacts in ESR III will occur as a result of the following activities identified during the three initial phases of the Project. These include the following:

*Construction phase*

Seabed preparation activities:

- Munitions clearance

Seabed intervention works:

- Trenching
- Rock placement
- Pipe-laying

- Anchor handling
- Hyperbaric tie-in activities
- Construction and support vessel movement

*Pre-commissioning and commissioning phase*

- Pipeline flooding, cleaning, gauging and pressure testing
- Pressure-test water discharge
- Pipeline commissioning

*Operational phase*

- Routine inspections and maintenance
- Pipeline presence

The predicted impacts are identified and assessed as per each resource or receptor in the physical and biological environment. Impacts that are deemed to be of significance when they occur are assessed in full by means of the methodology presented in **Chapter 7**. Impacts that are deemed to be insignificant based upon previous knowledge and experience in similar projects are described but not assessed in detail.

A summary table showing the significant impacts for ESR III is shown at the end of this section (**Table 9.58**).

### 9.5.2 Physical Environment – Physical Processes

**Overview**

This section identifies and assesses the potential impacts on the deep waters' physical processes in ESR III in terms of the methodology presented in **Chapter 7**. The physical processes in the Baltic Sea are described in **Section 8.5.2**. The Baltic Sea is characterised by an extensive freshwater excess that produces a strong stratification. The currents in the Arkona Basin are influenced by the large-scale circulation created by dense bottom currents entering over the sills in this area. The volume of the incoming saline water increases due to the downward flow of currents through the Arkona Basin, Bornholm Strait and Bornholm Basin.

The main activities in ESR III which are expected to impact on physical processes will occur during the operational phase. There are no expected impacts on the physical processes for the construction or pre-commissioning and commissioning phase in ESR III since physical processes are only likely to occur as a result of the presence of the pipelines on the seabed, over the long term.

Activities and the associated impacts that are assessed in this section are as follows:

*Operational phase:*

- Pipeline presence resulting in change in underwater current flow

**Impacts during the Operational Phase**

As for ESR I and ESR II, the presence of the pipelines on the seabed has the potential to alter the underwater currents. Where prevailing currents intersect the pipelines they will be forced to rise. This has the potential to alter the composition, strength and direction of the currents. Similarly, currents can be altered due to the effect of a temperature difference between the pipelines and the surrounding water.

*Change in underwater current flow*

The presence of the pipelines on the seabed in the area east of Bornholm has the potential to alter physical processes such as water mass exchange at the seabed as a result of increases in the degree of mixing of new deepwater. As described in **Section 9.4.2**, an increase in the degree of mixing of new deepwater could lead to lower salinity, increased flow rate and increased transport of oxygen, increasing the deposition of phosphorus in the deepwater and reducing levels of eutrophication.

Deepwater flow in ESR III has specific links to the wider Baltic area; deepwater inflow into the Bornholm Basin is the only method of oxygen supply to the deep waters of the Baltic Sea (below the halocline). As described in **Section 8.5.2**, in ESR III, the waters above the halocline are considered to be oxygenated. Therefore, the oxygen supply process is vital for the physical, biogeochemical and ecological status of the Sea, and indeed within ESR III. However, below the halocline the water is hypoxic, i.e. there are very low levels of oxygen.

The flow of water entering via the Bornholm Basin varies in volume, salinity and temperature causing natural variability to the salinity and temperature of deep water in ESR III. As described in **Chapter 8**, large volumes of saline inflow are sporadic, causing the depth of the halocline to vary and causing periodic hypoxic conditions in the deep water of ESR III.

A study, which is currently undergoing limited improvements, conducted to estimate the extent of the potential impact from the presence of the pipelines on the salinity, volume flow and oxygen concentration of new deepwater in the Bornholm Basin considered whether the presence of the pipelines could increase the degree to which new deepwater is mixed[(1)]. The study proceeded on the premise that the degree of mixing of the new deepwater might increase if the mixing efficiency of pipeline-generated turbulence is greater than that of natural turbulence generated by the present combination of friction between the water and the seafloor, and between water bodies moving at different speeds or in different directions. The study reported that if the Nord Stream pipelines extend to 1.5 m above the seabed, pipeline presence could dissipate about 0.5 % of the total potential energy of the currents, depending on the speed of the dense bottom current in the crossing section. However, the study found this to have little or no impact on the existing current patterns.

The creation of scour effects (erosion around the pipelines due to the interactions with current and waves) is undesirable. The impact of the proposed Nord Stream pipelines on scour was also modelled, and it was established that the solid obstruction by the pipelines within the Baltic Sea could indeed cause a blocking effect that will change the current conditions in the vicinity of the pipelines and may introduce scour. Within ESR III, the primary area of interest for scour effect is where the seabed can be characterised as very soft clay with a very high porosity and water content.

However, areas of very soft clay with a very high porosity within ESR III have water depths which vary between 50 and 70 m, meaning the influence of waves at the seabed and wave induced water velocity at pipeline level will be very small. The water flow at the pipeline level can therefore be described as pure current flow. Taking into consideration the conservative assumptions of modelling studies discussed here, it is considered that scour will not cause release of significant amounts of sediment that will cause adverse environmental impacts.

Underwater currents within the study area could also be impacted by minor changes in the water temperature in the vicinity of the pipelines during operation and through the introduction of solid bodies (the pipelines), blocking currents on the seabed. As discussed in **Section 9.4.2**, the temperature balance that occurs within the water operates quickly and as such the influence of temperature differences between the pipelines, the sediment, and the water body is expected to be negligible. As a result no essential negative temperature effects are predicted for the surroundings of the pipelines in the water and there will, therefore, be no significant change to currents due to the temperature changes.

As such, it is anticipated that the impact of the change in underwater current flow resulting from the Project within this location will be **insignificant.**

(1) Swedish Meteorological and Hydrological Institute. 2007. Possible effects upon inflowing deep water of a pipeline crossing the flow route in the Arkona and Bornholm Basins. (This study is currently undergoing limited improvements).

**Impact Summary**

The impacts identified and assessed in ESR III on physical processes are summarised in **Table 9.41**.

**Table 9.41 ESR III impact summary table for physical processes**

| Physical Processes - Ecological Sub-Region III | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Change in underwater current flow | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.5.3 Physical Environment – Water Column

**Overview**

Following the undertaking of a scoping and impact identification exercise, numerous interactions between the Project and the water column in ESR III have been identified, which could give rise to potential impacts. This section identifies and assesses the potential impacts on the water column in ESR III during the construction, pre-commissioning and commissioning and operational phases of the Project in terms of the methodology presented in **Chapter 7**.

The characteristics of the water column are not constant throughout the Baltic Sea and differ depending on location as well as depth. Accordingly, the significance of the associated Project impacts on the water column may also differ along the pipelines' route. The quality of the water column is dictated by its salinity and oxygen levels as well as by the concentrations of suspended solids, nutrients, heavy metals, organic pollutants, plankton and biological components. Full details as to the water quality in ESR III are presented in **Section 8.9.1**. Essentially the water column is important for all ecosystems in terms of supporting function and structure but is very resistant to change in terms of its interaction with the Project. In most cases, the water column will rapidly revert back to a pre-impact status once specific activities, such as those during construction, cease. This would depend on the magnitude of the impact and its persistence. As per the sensitivity criteria for the physical environment as detailed in **Chapter 7**, the water column has been awarded a **low** value/sensitivity throughout the Baltic Sea.

The main activities that are expected to impact on the water column are those that take place during the construction phase. The re-suspension and spreading of sediments by seabed intervention works is expected to impart the largest impact upon the water column. Accordingly, the characteristics of seabed sediments play a major role in determining the level of impact. No impacts are expected in ESR III during pre-commissioning as the intake of seawater and subsequent discharge of pressure-test water is to occur at the Russian landfall in ESR I. The impacts as a result of hyperbaric tie-ins following pre-commissioning have been included in the construction phase. Impacts during the operational phases are expected to be minimal in comparison to construction. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Re-suspension and spreading of sediments from munitions clearance, seabed intervention works, pipe-laying, anchor handling and hyperbaric tie-in activities resulting in:
  - Increase in turbidity

- Re-suspension and spreading of sediments from munitions clearance and seabed intervention works resulting in:
    - Release of contaminants
- Re-suspension and spreading of sediments from seabed intervention works resulting in:
    - Release of nutrients

*Operational phase*

- Pipeline presence resulting in:
    - Temperature change
    - Release of pollutants from anti-corrosion anodes

**Impacts during the Construction Phase**

Impacts upon the water column during the construction phase are limited to the re-suspension and spreading of sediments resulting in an increase in turbidity and the release of contaminants and nutrients as a result of munitions clearance, pipe-laying, anchor handling, seabed intervention works and hyperbaric tie-in activities.

*Increase in turbidity*

Construction works on the seabed will also result in the disturbance and subsequent re-suspension of sediments together with the associated compounds such as nutrients and contaminants, which may be present. This would increase the turbidity levels as well as the concentrations of these substances in the water column. Activities that are expected to disturb the seabed include munitions clearance, pipe-laying, anchor handling, seabed intervention works and hyperbaric tie-in activities. Seabed intervention works are expected to generate the most re-suspended sediment while munitions clearance, pipe-laying, anchor handling and tie-in activities are expected to contribute very little. The amount of sediment disrupted is highly dependent on the methods and equipment used during the pipelines' installation phase as well as the extent of the construction works. The degree to which sediments are generally prone to suspension is linked to the fines content and how consolidated the sediment is. Sediments are re-suspended for a period of time before being deposited (sedimentation) elsewhere. It should be noted that seabed intervention works are restricted to specific areas as depicted on **Atlas Maps PR-3a** and **PR-3b**. As such the associated level of impact would not extend along the entire pipelines' route in ESR III.

For the most part, the pipelines' route through ESR III is in the deep waters (80-210 m) of the Baltic Sea and below the halocline, which exists at a depth of 60-80 m. The presence and depth of the halocline is considered to be permanent. There are occasional periods, however, when the halocline is not present in ESR III. When present, the halocline significantly constrains the dispersal of suspended sediments and the associated contaminants and nutrients into the upper water column, as it acts as a lid, inhibiting the bottom-water column from mixing with the water column above the halocline. Certain compounds can, however, diffuse through the halocline. An example would be phosphorus. Currents (depending on strength and presence) along the seabed will increase the distance to which suspended sediments would be transported laterally below the halocline as well as the time period for which sediments remain in suspension.

Prior to construction it is envisaged that munitions and ordnance clearance will take place within the pipelines' corridor. Route optimisation has ensured that most ordnance will be avoided. However, five munitions have been detected within the pipelines' corridor in ESR III that will require clearing. Their exact location is currently confidential; however, one is located to the north east of Gotland in Swedish waters. Four further munitions are located in the western section of the Gulf of Finland, also within ESR III. These objects will require clearing by means of explosives in collaboration with the relevant authorities. The clearance of munitions has the potential to re-suspend and spread sediments as they are generally in place on or submerged within the seabed.

Modelling of the spread and sedimentation of sediments and the release of contaminants as a result of munitions clearance has been carried for munitions clearance sites in the Finnish EEZ only by means of a general numerical particle analysis model (Mike 3 PA)(1) . No modelling has been performed for munitions clearance in the Swedish EEZ (sections of which form part of ESR III). Similar effects to those for Finnish munitions clearance sites are, however, expected at these sites. The Mike 3 PA model incorporates specific hydrodynamic data to assess the transport of dissolved and suspended substances. The amount of re-suspension and spreading of sediment is dependent upon the amount and type of detonation explosives and the residual explosive in the munitions, the seabed type and the extent of underwater currents near the seabed. The same model, albeit with different input variables, has been used in the assessment of seabed intervention works locations.

The clearance of munitions is expected to result in the formation of a crater (average radii of 4.5 m) on the seabed and the re-suspension of sediment throughout the water column. On average, munitions clearance results in re-suspended sediment with a concentration above 1 mg/l within 1-2 km, with a maximum in some locations of 5 km, of the disturbance area for 13 hours. A concentration above 10 mg/l is expected to last for 4 hours on average and close to the clearance site. Sedimentation is limited and rarely exceeds 0.1 $kg/m^2$. Therefore, due to the limited extent and duration of increased turbidity levels and the fact that munitions clearance will only occur at specific points on the pipelines' route it is expected that the impact (**negative** and **direct**) on the water column in ESR III will be of **regional** scale (above background levels) and

(1) Nord Stream AG & Ramboll. 2008. Memo 4.3A-12 Spreading of sediment and contaminants from clearing of munitions.

of **short-term** duration (sedimentation rate). Impacts will be **reversible** within a few days as sediment settles to the seabed. Intensity is **low** as no major change in structure and function is expected. Impact magnitude is **low**. Therefore, impact significance is expected to be **minor**. The presence of a halocline will prevent the vertical dispersal of suspended sediment. It should be noted that munitions clearance is a common activity in the Baltic Sea.

The re-suspension and spreading of sediments is expected to be greatest during seabed intervention works that include trenching and rock placement. Modelling of the spread and sedimentation of sediments and contaminants during works in the seabed in ESR III has been carried out by using a general numerical particle analysis model (Mike 3 PA) for locations along the pipelines' route where post-lay trenching via plough and pre and post-lay rock placement will take place. The Mike 3 PA model involves numerous inputs in relation to the type of seabed intervention works. The initial input for sediment modelling is the expected spill rate for the various activities. The spill rate for trenching (20 kg/s) was determined by the average trenching speed, the nominal volume of displaced sediment, the percentage spill (2%) and the density of the spilled sediment. The spill rate for rock placement (1 kg/s) was determined by the placement rate, rock volume and falling velocity (kinetic energy converted to potential energy on impact). Sediments are released at heights of 5 and 2 m above the seabed for trenching and rock placement respectively. The distance a particle travels is governed by particle grain size, flocculation, grain size fractions, hindered settling in high concentration areas, water properties, grain size distribution and settling velocity. The different types of seabed intervention works and types of sediments for ESR III are detailed in **Table 9.42**.

**Table 9.42 Seabed intervention works (both pipelines') and sediments types for Ecological Sub-Region III**

| Area | Seabed Intervention Works | Sediment Types |
|---|---|---|
| Northern Central Basin | Predominantly rock placement with limited trenching. | Mud. |
| Fårö Deep | Minimal rock placement and trenching. | Post glacial mud and sandy mud. |
| Gotland Deep. | Limited rock placement. | Predominantly post glacial mud and sandy mud with limited sections of glacial clay and till (hard bottoms). |
| Bornholm Deep | None. | Post glacial mud and sandy mud. |

The areas and average duration of re-suspended sediment concentration > 1 mg/l for ESR III are shown on **Atlas Maps MO 5-7**, **12** and **21**. An excess concentration of 1 mg/l (the model used a background concentration of 0 mg/l) will hardly be visible in the water since normal concentrations in the Baltic Sea are typically in the range of 1 – 4 mg/l during normal weather. As such, the sediment clouds shown on the Atlas Maps may be regarded as the maximum extent of the sediment spreading (for the applied weather conditions). Sedimentation for ESR III in terms of the amount of sediment deposited on a square metre of seabed is depicted on **Atlas Maps 8-10**, **13** and **22**.

For rock placement to the east of Gotland, modelled re-suspended sediment spreading is limited (mainly due to the lighter disturbance of the seabed compared to trenching). Concentrations above 1 mg/l are expected at a maximum of 350 m away from the disturbance area and usually with a duration of less than 8 hours during normal weather. A concentration above 10 mg/l is expected to last for 6 hours close to the disturbance area. Sedimentation is modelled to range from 0.01 to 0.1 $kg/m^2$ up to a distance of 350 m from the disturbance area.

For trenching and rock placement to the north east of Gotland, modelled re-suspended sediment with a concentration above 1 mg/l is expected within 1.5 km of the disturbance area for approximately 12 hours. Re-suspended sediment at one section of trenching exceeds a concentration of 1 mg/l up 5 km for up to 12 hours. A concentration above 10 mg/l is expected to last for 5 hours close to the disturbance area. Sedimentation is modelled to range from 0.1 to 1.0 $kg/m^2$ at the source and from 0.01 to 0.1 $kg/m^2$ 1 to 5 km away.

For rock placement in the western section of the Gulf of Finland, modelled re-suspended sediment with a concentration above 1 mg/l is expected within 3 km of the disturbance area for approximately 10 hours. A concentration above 10 mg/l is expected to last for 7.5 hours close to the disturbance area. Sedimentation is modelled to range from 0.1 to 1.0 $kg/m^2$ at the source and from 0.01 to 0.1 $kg/m^2$ 1.5 km away.

For the most part, the presence of a halocline restricts the vertical movement of suspended sediments in the water column. Due to the limited extent and duration of increased turbidity levels and the fact that seabed intervention works will only occur at specific points on the pipelines' route it is expected that the impact (**negative** and **direct** due to a change in the resource) on the water column in ESR III will be **regional** (above background levels), of **short-term** duration (sedimentation rate) and of **low** intensity. Impact magnitude is **low**. Impact significance is expected to be **minor** (**low** sensitivity). Impacts will be **reversible** within a few days as sediment settles to the seabed.

Pipe-laying can result in the re-suspension and spreading of sediments due to the current generated in front of the pipelines as they near the seabed as well as from the pressure transfer when the pipelines hit the seabed. The amount of sediment that is expected to be placed into suspension during pipe-laying has been determined by considering the vertical velocity of the descending pipelines, the flow velocity of the water during displacement, the Shields parameter, which defines the limit at which particles start to move, the upwards flow generated by an increase in pore pressure due to sediment compression and both hard and soft sediment characteristics. Along a 1 km stretch of a pipeline it is expected that the amount of suspended sediment, when each pipeline hits the seabed, would be up to 600 kg 1 m above the seabed for soft sediments. During pipe-laying, anchors (anchor handling) will be used to position the pipe-laying vessel. Anchor handling involves the placement and retrieval of 12 anchors on the seabed for every 200 to 600 meters of pipeline laid. Anchor placement and retrieval, as well as the anchor cable sweeping across the seabed, will result in the re-suspension of sediments. The amount of sediment that is placed in suspension has been determined by considering similar variables to those used for pipe-laying. During both anchor placement and retrieval it is expected that 10-160 kg of sediment will be placed in suspension per anchor. Approximately 100-150 m of anchor cable is expected to lay at rest on the seabed and will sweep across the seabed as the lay vessel moves forward resulting in the release of 400-1600 kg of sediment. Anchor handling results in a suspended sediment concentration >10 mg/l over a very limited area of 0.004-0.016 $km^2$. Even though pipe-laying and anchor handling will extend along the entire pipelines' route in ESR III it is expected that the effects of these activities would compare well to the effects of bottom trawling activities (dragging of trawls along the seabed) in shallower areas as well as normal anchor placement in the Baltic Sea. In addition, the presence of a halocline will prevent the vertical dispersal of suspended sediment. As such, it is expected that such activities would contribute very little to the overall amount of sediment placed into suspension during the construction phase and thus the impact is **insignificant**.

Hyperbaric tie-in activities will take place at a distance of 675 km from the Russian landfall following pre-commissioning. A hyperbaric dry welding habit will be lowered onto a gravel foundation. It is expected that the re-suspension and spreading of sediments and contaminants will be on par if not less than that generated with the laying of the pipelines on the seabed and thus the impact is **insignificant**.

*Release of contaminants*

Contaminants (identified as cadmium, mercury, lead, zinc, copper, arsenic, chromium, nickel, polycyclic aromatic hydrocarbons (PAH) and tributyltin) are typically bonded to the sediment particles in most of ESR III. A contaminant's ability to spread and dissolve in the water column (model) as well as its relative toxicity (in terms of the desorbed and bioactive fractions and the predicted no-effect concentration in the water column) are discussed in **Section 9.3.3** under ESR I. Arsenic has been modelled to exceed the PNEC within 1 km from the pipelines while copper and PAHs have been modelled to display higher toxicity levels above the PNEC value at greater distances. The maximum concentrations of Cu and SUM16PAH for rock placement sites in ESR III are shown on **Atlas Map MO 32-49**.

Both munitions clearance and seabed intervention works will result in the release of contaminants into the water column. The spreading of contaminants by pipe-laying and anchor handling is not considered as only a limited amount of sediment is expected to be re-suspended.

Modelling has been performed for munitions clearance locations in the Finnish EEZ[(1)]. No modelling has been performed for munitions clearance in the Swedish EEZ (sections of which form part of ESR III). Similar effects to those for Finnish munitions clearance sites are, however, expected at these sites.

For munitions clearance locations in the Finnish EEZ, dissolved copper is modelled and predicted to exceed the PNEC (>0.02 µg/l) up to a distance of 1-3 km from the source during normal weather. The duration for which copper concentrations are expected to be greater than the PNEC is 6 hours. Dissolved PAHs are expected to exceed the PNEC (>0.000009 µg/l) up to a maximum distance of 1-3.5 km from the source during normal weather. The duration for which PAH concentrations are expected to be greater than the PNEC is 7 hours. The impacts at the Swedish munitions clearance site is expected to be similar to those that would occur at the Finnish sites.

Therefore, due to the limited extent and duration of increased contaminant concentration levels and the fact that munitions clearance will only occur at specific points on the pipelines' route it is expected that the impact (**negative** and **direct**) of the release of contaminants is expected to be **regional** (above the PNEC), of **short-term** duration due to the expected settling of suspended sediment bound contaminants and of **low** intensity as no change is expected in the structure and function of the water column. Impacts will be **reversible** within a few days. Impact magnitude is therefore **low**. As both the impact magnitude and receptor value/sensitivity are **low**, impact significance is expected to be **minor**.

Modelling has been performed for rock placement sites in ESR III. The spreading of contaminants was only considered at rock placement points since trenching areas are typically erosion areas and do not display a significant degree of contamination.

For rock placement to the east of Gotland, dissolved copper is modelled and predicted to exceed the PNEC (>0.02 µg/l) up to a distance of 1 km from the source during normal weather. The duration for which copper concentrations are expected to be greater than the PNEC is 24.4 hours. Dissolved PAHs are expected to exceed the PNEC (>0.000009 µg/l) up to a maximum distance of 3.5 km from the source during normal weather. The duration for which PAH concentrations are expected to be greater than the PNEC is 73.3 hours.

For rock placement to the west of the Gulf of Finland, dissolved copper is modelled and predicted to exceed the PNEC (>0.02 µg/l) up to a distance of 2 km from the source during normal weather. The duration for which copper concentrations are expected to be greater than the PNEC is 13-18 hours. Dissolved PAHs are expected to exceed the PNEC (>0.000009 µg/l)

(1) Nord Stream AG & Ramboll. 2008. Memo 4.3A-12 Spreading of sediment and contaminants from clearing of munitions.

up to a maximum distance of 1.5 km from the source during normal weather. The duration for which PAH concentrations are expected to be greater than the PNEC is 16-20 hours.

Due the limited extent and duration of increased contaminant concentration levels, the fact that seabed intervention works will only occur at specific points on the pipelines' route and that the halocline will restrict the vertical dispersal of suspended contaminants, it is expected that the impact (**negative** and **direct**) of the release of contaminants is expected to be **regional** (above background levels), of **short-term** duration due to the expected settling of suspended sediment bound contaminants and of **low** intensity as no change is expected in the structure and function of the water column. Impact magnitude is therefore **low**. Impacts will be **reversible** within a few days. As both the impact magnitude and receptor value/sensitivity are **low**, impact significance is expected to be **minor**. Seabed intervention works will not contribute additional contaminants to the Baltic Sea but would be active in their relocation.

The majority of the sediment within ESR III is likely to be hypoxic and rich in hydrogen sulphide ($H_2S$). During seabed intervention works, any $H_2S$ present in the sediment can be released into the water column after which it would react rapidly with any oxygen in the water forming $H_2SO_4$. This results in reduced oxygen levels in the water column. Seeing that the water column below the halocline in ESR III is considered to be hypoxic it is expected that limited reactions are likely. As such the release of $H_2S$ is expected to have an **insignificant** impact on oxygen levels and thus the water column.

Chlorinated dibenzo-p-dioxin (PCDD) and dibenzofuran (PCDF) compounds or 'dioxins' may be present in the sediments of ESR III. Dioxins are persistent organic pollutants that can cause severe, long-term impacts on marine biota such as fish, whole ecosystems and human health[(1)]. The source of dioxins, there presence in the sediments of the Baltic Sea as well as their effects on marine biota and human health are elaborated upon in **Section 9.3.3** under ESR I.

Dioxins that have accumulated in sediment tend to be tightly bonded to sediment particles and desorb quite slowly. As per the modelling results for the re-suspension and spreading of sediment, it is expected that re-suspended sediments will not be distributed throughout water column but will be concentrated within 10 vertical metres of the seabed and will settle over a few days. As most dioxins are bonded to the sediment particles it is therefore assumed that they will behave in the same manner and will settle on the seabed. As such, the impact on the water column is expected to be **insignificant** and only limited bioaccumulation in marine biota is expected.

*Release of nutrients*

A release of nutrients, such as nitrogen and phosphorus, during the re-suspension and spreading of sediment could stimulate phytoplankton production, should they reach the photic zone, and thereby increase the biomass. An increase in primary production due to the release of

(1) Helsinki Commission. 2004. Dioxins in the Baltic Sea.

nutrients could also potentially contribute to oxygen consumption by degradation of organic matter. A release of oxygen-consuming compounds during trenching or rock-placement may further aggravate situations with local oxygen deficiency at the sea bottom. **Section 9.3.3** summarises the expected amount of nitrogen and phosphorus to be released during seabed intervention works in the Baltic Proper, which includes ESR III. Overall the likely increase in nutrient concentration resulting from seabed intervention works in the Baltic Proper is small in relation to current nutrient inputs. Accordingly, the release of nutrients into the water column should not generate increases in nutrient concentrations outside the normal range of conditions. Since most of the nutrients in sediments are bound to particles, and will not contribute to primary production, much of the increase in concentration will be reversed as particles settle out. The immediate impact of the release of nutrients would occur during seabed intervention and thus will not be long-term in duration. The release of nutrients will result in an increase in nutrient concentration that would not extend beyond normal conditions[(1)] and therefore the impact on the water column is assessed to be **insignificant** in ESR III. The halocline would further reduce the upward dispersal of released nutrients.

**Impacts during the Operational Phase**

Impacts upon the water column during the construction phase are limited to a change in temperature by the movement of natural gas within the pipelines as well as the release of pollutants from anti-corrosion anodes in place on the pipelines.

*Temperature change*

A gas temperature of around 40ºC is expected at the Russian landfall as a result of the natural gas heating during compression. Simulation of temperature for a free-laying pipeline close to the Russian landfall, shows (with seawater temperature of -2ºC) an insignificant temperature increase (maximum 0.5°C) in the water near the seabed and in the water on the downstream side of the pipeline. It is expected that the gas will expand as it moves further away from the Russian landfall and thus decrease in temperature. In ESR III it is expected that the temperature of the gas and the temperature of the water column around the pipelines will be in equilibrium. The gas temperature is, however, expected to decrease slowly as it gets close to the German landfall. Overall, the impact on the water column in ESR III is expected to be **insignificant** as no change in water temperature is expected**.**

*Release of pollutants from anti-corrosion anodes*

To minimise external corrosion, anodes are to be installed at regular intervals along each pipeline. The potential impacts on water quality from pipeline anodes are related to the release of metal ions from the anode material during the lifetime of the pipelines. Various calculations in

(1) "Normal conditions" are defined as pre impact status conditions i.e. the existing water column for ESR III prior to commencement of the Project, as detailed in Section 8.9.1.

terms of the expected release of ions and their effect on the water column are described in **Section 9.3.3** under ESR I. Based on these calculations it is concluded that the impact on the water column is **insignificant.**

**Impact Summary**

The impacts identified and assessed in ESR III on the water column are summarised in **Table 9.43**.

**Table 9.43 ESR III impact summary table for the water column**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Water Column – Ecological Sub-Region III | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Hyperbaric tie-in activities | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of contaminants | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | Release of nutrients | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | Temperature change | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of pollutants from anti-corrosion anodes | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.5.4 Physical Environment – Seabed

**Overview**

The seabed in ESR III is predominantly characterised as being a mud substrate (sandy in parts) with sections of clay and glacial till that are located below the halocline and therefore in an anoxic environment that is largely devoid of life for most of the year. Despite the fact that ESR III does not support significant marine fauna and flora, it is considered to be of importance through the contribution that it makes to the various physical processes occurring in the Baltic Sea, such as erosion and accumulation (sedimentation) (e.g. see **Atlas Map GE-3**). In addition, the seabed serves as a major sink for nutrients and contaminants that have associated with particulate matter and have accumulated in the deep parts of the Baltic Sea. The seabed will also act as the primary support mechanism for the pipelines.

The seabed in ESR III is considered to have a low sensitivity throughout in periods of stagnation, where inflow of water with high concentration of oxygen and salt is missing. Since these conditions do not allow the seabed to support any habitats of particular ecological significance, and since there are no notable features on the seabed along the pipelines' route in ESR III, such as cold water corals, sea mounts, canyons or areas of sensitive seabed substrate (e.g. cobbles or sand waves), this habitat is not considered to be particularly sensitive to change.

The main activities in ESR III which are expected to impact on the seabed will occur during the construction phase and, to a lesser extent, the operational phase. No impacts are predicted for the pre-commissioning and commissioning phase. Impacts from the clearance of munitions areas in ESR III, discussed in **Section 9.4.2**, will be considered as part of the construction phase. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Munitions clearance, seabed intervention works, pipe-laying, anchor handling and hyperbaric tie-in activities resulting in:
    - Release of contaminants
    - Physical alteration of the seabed

*Operational phase:*

- Routine inspections and maintenance and pipeline presence resulting in:
    - Physical alteration of the seabed

- Pipeline presence resulting in:
  - Release of pollutants from anti-corrosion anodes

**Impacts during the Construction Phase**

Seabed intervention works, anchor handling, pipe-laying and hyperbaric tie-in activities in ESR III during the construction phase, as well as munitions clearance as part of seabed preparation, are likely to result in the release of contaminants and physical alteration of the seabed.

*Release of contaminants*

Of the potentially ecotoxic chemical compounds in the Baltic Sea (listed in **Section 9.3.4**), several are present at relatively high concentrations in ESR III. These are all considered likely to cause adverse biological effects if made bioavailable (see **Section 8.9.2)**. However, due to the presence of a halocline for most of the time in ESR III, which prevents mixing and creates an anoxic environment near the seabed which does not support much flora and fauna, any contaminants in disturbed sediments are unlikely to pass into the upper layers of water and impact on flora and fauna receptors. Further, rock placement uses inert gravel as described in **Section 9.2.1**, and therefore poses no contamination risk to the seabed. Therefore, it is considered that impacts from release of contaminants on the seabed in ESR III due to munitions clearance, seabed intervention works, pipe-laying and anchor handling are **insignificant**.

*Physical alteration of the seabed*

As described in ESR I, the extent of re-suspension and spreading of sediment, and other physical disturbance to the seabed(by the formation of craters) from munitions clearance will depend upon the amount and type of detonation explosions and the residual explosive in the device, as well as the seabed type and the extent of underwater current in close vicinity to the seabed. Munitions clearance necessary in ESR III prior to construction of the pipelines will cause re-suspension and spreading of sediments in the immediate area of the pipelines and associated sediment spreading over a wider area. Sedimentation of re-suspended sediment is, however, limited and thus no impact on the seabed in expected. Munitions clearance will also result in the formation of craters in the seabed. Based upon the munitions clearance modelling performed in the Finnish EEZ (**Section 9.4.3**) craters with average radii of 4.5 meters are likely in ESR III at munitions clearance sites. This will result in a **negative** and **direct** impact on a **local** scale (<500 m) and of **low** intensity as no major change in structure or function of the seabed is expected. Impacts will be of **short-term** duration and **reversible** as the craters will, overtime, be filled. The magnitude of the impact is **low**. As discussed in **Section 8.9.2**, the seabed is of **low** value/sensitivity and therefore the impact on the seabed in ESR II in terms of physical alteration of the seabed as a result of munitions clearance is considered to be **minor.**

Re-suspension and spreading of sediments in ESR III is likely to occur due to construction activities on the seabed. This includes the creation of mounds during trenching, introduction of gravel to the seabed during rock placement, creation of depressions during anchor handling and disturbance from hyperbaric tie-in activities. Trenching by ploughing has been calculated to result in a spill rate of 20 kg/s based on a trenching speed of 30 m/hr and the assumption that only 2% of the total volume trenched is spilled[(1)]. As discussed in **Section 9.3.4** rock placement has a lower spill rate of 1kg/s, and the sedimentation from anchor handling and hyperbaric tie-in activities are lower still. Sediments will be deposited over an area up to approximately 4 km from the construction area in ESR III, however no major change to the seabed is expected in terms of structure and function, and seabed intervention works are confined to specific sections of the pipelines' route.

Re-suspension and spreading of sediments in ESR III is also possible as a result of hyperbaric tie-in activities. These activities will take place at one point in ESR III, for each pipeline, at a distance of 675 km from the Russian landfall site. It is expected that the extent of re-suspension and spreading of sediments from hyperbaric tie-in activities will be similar to that for seabed intervention works, however the impact would be on a localised scale at this one point along the route only and will have a negligible impact on seabed structure and function.

Besides the re-suspension and spreading of sediments, physical alterations of the seabed in ESR III are expected to occur due to trenching and rock placement activities. As for ESR I, the formation of trenches is not expected to create a large amount of disturbance to the seabed structure, since these effects will not be permanent once the pipelines are in place within the trenches due the effects of underwater currents and gravity. Rock placement and pipe-laying will also cause physical alteration by the introduction of new substrate, however these activities will affect the substrate in a highly localised way, and will only affect a very small percentage of the Baltic Sea surface. There are no known notable seabed features such as cold water corals, sea mounts, canyons or areas of sensitive seabed substrate (e.g. cobbles or sand waves) along the pipelines' route in ESR III which will be affected by these activities. Seabed intervention works are assessed to have a **direct negative** impact on the seabed, which is **reversible** in the long-term, in terms of the structure of the seabed. Impacts act on a **local** to **regional** scale. Impacts are of **long-term** duration. Impact intensity is considered to be **low** as no major change in structure or function is expected. The impact magnitude is **low**. Therefore, due to the **low** value/sensitivity of the seabed the significance of the impacts on the seabed are assessed to be **minor**.

Anchor handling in ESR III is likely to cause physical alteration of the seabed, due to controlled positioning of anchors in the seabed, as described in **Section 9.3.4**. While it is expected that depressions will be refilled due to the redistribution of sediments mobilised by currents and

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(1) Nord Stream AG & Ramboll. 2008. Memo 4.3A5 - Spreading of sediments and contaminants during works in the seabed.

waves, this **negative** impact is expected to cause **local** impacts of **low** intensity. As discussed in **Section 8.9.2**, the seabed is considered to be of **low** value / sensitivity. Impacts will be **short-term** in duration. The magnitude of the impact is considered to be **low**. Impacts will also be **reversible** over time. The **direct** impact on the seabed in ESR III in terms of physical alteration of the seabed as a result of anchor handling is therefore considered to be **minor.**

**Impacts during the Operational Phase**

Impacts on the seabed from the operational phase in ESR III are limited to physical alteration of the seabed due to routine inspections and maintenance works and pipeline presence, and release of pollutants from anti-corrosion anodes due to pipeline presence.

*Physical alteration of the seabed*

Physical alteration of the seabed may also occur during the operational phase. Routine inspections and maintenance of the pipelines may involve occasional seabed disturbance, but this will occur infrequently and vessel movements will be restricted to the pipelines' route. Since the larger-scale seabed intervention works during the construction phase are not expected to impact significantly on the seabed, routine inspections and maintenance works are anticipated to have an **insignificant** impact on the seabed in ESR III.

Physical alteration of the seabed is also likely to occur as a result of the physical presence of the pipelines on the seabed. Sediment accumulation along the pipelines and scour effects are possible following the introduction of the pipelines on the seabed, as discussed in **Section 9.3.4**. However, the average velocity of underwater currents affecting the seabed in ESR III is relatively low, meaning sediment accumulation rates are low, and the sediment accumulation which does occur can be expected to partly or completely fill some of the depressions and holes caused during construction. Scour is only expected to cause seabed erosion in places where the seabed sediments have high porosity and a higher water content than usual, and where the current flows faster than 0.3 m/s in a direction perpendicular to the pipelines - a condition which is rarely the case for ESR III(1). Therefore, sediment accumulation and the scour effect of the pipelines are both anticipated to have an **insignificant** impact on the seabed.

*Release of pollutants from anti-corrosion anodes*

As described in **Section 9.3.3** indium-activated aluminium anodes have been selected for ESR III(2). For the two pipelines in ESR III, particularly along the sections of the pipelines which will be buried, small amounts of zinc and chromium are expected to be released into the sediment over the 50-year lifetime of the pipelines. However, burial of the pipelines will reduce the release of

(1) Nord Stream AG & Ramboll. 2008. Memo 4.3a2 - Blocking effects of the pipeline on the seabed causing accretion.

(2) Snamprogetti. 2008. Offshore CP System Sizing.

compounds to the marine environment[1], and will therefore have a lower impact on the environment than for the sections of pipelines exposed on the surface of the seabed. The impact of the anodes on the water column itself has been assessed as being insignificant (**Section 9.5.3**), therefore the impact on the seabed in ESR III is also considered to be **insignificant**.

### Impact Summary

The impacts on the seabed identified and assessed in ESR III are summarised in **Table 9.44.**

(1) Nord Stream AG & Ramboll. 2008. Memo 4.3s – Materials.

**Table 9.44 ESR III impact summary table for the seabed**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Seabed - Ecological Sub-Region III** | Release of contaminants | Munitions clearance, Seabed intervention works, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | Physical alteration of the seabed | Munitions clearance | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Local - Regional | Long-term | Low | Low | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of pollutants from anti-corrosion anodes | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.5.5 Physical Environment – Atmosphere

**Overview**

As described in **Section 9.2.1** impacts from pollutant release are most likely to arise from the construction phase and, to a lesser extent, the operational phase. Impacts on the atmosphere are not predicted to occur in ESR III during the pre-commissioning and commissioning phase. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Munitions clearance, seabed intervention works, pipe-laying and hyperbaric tie-in activities resulting in:
  - Emissions of pollutant gases

*Operational phase*

- Routine inspections and maintenance resulting in:
  - Emissions of pollutant gases

**Impacts during the Construction Phase**

During the construction phase for ESR III, munitions clearance, seabed intervention works, pipe-laying and hyperbaric tie-in activities have associated pollutant emissions which will potentially contribute to acidification, eutrophication and climate change, with associated negative impacts on marine and terrestrial receptors.

As described in **Section 9.3.5**, pollutant emissions will only be associated with those aspects of seabed intervention works which involve fuel combustion in engines on the sea surface. In ESR III, emissions during seabed intervention works are likely to arise from tugboat engines during trenching, rock placement machinery and machinery used during hyperbaric pipeline tie-in, as well as from vessel movement and welding equipment used during pipe-laying along the length of ESR III.

*Emissions of pollutant gases*

As for ESR I, in terms of munitions clearance, the release of a minor amount of toxic gases to the atmosphere from a possible detonation of munitions at the seabed is not expected to cause damage to any ecosystem receptors. The consequence of disturbance of munitions on the atmosphere is expected to be **insignificant**, since significant impacts on the environment from detonation at the seabed would be restricted to receptors such as the water column and seabed(1).

Pollutant gases and particulate matter emissions from seabed intervention works and pipe-laying activities, due to the diesel and bunker oil used by the offshore construction fleet, can contribute to acidification, eutrophication, and climate change. These are considered to be **irreversible** impacts, and act on a range of ecosystems, as described in **Section 8.5.1**.

However, as described in **Section 9.3.5**, and as shown in **Table 9.8**, emissions associated with Project activities are predicted to be most intense during the construction phase contributing 1.9, 1.4 and 0.44 % to the annual emissions of $CO_2$, $NO_x$ and $SO_2$ respectively for all activities (mainly shipping traffic) in the Baltic Sea. It is expected that there will be a **cumulative negative** impact on atmospheric $CO_2$ levels from construction activities, operating on a **national** to **transboundary** scale and over a **long-term** duration. However, since emissions levels relating to the Project are low compared to those from existing shipping traffic, impact intensity is considered to be **low** and impact magnitude is also considered to be **low**. The atmosphere is considered to have a **low** sensitivity, for reasons described in **Section 8.5.1**. The significance of this impact in ESR III, and for the length of pipelines' route as a whole, is expected to be **minor**.

**Impacts during the Operational Phase**

During the operational phase in ESR III, routine inspections and maintenance will have associated pollutant emissions, as for the construction phase, which will also potentially contribute to acidification, eutrophication and climate change, with associated negative impacts on marine and terrestrial receptors.

*Emissions of pollutant gases*

During the operational phase, the type of impacts on the atmosphere in ESR III will be similar to those during construction (emissions from vessels and machinery associated with routine inspections and maintenance). As described in **Section 9.3.5**, and as shown in **Table 9.8**, emissions associated with the operational phase of the Project are expected to contribute 0.13, <0.05 and <0.05 percent to the annual emissions of $CO_2$, $NO_x$ and $SO_2$ respectively for all activities (mainly shipping traffic) in the Baltic Sea. Emissions associated with routine inspections and maintenance will again be much lower than for those from the construction phase, although they will occur over a longer period. The impact is considered to be **insignificant**.

**Impact Summary**

The impacts on the atmosphere identified and assessed in ESR III are summarised in **Table 9.45**.

(1) Swedish Environmental Research Institute (IVL). 2008. Complementary IVL background report: Environmental aspects of dumped ammunition and remaining sea mines in the Baltic Sea.

**Table 9.45 ESR III impact summary table for the atmosphere**

| Atmosphere - Ecological Sub-Region III | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Emissions of pollutant gases | Munitions clearance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Seabed intervention works, Pipe-laying | Negative | Cumulative | National - Transboundary | Long-term | Low | Low | Low | Irreversible | **Minor** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.5.6 Biological Environment – Plankton

#### Overview

The plankton dynamics in the Baltic Sea vary widely with time and geographical scale. Values/sensitivities for both phytoplankton and zooplankton in ESR III are detailed in **Chapter 8** and summarised in **Table 9.46**.

**Table 9.46 Value/sensitivity of plankton in Ecological Sub-Region III**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Plankton** | | | | | | | | | | | | |
| Phytoplankton | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Zooplankton | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |

Given that plankton drift in the water column, there is no potential for the Nord Stream Project to change the abundance or distribution of plankton in general in the ESR. As described in ESR I, potential impacts on plankton as a result of the Project are expected to be **insignificant** in ESR III.

### 9.5.7 Biological Environment – Marine Benthos

#### Overview

As described in the baseline (**Chapter 8**), macrophytes within ESR III are only found near the shore in shallow areas where light permits the growth of macroalgae and seagrasses. Reed beds and other littoral vegetation are found on sheltered shores. The pipelines' corridor within ESR III lacks macrophyte and macroalgal communities as the waters are light deficient.

Zoobenthos are able to survive in much deeper water as they do not require light. As described in **Section 8.9.4**, zoobenthos were found during sampling of ESR III but in much lower numbers as compared to other ESRs. At greater depths in ESR III, the water is predominantly anoxic preventing the majority of fauna from surviving here and keeping the abundance and biomass of the zoobenthos community low.

Following a scope and impact identification exercise as described in **Chapter 7**, interactions between marine benthos in ESR III and the Nord Stream Project that could give rise to potential impacts have been identified. Values/sensitivities for marine benthos are detailed in **Chapter 8** and summarised in **Table 9.47.**

**Table 9.47 Value/sensitivity of marine benthos in Ecological Sub-Region III**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Benthos** | | | | | | | | | | | | |
| Macroalgae and aquatic vegetation | | | | | | | | | | | | |
| Bladder wrack and seagrass assemblage | Med | Med | Med | Med | Med | Med | Med | Med | Med | Med | Med | Med |
| Emergent vascular plants | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Algae on rocky bottom | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Zoobenthos | | | | | | | | | | | | |
| Soft-bottom community | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |

The majority of ESR III is devoid of life on the seabed. Benthic fauna are only expected to be found in waters with sufficient oxygen and are therefore usually found in shallower water (less than 60 to 80 m deep). However, in times of oxygen inflow from the North Sea, benthic fauna may also be found in deeper water. Sections of ESR III that are deeper than 50 m have insufficient light levels to allow photosynthesis. The Nord Stream Project is expected to only cause impacts to benthos in those areas within ESR III that support life and of these, only a small proportion will be impacted by the Project.

This section identifies and assesses the potential impacts on marine benthos in ESR III during the construction, pre-commissioning and operational phases of the Project in terms of the methodology presented in **Chapter 7**. The impacts as a result of hyperbaric tie-ins following pre-commissioning have been included in the construction phase. Impacts during the operational and pre-commissioning and commissioning phases are expected to be minimal in comparison to construction. The activities and the related impacts that are assessed in this section are as follows:

*Construction phase*

- Munitions clearance, seabed intervention works and pipe-laying resulting in:
    - Increase in turbidity

- Munitions clearance, seabed intervention works, pipe-laying and anchor handling resulting in:
  - Release of contaminants
- Seabed intervention works resulting in:
  - Release of nutrients
- Munitions clearance and seabed intervention works resulting in:
  - Noise and vibration
- Munitions clearance, seabed intervention works, pipe-laying, anchor handling and hyperbaric tie-in activities resulting in:
  - Physical loss of seabed habitats
- Seabed intervention works and pipe-laying resulting in:
  - Smothering
- Construction and support vessel movement resulting in:
  - Introduction of non-indigenous species (due to the transport and release of ballast water and via biofouling of ship hulls)

*Pre-commissioning and commissioning phase*

- Pipeline flooding and pressure-test water discharge resulting in:
  - Noise and vibration

*Operational phase*

- Routine inspections and maintenance works resulting in:
  - Physical alteration of the seabed
- Pipeline presence resulting in:
  - Introduction of secondary habitats
  - Temperature change
  - Physical alteration of the seabed

**Impacts during the Construction Phase**

Impacts upon the benthos during the construction phase are limited to an increase in turbidity, the release of contaminants and nutrients, noise and vibration, physical loss of seabed habitats and smothering of benthos as a result of munitions clearance, seabed intervention works including trenching, as well as pipe-laying, anchor handling and hyperbaric tie-in activities.

*Increase in turbidity*

As discussed in **Section 9.3.7**, munitions clearance will take place before construction activities begin. In ESR III there are four munitions to be cleared near ESR II and a further one in the rest of ESR III. The increase in turbidity from munitions clearance will have a **direct**, **negative** impact on marine benthos on a **regional** scale, impacting benthos in the **short-term** to **long-term** as recovery of the community is dependent on recruitment from the surrounding areas. Most benthic fauna, including non-burrowing species, would be expected to be able to survive even high levels of deposition, the impact would be **reversible** and the intensity of the impact is expected to be **low** as a localised group of individuals will be affected with many individuals expected to survive a certain degree of smothering. The magnitude of the impact is also expected to be **low**. As described above, the sensitivity of the benthos communities within ESR III is considered **low** for all communities as the medium sensitivity bladder wrack and seagrass are only found in coastal areas which are too far away from the pipelines to be impacted. The impact significance due to munitions clearance is therefore predicted to be **minor**.

Trenching, rock placement, installation of support structures and pipe-laying will all cause re-suspension of sediments thereby increasing turbidity in the water column. This impact is described in detail in **Section 9.3.7**. Within ESR III, the conditions are different as the water in this region is hypoxic along the pipelines' corridor. Models of sediment spread predict maximum construction induced deposits of 1 mm or less along the pipelines' corridor within ESR III. The species of benthic fauna found in the depauperate community along the pipelines' corridor within ESR III should be sufficiently mobile to extricate themselves from this small amount of sediment deposition. As such, the potential impact of sediment re-suspension and subsequent smothering of the benthos within ESR III is considered to be **insignificant**.

*Release of contaminants*

Munitions clearance, seabed intervention works, pipe-laying and anchor handling will cause disturbance to the seabed as detailed in **Section 9.3.3**, which could release contaminants to the water column and surface layers of the seabed. These contaminants have the potential to cause toxic effects to fauna on the seabed within ESR III and may have an indirect effect as a result of contamination of the water column on the benthos, particularly to suspension feeders. In addition, benthic fauna may bioaccumulate some of these contaminants resulting in increased concentrations within the organisms, potentially leading to harmful effects.

The level of contamination in the sediment within ESR III is not fully understood and, as described in **Section 9.5.3**, increases in contaminant concentrations are not predicted to be significant. The concentration of contaminants in the water column is also expected to decrease with time reducing the potential for harmful levels of contaminants to accumulate within the organisms. In addition to these contaminants, the deeper, anoxic sediment areas of ESR III may contain high concentrations of hydrogen sulphide ($H_2S$). This may have toxic effects on the benthos if released as a result of seabed disturbance during construction activities.

The mitigation measures described to minimise impacts from suspended sediment will also reduce the significance of potential impacts caused by contamination of the seabed and water column resulting from seabed disturbance. The residual impact from contaminants released from disturbed sediments to the benthos after these mitigation measures have been implemented is expected to be **negative**, **direct** to the seabed and **indirect** through the water column. It is expected to be **local** and **long-term** as particle-bound contaminants will be present in the surface layers of the sediment for many years. The impact on fauna from contaminants released from the sediment will have a **low** intensity and **low** magnitude as changes are expected to be at the limit of detection and affect a group of localised individuals. This impact is **reversible** since the effects will be limited in time. The benthos within ESR III that are likely to be impacted by a physical loss of habitat are considered to be of **low** sensitivity. The impact significance is expected to be **minor**.

*Release of nutrients*

Seabed intervention works are expected to release nutrients from disturbed sediment. As discussed in **Section 9.3.7**, an increase of 0.4% of nitrogen and 0.2% of phosphorus is expected compared to background inputs to the Baltic Sea. The amount of nutrients expected to be released during construction activities within ESR III is unknown but within ESR III the small predicted increase in nutrients is expected to have an **insignificant** impact on benthic fauna or flora within ESR III.

*Noise and vibration*

As for ESR I, impacts resulting from munitions clearance activities must be considered for ESR III. Munitions clearance causes a shockwave that has the potential to impact benthos and in particularly the larger, more mobile species. Details of the size and power of the potential shockwave are not available but it is considered likely that this activity would cause a **local** impact. A shockwave would cause a **direct**, **negative** and **reversible** impact. The impact is likely to be **temporary** as the shockwave would quickly dissipate with time and distance. The effects are not clear but it is expected there would be a **low** to **medium** intensity impact. The benthos along the pipelines' corridor within ESR III are considered to be of **low** sensitivity as the medium sensitivity bladder wrack and seagrass are only found in coastal areas which are too far away from the pipelines to be impacted. The details of the size and power of the shockwave are not known but it is expected it will have a **low** magnitude effect on the soft tissue of benthic fauna. The overall impact significance is therefore **minor**.

As described in **Section 9.3.7**, most benthic fauna along the pipelines' route are not sensitive to noise and will therefore not be affected by noise from construction activities. However, some invertebrates have been known to respond to noise and vibration in the water[(1),(2)]. Noise and vibration due to rock placement and construction and support vessel movement are expected to have no impact on benthic invertebrates beyond the impact area that will cause habitat loss and smothering. Trenching will occur in several areas of ESR III. At 150 m away from ploughing activities noise peaks are at 5 – 10 Hz and 20 – 80 Hz but will cause a sound power level greater than 80 dB re 1 µPa between 2 and 100 Hz. The majority of this noise is below the published hearing frequency of invertebrates that have been studied. The common lobster *Homarus gammarus* has a hearing range of 100 to 3,000 Hz[(3)]. This study by Horridge showed that the threshold of hearing was 110 dB at 500 Hz. As described in **Section 9.3.7**, there is no conclusive evidence to determine whether benthic fauna are impacted by noise but it is unlikely they will be affected by construction noise. The impact on benthos of noise and vibration due to rock placement, trenching and construction and support vessel movement is therefore considered to be **insignificant**.

*Physical loss of seabed habitats*

Munitions clearance, trenching, rock placement, installation of support structures and pipe-laying will result in a physical loss of seabed and potential destruction of fauna within the pipelines' corridor. Anchor handling can cause scarring of the seabed and may also cause destruction of fauna. However, the majority of ESR III covers areas of the pipelines' route that are deep and predominantly anoxic and so support little or no benthic community.

Munitions clearance will result in physical disturbance to the seabed and loss of benthos habitats that will be **negative** and **direct**. The impacts are likely to affect an area within 500 m of the pipelines' corridor and it will therefore be a **local** impact. The impact due to loss of habitat from the munitions clearance is likely to be **short-term** and **reversible.** The intensity of the impact is **medium** as localised habitat and associated benthos will be destroyed but not to the extent that the whole population will be affected. The magnitude of the impact will be **low** as only a small proportion of the benthic community in ESR III is expected to be affected. As marine benthos is of **low** sensitivity, overall this impact is expected to be of **minor** significance.

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(1) Horridge, G.A. 1966: Some recently discovered underwater vibration receptors in invertebrates. In: Barnes, H. (ed.), Some Contemporary Studies in Marine Science. George Allen and Unwin Ltd. London.

(2) Lovell, J.M., Findlay, M.M., Moate, R.M. & Yan, H.Y. 2005. The hearing ability of the prawn *Palaemon serratus*. Comparative Biochemistry and Physiology. Part A. 140.

(3) Horridge, G.A. 1966. Some recently discovered underwater vibration receptors in invertebrates. In: Barnes, H. (ed.). Some Contemporary Studies in Marine Science. George Allen and Unwin Ltd. London.

Rock placement will occur at several sections of the pipelines within ESR III and will require approximately 124,000 $m^3$ of rock to be placed along the pipelines' route within ESR III. The footprint of each area of rock placement is likely to cover an area between 8 and 15 m wide with a maximum of 60 m across the pipelines although it may be larger for some sections of the pipelines. The loss of habitat and destruction of benthos as a result of rock placement will be **negative** and **direct**. However, the impact will be restricted to within approximately 15 m of the pipelines and will therefore have a **local** effect in discrete areas. As with pipe-laying and trenching, the benthos would be expected to recover from the loss of habitat within the **short-term**. Rock placement is also likely to cause a **medium** intensity impact. The overall magnitude is likely to be **low** and the impact will be **reversible** as a localised group of individuals will be affected and although rock placement will permanently remove the existing habitat, a new habitat will be formed by the rocks themselves that will support a new benthic community. The benthos within ESR III is considered to be of **low** sensitivity as described above. The effect of rock placement on marine benthos from physical loss of seabed habitats is considered to be of **minor** significance.

The area of the seabed lost to trenching and pipe-laying is a long, narrow strip. As described in **Section 9.4.7**, the corridor for each pipeline is approximately 15 m wide and pipe-laying is expected to occur at a rate of 2 to 3 km a day. This is a small area of habitat loss in comparison to the total ESR III area. Trenching is expected to be required for approximately 33 km of the pipelines within ESR III. The pipelines will be laid and subsequently sunk into a trench and require excavation only immediately underneath the pipelines. This impact is expected to have a similar impact to that caused by pipe-laying in terms of loss of habitat. The impact from pipe-laying and post-lay trenching will be **negative** and **direct**. As the impact is restricted to a footprint that is approximately 7.5 m either side of the pipelines, the impact is **local**. Whilst the loss of habitat will be permanent, the benthos is expected to recover from this loss of habitat within the **short-term** provided ambient oxygen conditions permit their recovery. Benthos may be destroyed and habitat removed but the entire benthic population is not expected to be affected. This is therefore a **medium** intensity impact. However, overall this is a **low** magnitude impact as only a specific group of localised individuals living in these anoxic conditions are likely to be affected and it is highly unlikely that this impact will change the abundance or reduce the distribution of benthos. The loss of habitat is **reversible**. The benthos within ESR III that are likely to be impacted by a physical loss of habitat are considered to be of **low** sensitivity as the medium sensitivity bladder wrack and seagrass are only found in coastal areas which are too far away from the pipelines to be impacted. The overall impact significance is therefore expected to be **minor**.

The potential area of the seabed that may be impacted from anchor handling is likely to be a sizeable area as there will be a footprint from anchor handling along the entire length of the pipelines' corridor. An estimate of the physical impact area of each anchor is provided in **Section 9.3.7**. Anchoring will be restricted to a corridor up to 1 km wide on either side of the pipelines. Twelve anchors will be placed on the seabed at any one time, each covering an area of approximately 20 $m^2$. Therefore a total area of approximately 240 $m^2$ of the seabed will be affected at any one time. The number of anchor movements will determine the total area of benthic habitat that is affected.

The following mitigation measures are planned to address or reduce the significance of the identified potential impacts associated with physical loss of the seabed and impacts from anchor handling on the benthos:

- The proposed pipelines' route has been chosen and optimised to avoid sensitive seabed areas and protected areas to reduce impacts to benthic fauna

- Anchor handling will be kept as practically possible to a minimum. Anchors will not be dragged through the seabed but rather raised during relocation

The loss of habitat and physical disturbance of the seabed after mitigation of anchor handling is expected to be **negative** and **direct** but limited to discrete, **local** areas. The impact from anchor handling is expected to be **short-term** as re-colonisation of the area is considered possible after construction activities cease, provided that sufficient oxygen is available. The intensity of impact is **medium** as the impact will destroy the benthos and their habitats but will not affect the entire benthic population. The loss of habitat is **reversible**. The impact magnitude is **low** as the loss of habitat will affect a specific group of localised individuals living in the anoxic conditions of ESR III. The benthos within ESR III is considered to be of **low** sensitivity. The overall impact significance is therefore expected to be **minor** to the benthic community.

One hyperbaric tie-in will be carried out within ESR III and seabed disturbance from this tie-in has the potential to impact benthos within ESR III. The tie-in operation will require an offshore welding habitat with a large footprint causing a temporary physical loss of seabed. The impact is expected to be **negative** and **direct**. The size of the footprint is unknown but it is expected to incur a **local** and **short-term** effect. It is expected to cause a **medium** intensity impact as the benthos and their habitats may be destroyed but the impact will affect a small number of individuals living within the anoxic conditions of the deeper areas of ESR III. Impacts are **reversible**. The loss of habitat and individual benthic fauna will affect a specific group of localised individuals within a population resulting in a **low** magnitude impact. The impact significance is therefore expected to be **minor** as the sensitivity of the benthos potentially impacted is considered to be of **low** sensitivity.

*Smothering*

Trenching, rock placement, installation of support structures and pipe-laying will create spoil material that can blanket the surrounding area. Smothering of benthic flora and fauna can be partial, causing increased survival effort, or complete smothering that can lead to death. This is of particular concern for sessile fauna.

The following mitigation measures are planned to address or reduce the significance of the identified potential impacts associated with increased sedimentation on benthic fauna:

- The proposed pipelines' route has been chosen and optimised to avoid sensitive seabed areas and protected areas to reduce impacts to benthic fauna
- Seabed intervention works shall be restricted to the pipelines' corridor only

Trenching can form piles of soft sediment at the edge of the trenches as it is pushed up by the plough. This can also happen as a result of other types of seabed intervention works. Such piles may slump laterally, covering an area of seabed and smothering benthos with anoxic sediments. The residual risk of smothering of benthos as a result of lateral slumping of sediments after mitigation measures have been implemented is **negative** and **direct**. Laterally slumped material is expected to be mobilised only over relatively short distances and is therefore predicted to have a **local** impact. The effect of smothering on the benthos as a result of lateral slumping is expected to have a **short-term** to **long-term** effect depending on the thickness of deposited material. Many benthic species may survive a thin layer of sediments (< 10 mm), but will succumb underneath thicker layers of anoxic sediment. ESR III is poorly populated in the deeper, hypoxic areas but is expected to recover due to recolonisation by individuals migrating in from other areas. A **medium** intensity impact is expected as any fauna that are smothered will suffer from oxygen depletion and will be exposed to high levels of toxic hydrogen sulphide that are naturally found in sediments but this impact is not expected to compromise the entire benthic population. This impact is expected to have a **low** magnitude effect as the impact is expected to affect individuals within the pipelines' footprints only. This impact is **reversible** as smothering will cease at the end of construction and the area is expected to be colonised by new individuals from other benthic communities. As mentioned above the benthos within ESR III that are likely to be impacted by a physical loss of habitat are considered to be of **low** sensitivity. The overall impact significance is therefore expected to be **minor**.

*Introduction of non-indigenous species*

It is possible that invasive species enter the Baltic system through biofouling of the ship hull of the vessels involved in the construction. This could allow the accidental spread of invasive benthic species into and across the Baltic. The use of antifouling paints, careful cleaning of hulls, tanks and drilling and dredging equipment before use prior to entering the Baltic will limit the potential introduction of invasive species. The risk of intra-Baltic spread of formerly introduced species in one part of the Baltic (e.g. from ports in the western Baltic part) to another area by the project is negligible in comparison to existing maritime activities. Differences in environmental conditions between the various ESRs of the Baltic Sea also constrain the spread of the invasive species from one area to another. The conditions at the seabed along the pipelines route in ESR III particularly prove hostile to many benthic species. The unintentional introduction of invasive species into the Baltic Sea or from one area of the Baltic to another poses a negligible risk. Consequently, the residual impacts of the construction phase on benthic communities in ESR III will be **insignificant**.

### Impacts during the Pre-commissioning and Commissioning Phase

Potential impacts to benthos during the pre-commissioning and commissioning phase in ESR III are limited to noise due to pipeline flooding and pressure-test water discharge, since these activities will involve the movement of water in the pipelines along the route.

*Noise and vibration*

As mentioned above, most benthic fauna are not sensitive to noise, although some invertebrates do respond to noise and vibration. The noisiest aspect of the pre-commissioning and commissioning phase will be movement of water in the pipelines during pipeline flooding and pressure-test water discharge and movement of gas in the pipelines during commissioning. Noise produced during this activity will be much less than noise produced during trenching and so impacts from noise during the pre-commissioning and commissioning phase are expected to have an **insignificant** impact on marine benthos.

### Impacts during the Operational Phase

During the operational phase, physical alteration of the seabed due to routine inspections and maintenance and pipeline presence, and the introduction of secondary habitats, temperature change and the release of pollutants due to anti-corrosion anodes as a result of pipeline presence will have the potential to impact benthos.

*Physical alteration of the seabed*

Routine inspections of the pipelines are expected to have an **insignificant** impact on benthos in ESR III as inspections will be infrequent and restricted to the pipelines themselves, therefore resulting in low levels of disturbance to the seabed. However, maintenance or improvement works may result in localised disturbance including direct loss of benthic fauna and smothering due to sediment re-suspension. The impact is expected to be **negative** and **direct** incurring a **local** and **short-term** effect as maintenance activities will only affect a small area for a limited period of time. Impacts are expected to be of **medium** intensity. Impacts are **reversible** as impacted areas will be recolonised within a few years. Impacts are expected to be of **low** magnitude as only a very limited number of individuals are expected to be impacted, which are considered to be **low** sensitivity receptor as the medium sensitivity bladder wrack and seagrasses are too far away to be affected by this local change. The impact significance is expected to be **minor**.

*Introduction of secondary habitats*

As described in **Section 9.3.7**, pipeline presence may alter the composition and abundance of the benthic community. The pipelines will form a hard surface in what is largely a soft muddy environment which will support a different community of benthic fauna to that of the surrounding seabed and the hard substrates that are introduced by rock placement operations. Installation of support structures will further increase habitat diversity. An overall increase in localised biodiversity and abundance (possibly including invasive species previously introduced) may result although the magnitude of the impact in ESR III will be **low** due to the low oxygen concentrations that frequently characterise this ESR. Therefore a **direct** impact is expected which will be **local** to the pipelines' structure and **long-term** as the benthos are expected to use the pipelines as a habitat for as long as the pipelines are in place. This impact may be **positive** or **negative** depending on the composition of the benthic community that colonises the pipelines. The impact intensity is expected to be **low** as the impact is unlikely to be greater than the limit of detection. This impact is **irreversible** unless the pipelines are removed during decommissioning. The magnitude of the impact is expected to be **low** as only a localised group of individuals (**low** sensitivity) are expected to be impacted resulting in a **minor** impact to the benthos.

*Temperature change*

Natural gas flowing through the pipelines is expected to cause an increase in temperature at the Russian end of the pipelines and a decrease in temperature at the German end of the pipelines. However, these changes will be localised and will not extend into ESR III. Temperature differences between the pipelines and the marine environment are therefore considered to have **no impact** on the benthos in ESR III.

*Release of pollutants from anti-corrosion anodes*

In ESR III, aluminium anodes will be used to protect the pipelines from corrosion. Aluminium anodes release fewer contaminants to the water column than zinc anodes and the impact to the benthos as a result of such releases is considered **insignificant**.

**Impact Summary**

The impacts identified and assessed in ESR III on marine benthos are summarised in **Table 9.48**.

**Table 9.48 Impact summary table for marine benthos in ESR III**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Marine Benthos - Ecological Sub-Region III | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term - Long-term | Low | Low | Low | Reversible | **Minor** |
| | | Trenching, Rock placement, Installation of support structures, Pipe-laying | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of contaminants | Munitions clearance, Seabed intervention works, Pipe-laying, Anchor handling | Negative | Direct and indirect | Local | Long-term | Low | Low | Low | Reversible | **Minor** |
| | Release of nutrients | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Munitions clearance | Negative | Direct | Local | Temporary | Low - Medium | Low | Low | Reversible | **Minor** |
| | | Rock placement, Trenching, Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline flooding, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Physical loss of seabed habitats | Munitions clearance | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | | Rock placement | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | | Trenching, Pipe-laying | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | | Hyperbaric tie-ins | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | Smothering | Trenching, Rock placement, Installation of support structures, Pipe-laying | Negative | Direct | Local | Short-term - Long-term | Medium | Low | Low | Reversible | **Minor** |
| | Introduction of non-indigenous species | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | Physical alteration of the seabed | Routine inspections | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine maintenance | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | Introduction of secondary habitats | Pipeline presence | Positive or Negative | Direct | Local | Long-term | Low | Low | Low | Irreversible | **Minor** |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature change | Pipeline presence | - | - | - | - | - | - | - | - | **No impact** |
| | **Impact** | **Activity** | **Nature** | **Type** | **Impact Magnitude** | | | | **Value/ Sensitivity** | **Reversibility** | **Significance** |
| | | | | | **Scale** | **Duration** | **Intensity** | **Magnitude** | | | |
| | Release of pollutants from anti-corrosion anodes | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

## 9.5.8 Biological Environment – Fish

### Overview

In ESR III the Nord Stream Project has the potential to impact fish during construction, through impacts to water quality, changes to the seabed habitats, underwater noise, disturbance caused from construction and support vessel movement. Impacts to fish may occur during the pre-commissioning, commissioning and operational phases as a result of noise and vibration, the physical alteration of the seabed and temperature change.

Due to the ambient conditions and impoverished benthic community throughout most of ESR III, the majority of the ESR is not an important habitat for demersal and benthic fish species. However, as described in the **Section 8.9.5**, several economically important pelagic species are common in ESR III and economically important pelagic and demersal species including cod and sprat (*Sprattus sprattus balticus*) use the basins of ESR III as spawning grounds.

Values/sensitivities for fish in ESR III are detailed in **Section 8.9.5** and summarised in **Table 9.49**. In some cases, the sensitivity of a particular species may be higher or lower and impacts have then been assessed on species-specific basis.

**Table 9.49 Values/sensitivities of fish in Ecological Sub-Region III**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fish** | | | | | | | | | | | | |
| Pelagic fish (sprat and herring) | Low | Low | Med | Med | Med | Med | Med | Low | Low | Low | Low | Low |
| Demersal fish (cod and flatfish species) | Low | Low | Low | Low | Med | Med | Med | Med | Low | Low | Low | Low |
| Diadromous species | Low | Low | Low | Low | High | High | Low | Low | Low | Low | Low | Low |

**Atlas Map PR-3a** shows the locations of the various seabed intervention works planned for ESR III. The impacts as a result of a hyperbaric tie-in following pre-commissioning have been included in the construction phase. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Construction and support vessel movement and the re-suspension and spreading of sediments from munitions clearance, seabed intervention works, pipe-laying, anchor handling and hyperbaric tie-in activities resulting in:
  - Increase in turbidity
  - Release of contaminants
  - Noise and vibration
  - Visual/physical disturbance

*Pre-commissioning and commissioning phase*

- Construction and support vessel movement associated with the pre-commissioning and commissioning phase resulting in:
  - Noise and vibration

*Operational phase*

- Routine inspections and maintenance works and pipeline presence resulting in:
  - Noise and vibration
  - Physical alteration of the seabed
  - Temperature change

**Impacts during the Construction Phase**

Impacts upon fish during the construction phase are anticipated as a result of the seabed intervention works limited to the re-suspension and spreading of sediments, resulting in an increase in turbidity and the release of contaminants (heavy metals and organic pollutants) as a result of munitions clearance, pipe-laying, anchor handling, seabed intervention works and hyperbaric tie-in activities. Noise and vibration and disturbance from vessel movement are expected from the same activities.

*Increase in turbidity*

Re-suspension of sediments and consequent increases in turbidity will result from munitions clearance, seabed intervention, pipe-laying, anchor handling and hyperbaric tie-in works. Increases in turbidity as a result of munitions clearance, seabed intervention works and pipe-laying may potentially cause physiological damage to any fish species that are present in the areas of increased turbidity, particularly to flatfish such as flounder, plaice (*Pleuronectes platessa)*, turbot (*Psetta maxima*) and brill (*Scophthalmus rhombus*). The majority of ESR III, has a permanent halocline at 60 to 80 m (see **Atlas Maps BA-01** and **WA-1**), and has an impoverished benthic fish community in comparison to the other ESRs. Most fish species present (including a number of sensitive species such as Atlantic salmon, European eel, herring and shad (*Alosa* sp.) inhabit waters above the halocline. The zone of elevated turbidity will remain below the halocline, so the vast majority of species will not be affected by elevated turbidity as a result of construction works at the sea bottom and therefore the impact will be **insignificant** throughout much of ESR III.

The seabed in the Bornholm Deep, however, is a section of ESR III that is an important spawning area for sprat, cod and flounder. Cod usually spawn at or near the seabed when temperatures and oxygen conditions are suitable. Successful spawning in the Baltic Sea does not occur every year because oxygen concentrations in the deep water areas are not always high enough to allow egg development (See **Atlas Map WA-10**). Nonetheless, in some years (e.g. 2003) oxygen conditions in the Bornholm Deep basin are suitable and these years are extremely important to the persistence of the cod population. Elevated turbidity due to construction work during the cod spawning season could affect the reproductive success of cod in three ways:

- High suspended sediment concentrations may displace adults away from their natural spawning areas
- Re-suspension of sediment will mobilise organic matter and nutrients, which will be broken down by microorganisms and potentially causing oxygen concentrations to fall below the threshold at which successful egg development can occur (1 to 2 mgl-1 for most species)
- Re-settling sediment may smother eggs and larvae and prey items

This may result in reduced recruitment to the adult population for cod. Within the Bornholm Deep, the pipelines will be laid on the seabed and no further seabed intervention works are planned. Therefore, the re-suspension of sediment will be minimal in this important spawning area. Consequently the residual impact of munitions clearance, seabed intervention works and pipe-laying resulting in the increase in turbidity on fish species during the construction phase is expected to be **insignificant.**

Throughout the construction phase, anchors from each pipe-laying vessel and associated support vessels will have to be constantly repositioned. This and drifting anchors and chains dragging across the seabed and the additional impact of ship propellers in these shallow waters will give rise to increased turbidity. The lifting of the pipelines off the seabed and the repositioning back on the seabed will give rise to limited increased turbidity. However, in comparison to turbidity as a result of fishing and trawl nets, these impacts are considered to be minimal and therefore **insignificant**.

In ESR III, both pipelines will be tied in by means of a hyperbaric tie-in at KP 675 to the east of Gotland, of which does not lie within an important spawning ground. Re-suspension of sediments and consequent increases in turbidity will result from the hyperbaric tie-in activities. The zone of elevated turbidity (expected to be minimal) will be localised at KP 675. These areas are characterised as being beneath the halocline. Due to its tie-in activity being of a highly localised nature as well as due to the presence of a halocline the vast majority of species will not be affected by an increase in turbidity. The impact is deemed to be **insignificant**.

*Release of contaminant*

An increase in the concentration of dissolved contaminants in the water column due to the release of contaminants from re-suspended contaminated sediment during seabed intervention works could affect fish spawning and the fish themselves (see ESR I for details). Contaminants of concern include heavy metals and organic compounds including PAHs. Seabed intervention works will only take place in a limited number of locations in ESR III. These locations coincide with areas that are used by a number of species that spawn widely throughout the Baltic Sea but are not located in any specific spawning grounds such as those for cod, sprat or herring. Eggs and larvae from broadcast spawners will drift into construction areas, but the densities will be relatively low and represent a small proportion of the overall number. In addition, as a halocline exists in much of ESR III, eggs and larvae from pelagic spawners will remain in the upper layers of the water column and will not be affected by the release of contaminants immediately above the seabed.

Pelagic species in ESR III largely remain above the halocline and will therefore not be affected by the elevated concentrations of dissolved contaminants. Species such as cod and sprat which spawn within sections of ESR III, such as the Bornholm Deep could potentially be affected. However, the period of exposure will be very short and, fish are likely to avoid areas of elevated turbidity. Some fish species such as perch and roach use turbidity as a refuge when macrophytes are not present(1) and may be subject to higher levels of contaminants as a result. However, seabed intervention works will result in increased noise and vibration. Consequently fish will move away from the areas of increased turbidity as these areas coincide with where increased noise levels occur.

(1) Pekcan-Hekim, Z. 2007. Effects of turbidity on feeding and distribution of fish. Doctoral dissertation (article-based). University of Helsinki. Faculty of Biosciences. Department of Biological and Environmental Sciences, Aquatic Sciences.

The following mitigation measures are planned to be carried out where possible, to address or reduce the significance of the identified potential impacts associated with construction activities on benthic spawning fish:

- In order to reduce the volume of re-suspended sediments, the pipelines' route has been optimised to reduce the extent of seabed intervention works required. Where possible, the pipelines' route will traverse areas free of outcrops and depressions

- Anchor handling will be kept to a minimum to reduce sediment disturbance. Anchors will not be dragged through the seabed but rather raised during relocation

The lack of species that specifically spawn in the areas where the seabed intervention works will take place means that concentrations of eggs and larvae at these sites will be low, and densities of planktonic eggs and larvae naturally vary greatly. Any changes to the densities of eggs or larvae due to seabed intervention works will therefore be undetectable against natural variability and therefore the impact is assessed to be **insignificant.**

*Noise and vibration*

One of the main potential impacts to fish in ESR III will be increased levels of underwater noise and vibration as a result of construction. Approximately 2 to 3 km of pipeline will be laid per day, thus the daily potential for creation of noise and vibration will be restricted to this immediate area. Underwater noise and vibration could arise from a number of activities during the construction phase, particularly, seabed intervention works, the installation of support structures, pipe-laying and construction and support vessel engines.

Of the species in ESR III, cod and herring are the most sensitive to noise. The auditory detection limits of flatfish are understood to be considerably lower than cod and herring (see **Section 9.3.8**). Cod are capable of distinguishing between spatially separated sound sources and also between sources at different distances and they are particularly sensitive to noise at frequencies around 150 Hz and 160 Hz. The Bornholm Deep is an important spawning area for cod and the proposed pipelines' route extends for approximately 100 km through this important spawning ground in ESR III. As described in the baseline, the shallower slopes of Bornholm Deep and Gotland Deep in ESR III are also important for sprat and flounder (*Platichthys flesus*) spawning. In ESR III, herring is one of the most sensitive species to noise impacts and can hear in an extended range of frequencies of between 30 Hz and 4kHz with a hearing threshold of 75 decibels (dB) re 1µPa at 100 Hz(1). Increased noise levels in these areas will impact spawning success rates of cod, sprat and flounder if construction is carried out during the spawning

(1) Enger, P.S. 1967.Hearing in Herring. Comparative Biochemistry and Physiology. 22.

season between March and August. As herring do not spawn in ESR III[1] herring spawning will not be impacted.

As in ESR II (see **Section 9.4.8**) salmon spawning will not be impacted by noise related activities as salmon spawn in rivers. Salmon respond only to low-frequency tones (below 380 Hz), with best hearing at 160 Hz. The hearing of salmon is poor, with narrow frequency span, poor power to discriminate signals from noise and low overall sensitivity[2]. Salmon feeding in the area of the pipeline construction activities will be able to move away from any area of excessive noise and vibration.

Tissue damage can arise from the differential rate of transmission of sound pressure waves through tissues of varying densities. Several munitions have been detected within the pipelines' corridor in ESR III. Their exact location is currently confidential. Ruptures of the swim bladder, haemorrhages and ruptures to internal organs such as the kidneys or the liver may result as a result of the clearance of conventional munitions[3]. As described in **Section 9.3.8** the peak noise levels during such an event are expected to be significantly greater than the hearing thresholds of most fish in the Baltic, including herring and sprat. Fish with a swim bladder such as cod, herring and sprat are more sensitive than fish that lack swim bladders (e.g. flatfish).

The impacts of an explosion which cause the most harm to fish is caused by the differential rate of transmission of pressure waves[4]. A previous study carried out in the Baltic shows that all Baltic herring and sprat within a 1.5 km radius of a planned detonation were instantly killed[5]. Salmon and sea trout were affected only within the immediate vicinity of the explosion. As loud noise usually initiates an avoidance response, some fish in ESR III will move away from the pipelines as a result of disturbance from vessels associated with munitions clearance and return once munitions clearance has completed. However, displacement of fish away from their usual spawning grounds during the spawning season could have a significant impact on recruitment to the adult population. As such, fish spawing times will be considered during munitions clearance and an acoustic survey will take place prior to clearance to ensure that schools of fish are not present.

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(1) Swedish Environmental Research Institute (IVL). 2008. Personal communication.

(2) Hawkins, A. D. and Johnstone, A .D. F. 1978. The hearing of the Atlantic salmon (*Salmo salar*). Journal of Fish. Biology. 13.

(3) Wright, D.G and Hopky, G.E. 1998. Guidelines for the use of explosives in Canadian fisheries waters. Canadian Technical Report of Fisheries and Aquatic Sciences. 2107.

(4) Wright, D.G and Hopky, G.E. 1998. Guidelines for the use of explosives in Canadian fisheries waters. Canadian Technical Report of Fisheries and Aquatic Sciences. 2107.

(5) Karlsson, R-M., Almström, H. & R. Berglind. 2004. In Swedish: Environmental effects of underwater explosions – a literature review: FOI- Swedish Defence Research Agency report.

The impacts of noise generated as a result of munitions clearance on fish will be **negative, direct** and **temporary**. The impact will be on a **regional** scale around the clearance site. Impact intensity is expected to be **medium** to **high** depending on the fish present in the area impacted from the detonation. Impacts may be irreversible at an individual level if death, tissue damage or hearing loss occurs, however at a population level the impact is considered to be **reversible**. Impact magnitude is **medium** and value / sensitivity ranges from **low** to **high** depending on the species impacted. Therefore, impact significance is expected to be **minor** to **moderate**. It should be noted that munitions clearance is a common activity in the Baltic Sea.

In ESR III, the volume of rock to be placed along the pipelines' route is 124,168 $m^3$. Noise generated from rock placement is not expected to exceed background noise and thus **no impact** on fish is anticipated as a result of this particular activity which is carried out at spot locations throughout the pipelines' route in ESR III.

Post-lay trenching will take place for approximately 33 km of the pipelines' route, primarily in the north east of Gotland (See **Atlas Map PR-3a**). In terms of trenching, studies have shown that fish may be able to detect noise of frequency and magnitude with peak levels of 178 dB at 1 metre from the source at 160 Hz, with an overall source level of 185 dB at 1 metre(1). These studies have shown that fish may be able to detect noise of this frequency and magnitude at distances of more than 10 km (1). As trenching within ESR III will be carried out greater than 25 km from Gotland Deep, there will be associated noise impacts on fish but no impact on fish spawning grounds.

In ESR III, hyperbaric tie-in activities will be carried out at KP 675 to the east of Gotland an area which does not lie within an important spawning ground. The mitigation measure planned for fish in ESR III to reduce, minimise and where possible eliminate the impacts of noise emitted from the construction phase of the Project is to ensure wherever possible that equipment to be used during hyperbaric tie-ins is to comply with international standards in terms of noise emissions. Regular maintenance of equipment will be carried out as it is essential to ensure optimal equipment functionality.

As loud noise usually initiates an avoidance response, fish in ESR III will move away while construction is carried out and return once construction has completed. The impacts of noise generated from trenching and hyperbaric tie-ins on fish will be **negative** and **direct** and **regional**. However the mitigation measures proposed will ensure that the impacts will be **temporary**, **reversible** and of **low** intensity. Overall the residual impact will be of **low** magnitude. The sensitivity values of fish impacted by noise in this ESR range from **low** to **high** so therefore will be of **minor** to **moderate** significance.

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(1) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

Fish can acclimate to noise sources and studies have even demonstrated the ability of fish to acclimatise to airgun noise with time[(1)]. The species inhabiting the pipelines' route are already likely to be habituated to vessel noise from other marine traffic as detailed above and the addition of a pipe-laying vessel is unlikely to represent a significant increase in underwater noise. The maximum level of noise anticipated from the vessels is 162 dB. This is slightly higher than that of a fishing trawler (158 dB) and lower than that of the large tankers (177 dB) that are known to operate in the Baltic[(2)]. Impacts on fish as a result of increased vessel noise are deemed to be **insignificant.**

*Visual/physical disturbance*

The presence and passage of vessels throughout this ESR may have some impact on pelagic fish present in the area such as herring, cod, sprat and Atlantic salmon during construction. The increase in vessel traffic however, is unlikely to be a significant increase over existing background levels. The presence of pipe-laying vessels at any one location along the pipelines' route will be for a short duration, as 2 to 3 km of pipeline will be laid per day. The Baltic Sea is a heavily navigated waterway and vessels associated with commercial shipping and fishing vessels will regularly pass through the Project area (see **Atlas Map SH-1**). The addition of an extra few construction vessels over these short periods will not represent a significant increase, particularly because there will be an exclusion zone imposed on other non-project vessels. Due to this, the impact of the presence and passage of vessels on fish is therefore anticipated to be **insignificant** within the context of the Baltic Sea as noise emitted will be indistinguishable from background levels of vessels in the area.

**Impacts during the Pre-commissioning and Commissioning Phase**

During the pre-commissioning and commissioning phase potential impacts upon fish in ESR III are limited to noise and vibration associated with pipeline flooding and pressure-test water discharge.

*Noise and vibration*

Impacts on fish from pipeline flooding and pressure-test water discharge during the pre-commissioning and commissioning phase, and from movement of gas in the pipelines during commissioning, may result as a consequence of underwater noise and vibration, but these impacts are anticipated to be **insignificant** as noise and vibration levels will be low compared to levels from construction phase activities and as pre-commissioning and commissioning activities will be carried out over a short duration.

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(1) Chapman, C.J., and Hawkins, A.D. 1969. The importance of sound in fish behaviour in relation to capture by trawls. FAO Fisheries Reports 62(3).

(2) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

During the pre-commissioning and commissioning phase of the Project, the presence and passage of support vessels may have some impact on fish present in the area, such as herring, cod, sprat and salmon. As with the construction phase of the Project, this increase in boat traffic in ESR III will not be a significant increase over existing background levels and therefore impacts are anticipated to be **insignificant**.

**Impacts during the Operational Phase**

Impacts that will arise throughout the operational phase are anticipated to result from increased noise and vibration, temperature change along the pipelines' route and by physical disturbance of the seabed.

*Noise and vibration*

Routine inspections and maintenance works on the pipelines are assumed to have an **insignificant** impact in terms of noise on fish in ESR III, as inspections and works will be infrequent and restricted to the immediate pipelines' route.

The noise levels of natural gas movement through a pipeline has been known to range between 0.030 and 0.100 kHz, which is at the lowest levels detectable by many fish species. Modelled sound pressure levels within ESR III (predicted for KP 495.4) at increasing distances from the pipelines are shown in **Table 9.50**(1). The limit of hearing detection at the predicted frequency range for gas movement through a pipeline is 77 to 90 dB re 1µPa for cod and 75 to 77 dB re 1µPa for herring(2).

**Table 9.50 Predicted total noise level of gas movement in a pipeline at 10, 100 and 1000 m from the pipeline assuming sound radiation in cylindrical half-space(3)**

| | **KP 495.4 (Finnish - Swedish EEZ Border)** |
|---|---|
| 10 m | 56 dB re 1µPa |
| 100 m | 46 dB re 1µPa |
| 1000 m | 36 dB re 1µPa |

In the central areas of the Baltic Sea (KP 495.4 and beyond) sound pressure levels are below the limit of detection for both cod and herring.There is therefore no potential for noise from the

(1) Lommer, M. and Lemaire, G. 2008. Ødegaard & Danneskiold-Samsøe A/S. Noise along the Nord Stream pipelines in the Baltic Sea.

(2) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

(3) Lommer, M. and Lemaire, G. 2008. Ødegaard & Danneskiold-Samsøe A/S. Noise along the Nord Stream pipelines in the Baltic Sea.

pipelines during the operational phase to affect these species and subsequently the success of herring spawning.

Other than an initial startle response it is unlikely that any fish species will be adversely affected by the sounds emitted from the pipelines and, as they do with shipping noise, fish can detect the noise and will quickly become habituated to it. Evidence suggests that in fact many species aggregate around pipelines(1). As fish will naturally become acclimatised to the noise over time, it is expected that noise from operation of the pipelines would have no lasting impact on the distribution of fish and therefore the impact is expected to be **insignificant**.

*Physical alteration of the seabed*

As the surface area of the seabed taken up by the physical presence of the pipelines will represent less than 0.001% of the total seabed area of the Baltic Sea, the total substrate area of feeding and spawning grounds expected to be impacted in terms of the Baltic Sea is relatively small.

Fish such as cod and flounder spawn in the Bornholm Deep and the physical presence of the pipelines on the seabed will cause an obstruction to spawning to these fish species. However, as a result of the presence of the pipelines, fine substrates may increase in abundance in the softer areas of ESR III such as the Bornholm Basin where post glacial mud and sandy mud prevail (see **Atlas Map GE-2**). Much of the seabed east of Gotland is hard bottomed and therefore will not be impacted. Due to the small area of the substrate that will be impacted by the pipelines' footprint, the impact on feeding and spawning grounds (approximately 100 km of pipelines' route in the Bornholm Deep) is anticipated to result in **negative** and **direct** residual impacts following mitigation, on a **local** scale and of **long-term** duration. Impacts are **irreversible** unless the pipelines are subsequently moved during de-commissioning. These impacts will be of **low** intensity with a **low** magnitude. Impact significance is expected to be **minor** to **moderate** as the sensitivity values of fish present range from **low** to **high**.

As described previously (see **Section 9.3.8**) studies have shown that the addition of hard substrates (such as pipelines and materials used during rock placement) into the marine environment may be beneficial to fish populations in certain areas(2). However, the majority of the fish that inhabit ESR III are pelagic species and therefore will not derive any benefit from greater habitat diversity on the seabed. Some fish species do use sections of the seabed in ESR III for spawning but the depth and low oxygen concentrations in ESR III mean that the introduced hard substrates are unlikely to support a diverse benthic community. Aggregations of fish may occur around the pipelines or any artificial structures introduced by the Project such as

(1) Love, M. S. and York A.. 2005. A comparison of the fish assemblages associated with an oil/gas pipeline and adjacent seafloor in the Santa Barbara Channel, southern California Bight. Bulletin of Marine Science. 77 (1).

(2) Marine Conservation Society. 2000. Habitats Factsheet: Artificial Reefs.

areas of rock from rock placement. Aggregations of commercial fish species may lead to increased fishing along the pipelines' route, potentially creating basis for a profitable fishery. This may subsequently result in over exploitation of commercial fish stocks. In a study carried out along pipelines in the North Sea no measurable aggregation effect on commercial fish species was observed[1]. Consequently the impact of artificial habitat creation in ESR III is anticipated to be a long-term but low intensity impact which will be **insignificant** on fish populations.

Routine inspections and maintenance works on the pipelines may result in localised re-suspension and spreading of sediments should they interact with the seabed. These inspections and works will be infrequent and restricted to the immediate pipelines' route. This would have little bearing on fish in ESR III as they are not likely to be present beneath the halocline.

The following mitigation measures are proposed to address or reduce the significance of the identified potential impacts associated with routine inspections and maintenance works during the operational phase on fish:

- Any seabed intervention work required during operation will be kept to a minimum
- Disturbance of seabed sediments will be avoided or, in the case of repair, disturbance of sediments will be minimised

As these works are not expected to occur on a regular basis, the residual impacts on fish are expected to be **insignificant**.

*Temperature change*

The transfer of heat from the pipelines to the surrounding water as a result of temperature difference between the gas in the pipelines and the surrounding water will be minimal in ESR III [2] and therefore will have **no impact** on fish.

**Impact Summary**

The impacts identified and assessed in ESR III for fish are summarised in **Table 9.51**.

(1) Statoil. 1998. Tråltest over steinfyllinger på Sleipner kondensatrørledning 06.-14. juli 1998. (In Norwegian only)

(2) Nord Stream AG & Ramboll. 2008. Memo 4.3r - Temperature difference between pipeline and surroundings.

**Table 9.51 ESR III impact summary table for fish**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Fish– Ecological Sub-Region III | Increase in turbidity | Munitions clearance, Seabed intervention works, Pipe-laying | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Hyperbaric tie-ins | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of contaminants | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Medium-High | Medium | Low- High | Reversible | **Minor - Moderate** |
| | | Rock placement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Trenching, Hyperbaric tie-ins | Negative | Direct | Regional | Temporary | Low | Low | Low- High | Reversible | **Minor-Moderate** |
| | | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline flooding, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | Negative | Direct | Local | Short-term | Low | Low | Low-High | Reversible | **Minor-Moderate** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Physical alteration of the seabed | Pipeline presence | Negative | Direct | Local | Long-term | Medium | Low | Low-High | Irreversible | **Minor-Moderate** |
| | | Pipeline presence (addition of hard substrate) | - | - | - | - | - | - | - | - | **Insignificant** |
| | Temperature Change | Pipeline presence | - | - | - | - | - | - | - | - | **No impact** |
| | Visual/ physical disturbance | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |

## 9.5.9 Biological Environment – Sea Birds

### Overview

The pipelines in ESR III do not cross through any national or international site designated for birds, as described in **Chapter 8**, and there will therefore be no direct loss of habitat or other effects on birds within designated sites in the Baltic Sea. The pipelines will, however, pass some 25 km away from two wetlands of international importance, the Ramsar site "Bird Wetlands of Hanko and Tammisaari" within the Finnish EEZ and "Gotland, east coast" within the Swedish EEZ.

The majority of birds staging, breeding or wintering within the area of Hanko and Tammisaari will not be affected by the three phases of the Nord Stream Project as the distribution of the majority of the key species are restricted to the shallow waters in close vicinity to the shore line. The pipelines will pass this site of international importance in excess of 25 km and within a water depth of approximately 50 m. From the nine bird species currently listed in the Finnish Red Data Book, two species (lesser black-backed gull *Larus fuscus fuscus* and black-headed gull *Larus ridibundus*) may occur within the area impacted by the Project. A higher risk has been identified for piscivorous species such as terns and gulls. Arctic tern and common terns are the most numerous breeding tern species. Both species, protected under the EC Birds Directive, breed on Hanko and Tammisaari. Terns typically forage within 10 km of their breeding colony while, depending on the availability of food, these foraging ranges may be extended of up to 37 km in the case of common terns. Gulls such as common gull, black-headed gull, lesser black-backed gull and herring gull occur predominantly during the spring and autumn migration period while lesser black-backed gulls also breed within the local area. Highly sensitive species of waders (Ruff *Philomachus pugnax* and avocet *Recurvirostra avosetta*) and swans (migrating whooper swans *Cygnus cygnus*) are of much lower risk as they prefer the shallower waters of the coastline and will therefore not be affected by the Project.

The pipelines pass Gotland Island in parallel to the east coast over a length of approximately 180 km. The majority of the Gotland coastline including sensitive areas are located more than 25 km away from the pipelines. The site is of international importance for staging, wintering and breeding waterbirds(1). The site supports breeding waders, avocet (*Recurvirostra avosetta*), ringed plover (*Charadrius hiaticula*), dunlin (*Calidris alpina*), ruff (*Philomachis pugnax*), black-tailed godwit (*Limosa limosa*) and curlew (*Numenius arquata*). A number of tern species also breed here. Gotland Island also supports wintering and staging waterfowl species including smew (*Mergus albellus*), Bewick’s swan (*Branta columbianus*) and goosander (*Mergus merganser*). Important foraging and breeding habitat is restricted to the coastline and areas of

(1) RAMSAR. Information Sheet on Ramsar wetlands. http://www.wetlands.org/reports/ris/3SE008en.pdf (accessed September 23, 2008).

shallow water. Values/sensitivities for sea birds in ESR III are detailed in **Section 8.9.6** and summarised in **Table 9.52**. In some cases, the sensitivity of a particular species may be higher or lower and impacts have then been assessed on species-specific basis.

**Table 9.52 Values / sensitivities of sea birds in Ecological Sub-Region III**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Birds** | | | | | | | | | | | | |
| Breeding birds | Low | Low | Med | High | High | High | High | High | High | Med | Low | Low |
| Wintering birds | High | High | High | Med | Low | Low | Low | Low | Low | Med | High | High |
| Migratory birds | Low | Med | High | High | High | Low | Low | Low | High | High | High | Low |

The main activities that are expected to impact on sea birds are those that take place during the construction phase. These include activities resulting in direct habitat loss, increased noise levels and visual and also physical disturbance impact which are predicted to be the main impact upon the sea birds in ESR III. The loss of seabed habitat is not predicted to result in significant impacts on sea birds as the pipelines are located in deeper water in excess of 50 m water depth. No impacts are expected during pre-commissioning as the uptake of seawater and subsequent discharge of pressure-test water is to occur at the Russian landfall in ESR I.

*Construction phase*

- Munitions clearance, seabed intervention works, pipe-laying, anchor handling and hyperbaric tie-in activities resulting in:
  - Noise and vibration
  - Increase in turbidity
- Vessel movement resulting in:
  - Visual / physical disturbance

*Operational phase*

- Routine inspections and maintenance works resulting in:
  - Increase in turbidity

  - Noise and vibration

- Vessel movement resulting in:

  - Visual / physical disturbance

**Impacts during the Construction Phase**

During the construction phase, construction and support vessel movement associated with munitions clearance, seabed intervention works, pipe-laying and hyperbaric tie-in activities are likely to result in the re-suspension and spreading of sediments, noise and vibration and physical and visual disturbance of sea birds. Since benthic feeding species forage primarily within shallow water depths, the loss of seabed habitat at depths of over 50 m will not impact upon benthic feeding sea birds.

*Increase in turbidity*

Increased turbidity can result from munitions clearance, seabed intervention works including trenching and rock placement, and anchor handling. This can result in sediment plumes and sedimentation impacting upon bird feeding and foraging grounds, reducing the available food supply, and having an indirect impact on birds. However, the majority of bird feeding grounds in ESR III will not be affected by re-suspension and spreading of sediments since modelling has shown that sediment is not expected to travel further than 2 to 4 km from the disturbance point (see **Section 9.5.3**). Further, sediment plumes are expected to remain below the halocline, present over a large part of ESR III, where large schools of fish inhabiting ESR III are unlikely to be found for most of the year due to the anoxic environment the halocline produces. Whilst some birds such as the long-tailed duck can dive to depths as great as 50 m, this is unusual, with the majority of diving birds foraging at 10-20 m(1). Benthic fauna are also rare at greater depths and therefore it is unlikely that diving birds would feed on benthos within ESR III.

Since the pipelines within ESR III closely follow areas of the Baltic Sea heavily used by ships, the pipelines' route in ESR III is unlikely to be an important feeding and foraging grounds for sea birds. The presence of a halocline and distance of the main foraging areas from the pipelines' route will protect those bird's feeding grounds which do exist within ESR III from the effects of re-suspension and spreading of sediments. Hence the impact of increased sedimentation during construction is expected to be **insignificant** in ESR III.

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(1) Alerstom, T. and Christie, D.A. 1990. Bird Migration. Cambridge University Press.

*Noise and vibration*

Noise and vibration impacts on sea birds may be either direct due to the short-term displacement of sea birds, or indirect due to the displacement of fish and the subsequent redistribution of piscivorous species of birds.

Comparatively little is known about direct impacts of noise and vibration on sea bird populations. It is generally expected that the extent of visual disturbance impacts is larger than the extent of noise impacts. As offshore construction noise is almost exclusively associated with the presence of vessels resulting in visual and physical impacts it is often impossible to distinguish between impacts caused by increased noise levels and visual/physical impacts caused by the presence of vessels, as both impacts occur simultaneously.

As described in **Section 9.3.9**, the sensitivity of sea birds to noise impacts is species-specific and also appears to depend on the flock size of sea birds. Diving sea birds such as long-tailed ducks, velvet scoter and divers (*Gavia* spp.) are particularly sensitive to vessel movements and associated noise[(1),(2)], at typical distances of 1 to 2 km for the more sensitive bird species such as divers and scoters, and to a lesser extent cormorants, but other species such as gulls and terns are likely to be less affected[(3),(4)]. Studies on coastal birds have shown that noise impacts can result in various different types of response, including birds being startled or showing a “heads up” response to small scale movements and also birds leaving the affected area altogether[(5),(6)].

Munitions clearance will occur in greater water depth outside the typical diving depth of the majority of piscivorous species of sea birds and impacts are therefore considered to be **insignificant**.

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(1) Kube, J. & H. Skov. 1996. Habitat selection, feeding characteristics, and food consumption of long-tailed ducks, *Clangula hyemalis*, in the southern Baltic Sea. Meereswiss. Ber., Warnemünde. 18: 83-100.

(2) Bellebaum, J., Diederichs, A., Kube, J., Schulz, A. & G. Nehls. 2006. Flucht- und Meidedistanzen überwinternder Seetaucher und Meeresenten gegenüber Schiffen auf See. Ornithologische Rundbrief für Mecklenburg-Vorpommern Orn. Rundbrief Mecklenburg-Vorpommern 45, Sonderheft 1 (Tagungsbd. 5. deutsches See- und Küstenvogelkolloquium).

(3) Ruddock, M. & Whitfield, D.P. 2007. A Review of Disturbance Distances in Selected Bird Species, A report from Natural Research (Projects) Ltd to Scottish Natural Heritage.

(4) Skov, H., Durinck, J., Leopold, M.F. & Tasker, M.L. 2007. A quantitative method for evaluating the importance of marine areas for conservation of birds. Biology Conservation, 36(3).

(5) Institute of Coastal and Estuarine Studies (ICES). 1999. Avifaunal Disturbance Assessment: Flood Defence Works, Salt End. Report to the Environment Agency.

(6) Smit, C.J. & G.J.M. Visser. 1993. Effects of Disturbance on Shorebirds: A Summary of Existing Knowledge from the Dutch Wadden Sea and Delta Area. WSG Special Report.

As the pipelines in ESR III follow well established shipping routes it is likely that birds will be, to a certain extent, habituated to noise generated by vessels. In addition, the distance between noise and vibration-generating construction activities is in excess of 25 km from the nearest area of importance for birds. For this reason, and because noise generated at sea surface-level will be of comparable volume to that for other shipping activity in the Baltic Sea, it is concluded that noise impacts due to construction and support vessel movement will be **insignificant** in ESR III.

*Visual/physical disturbance*

Potential visual and physical impacts on birds in ESR III from vessels involved in the Project are most likely to impact on migrating birds aggregating on open water, post breeding flocks of moulting birds which are flightless and rafting on open water and birds feeding in open water.

Seabed preparation will include munitions clearance to the north of Gotland resulting in increased underwater noise. However, the munition site is located in an area of deeper water (below 50 m depth) and the likelihood that diving sea birds may be impacted is therefore very low. These impacts resulting from munitions clearance are therefore **insignificant**.

The construction activities within ESR III are not located close to the shallow waters that are regularly inhabited by sea birds in the Baltic Sea along most of the pipelines' route in ESR III. However, in some places, physical and visual disturbance of birds may result from vessels encountering single birds or flocks of birds foraging at sea, during pipeline construction. The distance from which different species of birds are affected by this type of disturbance varies between species (many are less sensitive to boats and some species even follow them), and also depends on the nature of a vessel's movement (see **Section 9.3.9**). The pipe-laying vessels for the Nord Stream Project will move slowly, since pipe-laying will progress at a rate of 2 to 3 km a day. Therefore, the risk of disturbing sitting birds is very low. Furthermore, the pipelines within ESR III closely follow areas of the Baltic Sea heavily used by ships, therefore many of the sea bird species which use these waters are likely to be accustomed to regular vessel movements in the area surrounding ESR III and will experience little, if any, additional disturbance as a result. While birds may maintain a stand off distance from the immediate area of construction works, the pipe-laying vessel is unlikely to disturb flocks and the impacts associated with construction and support vessel movement on sea birds during the construction phase are considered to be **insignificant** in ESR III.

**Impacts during the Operational Phase**

During the operational phase, vessel movement associated with routine inspections and maintenance works are likely to result in re-suspension and spreading of sediments, low-level noise and vibration and low-level physical and visual disturbance to sea birds.

*Increase in turbidity*

Routine inspections and pipeline maintenance works have limited impact upon sea birds. Increased turbidity occurs outside the foraging range of benthic feeding sea birds and remains under the halocline. Impacts are restricted to the pipelines' route and are expected to be far lower in both magnitude and duration than for the construction phase and for the operational phase are again considered to be **insignificant**.

*Noise and vibration*

Noise generation during routine inspections and maintenance is assumed to have a limited impact upon sea birds, since activities will be restricted to the pipelines' route. Generated noise is not expected to exceed the current baseline environment as routine inspections would only result in a few extra vessel sailings. The impacts on birds in terms of noise and vibration are expected to be far lower in both magnitude and duration than for the construction phase and impacts for the operational phase are considered to be **insignificant**. Since significant impacts on fish due to the movement of gas in the pipelines are considered to be minor (**Section 9.5.8**), it is also considered that indirect, negative impacts on birds will not result.

*Visual/physical disturbance*

Routine inspections and maintenance are only expected to result in a few extra vessel sailings. Vessel movements will be restricted to the pipelines' route. The pipelines follow highly used shipping routes and impacts will therefore be indistinguishable from the background. Impacts will be far lower in both magnitude and duration than for the construction phase and impacts for the operational phase are considered to be **insignificant**.

**Impact Summary**

The impacts identified and assessed in ESR III on sea birds are summarised in **Table 9.53.**

**Table 9.53 ESR III impact summary table for sea birds**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivit y | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitud e | | | |
| Sea Birds - Ecological Sub-Region III | Increase in turbidity | Munitions clearance, Seabed intervention works, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Munitions clearance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Visual/physical disturbance | Munitions clearance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |

## 9.5.10 Biological Environment – Marine Mammals

### Overview

Following the undertaking of a scoping and impact identification exercise, several interactions between marine mammals in ESR III and the Project have been identified, which could give rise to potential impacts. This section identifies and assesses the potential impacts on marine mammals in ESR III during the construction, pre-commissioning and commissioning, and operational phases of the Project in terms of the methodology presented in **Chapter 7**.

As described in **Section 8.6.6** there are very few marine mammal species that inhabit the Baltic Sea in contrast to ocean populations. In ESR III, there are three species normally present; one cetacean and two species of seal:

- Harbour porpoise (*Phocoena phocoena*)
- Ringed seal (*Phoca hispida baltica*)
- Grey seal (*Halichoerus grypus balticus*)

Each of these marine mammals has been described as a threatened and / or declining species of the Baltic Sea by HELCOM. Values/sensitivities for each marine mammal are presented in detail in **Section 8.9.7** and summarised in **Table 9.54**. The harbour seal is seldom present in ESR III as it prefers the coastal area in Sweden and Denmark (**Atlas Map MA-5**).

**Table 9.54 Values/sensitivities of marine mammals in Ecological Sub-Region III**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Marine mammals** | | | | | | | | | | | | |
| Harbour porpoise | Med | Med | Med | Med | Med | Med | Med | Med | Med | Med | Med | Med |
| Ringed seal | Med | High | High | High | High | Med | Med | Med | Med | Med | Med | Med |
| Grey seal | Med | High | High | Med | High | High | Med | Med | Med | Med | Med | Med |

The main activities, which are expected to impact on marine mammals, include those that take place during the construction phase. Impacts during the pre-commissioning and commissioning, and operational phases are expected to be minimal by comparison. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Munitions clearance, pipe-laying, anchor handling, seabed intervention works, hyperbaric tie-in activities and construction and support vessel movement resulting in:
    - Noise and vibration
- Re-suspension and spreading of sediment due to munitions clearance, pipe-laying, anchor handling, seabed intervention works and hyperbaric tie-in activities resulting in:
    - Increase in turbidity
    - Release of contaminants
- Construction and support vessel movement during winter resulting in:
    - Ice breaking

*Pre-commissioning and commissioning phase*

- The flooding of the pipelines during pressure testing and the commissioning of the pipelines resulting in:
    - Noise and vibration

*Operational phase*

- Natural gas movement in the pipelines resulting in:
    - Noise and vibration
- Routine inspections and maintenance works resulting in:
    - Noise and vibration
    - Increase in turbidity

**Impacts during the Construction Phase**

Impacts upon marine mammals during the construction phase are noise and vibration, an increase in turbidity and the release of contaminants due to munitions clearance, pipe-laying, anchor handling, seabed intervention works, hyperbaric tie-in activities and construction and support vessel movement. Ice breaking will occur due to vessel movement should pipe-laying take place during severe winters.

*Increase in turbidity*

An increase in turbidity due to the re-suspension and spreading of sediments during construction may result due to trenching, rock placement and hyperbaric tie-in activities at designated areas and anchor handling and pipe-laying activities along the entire pipelines' route in ESR III. The extent and duration of an increase in turbidity is detailed under the water column in **Section 9.5.3**. Significant (above background levels) increases in turbidity are expected to be of short-term duration and local to seabed intervention areas. Furthermore, the pipelines' route in ESR III is furthermore mostly located below the halocline, which prevents the circulation of water from the lower to the upper layers. As marine mammals use their hearing ability for navigation, as well as for hunting, an increase in turbidity is deemed to have an **insignificant** impact on individuals. Feeding areas are not expected to be affected as marine fauna on which marine mammals would prey are not present below the halocline for most of the year. Marine mammals would typically avoid the construction area.

*Release of contaminants*

An increase in contaminant concentration in the water column due to the release of contaminants from the re-suspension and spreading of sediments could theoretically raise the concentration of contaminants in the food chain and subsequently in mammal tissue. However, it is expected that any contaminants that may be released will only remain above the Predicted No-Effect Concentration (PNEC) for short periods of time in the immediate (1 - 2 km) vicinity of seabed intervention sites (**Section 9.5.3**). The presence of a zone of hypoxia below the halocline in most parts of ESR III further ensures that the likelihood of marine mammals being present along the pipelines' route is unlikely for most of the year due to lack of dissolved oxygen and suitable prey below the halocline. Overall the impacts due to a release of contaminants on marine mammals are deemed to be **insignificant** and are not assessed further. Marine mammals would typically avoid the construction area.

*Noise and vibration*

Noise and vibration will be generated during construction in ESR III as a result of munitions clearance, seabed intervention work (trenching and rock placement), pipe-laying, hyperbaric tie-in activities and construction and support vessel movement. Construction activity noise and vibration may impact on marine mammals.

The ringed and grey seals, as well as the harbour porpoise, communicate by emitting sounds that pass through the water column. These sounds can be detected across considerable distances and may influence the behaviour of these mammals. An increase in background noise or the introduction of specific sound sources may affect marine mammals in that they may be prevented from detecting important sounds (masking), their behaviour may be altered, temporary or permanent hearing loss may be experienced or damage to tissue may occur.

These potential effects are further elaborated upon in **Section 9.3.10** under ESR I.The hearing ability of the marine mammals in ESR III is detailed in **Section 8.6.6**.

Munitions clearance has the potential to cause considerable noise and vibration that would impact negatively on marine mammals. Several munitions have been detected within the pipelines' corridor in ESR III. Their exact location is currently confidential, however it is confirmed that a total of four are present within the western section of the Gulf of Finland and one to the northeast of Gotland. These munitions will require clearing by means of explosives in collaboration with the relevant authorities. Noise generated during clearing takes the form of an initial shock pulse followed by a succession of oscillating bubble pulses. Pulses at high peak levels have the potential to cause acoustic trauma and tissue damage should an individual mammal be in close proximity to the blast site(1). The expected level of noise and vibration generated will vary and is dependent on the amount of explosive used as well as the residual explosive within the device. As the impact (**negative** and **direct**) is of **temporary** duration, a slight behavioural change (recognition of the sound and / or swimming away) is expected in individual seals that are present within 2 - 3 km of the clearance site. Harbour porpoises may be affected up to 10 km away. Due to the presence of vessels during munitions clearance, it is expected that seals and the harbour porpoise would vacate the area and thus no tissue damage or hearing loss is expected. An acoustic survey will take place prior to clearance to ensure that marine mammals (and schools of fish) are not present. In addition, acoustic harassment devices will be employed to reduce the possibility that marine mammals will be present in close proximity to the clearance site. The impact will be on a **regional** scale. Impact intensity is expected to be **moderate** to **high** depending on marine mammal present. Impact magnitude is **medium**. Impact significance is expected to be **moderate**. Impacts may be irreversible at an individual level if tissue damage or hearing loss occurs, however at a population level, the impact is considered to be **reversible**. It should be noted that munitions clearance is a common activity in the Baltic Sea and that most marine mammals would avoid the immediate area due to vessel movement.

No direct measurements are available for the noise generated during pipe-laying on the seabed and anchor handling. The primary source of noise is expected to be the movement of anchors. The presence of heavy machinery on board the pipe-laying vessel is expected to generate low frequencies below 100 Hz. It should be noted that pipe-laying will take place at a rate of 2-3 km a day and thus the source of noise will move along the pipelines' route and will not remain fixed at one point for an extended period of time. Noise generated is expected to be on a par with normal shipping and fishing activities to which marine mammals have habituated and thus the impact of pipe-laying and anchor handling is expected to be **insignificant**.

Hyperbaric tie-in activities will occur on the seabed 675 km from the Russian landfall following pressure testing of the pipelines. These tie-in activities are described in **Chapter 4**. Potential impacts include noise and vibration as well as the disruption of seabed sediments. Tie-in activity

(1) Swedish Armed Forces Headquarters. 2007. Environmental effects of underwater explosions.

noise has not been measured or modelled but is assumed to be on par with typical pipe-laying activities, which are not deemed to generate a significant amount of noise. Any noise generated will be of **short-term** duration and **localised** to the tie-in area. No breeding areas or colonies are in close proximity to the area (<20 km). In most cases individual marine mammals would vacate the tie-in areas at the first instance of a foreign sound or change in background noise. The impact (noise) of tie-in activities on marine mammals is expected to be **insignificant**.

Marine mammals can perceive underwater noise generated by vessel movements (0.01-10 kHz with source levels between 130-160 dB), and the use of equipment at sea, a number of kilometres from a source. Such noise has a zone of responsiveness for marine mammals of 200-300 m(1). As the pipelines' route in ESR III is largely within or close to normal shipping lanes it is expected that seals and harbour porpoises in the area have already habituated to the noise and vibration generated by vessel movement and thus the impact is **insignificant**.

Seabed intervention works, which include trenching and rock placement, are restricted to the designated areas along the pipelines' route (**Atlas Maps PR-3a** and **3b**). Both activities will generate noise and vibration at the level that exceeds that generated by other construction activities. Trenching will generate the most noise. During trenching, harbour porpoises are expected to be affected (behavioural change) within a few kilometres of the construction site while for seals is expected to be limited to less than a kilometre. Noise generated by rock placement is not expected to exceed background noise and thus will have a negligible impact on marine mammals. As most of the pipelines' route through ESR III is in a predominantly "dead zone" (low levels of dissolved oxygen - hypoxia) below the halocline, marine mammals are not expected to be present in the close vicinity of the pipelines during construction and thus the source of noise. Noise may still, however, impact upon marine mammals in the general area and in the upper parts of the water column. In most cases marine mammals would vacate the construction area at the first instance of a foreign sound or change in background noise. Grey seals regularly occur along the entire pipelines' route in ESR III while ringed seals are restricted to the north western sections of ESR III near the Gulf of Finland. Harbour porpoises tend to concentrate in the coastal areas away from the deep water zones. Seal colonies are located in the coastal zones away from the pipelines' route and thus any impacts are expected to be on the individual rather than the population level. Impacts are both **negative** and **direct**, will be on a **regional** scale around the source of impact but of **short-term** duration during construction and will be of **low** intensity. Impact magnitude is **low**. Impact significance is expected to be **minor** to **moderate** (if grey and ringed seals are disrupted during the breeding season – **high** sensitivity, or harbour porpoise – **medium** sensitivity). Impacts are **reversible**.

(1) ENERGI E2. 2006. EIA Report - Marine mammals. Horns Rev 2, offshore wind farm.

*Ice breaking*

Sections of the Baltic Sea experience ice cover during the winter months. Most of the pipelines' route in ESR III would only experience ice cover during severe winters. The grey seal breeds (gives birth to pups) offshore on the ice and thus has the potential to be impacted upon should construction activities take place during their breeding season. Any vessel movements during winter would result in ice breaking in the southern sections of ESR III and thus have the potential to affect seal breeding habitats. This may result in behavioural changes as well as an increase in seal pup mortality rates[(1)]. The critical time for breeding (giving birth to pups) is from mid-February to mid-March for the ringed seal and between February and March for the grey seal. As most of the pipelines' route falls within or very close to normal shipping lanes, it is expected that should ice breaking be required, the potential for impacts on seals would be minimal (**Atlas Map SH1**). Seals do not typically dwell in areas where ice breaking is a regular occurrence.

If the construction schedule is followed, no ice breaking will take place and thus there will be **no impact**. However, in the highly unlikely event that ice breaking should be required and if breeding areas are affected the impact (**negative, direct** and **secondary**) is expected to be **regional** along the pipelines and vessel routes, of **short-term** duration and of **medium** intensity. Impact magnitude is **medium**. Impact significance is expected to be **moderate** for the grey seals if the ice breaking activities disrupt breeding areas (**high** value/sensitivity). Impacts are **reversible** within a few generations in a worst case scenario.

**Impacts during the Pre-commissioning and Commissioning Phase**

The uptake of seawater and subsequent discharge of pressure-test water during pre-commissioning is restricted to the Russian landfall (ESR I). As such, the only activities that will generate an impact in ESR III are pipeline flooding and pressure-test water discharge during pre-commissioning and the input of gas during commissioning. These activities would result in the generation of noise and vibration.

*Noise and vibration*

The movement of pressure-test water in the pipelines during pipeline flooding and pressure-test water discharge, and the input of gas during commissioning, will generate some noise and vibration. The noise generated is expected to be on a par with, if not slightly higher than normal gas movement within the pipelines (see section on the operational phase impacts). Furthermore, the pipelines will, for the most part be installed in a "dead zone" of hypoxia below the halocline in ESR III and thus it is highly unlikely that marine mammals will be present in the close vicinity

(1) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

of the pipelines. As such, generated noise is expected to have an **insignificant** impact on marine mammals in ESR III. No mitigation is required.

**Impacts during the Operational Phase**

Impacts upon marine mammals during the operational phase are limited to noise and vibration from gas movement within the pipelines and from routine inspections and maintenance works. An increase in turbidity is expected to coincide with maintenance works should they interact with the seabed.

*Noise and vibration*

As per the studies[(1),(2)] described under ESR I for marine mammals (**Section 9.3.10**), the noise generated by the movement of gas within the pipelines falls below the levels detectable by the marine mammals (~1 kHz for the harbour porpoise) present in ESR III. As such, it is expected that gas movement in the pipelines would have little to no impact on marine mammals at either an individual or population level. The impact is deemed to be **insignificant**.

Routine inspections would include external inspections of the pipelines by means of ROV and internal inspections using pigs (**Section 9.2.3**). Maintenance works are not expected but may include possible repair works on the pipelines or on the seabed where required. Routine inspections and maintenance works are expected to generate very little noise and are thus assumed to have an **insignificant** impact upon marine mammals and will be restricted to the pipelines' route and be infrequent (i.e. not constant).

*Increase in turbidity*

Maintenance works may be required on the pipelines or on the supporting seabed to ensure that the pipelines have a stable base. These works may result in localised re-suspension and spreading of sediments and a subsequent increase in turbidity and the release of contaminants. The following mitigation measures will be implemented to reduce the impacts:

- Any seabed intervention work, such as rock placement, required during operation will be kept to a minimum
- Disturbance of seabed sediments will be kept to a minimum
- Any surveys will avoid encounters with marine mammals wherever possible

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(1) Lommer, M. and Lemaire, G. 2008. Ødegaard & Danneskiold-Samsøe A/S. Noise along the Nord Stream pipelines in the Baltic Sea.

(2) Martec Limited. 2004. Effects of Pipelines/Gathering Lines on Snow Crab and Lobster.

As these works are not expected to occur on a regular basis and will be localised, the impacts on marine mammals are expected to be **insignificant**.

**Impact Summary**

The impacts on marine mammals identified and assessed in ESR III are summarised in **Table 9.55**.

**Table 9.55 ESR III impact summary table for marine mammals**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Marine Mammals - Ecological Sub-Region III | Increase in turbidity | Munitions clearance, Seabed intervention works, Pipe-laying, Anchor handling, Hyperbaric tie-ins | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of contaminants | Munitions clearance, Seabed intervention works, Pipe-laying, Anchor handling, Hyperbaric tie-ins | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Medium – High | Medium | Medium – High | Reversible | **Moderate** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Medium – High | Reversible | **Minor - Moderate** |
| | | Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Hyperbaric tie-ins | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | | Pipeline flooding, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Ice breaking | Construction and support vessel movement | - / Negative | - / Direct, Secon-dary | - / Regional | - / Short-term | - / Medium | - / Medium | - / High | - / Reversible | **No impact/ Moderate** |

### 9.5.11 Biological Environment – Nature Conservation Areas

#### Overview

This section identifies and assesses the potential impacts on nature conservation areas in ESR III during the construction, pre-commissioning and commissioning and operational phase of the Project.

As a result of the route optimisation process, the Nord Stream pipelines' route does not cross any nature conservation areas in ESR III as it continues from the Gulf of Finland into the deeper, offshore waters of the Baltic Sea. The route corridor passes within 20 km of one nature conservation area, other than Natura 2000 sites which are considered in **Chapter 10**. The pipelines' route passes this nearest nature conservation area – the West Estonian Archipelago UNESCO biosphere reserve – at a distance of approximately 12 km, as shown in **Table 9.56**.

Ramsar sites in the Baltic Sea are illustrated on **Atlas Map PA-4** and UNESCO and BSPA sites are shown on **Atlas Map PA-5**.

**Table 9.56 Nature conservation areas within 20 km of the pipelines' route in ESR III**

| Nature Conservation Area | Designation | Protected Habitats and Species | Distance to Pipelines (km) |
|---|---|---|---|
| West Estonian Archipelago | UNESCO | Seashore halophilous (salt-rich) meadows, pine forests, mixed spruce and deciduous forests, swamps and peat bogs.<br>The archipelago is important for breeding and migrating birds including the barnacle goose (*B. leucopsis*), greylag goose (*A. anser*), crane (*G. grus*), Bewick's swan (*C. columbianus*), Whooper swan (*C. cygnus*), wigeon (*A. penelope*), eider duck (*S. mollissima*), goldeneye (*B. clangula*), scaup (*A. marila*). Ringed seal (*P. hispida*) and grey seal (*H. grypus*). | 12 |

The scope of this assessment is limited to the particular impacts on features for which the nature conservation areas have been designated, including protected habitats in the areas. Impacts on floral and faunal receptors (fish, mammals, sea birds and marine benthos) are assessed in their relevant sections of this report. Where these species are specifically protected by the nature conservation designation, consideration will be given here as to the significance of potential impacts on these species from the installation of the pipelines' route in ESR III. As nature conservation areas are of national importance, their values/sensitivities are rated as **high**.

The West Estonian Archipelago has protected coastal habitats which may be impacted by the development. Protected habitats which may be affected include seashore halophilous (salt-rich) meadows, pine forests, mixed spruce and deciduous forests, swamps and peat bogs. The site is designated for its important populations of breeding and migrating sea and water birds. All of these habitats and species have the potential to be affected by the construction, pre-commissioning and commissioning and operation of a pipeline.

The main activities anticipated to affect the nature conservation area within 20 km of the pipelines in ESR III are those occurring during the construction phase of the Project, such as pipe-laying, anchor handling, hyperbaric tie-in activities and seabed intervention works. Munitions clearance is also expected to occur in ESR III and the impacts of this will be considered as part of the construction phase.

The impacts which are likely to affect these sites are limited to those which can operate away from the source, including noise and vibration, visual/physical disturbance and the re-suspension and spreading of sediments resulting in increased turbidity. Impacts during the pre-commissioning and commissioning and operational phase are expected to be comparatively small, due to the less invasive nature of the activities in these phases, and the smaller scale on which these activities will operate.

Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Munitions clearance, seabed intervention works, pipe-laying, anchor handling, hyperbaric tie-in activities and construction and support vessel movement resulting in:
  - Noise and vibration
- Re-suspension and spreading of sediments due to munitions clearance, seabed intervention works, pipe-laying, anchor handling and hyperbaric tie-in activities, resulting in:
  - Increase in turbidity
  - Physical alteration of the seabed

- Vessel movement resulting in:
  - Visual / physical disturbance

*Pre-commissioning and Commissioning phase*

- Pipeline flooding resulting in:
  - Noise and vibration
- Vessel movement resulting in:
  - Visual / physical disturbance

*Operational phase*

- Routine inspections and maintenance works and construction and support vessel movement resulting in:
  - Increase in turbidity
  - Noise and vibration
  - Physical alteration of the seabed
  - Visual / physical disturbance
- Pipeline presence resulting in:
  - Noise and vibration

**Impacts during the Construction Phase**

Potential impacts upon nature conservation areas in ESR III during the construction phase include impacts on fauna from noise and vibration and visual/physical disturbance, and turbidity impacts on habitats and fauna as a result of munitions clearance, seabed interventions works, pipe-laying, anchor handling, hyperbaric tie-in activities and construction and support vessel movement.

*Increase in turbidity*

Munitions clearance, a common activity in the Baltic Sea, is scheduled to take place in ESR III prior to the start of construction. As detailed above, it is necessary to clear five munitions along the pipelines' route in ESR III, via the use of explosives. The nearest nature conservation area to a munitions clearance site in ESR III is the West Estonian Archipelago UNESCO biosphere reserve, situated approximately 12 km south of the nearest munitions site, and within 30 km of a further 3 munitions. Munitions clearance will result in the re-suspension and spreading of sediments on the **regional** scale and will be of **short-term** duration (**Section 9.5.3**) The impact of an increase in turbidity on nature conservation areas will depend on the proximity of the clearance site to the protected area and its designated habitats and species. Impacts may also be felt by designated fauna outside the boundary of the protected area, for example if birds are foraging or seals are hunting outside the designated site and closer to the pipelines' corridor and experience more turbid water for a short period as a result of the munitions clearance. As the nature conservation area in ESR III, the West Estonian Archipelago is over 12 km from the munitions clearance areas, and effects are not expected to travel this distance, the impact of increased turbidity is expected to be **insignificant**.

Increases in turbidity due to the re-suspension and spreading of sediments in the water column will result from activities during other than munitions clearance such as seabed intervention works (including trenching and rock placement), pipe-laying, anchor handling and hyperbaric tie-in activities. As discussed in previous sections, this can potentially cause physiological damage to faunal species such as fish (**Section 9.5.8**) or smothering of important benthic communities (**Section 9.5.7**). However, impacts from an increase in turbidity will only affect species for a short duration within a relatively localised area surrounding the pipelines. Seabed intervention works are expected to generate the most re-suspended sediment while pipe-laying, anchor handling and hyperbaric tie-in activities are expected to contribute very little to increased turbidity. However, seabed intervention works are restricted to specific locations along ESR III and will not affect the whole route length.

Sedimentation modelling has been carried out for seabed intervention works in ESR III (as detailed in **Section 9.5.3**). The areas and average duration of re-suspended sediment concentrations for ESR III during seabed intervention works are illustrated on **Atlas Maps MO-5**, **7**, **12** and **21**. As normal water concentrations in the Baltic Sea are typically in the range of 1 – 4 mg/l during normal weather, concentrations over 1 mg/l are regarded as the maximum extent of the predicted sediment spread (as detailed in **Section 9.5.3**). Trenching and rock placement in ESR III is expected to result in re-suspended sediment concentrations of above 1 mg up to a maximum of 3 km from the disturbance area for approximately 10 hours, with the majority of sedimentation occurring in much closer proximity to the works. Therefore the maximum predicted sediment spread is likely to occur within 3 km of the pipelines' route for seabed intervention works, with less expected for other construction activities. Due to the distance of the West Estonian Archipelago conservation area (at least 12 km from the pipelines' route) from construction activities, the species and habitats associated with the site designation are not expected to be affected by an increase in turbidity as a result of the re-suspension and spreading of sediments. Therefore impacts from increased turbidity due to pipe-laying, anchor handling, hyperbaric tie-in activities and associated seabed intervention works are considered to be **insignificant** on the conservation area in ESR III.

*Noise and vibration*

The activities during construction that are likely to cause disturbance from noise and vibration are munitions clearance, seabed intervention works (rock dumping and trenching), pipe-laying, anchor handling, hyperbaric tie-in activities, and construction and support vessel movement.

Prior to the laying of the pipelines, munitions clearance will be required along the pipelines' route in ESR III. While route optimisation has minimised the number of munitions to be affected, it is necessary to clear five munitions that are situated along the pipelines' route via the use of explosives. Four of these munitions are situated close to the Gulf of Finland and one occurs to the north-east of Gotland. The West Estonian Archipelago UNESCO biosphere reserve is situated approximately 12 km south of the nearest munitions site, and within 30 km of a further three munitions.

Munitions clearance has the potential to cause considerable noise and vibration, which would impact negatively on fauna protected within the designation of a nature conservation area. Impacts may occur either within or outside the boundaries of the protected area, for example if fauna range closer to the munitions clearance site while foraging. The expected level of noise and vibration generated is not known, as it will vary depending on the amount of explosives used, and the residual explosives present within the device. Tissue damage or hearing loss as a result of a large explosion is possible in marine mammals (ringed, harbour and grey seal and harbour porpoise) and fish (especially the hearing sensitive species e.g. herring), and may occur in foraging birds, but is not predicted to occur as activity during munitions clearance is expected to cause fauna to move away from the immediate vicinity of the blast. The main impact expected is that marine mammals, sea birds and fish may be temporarily displaced from the vicinity of the munitions clearance area due to the noise and vibration produced (as detailed in **Sections 9.5.10, 9.5.9** and **9.5.8**). However, as the only nature conservation area in ESR III (other than Natura 2000 sites which are considered in **Chapter 10**) is situated at least 12 km from munitions clearance sites, the impact of noise and vibration on flora and fauna associated with the designated nature conservation area is anticipated to be minimal and therefore **insignificant**.

Trenching, which is restricted to specific points along the pipelines' route, is expected to generate more noise and vibration than that of the other construction activities. Rock placement is not expected to generate any noise that exceeds background levels(1). There are no noise level estimates available for the noise generated during pipe-laying and anchor handling, but levels are expected to be similar to that of normal shipping and fishing activities. Noise and vibration impacts associated with hyperbaric tie-in activities are expected to be similar in nature to those for pipe-laying, but smaller in magnitude and duration. The significance of any noise and vibration impacts on nature conservation areas will depend upon the distance between the source of the impact (originating from within the vicinity of the pipelines) and the conservation areas themselves. Potential receptors for impacts from noise and vibration are limited to marine

(1) Nedwell, J. and Howell, D. 2004. A review of offshore windfarm related underwater noise sources.

mammals, fish, sea birds and some marine benthos, both mobile and sessile. Of these groups of fauna, the West Estonian Archipelago conservation area (within 20 km of the pipelines' route) in ESR III is designated to protect important sea bird colonies.

As discussed in **Section 9.5.9**, comparatively little is known about the impacts of noise and vibration on sea birds. However, the noise generated by construction activities at sea surface level will be of comparable volume to that of other shipping activity in the Baltic Sea, which birds in the region will be habituated to. As noted above, pipe-laying will take place at a rate of 2 – 3 km a day, so the source of noise will move along the pipelines' route and will not remain fixed at any one point for an extended period of time, which will reduce the overall impact. The disturbance distance for visual and noise disturbance from boats is typically 1 – 2 km for the more sensitive bird species such as divers and scoters and to a lesser extent cormorant, with other species such as gulls and terns likely to be less affected(1),(2). As all nature conservation areas are situated at least 12 km from the pipelines' route, it is concluded that noise impacts on sea birds in the West Estonian Archipelago conservation area such as greylag goose, crane and Bewick's swan will be **insignificant** in ESR III.

Fish can also be impacted by noise and vibration. While not specifically protected in the nature conservation areas of ESR III, any displacement of fish on which bird species forage can have a temporary influence on sea bird distribution as a result. However, the fish in ESR III are likely to be habituated to vessel noise and other human activities in the Baltic Sea, due to the large volume of ship traffic in the sea. In addition, construction is scheduled to avoid the sensitive spawning period, as noted in **Section 9.5.8**. For these reasons, and in addition because of the distance between the construction work and the West Estonian Archipelago conservation area near the pipelines' route in ESR III (12 km from the pipelines' route), noise impacts will be minimal. Therefore it is considered that the impact of noise and vibration on fish associated with nature conservation areas will be **insignificant**.

*Physical alteration of the seabed*

Physical alteration of the seabed is likely to occur during construction due to munitions clearance, seabed intervention works, pipe-laying, anchor handling and hyperbaric tie-ins. However, since the pipelines does not pass directly through the nature conservation area in ESR III, and are situated at least 12 km away, physical alteration of the seabed is not expected to occur within nature conservation areas and impacts are therefore deemed to be **insignificant**.

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(1) Ruddock, M. & Whitfield, D.P. 2007. A Review of Disturbance Distances in Selected Bird Species, A report from Natural Research (Projects) Ltd to Scottish Natural Heritage.

(2) Skov, H., Durinck, J., Leopold, M.F. and Tasker, M.L. 2007. A quantitative method for evaluating the importance of marine areas for conservation of birds. Biology Conservation. 36 (3).

*Visual/physical disturbance*

Visual or physical disturbance from the movement of vessels during construction may affect sea bird populations that are protected by the nature conservation areas designated in ESR III. The nature conservation area detailed in **Table 9.57** holds important populations of breeding and staging waders and sea birds (as detailed in **Section 9.5.9**). The approximate distance at which disturbance occurs varies between species and depends on the nature of the vessel movement. As detailed above, for the more sensitive species, disturbance can occur at 1 – 2 km, whilst other species may be much less affected. Pipe-laying is expected to progress at the rate of 2 – 3 km per day, therefore vessel movement will be relatively slow and the risk of disturbing sea birds will be low. In addition, since the pipelines' corridor follows an established shipping route, sea birds will also be used to vessel movement in this area of the Baltic Sea. As the pipelines' route is at least 12 km from the nearest nature conservation area (the West Estonian Archipelago), the pipe-laying process is unlikely to disturb flocks within the protected areas and the impact of vessel movement on sea birds associated with nature conservation areas in ESR III is considered to be **insignificant**.

Disturbance to birds protected within the nature conservation area may also occur when the birds are out of the boundary of the protected site. The majority of the birds that are protected in the nature conservation area of ESR III are not sensitive to disturbance, such as gulls, terns and eider duck. Divers, scoters and cormorants, which are not specifically protected in the nature conservation areas listed in ESR III, are more sensitive(1). Studies have shown that birds such as the common scoter tend to avoid channels with high frequencies of shipping activity, even when these areas hold a high prey biomass(2). Therefore, as the pipelines' route follows a shipping channel, sensitive birds are unlikely to be present and those likely to be present are much less sensitive. Therefore the risk of disturbance is low and impacts are considered to be **insignificant** on conservation areas in ESR III.

**Impacts during the Pre-commissioning and Commissioning Phase**

Potential impacts upon nature conservation areas in ESR III during the pre-commissioning and commissioning phase are limited to noise and vibration impacts on fauna generated by pipeline flooding and the visual or physical disturbance of fauna from vessel movement during the works.

(1) Garthe, S. and Hüppop, O. 2004. Scaling possible adverse effects of marine wind farms on sea birds: developing and applying a vulnerability index. Journal of Applied Ecology. 41.

(2) Kaiser, M.J., Galanidi, M., Showler, D.A., Elliot, A.J., Caldow, R.W.G., Rees, E.I.S., Stillman, R.A. and Sutherland, W.J. 2006. Distribution and behaviour of Common Scoter Melanitta nigra relative to prey resources and environmental parameters. Ibis 148.

*Noise and vibration*

Noise and vibration generated by the movement of pressure-test water within the pipelines during pipeline flooding and pressure-test water discharge, and natural gas movement in the pipelines during commissioning, only has the potential to cause impacts on fauna in the immediate vicinity of the pipelines, and is likely to be of a similar level to that of normal gas movement within the pipelines. Since the pipelines' route runs at a distance of at least 12 km from the only nature conservation area in ESR III, the West Estonian Archipelago conservation area, noise and vibration impacts during pipeline flooding are expected to be **insignificant**.

*Visual/physical disturbance*

During the pre-commissioning and commissioning phase, there will be a low level of Project vessel movement in ESR III. This may lead to a low level of visual or physical disturbance to fauna, but it will be on a much smaller scale than expected from the construction phase. For this reason, and because of the reasons discussed above for the construction phase, the disturbance of sea birds specifically associated with the conservation area, in relation to vessel movement is likely to be low. No other communities or habitats associated with the designation are anticipated to be impacted as a result of visual/physical disturbance and therefore impacts of nature conservation areas are considered to be **insignificant**.

**Impacts during the Operational Phase**

In general, impacts during the operational phase will be similar to those during the construction phase, but on a much reduced scale. Natural gas movement in the pipelines will lead to some noise and vibration. Potential impacts as a result of routine inspections and maintenance works are expected to be an increase in turbidity as a result of the re-suspension and spreading of sediments, noise and vibration and physical alteration of the seabed. In addition, vessel movement may result in visual or physical disturbance to fauna in the vicinity of the pipelines.

*Increase in turbidity*

The re-suspension and spreading of sediments in the water column is possible as a result of routine inspections and maintenance work. Routine inspections are not likely to cause any significant impacts but maintenance work may require seabed intervention works of some nature. The extent of these impacts is likely to be much smaller than for the construction phase, but it is not possible to predict the frequency with which maintenance works will be required, nor the extent of seabed disturbance from these activities. However, due to the distance (12 km) of the only nature conservation area from the pipelines, an increase in turbidity along the pipelines' route is not expected to affect the protected area. Therefore, the re-suspension and spreading of sediments from routine maintenance works is expected to have an **insignificant** impact on conservation areas in ESR III.

*Noise and vibration*

As for the pre-commissioning and commissioning phase, noise and vibration generated by natural gas movement in the pipelines is expected to affect fauna in the immediate vicinity of the pipelines only. As the pipelines' route is situated at least 12 km from the only nature conservation areas in ESR III, the West Estonian Archipelago, the impact of noise and vibration as a result of natural gas movement in the pipelines is expected to be **insignificant** as neither flora or fauna associated with the designation is expected to be affected. Similarly, routine inspections and maintenance work will have an insignificant impact on conservation areas in ESR III in terms of noise and vibration, due to the distance of the pipelines from the protected area and because the scale of operations will be far smaller than for the construction phase (where impacts were also considered insignificant).

*Physical alteration of the seabed*

Physical alteration of the seabed is also possible during routine inspections and maintenance works once the pipelines are operational. Again, the extent of these impacts will be smaller than that of the construction and pre-commissioning and commissioning phases. Since the West Estonian Archipelago conservation area is at least 12 km from the pipelines, physical alteration of the seabed will not affect this area and is expected to have an **insignificant** impact on the nature conservation area in ESR III.

*Visual/physical disturbance*

There will be a low level of vessel movement associated with routine inspections and maintenance work which may result in low level visual or physical disturbance to sea birds associated with the nature conservation areas in ESR III. Routine inspections are expected to have limited impacts upon sea birds, especially as vessel movement is common throughout the area. As these works will be infrequent, and on a much smaller scale than that of the construction phase, the impact on birds associated with the nature conservation areas in ESR III is considered to be **insignificant**.

**Impact Summary**

The impacts identified and assessed in ESR III on nature conservation areas are summarised in **Table 9.57**.

**Table 9.57 Impact summary table for nature conservation areas in ESR III**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Nature Conservation Areas - Ecological Sub-Region III | Increase in turbidity | Munitions clearance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Trenching, Rock placement, Pipe-laying, Anchor handling, Hyperbaric tie-in activities | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections/ and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Munitions clearance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Seabed intervention works, Pipe-laying, Anchor handling, Hyperbaric tie-in activities | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline flooding, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Physical alteration of the seabed | Munitions clearance, Seabed intervention works, Pipe-laying, Anchor handling, Hyperbaric tie-in activities | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Visual/physical disturbance | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |

**Table 9.58 Summary of significant impacts for ESR III**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Water Column | Increase in turbidity | Munitions clearance | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | Release of contaminants | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| Seabed | Physical alteration of the seabed | Munitions clearance | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Local - Regional | Long-term | Low | Low | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| Atmosphere | Emissions of pollutant gases | Seabed intervention works, Pipe-laying | Negative | Cumulative | National - Transboundary | Long-term | Low | Low | Low | Irreversible | **Minor** |
| Marine Benthos | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term - Long-term | Low | Low | Low | Reversible | **Minor** |
| | Release of contaminants | Munitions clearance, Seabed intervention works, Pipe-laying, Anchor handling | Negative | Direct and indirect | Local | Long-term | Low | Low | Low | Reversible | **Minor** |
| | Noise and vibration | Munitions clearance | Negative | Direct | Local | Temporary | Low - Medium | Low | Low | Reversible | **Minor** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Physical loss of seabed habitats | Munitions clearance | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | | Rock placement | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | | Trenching, Pipe-laying | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | | Hyperbaric tie-ins | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | Smothering | Trenching, Rock placement, Installation of support structures, Pipe-laying | Negative | Direct | Local | Short-term - Long-term | Medium | Low | Low | Reversible | **Minor** |
| | Physical alteration of the seabed | Routine maintenance | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | Introduction of secondary habitats | Pipeline presence | Positive or Negative | Direct | Local | Long-term | Low | Low | Low | Irreversible | **Minor** |
| Fish | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Medium-High | Medium | Low - High | Reversible | **Minor-Moderate** |
| | | Trenching, Hyperbaric tie-ins | Negative | Direct | Regional | Temporary | Low | Low | Low - High | Reversible | **Minor-Moderate** |
| | | Pipeline presence | Negative | Direct | Local | Short-term | Low | Low | Low - High | Reversible | **Minor-Moderate** |
| | Physical alteration of the seabed | Pipeline presence | Negative | Direct | Local | Long-term | Medium | Low | Low- High | Irreversible | **Minor-Moderate** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Marine Mammals | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Medium – High | Medium | Medium – High | Reversible | **Moderate** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Medium – High | Reversible | **Minor - Moderate** |
| | Ice breaking | Construction and support vessel movement | - / Negative | - / Direct, Secondary | - / Regional | - / Short-term | - / Medium | - / Medium | - / High | - / Reversible | **No impact / Moderate** |

## 9.6 Ecological Sub-Region IV

### 9.6.1 Introduction

The pipelines pass through ESR IV over a total distance of 337.4 km, comprising three separate sections) of the pipelines' route flagged by sections of ESR II, as shown in **Figure 9.9**. The salinity of surface waters in ESR IV is relatively high. There is not normally a halocline in ESR IV, however a halocline can exist at an approximate depth of 50 m at the southernmost part of the ESR. The average surface water temperature fluctuates from 4˚C in April/May up to 20˚C in July/August, while deep-water temperatures fluctuate from 2˚C in April/May to 10˚C in October. The waters of ESR IV are generally oxygenated. In shallow parts of ESR IV, turbidity in the water column is high due to vertical mixing (re-suspension). Zones of non-sedimentation are present in the northern section of ESR IV, with scattered areas of sedimentation in the southern section, across the Arkona basin. Species richness varies, with the Gotland Basin within ESR IV having a very low species richness compared to the Bornholm Basin. The relatively shallow, sandy sediments in ESR IV are important for demersal and benthic fish species, and pelagic fish species that are common throughout the Baltic Sea. ESR IV also has some of the most important bird wintering areas in the Baltic Sea, including the Pomeranian Bay in German waters. The harbour seal, grey seal and harbour porpoise are present in ESR IV, but the harbour porpoise generally prefers shallow coastal areas, particularly south west of the Bornholm Basin. ESR IV is demarcated by the following KPs: KP 745.9 – 945; KP 1046.4 – 1057.4 and KP 1070.8 – 1198.1.

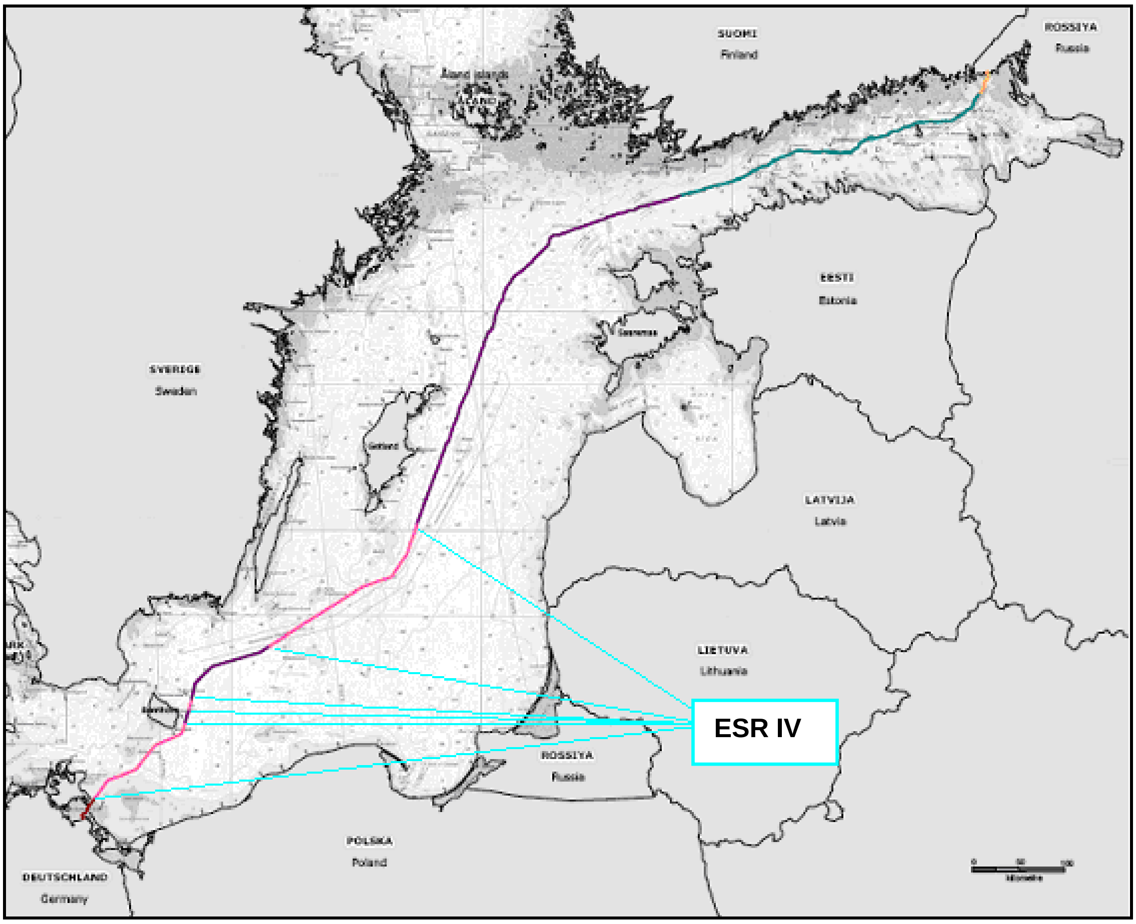


**Figure 9.9 The section of the pipelines' route passing through ESR IV (in pink)**

Predicted impacts in ESR IV will occur as a result of the following activities identified during the three initial phases of the Project. These include the following:

*Construction phase*

Seabed intervention works

- Dredging
- Trenching
- Rock placement

Offshore pipe-laying:

- Pipe-laying

- Anchor handling
- Above water tie-in activities
- Construction and support vessel movement

*Pre-commissioning and commissioning phase*

- Pipeline flooding, cleaning, gauging and pressure testing
- Pressure-test water discharge
- Pipeline commissioning

*Operational phase*

- Routine inspections and maintenance
- Pipeline presence

The predicted impacts are identified and assessed for each resource or receptor in the physical and biological environment. Impacts that are deemed to be of significance when they occur are assessed in full by means of the methodology presented in **Chapter 7**. Impacts that are deemed to be insignificant based upon previous knowledge and experience in similar projects are described but not assessed in detail.

A summary table showing the significant impacts for ESR IV is shown at the end of this section (**Table 9.75**).

### 9.6.2 Physical Environment – Physical processes

#### Overview

This section identifies and assesses the potential impacts on the physical processes in the deep waters of ESR IV in terms of the methodology presented in **Chapter 7**.

The physical processes in the Baltic Sea are described in **Section 8.5.2**. The Baltic Sea is characterised by an extensive freshwater excess that produces a strong stratification. As described in **Chapter 8**, the currents in the Arkona Basin are influenced by the large-scale circulation created by dense bottom currents entering over the sills in this area. The volume of the incoming saline water increases due to the downward flow of currents through the Arkona Basin, Bornholm Strait and Bornholm Basin.

The main activities in ESR IV which are expected to impact on physical processes will occur during the operational phase. There are no expected impacts on the physical processes for the construction or pre-commissioning and commissioning phase in ESR IV since physical processes are only likely to occur as a result of the presence of the pipelines on the seabed, over the long term.

Activities and the associated impacts that are assessed in this section are as follows:

*Operational phase:*

- Pipeline presence resulting in change in underwater current flow

**Impacts during the Operational Phase**

As for ESR I, II and III, the presence of the pipelines on the seabed has the potential to alter the composition, strength and direction of the currents. Similarly, currents can be altered due to the effect of a temperature difference between the pipelines and the surrounding water.

*Change in Underwater Current Flow*

The presence of the pipelines on the seabed in the area south and south-east of Bornholm has the potential to alter physical processes such as water mass exchange at the seabed as a result of potential increases in the degree of mixing of new deepwater. As discussed in **Section 9.4.2**, an increase in the degree of mixing of new deepwater could lead to lower salinity, increased flow rate and increased transport of oxygen, which can increase the deposition of phosphorus in the deepwater and reduce levels of eutrophication.

In ESR IV, deepwater inflow into the Arkona and Bornholm Basins is the only way that oxygen is supplied to the deep waters (below the halocline) of the Baltic Sea. As described in **Chapter 8**, the waters of ESR IV are considered to be oxygenated; however the waters around the Islands of Christiansø and Græsholmen to the south of Bornholm can become oxygen deficient at times due to the relative proximity to the deep waters of ESR III. The oxygen supply process is therefore important for the physical, biogeochemical and ecological status of the Baltic Sea, and indeed within ESR IV.

The flow of water entering via the Arkona Basin varies in volume, salinity and temperature causing natural variability to the salinity and temperature of deep water in ESR IV. As described in **Chapter 8**, large volumes of saline inflow are sporadic causing changes to the depth of the halocline and causing periodic anoxic conditions in the deep water of ESR IV.

As described in **Section 9.5.2**, a study(1) has concluded has found that the Nord Stream pipelines are likely to dissipate about 0.5 % of the total potential energy, which will have little or no impact on the existing current patterns. Furthermore, for the same reasons as described in **Section 9.5.2**, the influence of waves at the seabed and wave induced water velocity at pipeline level will be very small, such that scour will not cause release of significant amounts of sediment that will cause environmental impacts.

As for ESR III, the temperature balance that occurs within the water operates quickly and as such the influence of temperature differences between the pipelines, the sediment, and the water body will be negligible, meaning the change in currents due to the temperature changes will also be negligible.

As such, it is anticipated that the impact of the blocking effect resulting from the Project within this location will be **insignificant**.

**Impacts summary**

The impacts on physical processes identified and assessed in ESR IV are summarised in **Table 9.59.**

(1) Swedish Meteorological and Hydrological Institute. 2007. Possible effects upon inflowing deep water of a pipeline crossing the flow route in the Arkona and Bornholm Basins. (This study is currently undergoing limited improvements).

**Table 9.59 ESR IV impact summary table for physical processes**

| Physical Processes - Ecological Sub-Region IV | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Change in underwater current flow | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.6.3 Physical Environment – Water Column

**Overview**

Following the undertaking of a scoping and impact identification exercise, numerous interactions between the Project and the water column in ESR IV have been identified, which could give rise to potential impacts. This section identifies and assesses the potential impacts on the water column in ESR IV during the construction, pre-commissioning and commissioning, and operational phases of the Project in terms of the methodology presented in **Chapter 7**.

The characteristics of the water column are not constant throughout the Baltic Sea and differ depending on location as well as depth. Accordingly, the significance of the associated Project impacts on the water column may also differ along the pipelines' route. The quality of the water column is dictated by its salinity and oxygen levels as well as by the concentrations of suspended solids, nutrients, heavy metals, organic pollutants, plankton and biological components. Full details as to the water quality in ESR IV are presented in **Section 8.10.1**. Essentially the water column is important for all ecosystems in terms of supporting function and structure but is very resistant to change in terms of its interaction with the Project. In most cases, the water column will rapidly revert back to a pre-impact status once specific activities, such as those during construction, cease. This would depend on the magnitude of the impact and its persistence. As per the sensitivity criteria for the physical environment as detailed in **Chapter 7**, the water column has been awarded a **low** value/sensitivity throughout the Baltic Sea.

The main activities that are expected to impact on the water column are those that take place during the construction phase. The re-suspension and spreading of sediments by seabed intervention works is expected to impart the largest impact upon the water column. Accordingly, the characteristics of seabed sediments play a major role in determining the level of impact. No impacts are expected in ESR IV during pre-commissioning and commissioning as the intake of seawater and subsequent discharge of pressure-test water is to occur at the Russian landfall in ESR I. The impacts as a result of above water tie-ins that will take place before pre-commissioning have been included in the construction phase. Impacts during the operational phase are expected to be minimal in comparison to construction. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Re-suspension and spreading of sediments from seabed intervention works, pipe-laying, anchor handling and above water tie-in activities resulting in:
  - Increase in turbidity

- Release of contaminants
- Release of nutrients

*Operational phase*

- Pipeline presence resulting in:
    - Temperature change
    - Release of pollutants from anti-corrosion anodes

**Impacts during the Construction Phase**

Impacts on the water column during the construction phase are limited to the re-suspension and spreading of sediments resulting in an increase in turbidity and the release of contaminants (heavy metals and organic pollutants) and nutrients as a result of pipe-laying, seabed intervention works, anchor handling and above water tie-in activities.

*Increase in turbidity*

Construction works on the seabed will result in the disturbance and subsequent re-suspension of sediments together with associated compounds such as contaminants and nutrients, which may be present. This will increase turbidity levels as well as increasing the concentrations of these substances in the water column. Activities that are expected to disturb the seabed include pipe-laying, seabed intervention works, anchor handling and above water tie-in activities. Seabed intervention works are expected to generate the most re-suspended sediment while pipe-laying, anchor handling and above water tie-in activities are expected to contribute very little. The amount of sediment disrupted is highly dependent on the methods and equipment used during pipe-laying, as well as the extent of the construction works. The degree to which sediments are generally prone to suspension is linked to the fines content and how consolidated the sediment is. Sediments are re-suspended for a period of time before being deposited (sedimentation) elsewhere. It should be noted that seabed intervention works are restricted to specific areas as depicted on **Atlas Maps PR-3A** and **PR-3B**. As such the associated level of impact would not extend along the entire pipelines' route in ESR IV. The different types of seabed intervention works and types of sediments for ESR IV are detailed in **Table 9.60**.

**Table 9.60 Seabed intervention works (both pipelines') and sediments types for Ecological Sub-Region IV**

| Area | Seabed Intervention Works | Sediment Types |
|---|---|---|
| Gotland Deep/ Bornholm Basin | Trenching<br>Rock placement | Glacial clay and till (north east), and sand and coarse sediments (south west) |
| Bornholm Basin/Arkona Basin | Dredging (limited)<br>Trenching<br>Rock placement | Predominantly sand and coarse sediments with limited sections of glacial clay and till around Bornholm |

For the most part, the pipelines' route through ESR IV is at a depth range between 10 and 50 m. Sections of ESR IV to the south west of Gotland are in the deeper waters between 50 and 100 m. Currents (depending on strength and presence) along the seabed will increase the distance to which suspended sediments would be transported laterally and vertically as well as the time period for which sediments remain in suspension.

The re-suspension and spreading of sediments is expected to be greatest during seabed intervention works that include dredging, trenching and rock placement. Modelling of the spread and sedimentation of sediments and contaminants during works in the seabed in ESR IV has been carried out by using a general numerical particle analysis model (Mike 3 PA) for locations along the pipelines' route where dredging, trenching by plough and rock placement will take place. The Mike 3 PA model involves numerous inputs in relation to the type of seabed intervention works. The initial input for sediment modelling is the expected spill rate for the various activities. The spill rate for dredging (7 kg/s) and trenching (20 kg/s) was determined by the average dredging/trenching speed, the nominal volume of displaced sediment, the percentage spill (10 and 2%) and the density of the spilled sediment. The spill rate for rock placement (1 kg/s) was determined by the placement rate, rock volume and falling velocity (kinetic energy converted to potential energy on impact). Sediments are released at heights of 2, 5 and 2 m above the seabed for dredging, trenching and rock placement respectively. The distance a particle travels is governed by particle grain size, flocculation, grain size fractions, hindered settling in high concentration areas, water properties, grain size distribution and settling velocity.

The areas and average duration of re-suspended sediment concentration > 1 mg/l for ESR IV are shown on **Atlas Map MO-1** and **MO-30** for the section of ESR IV in the Bornholm and Arkona Basins and on **Atlas Maps MO 5-7** for the Gotland Deep/Bornholm Basin section. An excess concentration of 1 mg/l (the model used a background concentration of 0 mg/l) will hardly be visible in the water since normal concentrations in the Baltic Sea are typically in the range of 1 – 4 mg/l during normal weather and even higher during stormy conditions. As such, the sediment clouds shown on the Atlas Maps may be regarded as the maximum extent of the sediment spreading (for the applied weather conditions). Sedimentation for ESR IV in terms of the amount of sediment deposited on a square metre of seabed is depicted on **Atlas Maps MO-2** and **MO-31** and **MO 8-10**.

For dredging and trenching (restricted to two areas) in the Bornholm and Arkona Basins, modelled re-suspended sediment with a concentration above 1 mg/l is expected within 1-2 km of the disturbance area for 12-24 hours. A concentration above 10 mg/l (a value where avoidance reactions of some fish species can be observed) is expected to last for 2.3 hours close to the disturbance area. Sedimentation is modelled to range from 0.1 to 1.0 kg/m$^2$ 1 km from the disturbance area and from 0.01 to 0.1 kg/m$^2$ 1.5 km away. 1.0 kg/m$^2$ is equivalent to 1 mm of sediment over a square metre.

For trenching and rock placement in the Gotland Deep and Bornholm Basin, modelled re-suspended sediment with a concentration above 1 mg/l is expected within 3-4 km of the disturbance area for approximately 12 hours. Certain trenching areas (south of Gotland) experience increased turbidity for up to 72 hours. A concentration above 10 mg/l (a value where avoidance reactions of fish species can be observed) is expected to last for 4.9 hours close to the disturbance area. Sedimentation is modelled to range from 0.1 to 1.0 kg/m$^2$ at the source and from 0.01 to 0.1 kg/m$^2$ 2 km away. 1.0 kg/m$^2$ is equivalent to 1 mm of sediment over a square metre. Rock placement will occur in close vicinity to trenching activities. The effect has been included in the assessment for trenching.

Re-suspended sediments are expected to remain within 10 vertical metres of the seabed. However, the effect of currents and wave action can mobilise sediments towards the surface in the shallow areas. Due to the limited extent and duration of increased turbidity levels and the fact that seabed intervention works will only occur at specific points on the pipelines' route it is expected that the impact (**negative** and **direct**) on the water column in ESR IV will be of **regional** scale (above background levels) of **short-term** duration (sedimentation rate) and of **low** intensity. Impact magnitude is **low** and value/sensitivity is **low**. Impacts will be **reversible** within a few days as sediment settles to the seabed. Therefore, impact significance is expected to be **minor**.

Pipe-laying can result in the re-suspension and spreading of sediments due to the current generated in front of the pipelines as they near the seabed as well as from the pressure transfer when the pipelines hit the seabed. The amount of sediment that is expected to be placed into suspension during pipe-laying has been determined by considering the vertical velocity of the descending pipelines, the flow velocity of the water during displacement, the Shields parameter (which defines the limit at which particles start to move), the upward flow generated by an increase in pore pressure due to sediment compression and both hard and soft sediment characteristics. Along a 1 km stretch of a pipeline it is expected that the amount of suspended sediment, when the pipeline hits the seabed, would be up to 600 kg at a height of 1 m above the seabed for soft sediments. During pipe-laying, anchors will be used to position the pipe-laying vessel. Anchor handling involves the placement and retrieval of 12 anchors on the seabed for every 200-600 m of pipeline laid. Anchor placement and retrieval, as well as the anchor cable sweeping across the seabed, will result in the re-suspension of sediments. The amount of sediment that is placed in suspension has been determined by considering similar variables to those used for pipe-laying. During both anchor placement and retrieval it is expected that 10-160 kg of sediment will be placed in suspension per anchor. Approximately 100-150 m of anchor cable is expected to lay at rest on the seabed and will sweep across the seabed as the lay vessel moves forward resulting in the release of 400-1600 kg of sediment. Anchor handling results in a suspended sediment concentration >10 mg/l over a very limited area of 0.004-0.016 $km^2$. Even though pipe-laying and anchor handling will extend along the entire pipelines' route in ESR IV it is expected that the effects of these activities would compare well to the effects of bottom trawling activities (dragging of trawls along the seabed) as well as normal anchor placement in the Baltic Sea. As such it is expected that such activities would contribute very little to the overall amount of sediment placed into suspension during the construction phase and thus the impact is **insignificant**.

Above water tie-in activities will take place at KP 1195.9 following pipe-laying. According to the current lay sequence this is only applicable to the north-west pipeline (Line 1). During tie-in the two pipeline sections will be lifted from the seabed and brought alongside a barge where they will be welded together. Thereafter, the pipeline will be lowered to the seabed. The interactions between the pipelines and seabed during pipeline lifting and replacement will result in a minimal increase in turbidity in close vicinity to the pipelines. This is expected to be on a par with, or less than, normal pipe-laying on the seabed and thus the impact is regarded as **insignificant**.

*Release of contaminants*

Contaminants (identified as cadmium, mercury, lead, zinc, copper, arsenic, chromium, nickel, polycyclic aromatic hydrocarbons (PAH) and tributyltin) are typically bonded to the sediment particles in most of ESR IV. A contaminant's ability to spread and dissolve in the water column (model) as well as its relative toxicity (in terms of the desorbed and bioactive fractions and the predicted no-effect concentration in the water column) are discussed in **Section 9.3.3** under ESR I. The spreading of contaminants was only considered at rock placement points since trenching areas are typically erosion areas and do not display a significant degree of contamination. The spreading of contaminants by pipe-laying and anchor handling is not considered as only a limited amount of sediment is expected to be re-suspended. Arsenic has been modelled to exceed the PNEC within 1 km from the pipelines while copper and PAHs have been modelled to display higher toxicity levels above the PNEC value at greater distances. The maximum concentrations of CU and SUM16PAH for rock placement sites in ESR IV are shown on **Atlas Map MO 11**, which covers that area of ESR IV in the Gotland Deep. The locations of the affected areas are highly sensitive to the current speed and direction since the contaminants are treated as dissolved particles that do not settle. The section of ESR IV that spans the

Bornholm and Arkona Basins has not been modelled as seabed intervention works are not planned for these areas.

For rock placement to the south of Gotland, modelled contaminant (copper and PAHs) spreading is predicted to exceed the PNEC up to a distance of 2.5 km from the source. For copper this concentration is expected to last for 24 hours while for PAHs it is expected to last 73 hours. Contaminants have the ability to mobilise upwards but would generally be diluted. Due to the limited extent and duration of increased contaminant concentration levels and the fact that seabed intervention works will only occur at specific points on the pipelines' route it is expected that the impact (**negative** and **direct**) of the release of contaminants will be **regional**, of **short-term** duration and of **low** intensity. Impacts will be **reversible** within a few days. Impact magnitude is **low** and the value/sensitivity of the water column is **low**. Impact significance is expected to be **minor**. Seabed intervention works will not contribute additional contaminants to the Baltic Sea but would be active in their relocation.

During seabed intervention works, any $H_2S$ present in the sediment could be released into the water column, causing it to react rapidly with any oxygen in the water forming $H_2SO_4$. This would result in reduced oxygen levels in the water column. This effect is expected to be temporary as the exchange of water masses will ensure that the oxygen depleted water will be oxygenated. The impact is expected to be **insignificant**.

Chlorinated dibenzo-p-dioxin (PCDD) and dibenzofuran (PCDF) compounds or 'dioxins' may be present in the sediments of ESR IV. Dioxins are persistent organic pollutants that can cause severe, long-term impacts on marine biota such as fish, whole ecosystems and human health[(1)]. The source of dioxins, there presence in the sediments of the Baltic Sea as well as their effects on marine biota and human health are elaborated upon in **Section 9.3.3** under ESR I.

Dioxins that have accumulated in sediment tend to be tightly bonded to sediment particles and desorb quite slowly. As per the modelling results for the re-suspension and spreading of sediment, it is expected that re-suspended sediments will not be distributed throughout water column but will be concentrated within 10 vertical metres of the seabed and will settle over a few days. As most dioxins are bonded to the sediment particles it is therefore assumed that they will behave in the same manner and will settle on the seabed. As such, the impact on the water column is expected to be **insignificant** and only limited bioaccumulation in marine biota is expected.

*Release of nutrients*

A release of nutrients, such as nitrogen and phosphorus, during the re-suspension and spreading of sediment due to seabed intervention works could stimulate phytoplankton production, should the nutrients reach the photic zone, thereby increasing the biomass. An increase in primary production due to the release of nutrients could also potentially contribute to

(1) Helsinki Commission. 2004. Dioxins in the Baltic Sea.

oxygen consumption by degradation of organic matter. A release of oxygen-consuming compounds during trenching or rock-placement may further aggravate situations with local oxygen deficiency at the sea bottom. **Section 9.3.3** summarises the expected amount of nitrogen and phosphorus to be released during seabed intervention works in the Baltic Proper, which includes ESR IV. Overall, the likely increase in nutrient concentration resulting from seabed intervention works in the Baltic proper is small in relation to current nutrient inputs. Accordingly, the release of nutrients into the water column should not generate increases in nutrient concentrations outside the normal range of conditions. Since most of the nutrients in sediments are bound to particles, and will not contribute to primary production, much of the increase in concentration will be reversed as particles settle out. The immediate impact of the release of nutrients would occur during seabed intervention and thus will be of short duration. The release of nutrients will result in an increase in nutrient concentration that would not extend beyond normal conditions(1) and therefore the impact on the water column is assessed to be **insignificant** in ESR IV.

**Impacts during the Operational Phase**

Impacts upon the water column during the construction phase are limited to a change in temperature by the movement of natural gas within the pipelines as well as the release of pollutants from anti-corrosion anodes on the pipelines.

*Temperature change*

A gas temperature of around 40ºC is expected at the Russian landfall as a result of the natural gas heating during compression. Simulation of temperature changes for a free-laying pipeline close to the Russian landfall, shows (with seawater temperature of -2ºC) an insignificant temperature increase (maximum 0.5°C) in the water near the seabed and in the water on the downstream side of the pipeline. The gas will expand as it moves further away from the Russian landfall and will therefore decrease in temperature. In ESR IV it is expected that the temperature of the gas and the temperature of the water column around the pipelines will be in equilibrium. The gas temperature is, however, expected to decrease slowly as it gets close to the German landfall. As such, there may be slight change in temperature at the edge of ESR IV near ESR V. Overall, the impact on the water column in ESR IV is expected to be **insignificant** as no change in water temperature is expected**.**

*Release of pollutants from anti-corrosion anodes*

To minimise external corrosion, anodes are to be installed at regular intervals along each pipeline. The potential impacts on water quality from pipeline anodes are related to the release of metal ions from the anode material during the lifetime of the pipelines. Various calculations in

(1) "Normal conditions" are defined as pre impact status conditions i.e. the existing water column for ESR IV prior to commencement of the Project, as detailed in **Section 8.10.1**.

terms of the expected release of ions and their effect on the water column are described in **Section 9.3.3** under ESR I. Based on these calculations it is concluded that there is no significant risk posed by the release of compounds from aluminium anodes. Zinc anodes will only be used in lower salinity areas in ESR I, II and III. As such, the impacts on the water column in ESR IV are deemed to be **insignificant.**

**Impact Summary**

The impacts identified and assessed in ESR IV on the water column are summarised in **Table 9.61**.

**Table 9.61 ESR IV impact summary table for the water column**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Water Column – Ecological Sub-Region IV | Increase in turbidity | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Pipe-laying | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Above water tie ins | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of contaminants | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | Release of nutrients | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | Temperature change | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of pollutants from anti-corrosion anodes | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.6.4 Physical Environment – Seabed

**Overview**

The seabed in ESR IV is characterised as being shallow in places, with an exposed mineral bed substrate and sandbank habitats, and with comparatively high salinity and comparatively high oxygen levels everywhere except for the deeper water regions (see **Section 8.10.2**). The seabed in ESR IV supports significant marine fauna and flora. The sediments of the Pomeranian Bay consist mainly of fine to medium grained sands although sediments dominated by finer fractions (silt and clay) are also found locally, particularly on the seabed surface.

The seabed in ESR IV is considered to have a **low** sensitivity throughout, as described in **Chapter 8**. The seabed habitat in this ESR is known to support a number of species of ecological significance, including a number of macrophytes, bryozoans, amphipods, isopods and cnidarians as well as fish, bird and mammal species, and the impacts on these species are assessed below in **Sections 9.6.7 - 9.6.10**. However, the seabed is not considered to be particularly sensitive to change, being of **low** value/sensitivity.

As for the other ESRs, the main activities in ESR IV which are expected to impact on the seabed will occur during the construction phase and, to a lesser extent, the operational phase. Above water tie-in activities are not expected to have any impact on the seabed other than the effects due to anchor handling, which are discussed separately. No impacts on the seabed are predicted for the pre-commissioning and commissioning phase. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Seabed intervention works, pipe-laying and anchor handling resulting in:
    - Release of contaminants
    - Physical alteration of the seabed

*Operational phase:*

- Routine inspections and maintenance and pipeline presence resulting in:
    - Physical alteration of the seabed
- Pipeline presence resulting in:
    - Release of pollutants from anti-corrosion anodes

**Impacts during the Construction Phase**

As described in **Section 9.2.1,** seabed intervention works include dredging, trenching and rock placement. Above-water tie-ins, pipe-laying and anchor handling also occur during the construction phase. These activities are likely to result in the release of contaminants and physical alteration of the seabed.

*Release of contaminants*

Of the potentially ecotoxic chemical compounds in the Baltic Sea (listed in **Section 9.3.4**) none is present in high concentrations in ESR IV (see **Section 8.10.2**). Therefore, there are not likely to be large adverse effects on seabed flora and fauna due to the release of contaminants from construction works in ESR IV. Further, as discussed in **Section 8.10.2**, the seabed is considered to be of low value/sensitivity. Therefore, impacts due to release of contaminants on the seabed in ESR IV due to seabed intervention works, above-water tie-ins, pipe-laying and anchor handling are considered to be **insignificant**.

*Physical alteration of the seabed*

Re-suspension and spreading of sediments in ESR IV is likely to occur due to construction activities on the seabed. This includes the creation of mounds during dredging and trenching, introduction of gravel to the seabed during rock placement. As described in **Sections 9.3.4** and **9.5.3**, dredging has the highest spill rate of these activities, with a five-fold smaller spill rate from trenching, and lower spill rates still for rock placement and anchor handling. Above-water tie-ins and pipe-laying are not expected to impact on the seabed, as they will not cause significant re-suspension of sediments. Sediments from seabed intervention works will be deposited over an area up to approximately 4 km from the construction area, however as for the other ESRs, no major change to the seabed is expected in terms of structure and function, and seabed intervention works are confined to specific sections of the pipelines' route. Physical alteration of the seabed in ESR IV is also likely to result from dredging, trenching and rock placement activities due to the creation of mounds of sediment/gravel. Seabed intervention works are assessed to have a **direct negative** impact on the seabed, which is **reversible** in the long-term, in terms of the structure of the seabed. Impacts act on a **local** to **regional** scale. Impacts are of **long-term** duration. Impact intensity is considered to be **low** as no major change in structure or function is expected. The impact magnitude is **low**. Therefore, due to the **low** value/sensitivity of the seabed the significance of the impacts on the seabed are assessed to be **minor**. The only notable seabed features along the pipelines' route in ESR IV are Hoburgs Bank and North Midsjö Bank, however these will not be affected by these activities.

Anchor handling in ESR IV is likely to cause physical alteration of the seabed, due to controlled positioning of anchors in the seabed, as described in **Section 9.3.4**. While it is expected that depressions will be refilled due to the redistribution of sediments mobilised by currents and waves, this **negative** impact is expected to cause **local** impacts of **low** intensity. As discussed in **Section 8.10.2**, the seabed is considered to be of **low** value/sensitivity. Impacts will be **short-term** in duration. The magnitude of the impact is considered to be **low**. Impacts will also be **reversible** over time. The **direct** impact on the seabed in ESR IV in terms of physical alteration of the seabed as a result of anchor handling is therefore considered to be of **minor** significance.

**Impacts during the Operational Phase**

Impacts on the seabed from the operational phase in ESR IV are limited to physical alteration of the seabed due to routine inspections and maintenance and pipeline presence, and the release of pollutants from anti-corrosion anodes resulting from pipeline presence.

*Physical alteration of the seabed*

Physical alteration of the seabed may also occur during the operational phase. Routine inspections and maintenance of the pipelines may involve occasional seabed disturbance, but this will occur infrequently and vessel movements will be restricted to the pipelines' route. Since the larger-scale seabed intervention works during the construction phase are not expected to impact significantly on the seabed, routine inspections and maintenance works are anticipated to have an **insignificant** impact on the seabed in ESR IV.

In terms of sediment accumulation along the pipelines, this effect is possible following the introduction of the pipelines on the seabed, since their presence will change the flow conditions of sea currents in the pipelines' vicinity, as discussed in **Section 9.6.2**, and will potentially alter the accumulation zones of fine seabed material around the pipelines. However, the accumulation of sediment is unlikely to happen along the pipelines along the majority of ESR IV due to the sediment type in this region, and analysis by Snamprogetti has concluded that no scouring is foreseen along the pipelines' route in ESR IV(1). Therefore, physical alteration of the seabed due to both sediment accumulation and scour is considered to have an **insignificant** impact on the seabed in ESR IV.

*Release of pollutants from anti-corrosion anodes*

As described in **Section 9.3.4**, zinc alloy anodes have been selected for sections of the pipelines' route with very low average salinity, in parts of ESR IV(1), with the remaining sections of the route using indium-activated aluminium anodes. For the two pipelines in ESR IV, particularly along the sections of pipelines which will be buried, some zinc and chromium is expected to be released into the sediment over the 50-year lifetime of the pipelines. However, burial of the pipelines will reduce the release of compounds to the marine environment(2), and will therefore have a lower impact on the environment than for the sections of pipeline exposed on the surface of the seabed. The impact of the anodes on the water column itself has been

(1) Snamprogetti. 2008. Offshore CP System Sizing.

(2) Nord Stream AG & Ramboll. 2008. Memo 4.3s – Materials.

assessed as being insignificant (**Section 9.6.3**) therefore the impact on the seabed in ESR IV is also considered to be **insignificant**.

**Impact Summary**

The impacts on the seabed identified and assessed in ESR IV are summarised in **Table 9.62**.

**Table 9.62 ESR IV impact summary table for the seabed**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Seabed – Ecological Sub-Region IV** | Release of contaminants | Seabed intervention works, Above water tie-ins, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | Physical alteration of the seabed | Dredging, Trenching, Rock placement | Negative | Direct | Local - Regional | Long-term | Low | Low | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Routine inspections | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of pollutants from anti-corrosion anodes | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.6.5 Physical Environment – Atmosphere

**Overview**

The atmosphere is considered to have a **low** sensitivity, for reasons described in **Section 8.5.1**. As described in **Section 9.2.1**, impacts from pollutant release are most likely to arise from the construction phase and, to a lesser extent, the operational phase. No impacts on the atmosphere from ESR IV are predicted from the pre-commissioning and commissioning phase. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Seabed intervention works and pipe-laying activities resulting in:
  - Emissions of pollutant gases

*Operational phase:*

- Routine inspections and maintenance works resulting in:
  - Emissions of pollutant gases

**Impacts during the Construction Phase**

During the construction phase for ESR IV, seabed intervention works, pipe-laying and above water tie-in activities have associated pollutant emissions which will potentially result in acidification, eutrophication and climate change, with associated negative impacts on marine and terrestrial receptors, as discussed in **Section 9.3.5**.

As described in **Section 9.3.5**, pollutant emissions will arise from the vessels participating in the seabed interventions works, pipe-laying and above water tie-in activities. In ESR IV, emissions during seabed intervention works are likely to arise from dredging machinery in landfall areas, tugboat engines during trenching and rock placement machinery and vessel movement and welding equipment used during pipe-laying along the length of ESR IV.

*Emissions of pollutant gases*

As for ESR I, II and III, pollutant gases and particulate matter emissions from seabed intervention works, pipe-laying and above water tie-in activities, due to the diesel and bunker oil used by the construction fleet (both delivery and maintenance vehicles on land and marine traffic), can contribute to acidification, eutrophication, and climate change. However, as described in **Section 9.3.5**, and as shown in **Table 9.8**, emissions associated with Project activities are predicted to be most intense during the construction phase, contributing 1.9, 1.4

and 0.44 % to the annual emissions of $CO_2$, $NO_x$ and $SO_2$ respectively for all activities (mainly shipping traffic) in the Baltic Sea.

As for ESR I, II and III, and as described in **Section 9.3.5**, it is expected that there will be a **cumulative negative** impact on atmospheric $CO_2$ levels from construction activities, operating on a **national** to **transboundary** scale and over a **long-term** duration. Impacts are **irreversible**. However, emission levels relating to the Project are low compared to those from existing shipping traffic, and impact intensity is considered to be **low**. The sensitivity of the seabed is considered to be **low**, as described in **Section 8.10.2**, and impact magnitude is also considered to be **low**. Therefore, the significance of this impact in ESR IV, and for the length of the pipelines as a whole, is expected to be **minor**.

### Impacts during the Operational Phase

During the operational phase in ESR IV, external inspections and routine maintenance works will have associated pollutant emissions, as for the construction phase, which will also potentially contribute to acidification, eutrophication and climate change, with associated negative impacts on marine and terrestrial receptors.

*Emissions of pollutant gases*

During the operational phase, the source of impacts on the atmosphere in ESR IV will be similar to those during construction (emissions from vessels associated with routine inspections and maintenance). As described in **Section 9.3.5**, and as shown in **Table 9.8**, emissions associated with the operational phase of the Project are expected to contribute 0.13, <0.05 and <0.05 % to the annual emissions of $CO_2$, $NO_x$ and $SO_2$ respectively for all activities (mainly shipping traffic) in the Baltic Sea. Emissions associated with routine inspections and maintenance will again be much lower than for those from the construction phase, although they will occur over a longer period. The impact is considered to be **insignificant**.

### Impact Summary

The impacts on the atmosphere identified and assessed in ESR IV are summarised in **Table 9.63**.

**Table 9.63 ESR IV impact summary table for the atmosphere**

| Atmosphere - Ecological Sub-Region IV | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Emissions of pollutant gases | Seabed intervention works, Pipe-laying, Above-water tie-ins | Negative | Cumulative | National - Transboundary | Long-term | Low | Low | Low | Irreversible | **Minor** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |

## 9.6.6 Biological Environment – Plankton

### Overview

Values/sensitivities for plankton in ESR IV are detailed in **Chapter 8** and summarised in **Table 9.64**

**Table 9.64 Value/sensitivity of plankton in Ecological Sub-Region IV**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Plankton** | | | | | | | | | | | | |
| Phytoplankton | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Zooplankton | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |

Given that plankton drift in the water column, there is no potential for the Project to change the abundance or distribution of plankton in general in the ESR. As described in ESR I, potential impacts on plankton as a result of the Project are expected to be **insignificant** in ESR IV.

## 9.6.7 Biological Environment – Marine Benthos

### Overview

The baseline in **Chapter 8** describes a lack of macrophytes near the pipelines' route within ESR IV. The nearest macrophyte communities are several kilometres away at Hoburgs Bank and North and South Midsjö Banks. Brown algae were found at the Adlergrund that inhabit the rocky substrates.

Soft-bottom communities of benthic fauna are present throughout ESR IV and are dominated by species that are adapted to the dynamic environment of this area such as the soft-shelled clam (*Mya arenaria*) and many of the polychaete species.

As described for ESR I, II and III, a scope and impact identification exercise was conducted which is described in **Chapter 7**. Values/sensitivities for marine benthos are detailed in **Chapter 8** and summarised in **Table 9.65.**

**Table 9.65 Value/Sensitivity of marine benthos in Ecological Sub-Region IV**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Benthos** | | | | | | | | | | | | |
| Macroalgae and aquatic vegetation | | | | | | | | | | | | |
| Algae on rocky substrate | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Zoobenthos | | | | | | | | | | | | |
| Soft-bottom community | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Mussel beds* | High | High | High | High | High | High | High | High | High | High | High | High |

* Values apply to the section of the pipelines' route which crosses the Pomeranian Bay and Oderbank Natura 2000 sites.

This section identifies and assesses the potential impacts on marine benthos in ESR IV during the construction, pre-commissioning and commissioning and operational phases of the Project. The activities and the related impacts that are assessed in this section are as follows:

*Construction phase*

- Seabed intervention works, pipe-laying and anchor handling resulting in:
  - Increase in turbidity
  - Release of contaminants
  - Physical loss of seabed habitats
- Seabed intervention works resulting in:
  - Release of nutrients
- Seabed intervention works and pipe-laying resulting in:
  - Noise and vibration
  - Smothering
- Construction and support vessel movement resulting in:
  - Introduction of non-indigenous species (due to the transport and release of ballast water and via biofouling of ship hulls)

*Pre-commissioning and commissioning phase*

- Pipeline flooding and pressure-test water discharge resulting in:
  - Noise and vibration

*Operational phase*

- Routine inspections and maintenance and pipeline presence resulting in:
  - Physical alteration of the seabed
- Pipeline presence resulting in:
  - Introduction of secondary habitats
  - Temperature change
  - Release of pollutants from anti-corrosion anodes

**Impacts during the Construction Phase**

During the construction phase, impacts upon the marine benthos are limited to an increase in turbidity, the release of nutrients and contaminants (heavy metals & organic pollutants) an increase in noise, physical loss of seabed habitats and smothering, as a result of seabed intervention works, pipe-laying and anchor handling.

*Increase in turbidity*

Sediment spread has been modelled for the section of the pipelines near the Natura 2000 sites Hoburgs Bank and North Midsjö Bank. This model shows there will be an increased sediment concentration of more than 10 mg/l for a maximum of 8.1 hours for the area east of Hoburgs Bank (**Figure 9.10**) and for a maximum of 7.5 hours for the area east of North Midsjö Bank (**Figure 9.11**). Neither of these predicted sediment plumes is expected to have an impact on these areas as the sediment plume will not travel to these areas within the predicted duration of increased sediments. Therefore, the potential impact on benthos due to increased turbidity at Hoburgs Bank and North Midsjö Bank is considered to be **insignificant**.

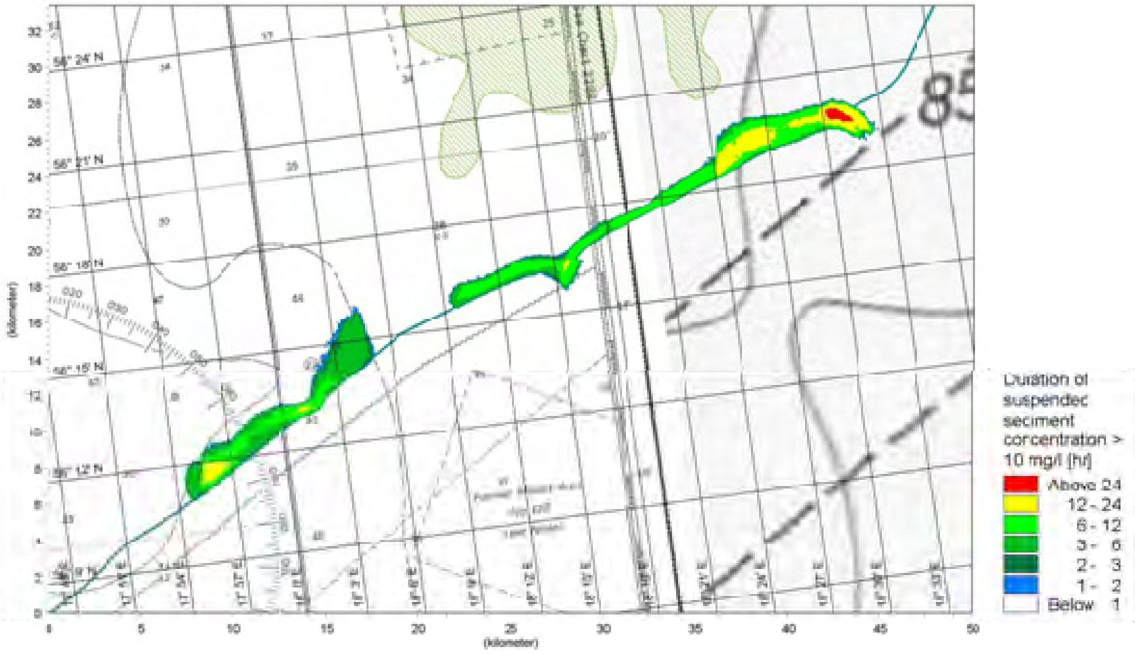


**Figure 9.10 Model of sediment spread near Hoburgs Bank**

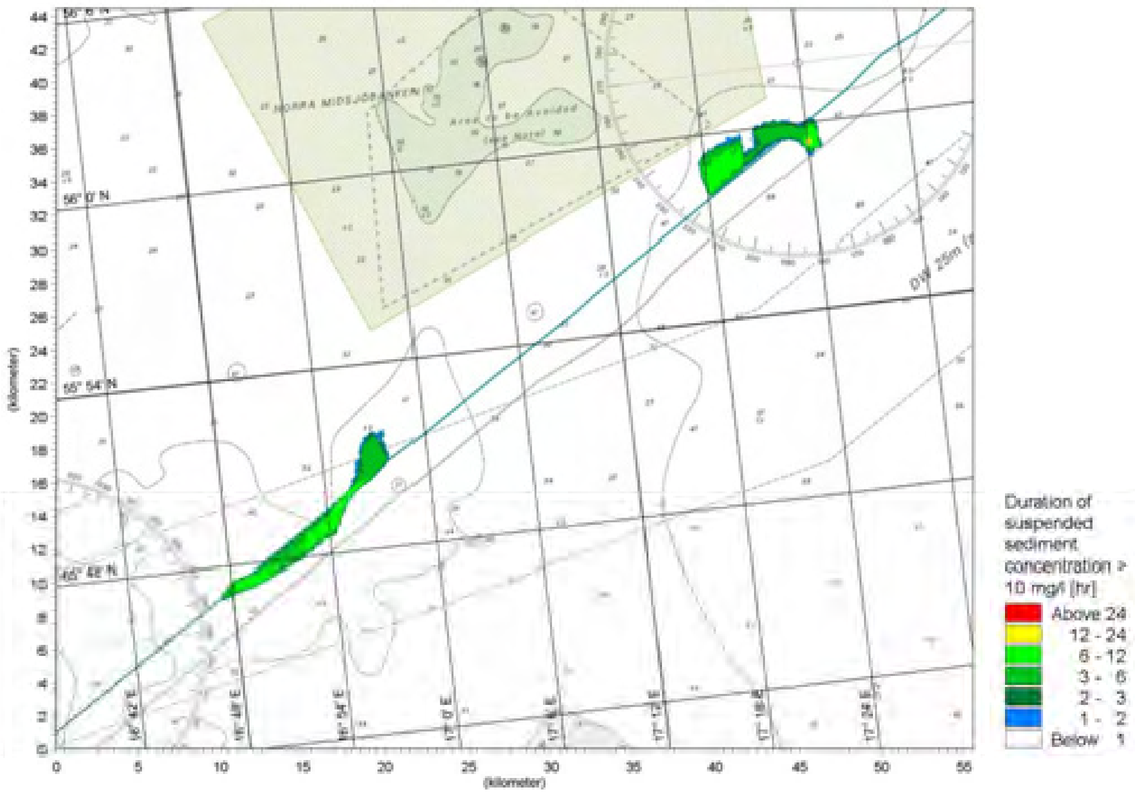


**Figure 9.11 Model of sediment spread near North Midsjö Bank**

The pipelines' route also passes close to several other Natura 2000 sites within ESR IV. It will pass approximately 0.5 km from the Pomeranian Bay and Oderbank Natura site (DE 1652-301) which has been designated, amongst other reasons, for its mussel beds covered in macrophyte vegetation. Sediment spread from trenching, rock placement, pipe-laying and anchor handling is likely to impact this Natura 2000 site. This impact will be **negative** and **direct**. The impact is expected to be **regional** as the sediment plume is expected to travel up to 4 km from the construction area. However, sediment modelling for ESR IV shows that a maximum of 1 mm of construction induced deposits is expected to reach these Natura 2000 sites. The mussel beds within these areas will be able to survive these low levels of sediment deposition. As such, this impact is predicted to have a **low** intensity on the benthos which will be of **short-term** duration. This impact is **reversible** with time. The magnitude of the impact will be **low** as only a small proportion of the entire population is likely to be affected. The impact will affect a **high** sensitivity receptor as the habitat, and therefore its mussel beds are protected. The overall significance of this impact is **moderate.**

Dredging, trenching, rock placement, pipe-laying and anchor handling will cause disturbance to the seabed in the rest of ESR IV and may result in increased turbidity of the water causing smothering of fauna as described in **Section 9.3.7**. The plumes from these activities have the potential to affect a **regional** area up to 4 km from the pipelines. For all these activities the impact is expected to be **negative** and **direct**. Most benthic fauna will be able to recover from the limited amount of sediment deposition that is expected to occur within ESR IV (up to 1 mm depth). The duration of the impact is therefore expected to be **short-term** and **reversible** with time. A limited number of individuals are likely to be damaged by being covered in the anoxic sediment and the rest of the population is expected to be unaffected; the impact is therefore expected to be of **medium** intensity. Smothering of benthos will potentially have a **low** magnitude effect on the benthic population within ESR IV. As the benthos ESR IV is predicted to be of **low** sensitivity, the overall impact significance is expected to be **minor**.

*Release of contaminants*

The impacts on benthos from contaminants released during sediment disturbance are described in **Section 9.3.7**. The mitigation measures described to minimise impacts from suspended sediment will also reduce the significance of potential impacts caused by contamination of the seabed and water column as a result of seabed disturbance. The residual impact from contaminants released from disturbed sediments to the benthos The impacts on benthos from contaminants released due to seabed intervention works, pipe-laying and anchor handling after these mitigation measures have been implemented is expected to be **negative**, **direct** to the seabed and **indirect** through the water column. It is expected to be **local** and **long-term** as particle-bound contaminants will be present in the surface layers of the sediment for many years. The impact on benthic fauna from contaminants released from the sediment is likely to be of **low** intensity and **low** magnitude since changes are expected to be at the limit of detection and affect a group of localised individuals. This impact is **reversible** as the effects will be limited in time. The benthos within the Natura 2000 sites Pomeranian Bay and Oderbank is not expected to be significantly affected. The benthos within the rest of ESR IV is predicted to be of **low** sensitivity so the overall impact significance is expected to be **minor**.

*Release of nutrients*

As described in previous sections (**Section 9.3.7** and **9.4.7**), seabed intervention works will disturb the sediment releasing nutrients. This impact is discussed in full in **Section 9.3.7** and is expected to have an **insignificant** impact on benthos within ESR IV.

*Noise and vibration*

As described in **Section 9.3.7**, some benthic fauna such as crustaceans are able to detect noise and have the potential to be impacted by noise from seabed intervention works and pipe-laying. As detailed in **Section 9.3.7**, noise from construction activities is expected to have an **insignificant** impact on marine benthos including the benthos within ESR IV.

*Physical loss of seabed habitats*

In ESR IV, dredging, trenching and rock placement activities will result in a physical loss of seabed. Construction activities will require vessels to anchor within ESR IV. The tie-in within ESR IV will be made above the water and therefore the only potential impact from this activity is from anchor handling by the vessels involved.

Dredging, trenching and pipe-laying are expected to cause the greatest disturbance to the benthos in ESR IV. These impacts to benthos are described in greater detail in **Section 9.3.7** and **9.4.7**. Trenching will cause a similar size footprint to pipe-laying itself (see details in **Section 9.3.7**), however, dredging activities are likely to cause a larger footprint since a trench must be dug before the pipe is laid. The trench made during dredging is likely to be bigger than the depression made during post-lay trenching and the amount of seabed disturbed during dredging is also expected to be greater. The impact from all these activities will be **negative** and **direct**. In terms of physical loss of the seabed, the impact from trenching and pipe-laying is likely to be restricted to a footprint that is approximately 7.5 m either side of the pipelines and is not likely to be much larger than this for dredging. The impact can therefore be classified as **local**. Whilst the loss of habitat underneath the pipelines will be permanent, the benthos is expected to recover from this loss of habitat within the **short-term**. The physical loss of seabed is of **medium** intensity as habitat is likely to be lost and benthos destroyed but the entire benthic population is not likely to be affected. A **low** magnitude impact is expected as only a specific group of localised individuals within the benthos are likely to be affected and it is highly unlikely that this impact will change the abundance or reduce the distribution of benthos. In addition, the shallow, sandy substrates within ESR IV are subject to natural disturbance during storms on a regular basis and are adapted to these conditions. Therefore, the impact of the loss of habitat on benthos will be **reversible**. No flora have been found within the pipelines' corridor in ESR IV and very little fauna have been found within this area. The fauna that is present in the vicinity of the pipelines' corridor is considered to be of **low** sensitivity. Therefore, the overall significance of this impact for ESR IV is expected to be **minor**. The exception to this is within Pomeranian Bay and Oderbank Natura 2000 sites which have **high** sensitivity mussel beds as they are protected by the Natura 2000 designation. In these areas, since mussel beds will be disturbed. The impact is considered to be **irreversible** as habitat will be permanently lost with the presence of the pipelines. The overall significance of habitat loss in these areas is considered to be **moderate**.

Rock placement will occur along several sections of the pipelines' route within ESR IV and is expected to total 34,000 $m^3$ of gravel. As described in **Section 9.4.7**, the footprint of each area of rock placement is likely to cover an area between 8 and 15 m wide across the pipelines, with a maximum width of 60 m. The loss of habitat and destruction of benthos as a result of rock placement will be **negative** and **direct**. However, the impact is likely to be restricted to within approximately 15 m of the pipelines and will therefore have a **local** effect in discrete areas. The benthos are expected to recover from the loss of habitat in the **short-term**. The intensity is also expected to be **medium** as the habitat will be lost but the whole benthic community is unlikely to be affected. The overall magnitude is expected to be **low** as only a small group of individuals within the benthic population are likely to be affected. The impact will be **reversible**. The overall impact significance is expected to be **minor**. In the **high** sensitivity Pomeranian Bay and Oderbank Natura 2000 sites the overall impact significance is, however, **moderate**. In these areas, since mussel beds will be disturbed, the impact is considered to be **irreversible**.

The impact of physical loss of habitat to the benthos as a result of anchor handling is likely to result in a sizeable impact to the benthos. As described in **Section 9.3.7**, anchor handling is expected to impact an area no larger than 240 $m^2$ at any one time but this impact will occur to a new section of the pipelines' route every time the anchors are moved. However, the substrate within ESR IV is dynamic and the impact to the benthic population is likely to be less than for more stable environments as the benthos is likely to be highly adapted to these dynamic conditions and would be expected to recover quickly. The loss of habitat and damage to the benthos as a result of anchor handling is expected to be **negative** and **direct** but limited to a **local** area. The impact is expected to be **short-term** as re-colonisation of the area is expected to occur rapidly once construction is complete. The impact is likely to have a **medium** intensity as the impact will destroy the habitat and may destroy individual benthos but is not expected to affect the whole community. The impact will have a **low** magnitude as only a small group of individuals within the benthic population are likely to be affected. The impact will be **reversible**. The overall impact is therefore expected to be of **minor** significance. As for the other construction activities, at the **high** sensitivity Pomeranian Bay and Oderbank Natura 2000 sites the overall impact significance is **moderate**.

*Smothering*

Dredging, trenching, rock placement, installation of support structures and pipe-laying will create spoil material that can blanket the surrounding area. This impact is described in detail in **Section 9.3.7**. Dredging and trenching in particular can cause piles of soft sediment to form at the edge of trenches. These piles may slump to smother benthos in the immediate vicinity causing a **local** impact. The effect is **negative** and **direct**. The effect of smothering on the benthos within ESR IV is expected to be of **short-term** duration. Most species within ESR IV are expected to survive underneath relatively thin layers of sediment although they may succumb if sediment is several centimetres thick. Thicker layers of sediment are not expected to occur although a precautionary approach is to predict a **medium** intensity impact as some individual fauna may suffer oxygen depletion and be subject to high levels of toxic hydrogen sulphide that are naturally present in the sediment. This impact is expected to have a **low** magnitude effect as the impact is expected to affect individuals within the pipelines' footprints only. The impact will be **reversible**. The majority of benthos that is predicted to be affected by sediment slumping within ESR IV is of **low** sensitivity resulting in an impact of **minor** significance overall. However, if fauna within the Pomeranian Bay and Oderbank Natura 2000 sites are affected, the overall impact significance would be expected to be **moderate** as the mussel beds within the Natura 2000 sites are of **high** sensitivity.

*Introduction of non-indigenous species*

The diversity and composition of benthos may be affected by invasive species that enter the Baltic system through biofouling of the ship hull of the vessels involved in the construction. Similarly, the vessel movements related to the construction of the pipelines, may aid in spreading invasive species that are already present in one to another area within the Baltic. The use of antifouling paints, careful cleaning of hulls, tanks and drilling and dredging equipment before use prior to entering the Baltic will limit the potential introduction of invasive species. The risk of intra-Baltic spread of formerly introduced species in one part of the Baltic (e.g. from ports in the northeastern part to ESR IV) by the project is negligible in comparison to existing maritime activities. Differences in environmental conditions between the various ESRs of the Baltic Sea reduce the spread of the invasive species from one area to another. ESR IV is more saline than ESR I, which is known to host a number of freshwater invasive species. Salinity may well prove a barrier to the distribution of these species. The unintentional introduction of invasive species into the Baltic Sea or from one area of the Baltic to another poses a negligible risk. Consequently, the residual impacts of the construction phase on benthic communities in ESR IV will be **insignificant**.

**Impacts during the Pre-commissioning and Commissioning Phase**

As for ESR III, potential impacts to benthos during the pre-commissioning and commissioning phase in ESR IV are limited to noise due to pipeline flooding and pressure-test water discharge, since these activities will involve the movement of water in the pipelines along the route, and gas movement in the pipelines during commissioning.

*Noise and vibration*

As mentioned above, most benthic fauna are not sensitive to noise, although some invertebrates do respond to noise and vibration. The noisiest aspects of the pre-commissioning and commissioning phase will be pipeline flooding, pressure-test water discharge and commissioning. Noise produced during these activities will be much less than noise produced during trenching and so impacts from noise during the pre-commissioning and commissioning phase are expected to have an **insignificant** impact on marine benthos.

**Impacts during the Operational Phase**

Impacts that will arise throughout the operational phase are anticipated to result from physical alteration of the seabed, introduction of secondary habitats, temperature change and release of contaminants from anti-corrosion anodes.

*Physical alteration of the seabed*

The pipelines will require routine inspections but as inspections will be infrequent and restricted to the pipelines themselves there will only be low levels of disturbance to the seabed and it is expected that they will have an **insignificant** impact on benthos in ESR IV. On the other hand, routine maintenance works may also be required which may result in **local** disturbance of the seabed resulting in direct loss of benthic fauna and smothering due to sediment re-suspension. This impact would be **negative** and **direct**. However it is likely that the impact would be **short-term** as maintenance activities will only affect a small area for a limited period of time and the benthos is expected to recover quickly within ESR IV. Although this impact could result in a physical loss of the seabed habitat and potentially destroy some fauna, the habitat within ESR IV is highly dynamic and the benthic population is expected to be adapted to these conditions resulting in a prediction of a **low** intensity effect on the population. The impact will be **reversible**. A **low** magnitude impact is expected, as only a limited number of individuals are expected to be impacted which are a **low** sensitivity receptor. The impact significance is expected to be **minor**. The exception to this is if re-suspension of the sediment reaches the Natura 2000 sites within ESR IV causing smothering. The receptors within the Natura 2000 sites are **high** sensitivity receptors and the overall impact would be **moderate** as a result.

*Introduction of secondary habitats*

The impact from pipeline presence will be similar to that in ESR I and is described in detail in **Section 9.3.7**. An overall increase in localised biodiversity and abundance may result as the pipelines will form a new hard substrate, possibly including invasive species previously introduced in the Baltic. However in the area of ESR IV near Hoburgs Bank, the seabed sediments are largely hard bottom glacial clay and will therefore have no significant impact on the benthos. Further south, the majority of sediment is sand and coarser sediments. The community of benthic fauna present in this more mobile, softer sediment may alter with the addition of a hard substrate for attachment. This impact would be **direct** and **irreversible** unless the pipelines are removed during decommissioning. The effect may be **positive** or **negative** in the majority of ESR IV depending on the community of benthos that colonised the area, but would be considered **negative** within the Natura 2000 sites as they are designated for conservation. The effect would impact a **local** area over the **long-term**. The impact intensity is expected to be **medium** as the impact will be greater than the limit of detection but will not affect the function of the benthos entirely. The increase in habitat diversity will have a **low** magnitude. The impact will affect a **low** sensitivity receptor except for in the Pomerania Bay and Oderbank Natura 2000 sites which are of **high** sensitivity. The overall significance of this impact is **minor** for the majority of ESR IV and **moderate** in the protected areas.

*Temperature change*

Natural gas flowing through the pipelines will cause an increase in temperature at the Russian end of the pipelines and a decrease in temperature at the German end of the pipelines. However, these changes will be localised and will not extend into ESR IV. Temperature differences between the pipelines and the marine environment are therefore considered to have **no impact** on benthos in ESR IV.

*Release of contaminants from anti-corrosion anodes*

In ESR IV, the anodes will mostly be made from indium-activated aluminium although some zinc anodes will be used in the section of ESR IV between Hoburgs Bank and South Midsjö Bank. The release of contaminants from these anodes is expected to have an **insignificant** effect on the benthos.

**Impact Summary**

The impacts identified and assessed in ESR IV on the benthos are summarised in **Table 9.66.**

**Table 9.66 Impact summary table for marine benthos in ESR IV**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Marine Benthos - Ecological Sub-Region IV** | Increase in turbidity | Trenching near Hoburgs Bank and North Midsjö Bank | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Trenching, Rock placement, Pipe-laying, Anchor handling at Pomeranian Bay and Oderbank | Negative | Direct | Regional | Short-term | Low | Low | High | Reversible | **Moderate** |
| | | Dredging, Trenching, Rock placement, Pipe-laying, Anchor handling (elsewhere) | Negative | Direct | Regional | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | Release of contaminants | Seabed intervention works, Pipe-laying, Anchor handling | Negative | Direct and indirect | Local | Long-term | Low | Low | Low | Reversible | **Minor** |
| | Release of nutrients | Seabed intervention works, | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Seabed intervention works, Pipe-laying | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline flooding, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | Physical loss of seabed habitats | Dredging, Trenching, Pipe-laying | Negative | Direct | Local | Short-term | Medium | Low | Low/High* | Reversible/ Irreversible* | **Minor/ Moderate*** |

| Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Rock placement | Negative | Direct | Local | Short-term | Medium | Low | Low/High* | Reversible/ Irreversible* | **Minor/ Moderate*** |
| | Anchor handling | Negative | Direct | Local | Short-term | Medium | Low | Low/High* | Reversible | **Minor/ Moderate*** |
| Smothering | Dredging, Trenching, Rock placement Installation of support structures, Pipe-laying | Negative | Direct | Local | Short-term | Medium | Low | Low/High* | Reversible | **Minor/ Moderate*** |
| Introduction of non-indigenous species | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| Physical alteration of the seabed | Routine inspections | - | - | - | - | - | - | - | - | **Insignificant** |
| | Routine maintenance | Negative | Direct | Local | Short-term | Low | Low | Low/High* | Reversible | **Minor/ Moderate*** |
| Introduction of secondary habitats | Pipeline presence | Positive or Negative / Negative * | Direct | Local | Long-term | Medium | Low | Low/High* | Irreversible | **Minor/ Moderate*** |
| Temperature change | Pipeline presence | - | - | - | - | - | - | - | - | **No impact** |
| Release of pollutants from anti-corrosion anodes | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

* Values apply to the section of the pipelines' route which crosses the Pomeranian Bay and Oderbank Natura 2000 sites.

## 9.6.8 Biological Environment – Fish

### Overview

In ESR IV the Nord Stream Project has the potential to impact fish during construction, through impacts to water quality, changes to the seabed habitats, underwater noise, disturbance caused from construction and support vessel movement. Impacts to fish may occur during the pre-commissioning, commissioning and operational phases as a result of noise and vibration, the physical alteration of the seabed and temperature change.

ESR IV has a particularly rich benthic community in comparison to other parts of the Baltic Sea and is therefore an important habitat for demersal and benthic fish, as well as pelagic fish species. In ESR IV, pelagic fish common in Pomeranian Bay and around Bornholm include Atlantic salmon, sprat and sea trout. The pelagic fish community to the north east of Bornholm is dominated by herring, sprat and salmon.

Values/sensitivities for fish in ESR IV are detailed in **Section 8.10.5** and summarised in **Table 9.67**. In some cases, the sensitivity of a particular species may be higher or lower and impacts have then been assessed on species-specific basis.

**Table 9.67 Values/sensitivities of fish in Ecological Sub-Region IV**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fish** | | | | | | | | | | | | |
| Pelagic fish (sprat and herring) | Low | Low | Med | Med | Med | Med | Med | Low | Low | Low | Low | Low |
| Demersal fish (cod and flatfish species) | Low | Low | Med | Med | Med | Med | Med | Med | Low | Low | Low | Low |
| Freshwater fish community | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Diadromous species (salmon, eel) | Low | Low | Low | Low | High | High | High | High | High | High | Low | Low |

The main impacts that are expected to affect fish in ESR IV are as a result of noise and vibration generated from project related activities as well as from the re-suspension of sediments by seabed intervention works. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Construction and support vessel movement and the re-suspension and spreading of sediments from seabed intervention works, pipe-laying, anchor handling and above water tie-in activities resulting in:
  - Increase in turbidity
  - Release of contaminants
  - Noise and vibration
  - Visual/physical disturbance

*Pre-commissioning and commissioning phase*

- Construction and support vessel movement associated with the pre-commissioning and commissioning phase resulting in:
  - Noise and vibration

*Operational phase*

- Routine inspections and maintenance works and pipeline presence resulting in:
  - Noise and vibration
  - Physical alteration of the seabed
  - Temperature change

**Impacts during the Construction Phase**

Seabed intervention works will result in impacts on fish in ESR IV through increased turbidity and the release of contaminants (heavy metals & organic pollutants) from disturbance to sediments. Noise and vibration and disturbance from construction and support vessels are expected from the same activities. The impacts as a result of above water tie-ins prior to pre-commissioning have been included in the construction phase.

*Increase in turbidity*

Re-suspension of sediments and consequent increases in turbidity will result from seabed intervention works, pipe-laying, anchor handling and above water tie-in activities and are considered as the main impacts likely to affect fish in ESR IV. As described in ESR I it is expected that anchor handling would contribute very little to the overall amount of sediment placed into suspension during the construction phase.

Trenching and dredging will be carried out for 133 km (including both pipelines) and 2.1 km (between KP 1196 - 1198.1) respectively. These activities will result in increased turbidity and could potentially cause physiological damage to any fish species that are present in ESR IV. Flatfish such as flounder, turbot, plaice and brill (*Scophthalmus rhombus)* are abundant throughout the shallow waters of ESR IV. Flatfish are habituated to turbid conditions associated with living on the seabed and thus are not sensitive to increased turbidity. Studies show that increased turbidity has little effect on the ability of juvenile cod to locate prey(1). In general in ESR IV no halocline exists and a number of sensitive pelagic species such as Atlantic salmon, European eel and herring could potentially be affected by increased turbidity. Migrating eels have never been caught in the ocean(2), however it is thought they migrate in close proximity to the coasts(3) and therefore their migration will not be impacted by the Project in ESR IV. The waters of the Pomeranian Bay are known to exhibit a halocline at an approximate depth of 50 m. In areas of ESR IV where a halocline exists the zone of elevated turbidity will remain below this halocline and therefore pelagic fish above the halocline will not be impacted. Much of the seabed along the proposed pipelines' route in ESR IV is nevertheless sandy or hard bottomed and is not likely to be disturbed or remain suspended in the water column for long periods of time.

Oderbank in Pomeranian Bay and the North Midsjö Bank are important spawning and nursery areas for the commercially important species including turbot and cod. Turbot spawn on the banks and eggs remain in the top layers of the water column. Post-lay trenching is to be carried out throughout the pipelines' route at Oderbank and at approximately 10 km of the route near North Midsjö Bank. Elevated turbidity due to seabed intervention works during the spawning season could affect the reproductive success of turbot by causing displacement of adults away from their natural spawning areas and the smothering of eggs, larvae and prey items. This may result in reduced recruitment to the adult population for turbot. However, the sediment along the pipelines' route in this area consists of sand and coarser sediments (see **Atlas Map GE-2**) and sediment dispersion modelling carried out indicates minimal re-suspension of sediment will result from trenching activity and re-suspended sediment will settle relatively quickly (see **Atlas Map MO-2**). Subsequently, increases in turbidity and levels of re-settling sediment will be minimal in this important spawning and nursery grounds. Thus, it is unlikely that significant numbers of eggs and larvae will be smothered and displacement of adults from spawning grounds.

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(1) Meager, J.J., Solbakken, T., Utne-Palm, A.C. and Oen, T. 1978. Effects of turbidity on the reactive distance, search time, and foraging success of juvenile Atlantic cod (*Gadus morhua*).

(2) Finnish Game and Fisheries Research Institute. Eel (*Anguilla Anguilla*) http://www.rktl.fi/english/fish/fish_atlas/eel/ (accessed September 29, 2008).

(3) Yrkesfiskeren. December 2006. Resultat av ålmärkning i Östersjön. no. 23/24. (In Swedish only).

The following mitigation measures are planned to be carried out where possible, to address or reduce the significance of the identified potential impacts associated with seabed intervention works on spawning fish:

- In order to reduce the volume of re-suspended sediments, the pipelines' route has been optimised to reduce the extent of seabed intervention works required

- Anchor handling will be kept to a minimum where practically possible, to reduce sediment disturbance. Anchors will not be dragged through the seabed but rather raised during relocation

In areas of ESR IV where trenching occurs, increased turbidity will be minimised as sandy or harder substrates dominate in these areas. Following mitigation, the residual impact on fish species in the area due to seabed intervention works will be **insignificant**.

Throughout the construction phase, anchors from the pipe-laying vessel and associated support vessels will have to be constantly repositioned. This and drifting anchors and chains dragging across the seabed and the additional impact of ship propellers in these shallow waters will give rise to increased turbidity. The lifting of the pipelines off the seabed during above water tie-in activities and their repositioning back on the seabed will give rise to limited increased turbidity. However, in comparison to turbidity as a result of fishing and trawl nets, these impacts are considered to be minimal and therefore **insignificant**.

*Release of contaminants*

The re-suspension of dissolved contaminants in the water column from re-suspended contaminated sediment could, theoretically, raise the concentration of contaminants in the food chain and affect fish spawning and the fish themselves. The levels of contaminants in ESR IV are considered to be low in general (as described in **Chapter 8**) due to the erosion/ transportation conditions. Therefore seabed intervention works are not anticipated to cause a high increase in suspension of contaminants compared to the other ESRs.

Trenching will be carried out along the pipelines' route throughout much of ESR IV in spawning and nursery grounds of turbot and cod as described above. Fish exposed to elevated concentrations of contamination will absorb contaminants through their gills, accumulating it within the liver, stomach, and gall bladder, which can lead to long-term, sub-lethal effects. Adult fish are mobile and generally able to detect heavily contaminated areas(1) or areas of low water quality and will move away from these areas. Pelagic species in ESR IV will be affected by the elevated concentrations of dissolved contaminants. However, the period of exposure will be very short and, fish are likely to avoid areas of elevated turbidity, where suspended contaminants

(1) International Petroleum Industry Environmental Conservation Association (IPIECA). 2000. Biological Impacts of Oil Pollution - Fisheries. IPIECA Report Series. 8.

may occur. However, these effects are often short lived and once fish move away from the source of contamination they can metabolise the pollutants and cleanse themselves within weeks of exposure[(1),(2)]. Some fish species such as perch and roach use turbidity as a refuge when macrophytes are not present[(3)] and may be subject to higher levels of contaminants as a result. However, seabed intervention works will result in increased noise and vibration. Consequently fish will move away from the areas of increased turbidity as these areas coincide with where increased noise levels occur.

A much greater threat to fish populations is posed from exposure of eggs and larvae to increased contaminants as they can not actively move away from the contaminated areas. High levels of contamination may cause eggs and larvae to experience increased mortality rates, potentially affecting later recruitment to the adult population. Even low concentrations of contaminants can have marked effects on the proportions of eggs which hatch and on the growth rates and development of larvae. Many of these sub-lethal effects may eventually lead to mortality and reduction in recruitment to adult populations. Turbot eggs and larvae at Oderbank will be present from the end of June when spawning occurs, to the end of the summer when turbot develop into adults. Seabed intervention works are anticipated to take place in ESR IV during this period. However, fish eggs and larvae, including those of the turbot, mostly occur in the upper layers of the water column and are less likely to be impacted by re-suspension of sediments and consequently increased contaminants in the water column. Any changes to the densities of eggs or larvae due to seabed intervention works will therefore have a minimal impact and is assessed to be **insignificant.**

*Noise and vibration*

Increased levels of underwater noise and vibration have the potential to impact fish. Of the species in ESR IV, cod and clupeids are the most sensitive to noise [(1)]. Flatfish such as flounder, turbot (*Psetta maxima)* and sole *(Solea solea)* in general have poor hearing sensitivities and are therefore more likely to be affected by impacts from vibration rather than noise in ESR IV.

Tissue damage is not likely to occur to fish in ESR IV during the construction phase as no piling activity or munitions clearance is planned along the pipelines' route in this ESR. Noise generated from rock placement is not expected to exceed background noise as described in

(1) Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP). 1993. (IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution). Impact of Oil and Related Chemicals and Wastes on the Marine Environment. GESAMP Reports and Studies. 50.

(2) Heath, A.G. 1995. Water Pollution and Fish Physiology. Second ed. Lewis Publishers. Boca Raton. FL.

(3) Pekcan-Hekim, Z. 2007. Effects of turbidity on feeding and distribution of fish. Doctoral dissertation (article-based). University of Helsinki. Faculty of Biosciences. Department of Biological and Environmental Sciences, Aquatic Sciences.

ESR I and thus **no impact** on fish is anticipated as a result of rock placement at spot locations throughout the pipelines' route in ESR IV.

Post-lay trenching will be carried out for 65 km and 68 km for the North-west pipeline South-east pipeline respectively in ESR IV and dredging will be carried out for approximately 2.2 km of the pipelines' route (See **Atlas Map PR-3a**). As described in ESR I, fish may be able to detect noise of frequency and magnitude with peak levels of 178 dB at 1 metre from the source at 160 Hz, with an overall source level 185 dB at 1 m and at distances of more than 10 km from the noise source(1).

The Bornholm Basin is an important nursery ground for cod and part of this basin falls within ESR IV. As trenching will take place within this nursery ground, the noise produced (peak levels of 178 dB at 1 m from the source at 160 Hz) will most likely result in an avoidance response in juvenile cod present. These noise levels, although within the detectable range for cod, are highly unlikely to cause physical damage to either adult or juvenile fish(2). These noise levels will generally result in behavioural responses that will lead to fish moving away from the noise source. Thus the impact on cod is not considered to be significant.

Pelagic fish common in the Pomeranian Bay and around Bornholm include salmon, sprat and sea trout and the pelagic fish community to the north east of Bornholm is dominated by herring, sprat and Atlantic salmon. The pelagic, demersal and benthic fish feeding in the vicinity of the pipelines' construction activities will temporarily move away from any area of excessive noise and vibration created during the construction phase.

Increased noise levels in these areas could potentially impact migratory species such as Atlantic salmon and the European eel if construction is carried out during their migration periods. Salmon respond only to low-frequency tones (below 380 Hz), with best hearing at 160 Hz. The hearing of salmon is poor, with narrow frequency span, a poor ability to discriminate signals from noise and low overall sensitivity(3). Salmon spawn in rivers and hence spawning will not be impacted by noise related activities in ESR IV. Salmon migrating and feeding in the area of the pipeline construction activities will be able to move away from any area of excessive noise and vibration. As salmon only respond to low-frequency tones, they will not be impacted by noise during the construction phase.

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(1) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

(2) Hastings, M. C. and Popper, A. N. 2005. Effects of sound on fish. California Department of Transportation. Contract 43A0139 Task Order, 1. http://www.dot.ca.gov/hq/env/bio/files/Effects_of_Sound_on_Fish23Aug05.pdf (accessed October 14, 2008).

(3) Hawkins, A. D. and Johnstone, A. D. F. 1978.The hearing of the Atlantic salmon (Salmo salar). Journal of Fish. Biology. 13.

The Baltic Sea is an important part of the European eel migratory route. The European eel is known to migrate in close proximity to the Swedish coast[(1)], however, the pipelines' route is at a distance too far (> 30 km) from their normal migration route for any produced noise or vibration to impact eel populations. Therefore noise emitted from project activities is not expected to affect eel migration.

As loud noise usually initiates an avoidance response, demersal, pelagic and benthic fish in ESR IV will move away while construction is carried out and return once it is completed. Overall, the impacts of noise generated from seabed intervention works on fish in ESR IV will be **negative, direct** and **regional**. However the mitigation measures incorporated as part of route optimisation will ensure that the impacts will be **temporary** and of **low** intensity. Overall the residual impact will be of **low** magnitude and will act on **low** to **high** sensitivity receptors, depending on the time of year. Impacts will also be **reversible**. Impacts will therefore be of **minor** to **moderate** significance.

Levels of noise emitted from the activities associated with the above water tie-in at KP 1195.9 (for the North West pipeline only) are anticipated to be relatively low compared to overall noise levels emitted from the seabed intervention works as the major works will not take place in the water. These impacts are therefore also considered to be **insignificant**.

The maximum level of noise anticipated from construction vessels is 162 dB. This is similar to the range emitted from vessels already operating in the Baltic Sea (see **Section 9.3.8** for details), and therefore impacts on fish as a result of construction vessel noise are deemed to be **insignificant**. Continued detection of noise activity by fish often results in habituation to the sound for short-term impacts, followed by a re-commencement of normal behaviour[(2)].

*Visual/physical disturbance*

Vessels associated with commercial shipping and fishing regularly pass through ESR IV and the presence and passage of additional construction and support vessels over the construction period will not represent a significant increase in disturbance to pelagic fish species such as herring, sprat, mackerel, sea trout and Atlantic salmon that are found in ESR IV. This additional traffic may be heavy at times, however the impact will be short-term in duration since 2 to 3 km of pipeline is planned to be laid per day (350 m per day between KP 1198.1- 1195.9). The impacts of increased vessel traffic on fish are anticipated to be **insignificant**.

(1) Westerberg, H., Lagenfelt, I., and Svedang, H. 2007. Silver eel migration behaviour in the Baltic. ICES Journal of Marine Science. 64.

(2) Knudsen, F.R., Enger, P.S. and Sand, O. 1992. Awareness reactions and avoidance responses to sound in juvenile Atlantic salmon, *Salmo salar* L. Journal of Fish Biology. 40.

**Impacts during the Pre-commissioning and Commissioning Phase**

During the pre-commissioning and commissioning phase potential impacts upon fish are limited to noise associated with movement of water in the pipelines during pipeline flooding and pressure-test water discharge and noise due to gas movement during commissioning.

*Noise and vibration*

The noise level of natural gas movement through a pipeline has been known to range between 0.030 and 0.100 kHz, which is at the lowest levels detectable by many fish species. Sound pressure levels are below the limit of detection for cod and herring, the most sensitive species in ESR IV. There is therefore limited potential for noise from the pipelines during the pre-commissioning and commissioning phase to affect fish.

Other than an initial startle response it is unlikely that any fish species will be adversely affected by the sounds emitted from the pipelines during pipeline flooding, pressure-test water discharge and commissioning, as they do with shipping noise, fish within ESR IV that can detect the noise will quickly become habituated to it. However, these impacts are anticipated to be less significant than those associated with the construction phase, as pre-commissioning activities will be carried out over a much smaller area and over a shorter duration. Impacts are therefore considered to be **insignificant**.

**Impacts during the Operational Phase**

Impacts that will arise throughout the operational phase are anticipated to result from increased noise and vibration, temperature change along the pipelines' route and physical disturbance of the seabed.

*Noise and vibration*

The noise levels of natural gas movement through the pipelines will be of a similar range to that described in the pre-commissioning and commissioning phase above. It is unlikely that any fish species will be adversely affected by the sounds emitted from the pipelines. This impact (**negative** and **direct**) will therefore be **short-term** (as fish that can detect the noise will quickly become habituated to it in a similar manner to habituation to shipping noise), however the noise will continue for the duration of the pipelines' operation and therefore will be of greater significance to noise emitted from the pre-commissioning and commissioning phase. The impact will be **local**, of a **low** intensity. The impact will be of **low** magnitude, will be **reversible**, and will act on a receptor of **low** to **high** value/sensitivity. This impact will therefore be of **minor** to **moderate** significance.

Routine inspections and maintenance works on the pipelines are assumed to have an **insignificant** impact in terms of noise on fish in ESR IV, as inspections and works will be infrequent and will be restricted to the immediate pipelines' route.

*Physical alteration of the seabed*

As the surface area of the seabed taken up by the physical presence of the pipelines will represent less than 0.001 % of the total seabed area of the Baltic Sea, the total area of feeding and spawning grounds expected to be impacted is relatively small.

Fish species that spawn in ESR IV do so in the water column and therefore the physical presence of the pipelines on the seabed will not cause an obstruction to spawning. However, as a result of the presence of the pipelines, fine substrates may accumulate around the pipelines in areas where sediment is fine such as to the east of Bornholm. Much of the seabed along the proposed pipelines' route in ESR IV is nevertheless sandy or hard bottomed and therefore will not be impacted and therefore the impact is anticipated to be **insignificant**.

A number of sensitive migratory species occur within the water column in ESR IV such as European eel, herring and Atlantic salmon. Herring and Atlantic salmon migrate in shallow waters and the physical presence of the pipelines will not act as a barrier to their migration. European eel are known to take resting periods on the seabed by day, however during migration eels are known to swim within 0.5 m of the waters surface at night(1). Due to this, there is no potential for the presence of the pipelines on the seabed to act as a barrier to their migration. As such, it is anticipated that there will be **no impact** to fish migration due to the presence of the pipelines in ESR IV and therefore no mitigation measures are proposed.

As described in ESR I, the addition of hard substrates (such as pipelines and materials used during rock placement) into the marine environment may be beneficial to fish populations in certain areas. Benthic and demersal species will benefit from increased habitat heterogeneity and the associated increase in prey availability gained from the presence of the pipelines and associated materials. Aggregations of fish may occur around the pipelines or any artificial structures introduced by the Project such as areas of rock from rock placement. Aggregations of commercial fish species may lead to increased fishing along the pipelines' route, potentially creating basis for a profitable fishery. This may subsequently result in over exploitation of commercial fish stocks. In a study carried out along pipelines in the North Sea no measurable aggregation effect on commercial fish species was observed(2). Consequently the impact of artificial habitat creation on benthos is anticipated to be **direct**, **long-term** in duration and of **medium** intensity. The impact will be **negative**, however it may be beneficial for fish communities in some areas. It will be on a **local** scale and will therefore be of **low** magnitude and **irreversible.** The impact will be of **minor** to **moderate** significance as the fish present have sensitivity values ranging from low to high depending on the time of year in ESR IV.

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(1) Westerberg, H., Lagenfelt, I., and Sveda¨ng, H. 2007. Silver eel migration behaviour in the Baltic. – ICES Journal of Marine Science. 64.

(2) Statoil. 1998. Tråltest over steinfyllinger på Sleipner kondensatrørledning 06.-14. juli 1998. (In Norwegian only).

Routine inspections and maintenance works on the pipelines may result in localised re-suspension and spreading of sediments along the immediate pipelines' route. This increase in turbidity could potentially have an impact on fish, specifically benthic and demersal species. However, the majority of the seabed is sandy and/or hard in ESR IV and therefore increased turbidity will be reduced, combined with the tendency of fish to move away from disturbance.

The following mitigation measures are proposed to address or reduce the significance of the identified potential impacts associated with routine inspections and maintenance works during the operational phase on fish:

- Any seabed intervention work required during operation will be kept to a minimum where practically possible
- Disturbance of seabed sediments will be avoided or, in the case of repair, disturbance of sediments will be minimised where practically possible

As routine inspections and maintenance works will be infrequent, residual impacts on fish are expected to be **insignificant**.

*Temperature change*

The transfer of heat from the pipelines to the surrounding water as a result of temperature difference between the gas in the pipelines and the surrounding water will be minimal in ESR IV and therefore will have **no impact** on fish in ESR IV.

**Impact Summary**

The impacts identified and assessed in ESR IV for fish are summarised in **Table 9.68**.

**Table 9.68 ESR IV impact summary table for fish**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Fish– Ecological Sub-Region IV | Increase in turbidity | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Inspections and maintenance works | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of contaminants | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Rock placement | - | - | - | - | - | - | - | - | **No impact** |
| | | Seabed intervention works | Negative | Direct | Regional | Temporary | Low | Low | Low-High | Reversible | **Minor-Moderate** |
| | | Above-water tie-ins | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline flooding, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | Negative | Direct | Local | Short-term | Low | Low | Low-High | Reversible | **Minor-Moderate** |
| | Physical alteration of the seabed | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | | Rock placement, Pipeline presence (addition of hard substrate) | Negative | Direct | Local | Long-term | Medium | Low | Low-High | Irreversible | **Minor-Moderate** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Temperature Change | Pipeline presence | - | - | - | - | - | - | - | - | **No impact** |
| | Visual/ physical disturbance | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.6.9 Biological environment – Sea birds

#### Overview

In ESR IV, five Important Bird Areas within the Danish and Swedish EEZ will be passed within 25km of the pipelines' route: Hoburgs Bank, North Midsjö Bank (Norra Midsjøbanken), South Midsjö Bank (Sødra Midsjøbanken), Rønne Bank and Ertholmene (Christiansø). The Pomeranian Bay within the German EEZ will be crossed by the pipelines. The Pomeranian Bay is one of the most important areas for wintering and staging birds in the Baltic Sea and includes areas of shallow water along Oderbank and the Adlergrund which are particularly important for wintering ducks.

As summarised in **Section 8.10.6**, assemblages of sea bird populations in ESR IV include internationally important populations of wintering and staging birds during the spring/autumn migration period. Divers, diving ducks and auks occur in internationally important numbers at Hoburgs Bank, North and South Midsjø Banks, Rønne Bank and Pomeranian Bay. Furthermore, Hoburgs Bank is regarded as of global importance for wintering long-tailed ducks (*Clangula hyemalis*). Ertholmene islands to the north of Bornholm also support nationally and/or internationally important breeding colonies of common eider (*Somateria mollissima*), common guillemot (*Uria aalge*) and razorbill (*Alca torda*). The above mentioned species are common and neither red-listed nor protected under the EC Birds Directive, meaning they are of **low** significance and low ecological value. However, significant impacts on these species may occur, since impacts may affect a large number of birds.

Species of high ecological value in ESR IV include red-throated diver (*Gavia stellata*), black-throated diver (*G. arctica*), black tern (*Chlidonias niger*), Slavonian grebe (*Podiceps auritus*) and little gull (*Larus minutus*). These species are listed in Annex I of the EC Birds Directive and therefore considered as having a **high** sensitivity. The Pomeranian Bay supports substantial numbers of these species during the winter and spring/autumn migration period. The two former species together with the endemic species black guillemot (*Cepphus grylle*) are also listed in the HELCOM list of threatened/and or declining species.

Values/sensitivities for sea birds in ESR IV are detailed in **Section 8.10.6** and summarised in **Table 9.69**. In some cases, the sensitivity of a particular species may be higher or lower and impacts have then been assessed on a species-specific basis.

**Table 9.69 Values/sensitivities of sea birds in Ecological Sub-Region IV**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Birds** | | | | | | | | | | | | |
| Breeding birds | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Wintering birds | High | High | High | Med | Low | Low | Low | Low | Low | Med | High | High |
| Migratory birds | Low | Med | High | High | High | Low | Low | Low | High | High | High | Low |

The main activities that are expected to impact on populations of sea birds are those that take place during the construction phase. Increased turbidity caused by seabed intervention works, increased noise levels and visual and physical disturbance and are expected to cause the largest impact upon sea birds. No impacts are expected in ESR IV during pre-commissioning as the uptake of seawater and subsequent discharge of pressure-test water is to occur at the Russian landfall in ESR I. Impacts during the operational phases are expected to be minimal in comparison to construction.

Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Seabed intervention works resulting in:
  - Increase in turbidity
  - Loss of seabed habitat
- Seabed intervention works, pipe-laying and construction and support vessel movement resulting in:
  - Noise and vibration
- Seabed intervention works and construction and support vessel movement resulting in:
  - Visual/physical disturbance

*Operational phase*

- Routine inspections and maintenance works and associated vessel movement resulting in:
  - Increase in turbidity

- Noise and vibration
- Visual/physical disturbance

**Impacts during the Construction Phase**

During the construction phase, seabed intervention works, pipe-laying, anchor handling and above water tie-in activities are likely to result in increased levels of noise and vibration, visual and physical disturbance, increased levels of turbidity and loss of seabed habitat. Vessel movement may also lead to physical and visual disturbance to sea birds.

The large majority of sea birds within ESR IV comprise fish and benthic feeding species such as divers, diving ducks, auks and gulls. The preferred pipelines' route has been chosen and optimised to avoid areas supporting high densities of sea birds such as the shallow waters of the Rønne Bank and Oderbank. Short-term impacts will primarily affect sea birds within the area of the Pomeranian Bay which is crossed by the Project.

*Increase in turbidity*

Seabed intervention works including dredging, trenching and rock placement resulting in increased turbidity may cause direct and indirect affects upon sea birds due to negative impacts on birds foraging for resources such as fish and benthic fauna. Increased levels of turbidity will affect Gotland Deep, the Bornholm Basin and Arkona Basins (see **Section 9.6.3**).

Areas sensitive to sedimentation plumes comprise Hoburgs Bank, North Midsjö Bank and the Pomeranian Bay due to the vicinity of the pipelines to these sites. These areas are characterised by relatively shallow water and support a number of fish and benthic feeding/diving sea bird species such as red-throated diver, black-throated diver, long-tailed ducks during spring, autumn and winter while cormorants also breed along the German coastline in internationally important numbers. Blue mussels occur in dense populations throughout these areas and provide an important food resource for a variety of diving ducks, especially for globally important populations of long-tailed ducks along Hoburgs Bank.

Sediments are released at heights of 2, 5 and 2 m above the seabed for dredging, trenching and rock placement respectively. Within the area of the Bornholm and Arkona Basins, modelled sediment is expected to settle within 1 - 2 km of the disturbance area and remains in suspension for an average of 12 - 24 hours (>1 mg/l). Certain trenching areas (south of Gotland) experience increased turbidity for up to 72 hours. As outlined in **Section 9.6.7**, these low levels will not be lethal for populations of blue mussels. The spreading of suspended solids occurs only in a localised area and in small amounts and will not adversely affect the sensitive areas supporting blue mussels, such as the tidal and intertidal areas of the coastlines and bank system in the vicinity of the pipelines[1]. Therefore, indirect impacts on populations of sea birds feeding on blue mussels are considered to be **insignificant**.

Impacts on other sensitive species such as breeding little tern, divers, long-tailed ducks and cormorant are short-term and localised. Cormorants are considered to be the most sensitive species to increased levels of suspended solids[2]. This species occurs, however, in lower densities within the Pomeranian Bay in ESR IV, and its population is currently stable and increasing throughout the Baltic Sea[3]. It is considered to be highly unlikely that the long-term integrity of sea bird populations will be adversely affected. Within the area of Hoburgs Bank, Midsjö Banks and Rønne Bank, only small numbers of birds are affected, whereas larger numbers of birds will be affected within the area of the Pomeranian Bay. However, the timing of pipe-laying activities will be planned carefully and will be carried out outside the herring spawning season from January until the end of April, within the area of the Pomeranian Bay. Impacts on nature conservation areas in ESR IV caused by re-suspension and spreading of sediments due to seabed intervention works are therefore considered to be **insignificant**.

*Noise and vibration*

Noise and vibration impacts on sea birds may be direct due to the short-term displacement of sea birds or indirect due to the displacement of fish and the subsequent redistribution of piscivorous species of birds.

Comparatively little is known about direct impacts of noise and vibration on sea bird populations. It is generally expected that the extent of visual disturbance impacts is larger than the extent of noise impacts. As construction noise offshore is almost exclusively associated with the presence of vessels resulting in visual impacts it is often impossible to distinguish between impacts caused by increased noise levels and visual/physical impacts caused by the presence of vessels as both impacts occur simultaneously.

As described in **Section 9.3.9**, the sensitivity of sea birds to noise impacts is species-specific and also appears to depend on the flock size of sea birds. Diving sea birds such as long-tailed ducks, velvet scoter and divers (*Gavia* spp.) are particularly sensitive to vessel movements and associated noise[4], at typical distances of 1 to 2 km for the more sensitive bird species such as

(1) Ramboll. 2008. Environmental Study – Nord Stream pipelines in the Swedish EEZ.

(2) Institut für Angewandte Ökologie (IfAÖ). 2009. Umweltverträglichkeitsstudie (UVS) zur Nord Stream Pipeline von der Grenze der deutschen Ausschließlichen Wirtschaftszone (AWZ) bis zum Anlandungspunkt.

(3) DHI Water & Environment. 2003. Development of Baltic waterbird monitoring strategy, Pilot phase. http://sea.helcom.fi/dps/docs/documents/Nature%20Protection%20and%20Biodiversity%20Group%20(HABITAT)/HABITAT%205,%202003/doc%204-10.pdf (accessed October 16, 2008).

(4) Institut für Angewandte Ökologie (IfAÖ). 2009. Umweltverträglichkeitsstudie (UVS) zur Nord Stream Pipeline von der Grenze der deutschen Ausschließlichen Wirtschaftszone (AWZ) bis zum Anlandungspunkt.

divers and scoters, and to a lesser extent cormorants, but other species such as gulls and terns are likely to be less affected(1),(2). Studies on coastal birds have shown that noise impacts can result in various different types of response, including birds being startled or showing a “heads up” response to small scale movements and also birds leaving the affected area altogether(3),(4).

Increased underwater noise levels due to dredging and trenching may affect benthic and piscivorous species of sea birds along the majority of the pipelines’ route in ESR IV resulting in the displacement of birds. Species at risk are primarily diving ducks such as long-tailed ducks especially within the area of the Pomeranian Bay and Hoburgs Bank. These areas of shallower water provide suitable foraging habitat for a wide range of species as indicated by dense populations of wintering and migrating sea birds. Piscivorous species of high value/sensitivity comprise primarily divers, as well as some species of diving ducks such as smews. The construction of the offshore sections of the pipelines in ESR IV will be carried out during the summer months when the majority of birds are absent in order to avoid disturbance impacts to wintering and staging birds. The impact of increased underwater noise, **direct** and **negative**, is therefore **reversible** and the intensity is **low**. Impact magnitude is **low** and the impact occurs on a **local** scale over a **short-term** period. Birds will return once the construction of the pipelines is completed. Impacts on internationally important populations of sea birds including internationally protected species and those listed as rare in the Baltic Sea will be minimised by the careful timing of the construction period. Sea birds reach peak numbers along the Boddenrandschwelle during the herring spawning season. Therefore, construction works will not be carried out between January and April inclusive, in order to minimise impacts on sea birds. However, some overlap between the construction period and sensitive times of the year such as the autumn migration season may occur, resulting in **moderate** significant impacts on species of **high** sensitivity including, amongst others, divers and Slavonian grebes. **Minor** significant impacts will also occur on common species of **low** or **medium** sensitivity such as common guillemot and razorbills breeding on the islands of Ertholmene, and common scoter and cormorant, especially along the Boddenrandschwelle.

Further indirect negative impacts on sea birds will result due to the short-term displacement of fish from the local area. This may, in turn affect piscivorous species of sea birds especially within the area of the Hoburgs Banks, North and South Midsjö Banks and the Pomeranian Bay. The Pomeranian Bay supports piscivorous species in high densities during the winter and also

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(1) Ruddock, M. & Whitfield, D.P. 2007. A Review of Disturbance Distances in Selected Bird Species, A report from Natural Research (Projects) Ltd to Scottish Natural Heritage.

(2) Skov, H., Durinck, J., Leopold, M.F. and Tasker, M.L. 2007. A quantitative method for evaluating the importance of marine areas for conservation of birds. Biology Conservation. 36 (3).

(3) Institute of Coastal and Estuarine Studies (ICES). 1999. Avifaunal Disturbance Assessment: Flood Defence Works, Salt End. Report to the Environment Agency.

(4) Smit, C.J. & G.J.M. Visser. 1993. Effects of Disturbance on Shorebirds: A Summary of Existing Knowledge from the Dutch Wadden Sea and Delta Area. WSG Special Report.

during spring/autumn migration (in internationally important numbers) in areas which will be directly crossed by the pipelines. Black and red-throated divers may therefore be affected if following their prey and be displaced, although these birds are known to be sensitive to boats and hence any effects on fish species are likely to be less important. Further, piscivorous species likely to be affected comprise Slavonian grebe, red-breasted merganser, great-crested grebe, red-necked grebe and cormorant. Black guillemot may also be impacted upon within the area of North and South Midsjö Banks, located in close proximity to the pipelines.

The scale of **indirect negative** noise impacts is **regional** (see **Section 9.6.8**) but impacts are **short-term** and **reversible**. The intensity and magnitude of impact are **low** and it will only affect individuals or small proportions of the Baltic Sea populations of these species. Most will simply maintain a stand-off from the works over a very short period of time. The sensitivity of affected birds varies and depends on their protection status. **Moderate** significant impacts are therefore predicted for Slavonian grebes and red and black-throated diver as they are all species listed in Annex I of the EC Birds Directive, and black guillemot as it is listed in the HELCOM list of threatened and/or declining species(1). The construction of the pipelines will be carried out outside the herring spawning season and the careful timing of construction activities will minimise negative impacts on sea birds such as divers, which reach peak densities during the spawning season in the Pomeranian Bay. Impacts on these species are **moderate**, while impacts on the remaining species result in **minor** significant impacts. However, indirect noise impacts are **reversible** in the short-term and birds will return once the construction of the pipelines has ceased. The pipelines' route has been optimised to reduce the extent of seabed intervention works in order to minimise impacts on sensitive areas.

The impact of increased levels of airborne noise on sea birds due to construction and support vessel movement is likely to be smaller than the impact due to visual disturbance from these vessels, and the noise levels emitted by construction vessels will be similar to that of vessels already operating in the Baltic Sea and will not lead to a significant increase from the baseline noise environment. These impacts are therefore **insignificant**. Increased levels of noise and vibration may also cause indirect impacts on sea birds in ESR IV due to temporary displacement of fish during the construction period, however these impacts will also be **insignificant**.

*Loss of seabed habitat*

Seabed intervention works including trenching and rock placement will lead to a temporary loss of seabed habitat in ESR IV causing negative impacts on benthic feeding species such as diving ducks. The dense populations of blue mussels within the area of the Bodden marginal well and Hoburgs Bank are regarded as key habitat for these species as indicated by large populations of diving ducks within these areas. Key species of sea birds comprise internationally important

(1) HELCOM lists of threatened and/or declining species and biotopes/habitats in the Baltic Sea area. Baltic Sea Environment Proceedings No. 113.

populations of Slavonian grebe (*Podiceps auritus*), long-tailed ducks (*Clangula hyemalis*), black scoter (*Melanitta nigra*) and velvet scoter (*Melanitta fusca*). The loss of habitat will be restricted to the pipelines' corridor and habitat loss will not cause a long term threat to sea birds in ESR IV. The impact is considered to be **insignificant**.

*Visual and physical disturbance*

Vessel movements associated with seabed intervention works, pipe-laying and above water tie-in activities are likely to result in visual and physical disturbance to sea birds.

Short-term visual and physical disturbance impacts during the construction phase will primarily affect populations of wintering and staging birds during spring/autumn migration on North and South Midsjö Banks, Hoburgs Banks and the Pomeranian Bay. The zone of visual disturbance is not known for all species present within ESR IV. However, more detailed information exists for some key species such as the diver, common scoter, velvet scoter and long-tailed duck which have been identified as being particularly sensitive to visual impacts. The flight distances of these species varies greatly and also appears to depend on the flock size(1),(2). Very slow moving vessels will be used for pipe-laying and anchor handling, moving at 2-3 km in 24 hours. Between KP 1222.8 and KP 1195.9 the pipelines will be laid using a deep water lay vessel, with a lay rate 350 m per day. It is estimated that visual impacts from slow moving vessels and other sources of visual disturbance to birds will be only act within a 1-2 km radius around the lay barge and even then will only affect the most sensitive species(3).

The majority of species which are sensitive to vessel movements are found within the area of Hoburgs Bank, North and South Midsjö Banks and the Pomeranian Bay. Less sensitive species such as gulls and terns occur only in minor numbers.

The scale of **negative**, **direct** impacts on sea birds from visual and physical disturbance associated with seabed intervention works, pipe-laying and above-water tie-in activities and associated construction and support vessel movement is **local** to **regional,** depending on the species present. Impacts are **short-term** and of **low** intensity within the area of Hoburgs Bank and North and South Midsjö Banks, as the pipelines follow highly trafficked shipping routes and the impacts may therefore be at the detection limit as birds will be, to a certain extent, accustomed to vessel movement. The magnitude of impact is **low** and the effects are not

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(1) Kube, J. & H. Skov. 1996. Habitat selection, feeding characteristics, and food consumption of long-tailed ducks, *Clangula hyemalis*, in the southern Baltic Sea. Meereswiss. Ber., Warnemünde. 18: 83-100.

(2) Bellebaum, J., Diederichs, A., Kube, J., Schulz, A. & G. Nehls. 2006. Flucht- und Meidedistanzen überwinternder Seetaucher und Meeresenten gegenüber Schiffen auf See. Ornithologische Rundbrief für Mecklenburg-Vorpommern Orn. Rundbrief Mecklenburg-Vorpommern 45, Sonderheft 1 (Tagungsbd. 5. deutsches See- und Küstenvogelkolloquium).

(3) Ramboll. 2008. Environmental Study – Nord Stream pipelines in the Swedish EEZ.

predicted to bring about a change in abundance or distribution of a species. The short-term redistribution of sea birds in ESR IV is not predicted to result in long-term changes in species abundance and distribution as sea birds will return once the construction of the pipelines is completed. Impacts are **reversible**.

The section to the south of Hoburgs Bank and adjacent to the North and South Midsjö Banks crosses primarily through an area where the water depth is greater than 30 m and which supports lower densities of sea birds. Construction activities as described above can, however, cause disturbance to wintering long-tailed duck populations as this species uses offshore habitats with water-depths of up to 48 m. Impacts on black guillemots, one of the important species of this bank complex, are likely to be **minor** as this species prefers areas with water depths of 12-20 m which occur further than 10 km away from the pipelines.

Breeding populations of common guillemots, common eider and razorbills utilising the islands of Ertholmene will not be adversely affected by the Project in ESR IV. However, construction activities in the vicinity of the island may affect small numbers of guillemots feeding within the area of the pipelines. Recent surveys on common guillemot and razorbill indicate that the main foraging range, as indicated by dense concentrations of birds, is mainly located in closer distance to the islands of Ertholmene and only small numbers feed in the vicinity of the pipelines(1). Vessel movements within the Pomeranian Bay during seabed preparation, seabed intervention and pipe-laying will affect internationally important populations of divers, grebes, great-crested grebe, red-necked grebe and Slavonian grebe, long-tailed duck, common scoter and velvet scoter, red-breasted merganser and black guillemot.

Vessel movements may result in **minor** significant impacts on common species of **low** or **medium** value/sensitivity such as cormorants, long-tailed duck, common scoter, common eider, red-breasted merganser, common guillemot and razorbill. These species are common throughout the Baltic Sea and are not protected under the EC Birds Directive. Impacts on common species within the area of the Hoburgs Banks and North and South Midsjö Banks will be minor as the pipelines follow established shipping routes and birds will be, to a certain degree, accustomed to visual impacts by vessels. Further, as construction will not be carried out between January and April inclusive impacts will only occur over a short period of time. From the above listed species, long-tailed ducks are known to be the most sensitive to visual impacts and stand off areas of these species reach up to 1500 m, if large flocks are affected. This species is the most numerous species of diving duck present within ESR IV. Although impacts on these are still of minor significance, impacts on long-tailed ducks are slightly higher than for other common bird species.

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(1) DHI. 2008. Baseline investigation - Baltic Gas Pipeline: The use of the area northeast of Ertholmene be breeding guillemot *Uria aalge* and razorbill *Alca torda*. Unpublished.

Vessel movements may result in **moderate** significant impacts on species of **high** value/sensitivity such as velvet scoter, black guillemot, red- and black-throated diver and Slavonian grebe. The two former species are listed in the HELCOM list of threatened and/or rare species in the Baltic Sea regions whereas the three latter species as listed in the EC Birds Directive. The careful timing of the construction of the pipelines within the German EEZ will largely avoid impacts on Slavonian grebes. This species occurs predominantly within the area of Oderbank and the majority of the wintering population will therefore not be affected. As the construction of the offshore section of the pipelines' route in the German EEZ will be carried out outside the herring spawning season, impacts on Slavonian grebe will be largely avoided. The significance of the impact on divers, although still moderate, may be higher than on Slavonian grebes, as the diver population is relatively evenly distributed within the Pomeranian Bay, with higher numbers during the herring spawning season. The breeding colony of black guillemot will not be adversely affected as the pipelines' route within this area follows established shipping routes and birds will be, to a certain degree, habituated to visual impacts from vessels.

**Impacts during the Operational Phase**

*Noise and vibration*

After the pipelines are laid, the construction-related impacts on birds due to increased background noise and other disturbance will cease. Routine inspections and maintenance are likely to have a limited impact upon sea birds. As outlined in **Section 9.6.8**, it is unlikely that any fish species will be adversely affected by the sounds emitted from the pipelines and therefore there will be no significant indirect impact to fish feeding bird species in ESR IV. Operational impacts are therefore **insignificant**.

*Visual/physical disturbance*

Routine inspections and maintenance are assumed to have limited impact upon sea birds, will be restricted to the pipelines' route and will be occasional and infrequent. As these works are not expected to occur on a regular basis, and would only result in a few extra vessel sailings, the impacts on birds in terms of noise and vibration, re-suspension and spreading of sediments and visual/physical disturbance in ESR IV are expected to be far lower in both magnitude and duration than for the construction phase. For the operational phase, these impacts are also considered to be **insignificant**.

**Impact Summary**

The impacts identified and assessed in ESR IV on sea birds are summarised in **Table 9.70**.

**Table 9.70 ESR IV impact summary table for sea birds**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Sea Birds - Ecological Sub-Region IV | Increase in turbidity | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Dredging, Trenching | Negative | Direct and indirect | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor – Moderate** |
| | | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Loss of seabed habitat | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | Visual/physical disturbance | Seabed intervention works, Pipe-laying, Above-water tie-ins, Construction and support vessel movement | Negative | Direct | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |

## 9.6.10 Biological Environment – Marine Mammals

### Overview

Following the undertaking of a scoping and impact identification exercise, several interactions between marine mammals in ESR IV and the Project have been identified, which could give rise to potential impacts. This section identifies and assesses the potential impacts on marine mammals in ESR IV during the construction, pre-commissioning and commissioning, and operational phases of the Project in terms of the methodology presented in **Chapter 7**.

In ESR IV, there are three marine mammal species present, one cetacean and two species of seal:

- Harbour porpoise (*Phocoena phocoena*)
- Harbour seal (*Phoca vitulina*)
- Grey seal (*Halichoerus grypus balticus*)

Each of these marine mammals has been described as a threatened and/or declining species of the Baltic Sea by HELCOM. Values/sensitivities for each marine mammal are presented in detail in **Section 8.10.7** and summarised in **Table 9.71**. The ringed seal is not commonly found in ESR IV as it prefers the Gulf of Finland (**Atlas Map MA-3**).

**Table 9.71 Values/sensitivities of marine mammals in Ecological Sub-Region IV**

| Species | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Marine mammal | | | | | | | | | | | | |
| Harbour porpoise | Med | Med | Med | Med | Med | High | High | High | High | Med | Med | Med |
| Harbour seal | Med | Med | Med | Med | Med | High | High | High | High | Med | Med | Med |
| Grey seal | Med | High | High | Med | High | High | Med | Med | Med | Med | Med | Med |

The main activities which are expected to impart an impact on marine mammals include those that take place during the construction phase. Impacts during the pre-commissioning and commissioning and operational phases are expected to be minimal by comparison. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Seabed intervention works, pipe-laying, anchor handling, above water tie-in activities and construction and support vessel movement resulting in:
    - Noise and vibration
- Re-suspension and spreading of sediment due to seabed intervention works, pipe-laying, above water tie-in activities and anchor handling resulting in:
    - Increase in turbidity
    - Release of contaminants
- Construction and support vessel movement during winter resulting in:
    - Ice breaking

*Pre-commissioning and commissioning phase*

- Pipeline flooding and pipeline commissioning resulting in:
    - Noise and vibration

*Operational phase*

- Pipeline presence resulting in:
    - Noise and vibration (due to movement of natural gas in the pipelines)
- Routine inspections and maintenance works resulting in:
    - Increase in turbidity
    - Noise and vibration

**Impacts during the Construction Phase**

Impacts upon marine mammals during the construction phase are an increase in turbidity, the release of contaminants and noise and vibration due to seabed intervention works, pipe-laying, anchor handling, above water tie-in activities and construction and support vessel movement. Ice breaking would occur due to vessel movement if pipe-laying were to take place during the winter months.

*Increase in turbidity*

An increase in turbidity due to the re-suspension and spreading of sediments during construction may result due to dredging, trenching, rock placement and above water tie-in activities at designated areas and anchor handling and pipe-laying activities along the entire pipelines' route in ESR IV. The seabed sediments in ESR IV are predominantly sandy in texture. Small sections of postglacial mud, sandy mud and glacial till are also present. The extent and duration of an increase in turbidity is detailed under the water column in **Section 9.6.3**. Significant increases in turbidity within the water column are expected to be of short-term duration and regional in scale. Despite the type of intervention works planned for ESR IV (predominantly trenching and rock placement), which will disturb the seabed, these sediments are not prone to re-suspension like those of a finer texture like silt. As marine mammals use their hearing ability for navigation, as well as for hunting, an increase in turbidity is expected to yield an **insignificant** impact on individuals. Other marine fauna, on which marine mammals would feed, may vacate the construction area due to noise and an increase in turbidity. This may temporality affect feeding areas but the associated impact is expected to be **insignificant** as marine mammals are able to hunt over large distances and would typically avoid the construction areas.

*Release of contaminants*

An increase in contaminant concentration in the water column due to the release of contaminants from the re-suspension and spreading of sediments during to seabed intervention works, pipe-laying, anchor handling and above water tie-in activities could theoretically raise the concentration of contaminants in the food chain and subsequently in mammal tissue. However, as most of ESR IV is an erosion area and low levels of contaminants are present in the sediment it is expected that the impact on marine mammals would be **insignificant** (**Chapter 8** and **Section 9.6.3**). In general, marine mammals are expected to vacate the construction area due to noise.

*Noise and vibration*

Noise generation during construction in ESR IV is likely to arise from seabed intervention works (post lay trenching and rock placement), pipe-laying, anchor handling, above water tie-in activities and construction and support vessel movement. All of these activities may impact on marine mammals.

The harbour and grey seals, as well as the harbour porpoise, communicate by emitting sounds that pass through the water column. These sounds can be detected across vast distances and construction noise may influence the behaviour of these mammals. An increase in background noise or the introduction of specific sound sources may affect marine mammals in that they may be prevented from detecting important sounds (masking), their behaviour may be altered, temporary or permanent hearing loss may be experienced or damage to tissue may occur.

These potential effects are further elaborated upon in **Section 9.3.10** under ESR I. The hearing ability of the species of marine mammals in the Baltic Sea is detailed in **Chapter 8**.

Seabed intervention works, which include dredging, trenching and rock placement, are restricted to the designated areas along the pipelines' route (**Atlas Maps PR-3a** and **3b**). Dredging will only occur along a short section (2.2 km) of the pipelines' route in ESR IV in the vicinity of the Greifswalder Bodden. All three activities will generate noise and vibration at the level that exceeds that generated by other construction activities. Dredging and trenching will generate the most noise. Harbour porpoises are expected to be affected (behaviour change) within a few kilometres of the construction site while for seals it is expected to be limited to less than a kilometre. Noise generated by rock placement is not expected to exceed background noise and thus will have a negligible impact on marine mammals. Most of the pipelines' route through ESR IV is at a depth of 20-80 metres below surface level (m.b.s.l). Despite the fact that the identified marine mammals prefer shallow coastal areas; there is a possibility that they will be present in ESR IV for hunting and feeding (**Chapter 8**). As such, noise may impact upon individual marine mammals in the general area (2-3 km radius from the construction site). In most cases marine mammals would vacate the construction area at the first instance of a foreign sound or change in background noise. There is a grey seal conservation area (Natura 2000 site, DE1251-301) to the north (~10 km) of the pipelines' route in the southern section of ESR IV. A grey seal colony is also present to the east of Bornholm at Ertholmene (~10 km). No harbour seal colonies are located within 10 km of the pipelines' route. Noise generated during seabed intervention is not expected to affect these areas. The harbour porpoise has been recorded throughout ESR IV with a concentration of <0.1 individuals/km$^2$. Higher numbers have been sited in the southern part of ESR IV between Bornholm and the Greifswalder Bodden. Individuals may be present in the vicinity of the construction area. Impacts are both **negative** and **direct**, will be on a **regional** scale around the source of impact but of **short-term** duration during construction and will be of **low** to **medium** intensity. Impact magnitude is **low** and value/sensitivity ranges from **medium** to **high** depending on seasonal breeding habits. The harbour porpoise has a high value/sensitivity in the southern part of ESR IV during the breeding season (June – September). Impacts are **reversible**. Impact significance is expected to be **minor** to **moderate** (if seals and the harbour porpoise are disrupted during the breeding season).

No direct measurements are available for the noise generated during pipe-laying on the seabed, anchor handling and above-water tie-in activities. The primary source of noise is expected to be the movement of anchors. The presence of heavy machinery on board the pipe-laying vessel is expected to generate low frequencies below 100 Hz. It should be noted that pipe-laying will take place at a rate of 2-3 km a day and thus the source of noise will move along the pipelines' route and will not remain fixed at one point for an extended period of time. Noise generated is expected to be on par with normal shipping and fishing activities to which marine mammals have habituated and thus the impact of pipe-laying, anchor handling and above-water tie-in activities is expected to be **insignificant**.

Marine mammals can perceive underwater noise generated by vessel movements (0.01-10 kHz with source levels between 130-160 dB), and the use of equipment at sea, a number of kilometres from a source. Such noise has a zone of responsiveness for marine mammals of 200-300 m[(1)]. As the pipelines' route in ESR IV is largely within or close to normal shipping lanes it is expected that seals and harbour porpoises in the area have already habituated to the noise and vibration generated by vessel movement and thus the impact is **insignificant**.

*Ice breaking*

The northern section of ESR IV is generally ice free during even the most severe winters while for the southern section the probability for ice coverage is in the region of 25% with most restricted to the coastal areas. The grey seal breeds (gives birth to pups) offshore on the ice and thus has the potential to be impacted upon should construction activities take place during their breeding season. Furthermore, the pipelines' route passes close (~10 km) to a conservation area for the grey seal. Any vessel movements during winter would result in ice breaking in the southern sections of ESR IV and thus have the potential to affect seal breeding habitats. This may result in behavioural changes as well as an increase in seal pup mortality rates[(2)]. The critical time for breeding for seals is from February to March (grey seal) and from June to August (harbour seal).

However, construction is expected to take place outside of the period relevant to grey seals (winter and ice conditions) and thus the possibility of ice breaking is highly unlikely. As most of the pipelines' route falls within or very close to normal shipping lanes, it is expected that should ice breaking be required, the potential for impacts on seals would be minimal (**Atlas Map SH1**). Seals do not typically dwell in areas where ice breaking is a regular occurrence. Nevertheless, during winter, sections of the pipelines' route identified as breeding areas will be avoided where possible.

If the construction schedule is followed, no ice breaking will take place and thus there will be **no impact**. However, in the highly unlikely event that ice breaking should be required and if breeding areas are affected; the impact (**negative, direct** and **secondary**) is expected to be **regional** along the pipelines and vessel routes, of **short-term** duration and of **medium** intensity. Impact magnitude is **medium**. Impacts are **reversible** within a few generations in a worst case scenario. Impact significance is expected to be **moderate** for the grey seals if the ice breaking activities disrupt breeding areas (**high** value/sensitivity).

(1) ENERGI E2. 2006. EIA Report - Marine mammals. Horns Rev 2, offshore wind farm.

(2) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

### Impacts during the Pre-commissioning and Commissioning Phase

The uptake of seawater and subsequent discharge of pressure-test water during pre-commissioning is restricted to the Russian landfall (ESR I). As such, the only activities that will generate an impact (noise and vibration) in ESR IV are pipeline flooding during pressure testing, pressure-test water discharge and the input of gas during commissioning.

*Noise and vibration*

The movement of pressure-test water (pipeline flooding) in the pipelines during pressure testing and pressure-test water discharge, and the input of gas during commissioning will generate some noise and vibration. The noise generated is expected to be on par if not slightly higher than normal gas movement within the pipelines (see section on the operational phase impacts). As such, generated noise is expected to have an **insignificant** impact on marine mammals in ESR IV. No mitigation is required.

### Impacts during the Operational Phase

Impacts upon marine mammals during the operational phase are limited to noise and vibration from gas movement within the pipelines and from routine inspections and maintenance works. An increase in turbidity is expected to coincide with maintenance works should they interact with the seabed.

### Noise and vibration

As per the studies[(1),(2)] described under ESR I for marine mammals (**Section 9.3.10**), the noise generated by the movement of gas within the pipelines falls below the levels detectable by the marine mammals (~1 kHz for the harbour porpoise) present in ESR IV. As such, it is expected that gas movement in the pipelines would have little to no impact on marine mammals at either an individual or population level. On the contrary, the pipelines are expected to become artificial habitats for other marine fauna and may thus become a hunting ground for certain marine mammals. The impact is deemed to be **insignificant**.

Routine inspections would include external inspections of the pipelines by means of ROV and internal inspections using pigs (**Section 9.2.3**). Maintenance works are not expected but may include possible repair works on the pipelines or on the seabed where required. Routine inspections and maintenance works are expected to generate very little noise and are thus assumed to have an **insignificant** impact upon marine mammals and will be restricted to the pipelines' route and be infrequent (i.e. not constant).

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(1) Lommer, M. and Lemaire, G. 2008. Ødegaard & Danneskiold-Samsøe A/S. Noise along the Nord Stream pipelines in the Baltic Sea.

(2) Martec Limited. 2004. Effects of Pipelines/Gathering Lines on Snow Crab and Lobster.

*Increase in turbidity*

Maintenance works may be required on the pipelines or on the supporting seabed to ensure that the pipelines have a stable base. These works may result in localised re-suspension and spreading of sediments and a subsequent increase in turbidity and the release of contaminants. The following mitigation measures will be implemented to reduce the impacts:

- Any seabed intervention work, such as rock placement, required during operation will be kept to a minimum
- Disturbance of seabed sediments will be kept to a minimum
- Any surveys will avoid encounters with marine mammals wherever possible.

As these works are not expected to occur on a regular basis and will be localised, the impacts on marine mammals are expected to be **insignificant**.

**Impact Summary**

The impacts on marine mammals identified and assessed in ESR IV are summarised in **Table 9.72**.

**Table 9.72 ESR IV impact summary table for marine mammals**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Marine Mammals - Ecological Sub-Region IV | Noise and vibration | Seabed intervention works | Negative | Direct | Regional | Short-term | Low-Medium | Low | Medium – High | Reversible | **Minor - Moderate** |
| | | Pipe-laying, Anchor handling, Above water tie-in activities | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline flooding, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Increase in turbidity | Dredging, Trenching, Rock placement, Above-water tie-ins | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Release of contaminants | Seabed intervention works, Pipe-laying, Anchor handling, Above water tie-in activities | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Ice breaking | Construction and support vessel movement | - / Negative | - / Direct, Secondary | - / Regional | - / Short-term | - / Medium | - / Medium | - / High | - / Reversible | **No impact/ Moderate** |

### 9.6.11 Biological Environment – Nature Conservation Areas

**Overview**

This section identifies and assesses the potential impacts on nature conservation areas in ESR IV during the construction, pre-commissioning and commissioning and operational phase of the Project.

Route optimisation was undertaken to ensure that the Nord Stream pipelines' route in ESR IV passed through the minimum number of nature conservation sites possible. However, the number and spread of designated sites necessitates that the route still passes through a variety of nature conservation areas, the majority of which are Natura 2000 sites which are considered in **Chapter 10**. Excluding the Natura 2000 sites, the pipelines' route does not cross any other nature conservation areas in ESR IV, but does pass within 3 km of a UNESCO biosphere reserve, South-east Rügen. The route also passes within 14 km of the Island of Usedom National Park and Nature Reserve, as listed in **Table 9.73**. UNESCO sites (along with BSPA sites) are illustrated on **Atlas Map PA-5**.

**Table 9.73 Nature conservation areas within 20 km of ESR IV**

| **Nature Conservation Area** | **Designation** | **Protected Habitats and Species** | **Distance to Pipelines (km)** |
|---|---|---|---|
| South-east Rügen | UNESCO biosphere reserve, Nature Reserve | Temperate broadleaf forests, moraine landscapes with beech forest, coastal beech communities, sand dunes, salt meadows, beaches, shallow inlet waters and salt reed banks. Important breeding and staging area for birds, including the Caspian tern (*S. caspia*), white-tailed eagle (*H. albicilla*) and migrating greylag goose (*A. anser*) and white-fronted goose (*A. albifrons*). Spawning area for cod and Baltic herring. | 3 |
| Island of Usedom | National Park, Nature Reserve | Beaches and coastline, dunes, eutrophic lakes, beech forests and moorland. Important for breeding bird colonies and for migrating ducks and geese including cormorant (*P. carbo*), whooper swan (*C. cygnus*), bean goose (*A. fabalis*), white-fronted goose *(A. albifrons*), tufted duck (*A. fuligula*), scaup (*A. marila*), goldeneye (*B. clangula*), smew (*M. albellus*) and goosander (*M. merganser)* | 14 |

The scope of this assessment is limited to the particular impacts on features for which the nature conservation areas have been designated, including protected habitats in the areas. Impacts on floral and faunal receptors (fish, mammals, sea birds and marine benthos) are assessed in the other sections in this report. However where these species are specifically protected by the nature conservation designation, consideration will be given here as to the significance of impacts on these species from the installation of the pipelines' route in ESR IV. As the nature conservation areas are of national and international importance, their values/sensitivities are rated as **high**.

All of the nature conservation areas which have the potential to be affected by the Nord Stream pipelines' route in ESR IV are coastal or consist of islands, and therefore have protected coastal habitats which may be impacted by the development. The main habitats of importance (as shown in **Table 9.73**)[1] are beaches and coastline, sand dunes, coastal beech communities, salt meadows, salt reed banks and shallow inland waters. Breeding and migrating sea and water birds are also protected within the nature conservation areas in ESR IV, along with spawning areas for cod and Baltic herring, which also have the potential to be affected by the construction, pre-commissioning and commissioning and operation of a pipeline.

The main activities anticipated to affect nature conservation areas in ESR IV are those occurring during the construction phase of the Project, such as post-lay trenching, dredging, anchor handling and above water tie-in activities. The impacts which are likely to affect these sites are limited to those which can operate away from the source, including noise and vibration, visual/physical disturbance and the re-suspension and spreading of sediments resulting in an increase in turbidity.

Impacts during the pre-commissioning and commissioning and operational phase are expected to be comparatively small, due to the less invasive nature of the activities in these phases, and the smaller scale on which these activities will operate.

Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Seabed intervention works, pipe-laying, anchor handling, above water tie-in activities and construction and support vessel movement resulting in:
  - Noise and vibration
- Re-suspension and spreading of sediments due to seabed intervention works, pipe-laying, anchor handling and above water tie-in activities resulting in:
  - Increase in turbidity
  - Physical alteration of the seabed
- Construction and support vessel movement resulting in:
  - Visual/physical disturbance

*Pre-commissioning and commissioning phase:*

- Pipeline flooding resulting in:
  - Noise and vibration

(1) Nord Stream AG & Ramboll. 2007. Memo 4.3G -Protected Areas.

- Construction and support vessel movement resulting in:
  - Visual/physical disturbance

*Operational phase:*

- Routine inspections and maintenance works and construction and support vessel movement resulting in:
  - Increase in turbidity
  - Noise and vibration
  - Physical alteration of the seabed
  - Visual/physical disturbance
- Pipeline presence resulting in:
  - Noise and vibration

**Impacts during the Construction Phase**

Potential impacts upon nature conservation areas in ESR IV during the construction phase include impacts on fauna from noise and vibration, visual/physical disturbance and turbidity impacts on habitats and fauna due to seabed intervention works and pipe-laying activities.

*Increase in turbidity*

Increases in turbidity in the water column due to the re-suspension and spreading of sediments will result from seabed intervention works including trenching (in specific areas) and dredging activities, as well as from pipe-laying, anchor handling and above water tie-in activities. As discussed in previous sections, this can potentially cause physiological damage to faunal species such as fish (**Section 9.6.8**), or smothering of important benthic communities (**Section 9.6.7**). However, impacts will only affect species for a short duration within a relatively localised area surrounding the pipelines.

Seabed intervention works are expected to generate the most re-suspended sediment while pipe-laying, anchor handling and above water tie-in activities are thought to contribute very little. Seabed intervention works are restricted to specific locations along ESR IV and will not affect the whole route length. Sedimentation modelling has been carried out for seabed intervention works in ESR IV (as detailed in **Section 9.6.3**). The areas and average duration of re-suspended sediment concentrations for ESR IV during seabed intervention works are illustrated on **Atlas Maps MO-1**, **5** – **7** and **30**. As normal water concentrations in the Baltic Sea are typically in the range of 1 – 4 mg/l during normal weather, concentrations over 1 mg/l are regarded as the maximum extent of the predicted sediment spread (as detailed in **Section 9.6.3**). Dredging, trenching and rock placement in ESR IV are expected to result in re-suspended sediment concentrations of above 1 mg/l up to a maximum of 1 – 2 km for 12 – 24 hours in the southernmost part of ESR IV, where the route approaches Greifswalder Bodden. The majority of re-suspended sediments will occur in much closer proximity to the works. This sediment extent is restricted to specific locations along the route where seabed intervention works are expected.

As South-east Rügen UNESCO biosphere reserve is located approximately 3 km to the west of the pipelines' route in ESR IV, this site is out of the extent of a predicted increase in turbidity (as illustrated on **Atlas Map MO-1**) but it is possible that fauna protected by the nature conservation site might experience impacts outside the boundary of the designated area. However, the greatest impact in terms of sedimentation will occur along the 50 m corridor to either side of the pipelines' route during the pipe-laying process, with less significant impacts occurring over the wider area. Potential impacts to fauna due to an increase in turbidity in the area surrounding South-east Rügen UNESCO biosphere reserve are expected to be short-term and marginal and are therefore deemed **insignificant**.

Usedom Island National Park is situated at a distance of 14 km from the pipelines' route, which is well outside any predicted impacts with regards to turbidity. Therefore, the impact on this site is considered to be **insignificant**.

*Noise and vibration*

The activities during construction that are likely to cause noise and vibration disturbance are dredging, trenching, rock placement, pipe-laying, anchor handling, above water tie-in activities and construction and support vessel movement, all of which are planned to take place in ESR IV. There are no noise level estimates available for the noise generated during pipe-laying, anchor handling, and above water tie-in activities, but these are thought to be on a par with that of normal shipping and fishing activities. Rock placement is not expected to generate noise that exceeds background levels(1). Dredging and trenching are anticipated to produce the most noise and vibration during seabed intervention works. The significance of any noise and vibration impacts on nature conservation areas will depend upon the distance between the source of the impact (originating from within the vicinity of the pipelines) and the conservation areas themselves. Potential receptors for impacts from noise and vibration are limited to marine mammals, fish and sea birds. Of these groups of fauna, only sea birds and spawning sites for cod and Baltic herring are specifically protected in the nature conservation areas near the pipelines in ESR IV.

(1) Nedwell, J. and Howell, D. 2004. A review of offshore windfarm related underwater noise sources.

In terms of sea birds, as discussed in **Section 9.6.9**, comparatively little is known about the impacts of noise and vibration on these species. However, the noise generated at sea surface-level will be of comparable volume to that for other shipping activity in the Baltic Sea, which birds in the region will be habituated to. In addition, pipe-laying will take place at a rate of 2 - 3 km a day using deep lay vessels and between KP 1222.8 and KP 1195.9 the pipeline will be laid with a shallow water lay vessel, with a lay rate 350 m per day i.e. during dredging. The source of noise will move along the pipelines' route and will not remain fixed at one point for an extended period of time.

The disturbance distance for visual and noise disturbance from boats is typically 1 – 2 km for the more sensitive bird species such as divers and scoters and to a lesser extent cormorant, but other species such as gulls and terns are likely to be less affected(1),(2). As South-east Rügen is 3 km from the pipelines' route, and the Island of Usedom is 14 km away, it is concluded that noise impacts on sea birds in protected areas are expected to be **insignificant** in ESR IV.

While benthic species are not specifically protected within the conservation areas of ESR IV, they provide a food supply for protected species in nature conservation areas. Since the noise and vibration impacts from construction in any one area will be temporary, they are unlikely to lead to a significant reduction in population numbers of benthic species, and therefore impacts on benthic species from noise and vibration will be **insignificant** for conservation areas in ESR IV.

Fish can also be impacted by noise and vibration and the Baltic herring is thought to be particularly sensitive to noise impacts. Any displacement of fish on which bird species forage can have a temporary influence on sea bird distribution as a result. Fish in ESR IV are already likely to be habituated to vessel noise and other activities in the Baltic Sea, due to the large amount of ship traffic in the sea. Increased noise levels may impact on spawning success if construction is carried out during the spawning season of cod and herring in the ESR. However, due to the distance between the construction work and the nature conservation areas (3 km and 14 km respectively for South-east Rügen and the Island of Usedom), noise impacts on fish in the nature conservation areas will be minimal and as a result of noise and vibration impacts will be **insignificant** on both of the conservation areas.

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(1) Ruddock, M. & Whitfield, D.P. 2007. A Review of Disturbance Distances in Selected Bird Species, A report from Natural Research (Projects) Ltd to Scottish Natural Heritage.

(2) Skov, H., Durinck, J., Leopold, M.F. and Tasker, M.L. 2007. A quantitative method for evaluating the importance of marine areas for conservation of birds. Biology Conservation. 36 (3).

*Physical alteration of the seabed*

Physical alteration of the seabed is likely to occur during construction due to dredging, post-lay trenching, pipe-laying and anchor handling. However, since the pipelines do not pass directly through any of the nature conservation areas in ESR IV, physical alteration of the seabed is not predicted to occur and impacts on the nature conservation areas are deemed to be **insignificant**.

*Visual/physical disturbance*

Visual or physical disturbance from the movement of vessels during the construction phase may affect sea bird populations that are protected by the nature conservation areas designated in ESR IV. The nature conservation areas hold important populations of breeding and feeding waders and sea birds, including internationally important migrant populations (as detailed in **Section 9.5.9**). The approximate distance at which disturbance occurs varies between species and depends on the nature of the vessel movement. As detailed above, for the more sensitive species disturbance can arise at 1 – 2 km, whilst other species are much less affected. Pipe-laying is expected to progress at the rate of 2 – 3 km/day, therefore vessel movement will be relatively slow and the risk of disturbing sea birds will be low. In addition, sea birds will be used to vessel movement in this part of the Baltic Sea, as the pipelines follow an established shipping route. As the nature conservation areas in ESR IV are at least 3 km from the pipelines' route, the pipe-laying process is unlikely to disturb flocks and the impact on vessel movement on sea birds associated with the nature conservation areas in ESR IV is considered to be **insignificant**.

Disturbance to birds protected within the nature conservation areas may also occur when the birds are out of the boundary of the protected site. The majority of birds are not sensitive to disturbance. Cormorants, which are listed as present in South-east Rügen are however sensitive(1). However, studies have shown that birds such as common scoter (which are also sensitive to disturbance) tend to avoid channels with high frequencies of shipping activity, even when these areas hold a high prey biomass(2). As the pipelines' route follows a shipping channel, sensitive birds are unlikely to be present so the risk of disturbance of these species and habitats associated with the designation of the conservation area is low and impacts are considered **insignificant** on conservation areas.

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(1) Garthe, S. and Hüppop, O. 2004. Scaling possible adverse effects of marine wind farms on sea birds: developing and applying a vulnerability index. Journal of Applied Ecology. 41.

(2) Kaiser, M.J., Galanidi, M., Showler, D.A., Elliot, A.J., Caldow, R.W.G., Rees, E.I.S., Stillman, R.A. and Sutherland, W.J. 2006. Distribution and behaviour of Common Scoter Melanitta nigra relative to prey resources and environmental parameters. Ibis 148

**Impacts during the Pre-commissioning and Commissioning Phase**

Potential impacts upon nature conservation areas in ESR IV during the pre-commissioning and commissioning phase are limited to noise and vibration impacts on fauna generated by pipeline flooding and the visual or physical disturbance of fauna from vessel movement during the works.

*Noise and vibration*

Noise and vibration generated by the movement of pressure-test water within the pipelines during pipeline flooding and pressure-test water discharge, and due to gas movement in the pipelines during commissioning will only cause potential impacts on fauna in the immediate vicinity of the pipelines. However, as discussed in **Sections 9.6.7**, **9.6.8** and **9.6.10**, impacts on marine benthos, fish species and marine mammals in the immediate area of the pipelines have been shown to be insignificant, therefore noise and vibration during pre-commissioning and commissioning is also expected to have an **insignificant** impact on nature conservation areas within ESR IV.

*Visual/physical disturbance*

During the pre-commissioning and commissioning phase, no vessel movement is expected to be required in ESR IV. Therefore no visual or physical disturbance is predicted and the impact on nature conservation areas is expected to be **insignificant**.

**Impacts during the Operational Phase**

In general, impacts during the operational phase will be similar to those during the construction phase, but to a much lesser extent. Potential impacts upon nature conservation areas in ESR IV during the operational phase from natural gas movement in the pipelines are limited to noise and vibration. Impacts as a result of routine inspections and maintenance works are limited to noise and vibration, re-suspension and spreading of sediments and physical alteration of the seabed.

*Increase in turbidity*

Re-suspension of sediments in the water column and an associated increase in turbidity is possible in association with routine inspections and maintenance work. Routine inspections are not likely to cause any significant impacts, however maintenance work may require seabed intervention works of some nature. The extent of these impacts are likely to be much smaller than for the construction phase, however it is not possible to predict the frequency with which maintenance works will be required, nor the extent of seabed disturbance from these activities. However, due to the distance of all the nature conservation areas from the pipelines, an increase in turbidity related to routine maintenance works is expected to have an **insignificant** impact on conservation areas in ESR IV as the species and habitats associated with the conservation areas are not expected to be impacted.

*Noise and vibration*

Routine inspections and maintenance work will have an **insignificant** impact on conservation areas in terms of noise and vibration, since the scale of operations will be far smaller than for the construction phase, and the impacts for the construction phase were themselves considered to have an **insignificant** impact on conservation areas in ESR IV as discussed above. Similarly, noise and vibration generated by natural gas movement in the pipelines is expected to have an **insignificant** impact on the nature conservation areas in ESR IV since impacts on marine mammals, benthos and fish species in the immediate area of the pipelines associated with the designation have been shown to be insignificant, as discussed in **Sections 9.6.7**, **9.6.8** and **9.6.10**.

*Physical alteration of the seabed*

Physical alteration of the seabed associated with routine inspections and maintenance work may occur and again the extent of these impacts will be smaller than for the construction and pre-commissioning and commissioning phases. Since both of the nature conservation areas are over 3 km from the pipelines, physical alteration of the seabed is expected to have an **insignificant** impact on the species and habitats associated with the conservation areas in ESR IV.

*Visual/physical disturbance*

There will be a low level of vessel movement associated with routine inspections and maintenance work which may result in low level visual or physical disturbance to the sea birds associated with the nature conservation areas in ESR IV. Routine inspections are considered to have a limited impact upon sea birds, especially as vessel movement is common in the area. As these works will be infrequent, and on a much smaller scale than that of the construction phase, the impact on birds associated with the nature conservation areas in ESR IV is deemed **insignificant**.

**Impact Summary**

The impacts identified and assessed in ESR IV on nature conservation areas are summarised in **Table 9.74**.

**Table 9.74 Impact summary table for nature conservation areas in ESR IV**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Nature Conservation Areas - Ecological Sub-Region IV | Increase in turbidity | Seabed intervention works, Pipe-laying, Anchor handling, Above-water tie-ins | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Dredging, Trenching, Rock placement, Pipe-laying, Anchor handling, Above-water tie-ins | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline flooding, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Physical alteration of the seabed | Dredging, Trenching, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Visual/physical disturbance | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |

**Table 9.75 Summary of significant impacts for ESR IV**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Water** | Increase in turbidity | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | Release of contaminants | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| **Seabed** | Physical Alteration of the Seabed | Seabed intervention works | Negative | Direct | Local - Regional | Long-term | Low | Low | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| **Atmosphere** | Emissions of pollutant gases | Seabed intervention works, Pipe-laying, Above-water tie-ins | Negative | Cumulative | National - Transboundary | Long-term | Low | Low | Low | Irreversible | **Minor** |
| **Marine Benthos** | Increase in turbidity | Trenching, Rock placement, Pipe-laying, Anchor handling at Pomeranian Bay and Oderbank | Negative | Direct | Regional | Short-term | Low | Low | High | Reversible | **Moderate** |
| | | Trenching, Rock placement, Pipe-laying, Anchor | Negative | Direct | Regional | Short-term | Medium | Low | Low | Reversible | **Minor** |

| Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Scale | Duration | Intensity | Magnitude | | | |
| | handling (elsewhere) | | | | | | | | | |
| Release of contaminants | Seabed intervention works, Pipe-laying, Anchor handling | Negative | Direct and indirect | Local | Long-term | Low | Low | Low | Reversible | **Minor** |
| Physical loss of seabed habitats | Dredging, Trenching, Pipe-laying | Negative | Direct | Local | Short-term | Medium | Low | Low/High* | Reversible/ Irreversible* | **Minor/ Moderate*** |
| | Rock placement | Negative | Direct | Local | Short-term | Medium | Low | Low/High* | Reversible/ Irreversible* | **Minor/ Moderate*** |
| | Anchor handling | Negative | Direct | Local | Short-term | Medium | Low | Low/High* | Reversible | **Minor/ Moderate*** |
| Smothering | Dredging, Trenching, Rock placement, Installation of support structures, Pipe-laying | Negative | Direct | Local | Short-term | Medium | Low | Low/High* | Reversible | **Minor/ Moderate*** |
| Physical alteration of the seabed | Routine maintenance | Negative | Direct | Local | Short-term | Low | Low | Low/High* | Reversible | **Minor/ Moderate*** |
| Introduction of secondary habitats | Pipeline presence | Positive or Negative/ Negative* | Direct | Local | Long-term | Medium | Low | Low/High* | Irreversible | **Minor/ Moderate*** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Fish | Noise and vibration | Seabed intervention works | Negative | Direct | Regional | Temporary | Low | Low | Low - High | Reversible | **Minor-Moderate** |
| | | Pipeline presence | Negative | Direct | Local | Short-term | Low | Low | Low - High | Reversible | **Minor-Moderate** |
| | Physical alteration of the seabed | Rock placement, pipeline presence (additional of hard substrate) | Negative | Direct | Local | Long-term | Medium | Low | Low - High | Irreversible | **Minor - Moderate** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Sea Birds** | Noise and vibration | Dredging, Trenching | Negative | Direct and Indirect | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| | Visual/physical disturbance | Seabed intervention works, Pipe-laying, Above-water tie-ins, Construction and support vessel movement | Negative | Direct | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| **Marine** | Noise and vibration | Seabed intervention works | Negative | Direct | Regional | Short-term | Low-Medium | Low | Medium - High | Reversible | **Minor - Moderate** |
| | Ice breaking | Construction and support vessel movement | - / Negative | - / Direct, Secondary | - / Regional | - / Short-term | - / Medium | - / Medium | - / High | - / Reversible | **No impact/ Moderate** |

* Values apply to the section of the pipelines' route which crosses the Pomeranian Bay and Oderbank Natura 2000 sites.

## 9.7 Ecological Sub-Region V

### 9.7.1 Introduction

The pipelines pass through ESR V over a distance of 24.6km, as shown in **Figure 9.12**. The seabed in ESR V comprises postglacial mud, sandy mud, sand and coarser sediments overlaying cretaceous chalk, limestone, mudstone and sandstone. The long-term average water salinity is relatively low. Oxygen concentrations are high, however both oxygen over saturation and oxygen depletion events regularly cause the death of benthic invertebrates and fish, affecting the composition of ecological communities in the water. High levels of sedimentation and re-deposition occur in the water. Levels of heavy metals are also high, as are concentrations of tri-butyltin, and anthropogenic pollutants. Macrophyte meadows and blue mussel beds in the deeper regions of the ESR provide internationally important spawning and nursery grounds for fish including for the spring herring variety of the Baltic Sea herring. Three fish species in ESR V are included within the Red List for the Baltic Sea as ‘endangered’. The shallow waters of ESR V support a high abundance of benthic-feeding sea birds, and include the most important areas for wintering sea birds in the Baltic Sea. Thirteen bird species of international importance have been identified. Harbour porpoises, harbour seals and grey seals are also found along the German coast in ESR V. ESR V is demarcated by the following KPs: KP 1198.1 – 1222.7.

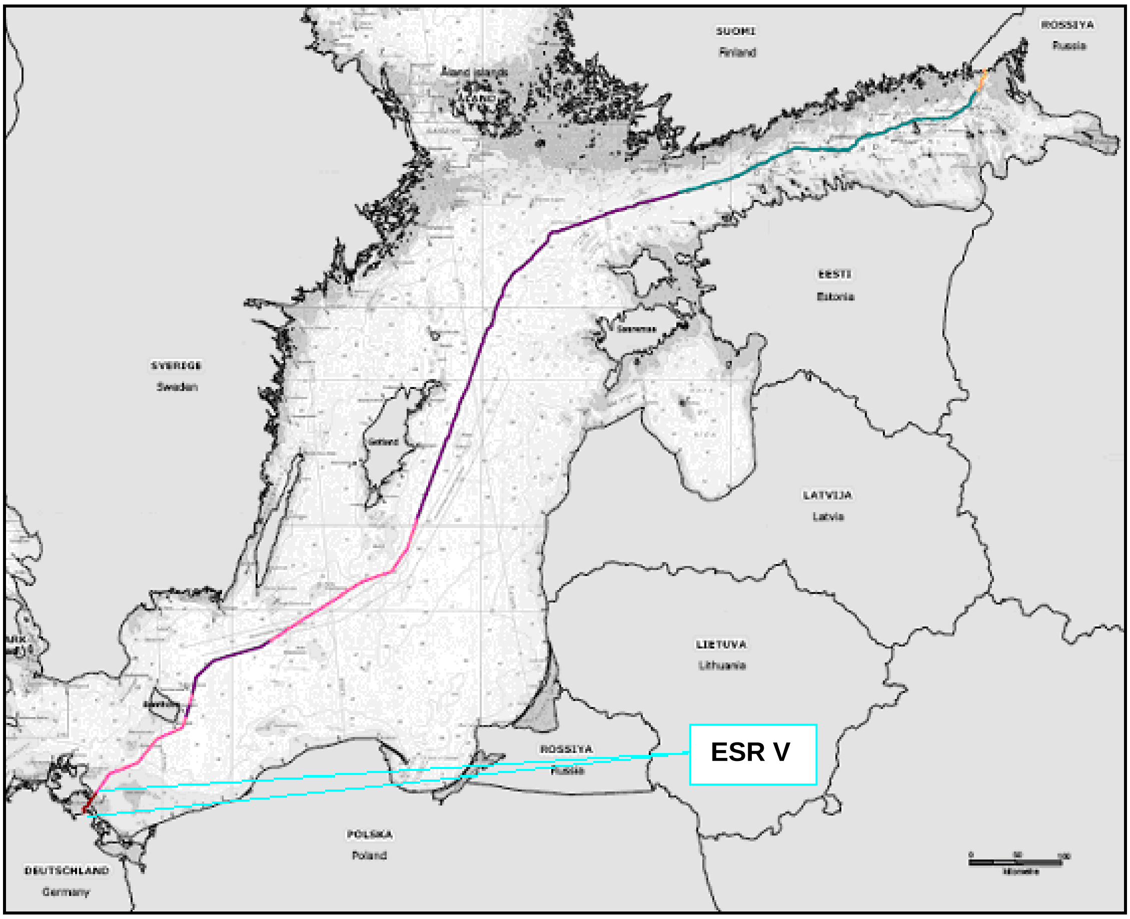


**Figure 9.12 The section of the pipelines' route passing through ESR V (in brown)**

Predicted impacts in ESR V will occur as a result of the following activities identified during the three initial phases of the Project. These include the following:

*Construction phase*

Seabed preparation activities:

- Boulder removal
- Wreck removal

Seabed intervention works:

- Dredging
- Sheet piling

Offshore pipe-laying:

- Pipe-laying
- Anchor handling
- Construction and support vessel movement

*Pre-commissioning and commissioning phase*

- Pipeline flooding, cleaning, gauging and pressure testing
- Pressure-test water discharge
- Pipeline drying
- Pipeline commissioning

*Operational phase*

- Routine inspections and maintenance
- Pipeline presence

The predicted impacts are identified and assessed as per each resource or receptor in the physical and biological environment. Impacts that are deemed to be of significance when they occur are assessed in full by means of the methodology presented in **Chapter 7.** Impacts that are deemed to be insignificant based upon previous knowledge and experience in similar projects are described but not assessed in detail.

A summary table showing the significant impacts for ESR V is shown at the end of this section (**Table 9.93**).

### 9.7.2 Physical Environment – Physical Processes

#### Overview

This section does not include a discussion around the construction and pre-commissioning and commissioning phases of the Project since the issue only relates to the operation of the Project, i.e. the long term presence of the pipelines on the seabed. The section therefore identifies and assesses the potential impacts on deepwater physical processes in ESR V during the operational phase of the Project in terms of the methodology presented in **Chapter 7**.

**Impacts during the Operational Phase**

The pipelines will be completely buried in a trench within ESR V. Underwater currents within the study area could be impacted by minor changes in the water temperature in the vicinity of the pipelines during operation. However, the temperature balance that occurs within the water is fast and as such the influence of temperature differences between the natural gas pipelines, the sediment, and the water body will be low. As a result of this and the fact that the pipelines in ESR V will be buried, no essential negative temperature effects are predicted for the surroundings of the pipelines in the water and any impact to underwater currents due to rises in water temperature will be **insignificant**.

As the active currents within ESR V are complex, the introduction of new pipelines on the seabed within this area could cause impacts of significance with regards physical processes through pipeline-generated turbulence. However, within ESR V the pipelines are to be laid by way of a temporary open laying trench which will be refilled after the laying of the pipelines so that the original pre-existing conditions of the seabed relief will return one construction work ceases. As a result, the impacts from pipeline presence with regards physical processes within ESR V is expected to be **insignificant**.

**Impacts summary**

The impacts from pipeline presence with regards to physical processes within ESR V are expected to be **insignificant**.

The impacts on physical processes identified and assessed in ESR V are summarised in **Table 9.76.**

**Table 9.76 ESR V impact summary table for physical processes**

| Physical Processes - Ecological Sub-Region V | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Change in underwater current flow | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.7.3 Physical Environment – Water Column

**Overview**

Following the undertaking of a scoping and impact identification exercise, numerous interactions between the Project and the water column in ESR V have been identified, which could give rise to potential impacts. This section identifies and assesses the potential impacts on the water column in ESR V during the construction, pre-commissioning and commissioning and operational phases of the Project in terms of the methodology presented in **Chapter 7**.

The characteristics of the water column are not constant throughout the Baltic Sea and differ depending on location as well as depth. Accordingly, the significance of the associated Project impacts on the water column may also differ along the pipelines' route. The quality of the water column is dictated by its salinity and oxygen levels as well as by the concentrations of suspended solids, nutrients, heavy metals, organic pollutants, plankton and biological components. Full details as to the water quality in ESR V are presented in **Section 8.11.1.** Essentially the water column is important for all ecosystems in terms of supporting function and structure but is very resistant to change in terms of its interaction with the Project. In most cases, the water column will rapidly revert back to a pre-impact status once specific activities, such as those during construction, cease. This would depend on the magnitude of the impact and its persistence.As per the sensitivity criteria for the physical environment as detailed in **Chapter 7**, the water column has been awarded a **low** value/sensitivity throughout the Baltic Sea.

The main activities that are expected to impact on the water column are those that take place during the construction phase. The re-suspension and spreading of sediments by seabed intervention works is expected to impart the largest impact upon the water column. Accordingly, the characteristics of seabed sediments play a major role in determining the level of impact. No impacts are expected in ESR V during pre-commissioning as the intake of seawater and subsequent discharge of pressure-test water is to occur at the Russian landfall in ESR I. Impacts during the operational phases are expected to be minimal in comparison to construction. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Re-suspension and spreading of sediments from boulder removal, wreck removal, seabed intervention works, pipe-laying and anchor handling resulting in:
    - Increase in turbidity
    - Release of contaminants

- Release of nutrients

*Operational phase*

- Pipeline presence resulting in:
  - Temperature change
  - Release of pollutants from anti-corrosion anodes

**Impacts during the Construction Phase**

Impacts upon the water column during the construction phase are limited to the re-suspension and spreading of sediments resulting in an increase in turbidity and the release of contaminants and nutrients due to boulder removal, wreck removal, seabed intervention works, pipe-laying, and anchor handling.

*Increase in turbidity*

Construction works on the seabed will result in the disturbance and subsequent re-suspension of sediments together with the associated compounds such as contaminants and nutrients, which may be present. This would increase the turbidity levels as well as the concentrations of these substances in the water column. Activities that are expected to disturb the seabed include boulder removal, wreck removal, seabed intervention works, pipe-laying and anchor handling. Seabed intervention works are expected to generate the most re-suspended sediment. The amount of sediment disrupted is highly dependent on the methods and equipment used during the pipelines' installation phase as well as the extent of the construction works. The degree to which sediments are generally prone to suspension is linked to the fines content and how consolidated the sediment is. Sediments are re-suspended for a period of time before being deposited (sedimentation) elsewhere. This depends on current flow. It should be noted that dredging in ESR V takes place along the whole pipelines' route as depicted on **Atlas Maps PR-3A** and **PR-3B**. The construction of a cofferdam by sheet piling will only take place close to the landfall area. Seabed intervention work (dredging and sheet piling) and the types of sediments for ESR V are detailed in **Table 9.77**.

**Table 9.77 Seabed intervention works (both pipelines) and sediments types for Ecological Sub-Region V**

| Area | Seabed Intervention Works | Sediment Types |
|---|---|---|
| Boddenrandschwelle | Dredging (pre-lay trenching) | Glacial till (hard bottom) and Sand and coarse sediments |
| Greifswalder Bodden | Dredging (pre-lay trenching)<br>Sheet Piling | Sand and coarse sediments |

The proposed pipelines' route through the Greifswalder Bodden is shallow with an average depth of 5.8 m and a maximum of 13.6 m. The Boddenrandschwelle, which serves as the boundary between the Greifswalder Bodden and the Bay of Pomerania has depths of 2-3 m. The Boddenrandschwelle is cut by two natural deepwater channels, Landtief and Osttief, which are particularly pronounced during historic storm surge events. They are now used as shipping channels and have been partly developed for this purpose. No halocline is present in ESR V. Due to the shallow nature of Greifswalder Bodden there is a high degree of exposure of the seabed to the currents and wave action of the surface water. This results in a higher turbidity level than the rest of the Baltic Sea. Turbidity levels range from 1-10 mg/l with short-term peaks up to 100 mg/l (typically 40-70 mg/l). Currents (depending on strength and presence) will increase the distance to which suspended sediments would be transported laterally as well as the time period for which sediments remain in suspension. The water column within ESR V is fully exchanged (with the Baltic Sea) every 30 days on average.

Stone and boulder fields have been identified along certain sections of the pipelines' route in ESR V. These fields are generally located within the Boddenrandschwelle. During construction, boulders that may interfere with the construction activities are to be removed. As stone and boulder fields serve as habitats on the seabed, removed boulders will be replaced following construction. The removal of boulders may result in a very **local** increase in turbidity. However, re-suspended sediment is not expected to increase the current turbidity levels, which are generally quite high, and thus this impact is regarded as being **insignificant**.

A part of the Schiffssperre (ship lock) at the Boddenrandschwelle currently encroaches on the pipelines' route. This would affect a single ship wreck in the Schiffssperre. To prevent any damage to the wreck, it is proposed that the wreck is removed by means of a supportive steel frame. With the removal of the wreck, re-suspension and spreading of sediment will occur, which will result in a local increase in turbidity. However, it is assumed that the process for wreck removal will be slow so as to prevent damage to the wreck and thus disturbance of the seabed will be kept to a minimum. As such, the impact on the water column is regarded as being **insignificant**.

The re-suspension and spreading of sediments (and organic matter) is expected to be greatest during dredging and trench backfilling, which will take place for the entire pipelines' route in ESR V. Sediment that is dredged will be transported and stored temporarily at the dumping site off Usedom. Sheet piling, which will take place during the construction of the cofferdam, will also result in the disruption of sediments but the impact is expected to be superseded by those associated with dredging. Modelling (by means of a Computational Flow Dynamics model – CFD – and a Langrange-type tracer model) of the spread and sedimentation of sediments during dredging and backfilling in ESR V has been carried out by the Institute for Spatial Data

Processing in Hinrichshagen, Germany (Institut für Geodatenverarbeitung - IfGdV)[1]. During the formulation of the model, some assumptions were made that are based on scenarios that are considered unrealistic and unlikely to occur. As such, it must be stated that the model presents a "worst case scenario" where the maximum possible impact at extreme conditions is considered. The model further highlights areas where higher turbidity levels can be expected. The assumptions made include:

- All dredgers will operate simultaneously at the same location. This scenario will not occur
- Sediments of fine texture and with high organic matter have been used as inputs in some areas
- A literature based maximum value of 1000 mg/l for suspended matter concentration during dredging (backhoe dredger) was used

Simulations have been made at wind speeds of 5 and 10 m/s for all wind directions. However, as 65 to 80 % of the wind events fall within the calm range (5.4 m/s), the focus will be on the impact associated with the 5 m/s wind scenario. It is assumed that dredging activities will cease or be greatly reduced during wind speeds of 10 m/s. Simulations have been made for a 5 day period and highlight the maximum drift. **Figure 9.13** and **Figure 9.14** present visual representations for maximum turbidity and sedimentation rates for wind speeds of 5 m/s from all directions over a 5 day period.

The disruption of sediments (such as sand) with a low tendency for prolonged re-suspension in the central section of the pipelines' route results in maximum suspended matter concentrations of 1700 mg/l within 100 m, 500 mg/l up to 150 m, 300 mg/l up to ~250 m and 100 mg/l up to 600 m from the disturbance area within a 5 day period. A suspended matter concentration of 50 mg/l, which corresponds to the increase in turbidity incurred naturally during frequent storm events, is expected to extend up to 1000 m (typically <500 m) from the disturbance area. Maximum sedimentation rates of up to 4700 g/m$^2$ are expected within 100 m of the disturbance area. Sedimentation rates of 500 and 100 g/m$^2$ are expected within ~150 and ~200 m of the disturbance area respectively.

(1) Institut für Geodatenverarbeitung. 2008. Assessment of the turbidity in connection with pipe-laying work in the Greifswald Bodden - Nord Stream Pipeline Project.

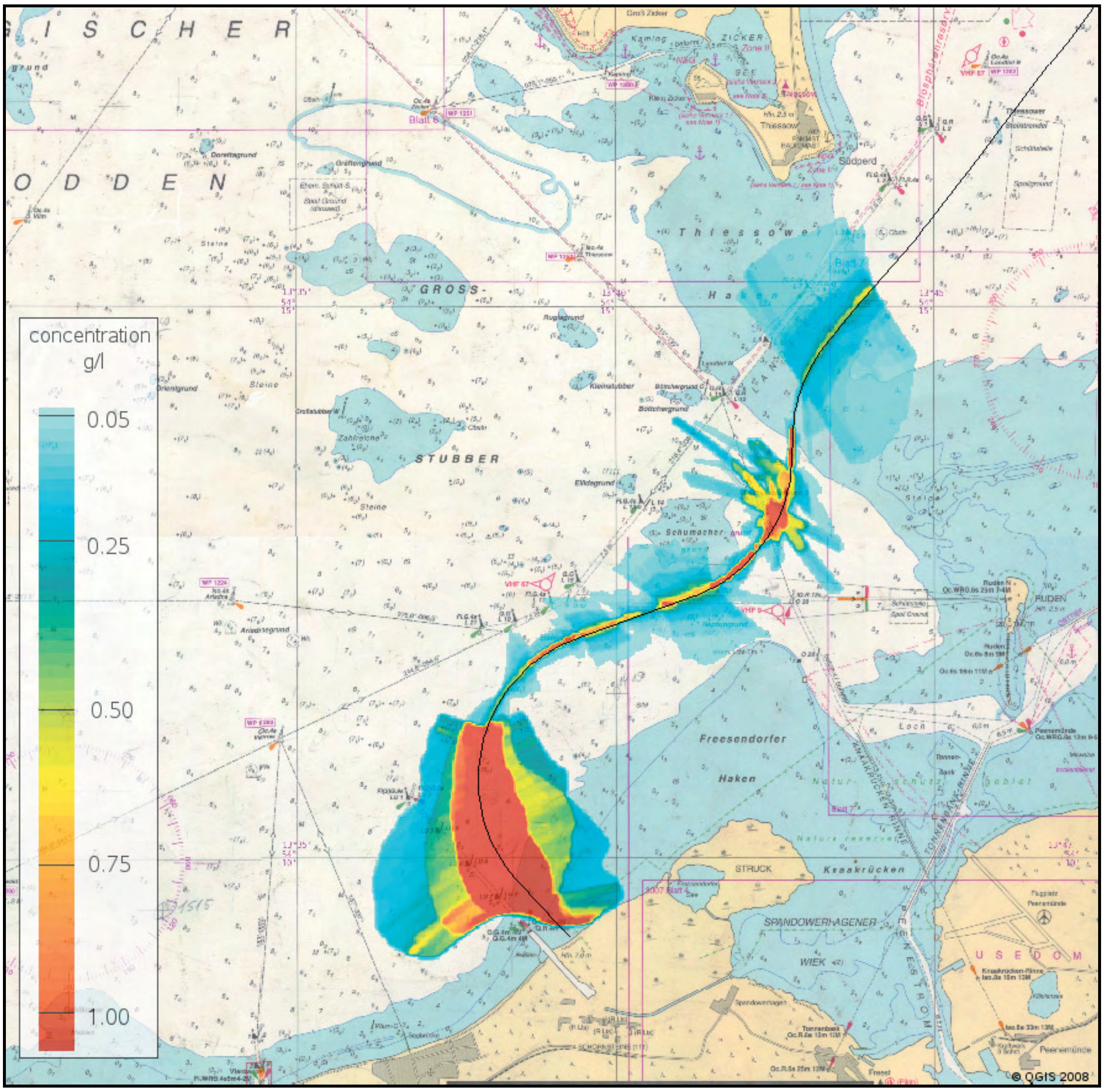


**Figure 9.13 Summary of the maximum turbidity (in g/l) areas for all wind directions with a wind speed of 5 m/s and an interference interval of 5 days**

The disruption of sediments (such as silty sands some with strong organic content) with an increased tendency for prolonged re-suspension in the vicinity of the landfall and the Boddenrandschwelle results in maximum suspended matter concentrations of 3000 mg/l at 100 m, 500 mg/l up to 900 m (maximum of 2200 m near the landfall approach), 300 mg/l up to 1200 m and 100 mg/l up to 2400 m from the disturbance area within a 5 day period. A suspended matter concentration of 50 mg/l is expected to extend up to ~2400 m from the disturbance area. Sediment spreading will increase with high wind speeds (10 m/s). Maximum sedimentation rates of up to 4700 g/m$^2$ are expected within 100 m of the disturbance area. Sedimentation rates of 500 and 100 g/m$^2$ are expected within ~150 and ~200 m of the disturbance area respectively.

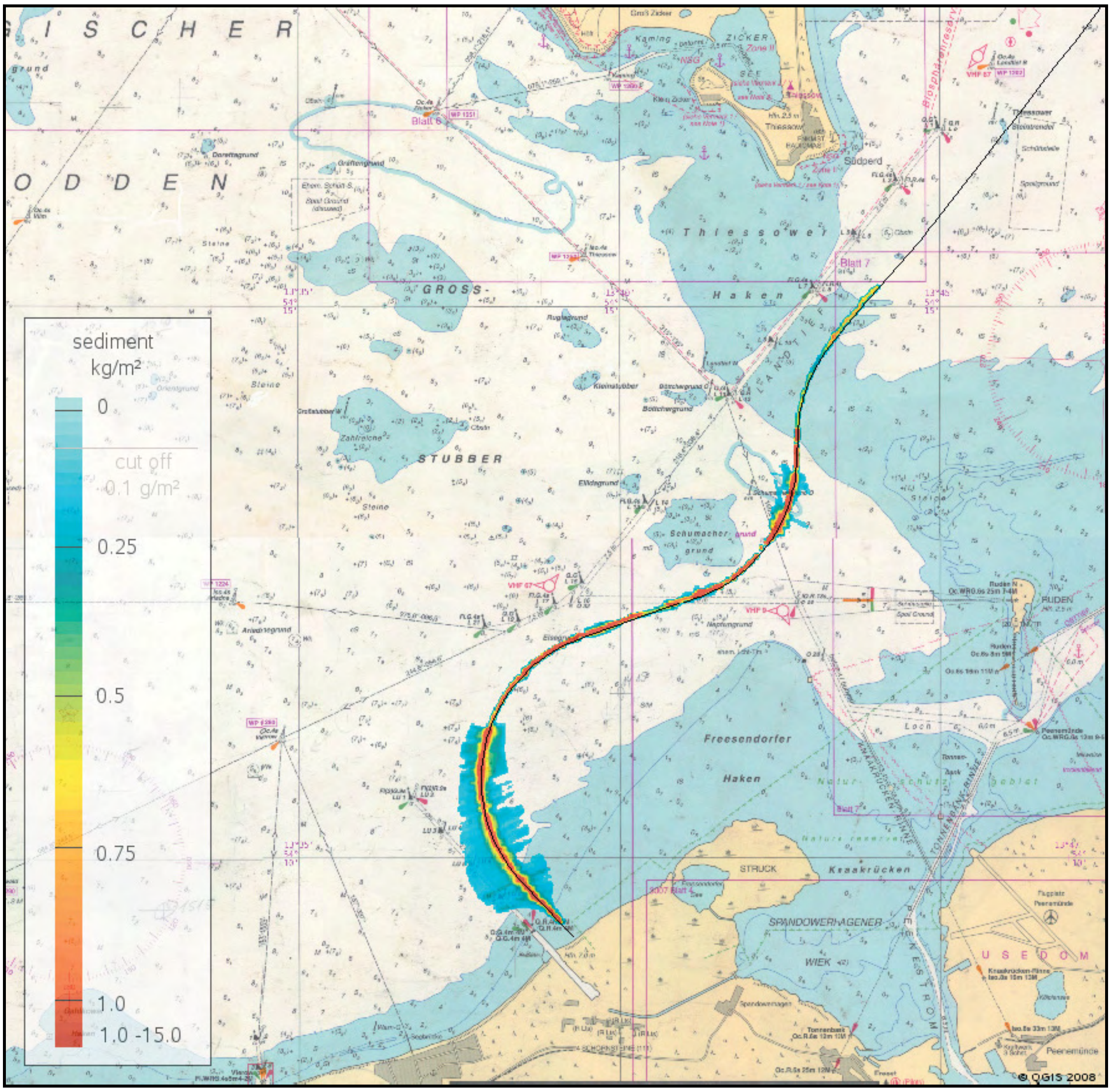


**Figure 9.14** **Summary of sedimentation rates (in kg/m²) for all wind directions with a wind speed of 5 m/s and an interference interval of 5 days**

Based upon the results of the modelling, the areas where an increase in turbidity is expected to be highest during dredging and backfilling include:

- The cofferdam (KP 1222.1 to the landfall)
- Approach to Lubmin Harbour (KP 1216.6 to 1222.0)
- Eastern Schumachergrund including the approach (KP 1211.5 to 1212.9)

In order to reduce the scale and intensity to which an increase in turbidity may be apparent during dredging and backfilling activities, the following mitigation measures will be implemented:

- Turbidity will be monitored during the construction phase
- If suspended matter concentrations exceed 50 mg/l above background turbidity (running average of measured values) within 500 m of the disturbance area, dredging will slow down, move elsewhere or cease, or silt screens will be introduced. Peak values should not exceed 100 mg/l above background turbidity beyond a distance of 500 m (during extreme sea conditions naturally occurring suspended matter concentrations can be 100 mg/l for short periods)
- The cofferdam area will be an enclosed area, which would prevent the spreading of sediment
- Silt screens will be used near the dumping point should turbidity increase beyond 50 mg/l above background turbidity at a distance of 500 m from the dumping ground (running average of measured values). Peak values should not exceed 100 mg/l above background turbidity at a distance of 500 m to the dumping ground

Based upon the worst case scenario modelling results and following the implementation of the proposed mitigation measures, which would restrict the extent of sediment spreading, the impact of an increase in turbidity in the water column (**negative** and **direct**), due to seabed intervention works in ESR V, is expected to be on the **local** to **regional** (silty sands with organic content) scale, of **short-term** duration and of **medium** intensity. Impacts will be **reversible** within a few days as sediment settles to the seabed. Any particles (<0.063 mm in diameter) and organic matter still in suspension will be removed from ESR V during the exchange of water with the Baltic Sea every 30 days on average. Impact magnitude is **medium** and value/sensitivity is **low**, therefore impact significance is expected to be **minor**.

Pipe-laying can result in the re-suspension and spreading of sediments due to the current generated in front of the pipelines as they near the seabed as well as from the pressure transfer when the pipelines hit the seabed. The amount of sediment that is expected to be placed into suspension during pipe-laying has been determined by considering the vertical velocity of the descending pipelines, the flow velocity of the water during displacement, the Shields parameter, which defines the limit at which particles start to move, the upwards flow generated by an increase in pore pressure due to sediment compression and both hard and soft sediment characteristics. Along a one kilometre stretch of a pipeline it is expected that the amount of suspended sediment, when the pipeline hits the seabed, would be up to 600 kg 1 m above the seabed for soft sediments. During pipe-laying, anchors (anchor handling) will be used to position the pipe-laying vessel. Anchor handling involves the placement and retrieval of 12 anchors on the seabed for every 200-600 meters of pipeline laid. Anchor placement and retrieval, as well as the anchor cable sweeping across the seabed, will result in the re-suspension of sediments. The amount of sediment that is placed in suspension has been determined by considering similar variables to those used for pipe-laying. During both anchor placement and retrieval it is expected that 10-160 kg of sediment will be placed in suspension per anchor. Approximately 100-150 m of anchor cable is expected to lay at rest on the seabed and will sweep across the seabed as the lay vessel moves forward resulting in the release of 400-1600 kg of sediment. Anchor handling results in a suspended sediment concentration >10 mg/l over a very limited area of 0.004-0.016 $km^2$. Even though pipe-laying (in a trench) and anchor handling would extend along the entire pipelines' route in ESR V it is expected that the effects of these activities would compare well to the effects of bottom trawling activities (dragging of trawls along the seabed) as well as normal anchor placement in the Baltic Sea. As such it is expected that pipe-laying and anchor handling would contribute very little to the overall amount of sediment placed into suspension during the construction phase and thus the impact is **insignificant**.

*Release of contaminants*

For the most part the pipelines' route in ESR V passes through areas that are characterised by sediment textures ranging from fine to coarse sands. These areas are typically erosion areas with low contaminant levels (**Chapter 8**). Higher contaminant levels correlate to fine grain cohesive sediments and organic matter. There are small accumulation zones in ESR V characterised by such finer sediments (silty sands) that display slightly higher contaminant levels. Due to the characteristics of the seabed sediments, no contaminant modelling has taken place in ESR V. It is unlikely that the re-suspension and spreading of sediments from dredging will result in an increase in contaminant concentration in the water column above background levels. Natural processes such as wave action, current flow and storm events interact with the seabed due to the shallow nature of the Greifswalder Bodden, which ensure that turbidity levels are higher than the rest of the Baltic Sea. Any contaminants that are brought into suspension are likely to be bound to sediment particles and will thus settle quickly once construction ceases. The impact on the water column due to seabed intervention works is therefore considered to be **insignificant**.

*Release of nutrients*

A release of nutrients, such as nitrogen and phosphorus, during the re-suspension and spreading of sediments due to seabed intervention works could stimulate phytoplankton production. An increase in primary production due to the release of nutrients could also potentially contribute to oxygen consumption by degradation of organic matter. A release of oxygen-consuming compounds during trenching or rock-placement may further aggravate situations with local oxygen deficiency at the sea bottom. Overall the likely increase in nutrient concentration resulting from seabed intervention works in the Greifswalder Bodden is small in relation to current nutrient inputs. Accordingly, the release of nutrients into the water column should not generate increases in nutrient concentrations outside the normal range of conditions. Since most of the nutrients in sediments are bound to particles, and will not contribute to primary production, much of the increase in concentrations will be reversed as particles settle out. The immediate impact of the release of nutrients would occur during seabed intervention and thus will be of short duration. The release of nutrients will result in an increase in nutrient concentration that would not extend beyond normal conditions[1] and therefore the impact on the water column is assessed to be **insignificant** in ESR V.

**Impacts during the Operational Phase**

Impacts upon the water column during the operational phase are limited to a localised temperature change due to the presence of low temperature natural gas within the pipelines as well as the release of pollutants from anti-corrosion anodes in place on the pipelines.

*Temperature change*

A gas temperature of around 40ºC is expected at the Russian landfall as a result of the natural gas heating during compression. The gas temperature will slowly decrease as the gas expands (Joule-Thomson effect) and due to the exchange of heat with the surrounding environment. Low gas temperatures are expected at the receiving terminal in ESR V. If the temperature of the gas differs from the temperature of the surrounding water column or sediment, a temperature change in the water may result.

Snamprogetti[2] evaluated the temperature change in the immediate receiving environment as a result of the fully buried pipelines in ESR V. Profiles were defined along the pipelines' route in ESR V for the temperature of the natural gas, the external heat transmission coefficient, the external surface temperature of the pipelines, the sediment temperature at 20 cm below the seabed and other parameters.

Based upon the simulations and profiles it is expected that the sediment 20 cm beneath the seabed will experience a temperature change of a maximum of 1.8°C in summer and 1.2°C in winter. A change in sediment temperature is not expected in the upper sections of the seabed profile and thus no temperature change in the water column is expected. As such, the impact on the water column is deemed to be **insignificant**.

*Release of pollutants from anti-corrosion anodes*

To minimise external corrosion, anodes are to be installed at regular intervals along each pipeline. The potential impacts on water quality from pipeline anodes are related to the release of metal ions from the anode material during the lifetime of the pipelines. The pipelines in ESR V are completely buried in water logged sediment and thus any impact on water quality will be on

(1) Normal conditions' are defined as pre impact status conditions i.e. the existing water column for ESR V prior to commencement of the Project, as detailed in **Section 8.11.1**.

(2) Snamprogetti. 2008. Impact on the Environmental Temperature at German Landfall.

the local scale in the supporting sediment. Various calculations in terms of the expected release of ions and their effect on the water column are described in **Section 9.3.3** under ESR I. Based on these calculations it is concluded that the impact on the greater water column above the seabed is **insignificant.**

**Impact Summary**

The impacts identified and assessed in ESR V on the water column are summarised in **Table 9.78**.

**Table 9.78 ESR V impact summary table for the water column**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Water Column – Ecological Sub-Region V** | Increase in turbidity | Boulder removal | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Wreck removal | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Seabed intervention works | Negative | Direct | Local - Regional | Short-term | Medium | Medium | Low | Reversible | **Minor** |
| | | Pipe-laying | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of contaminants | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of nutrients | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | Temperature change | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of pollutants from anti-corrosion anodes | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.7.4 Physical Environment – Seabed

**Overview**

The seabed in ESR V is predominantly characterised by postglacial mud, sandy mud, sand and coarser sediments overlaying cretaceous chalk, limestone, mudstone and sandstone. On the north-east edge of the Boddenrandschwelle, at the eastern limit of ESR V, there are extensive overlapping deposits of mould clay or its residual sediment; the areas between them are filled with, and partly overlain, by sands transported during the Holocene age. As described in **Section 8.11.2**, there are high levels of sedimentation and re-deposition. As described in **Section 8.11.1**, the long-term average salinity is relatively low (7.3 psu). Oxygen concentrations are generally high. Heavy metal contamination is higher in ESR V than for the other ESRs, therefore adverse biological effects are more likely to occur through disturbance of sediments in ESR V than for other ESRs.

The seabed in ESR V supports large populations of benthic biomass, including macrophyte meadows and blue mussel beds in the deeper regions which in turn support spawning fish and benthic-feeding sea bird populations. The impacts on these species are assessed below in **Sections 9.7.6 – 9.7.10**. However, since there are no notable features such as cold water corals, sea mounts, canyons or areas of sensitive seabed substrate (e.g. cobbles or sand waves) on the seabed along the pipelines' route in ESR V, other than in the near shore area where the cofferdam will be constructed, the seabed itself is not considered to be particularly sensitive to change and is considered to have a **low** sensitivity throughout, as described in **Section 8.11.2**. The main activities in ESR V which are expected to impact on the seabed will occur during the construction phase and, to a lesser extent, the operational phase. Impacts on the seabed are not expected to occur from the pre-commissioning and commissioning phase.

Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Boulder removal, wreck removal, seabed intervention works, anchor handling and pipe-laying activities resulting in:
  - Release of contaminants
  - Physical alteration of the seabed

*Operational phase*

- Routine inspections and maintenance resulting in:
    - Physical alteration of the seabed
- Pipeline presence resulting in:
    - Temperature change
    - Release of pollutants from anti-corrosion anodes

**Impacts during the Construction Phase**

Seabed preparation works (boulder removal and wreck removal), as well as seabed intervention works (dredging and sheet piling) and anchor handling activities in ESR V during the construction phase are likely to result in the re-suspension and spreading of sediments, and physical alteration of the seabed.

*Release of contaminants*

Of the potentially ecotoxic chemical compounds in the Baltic Sea (listed in **Section 9.3.4**), heavy metals in particular are present at high concentrations in ESR V – notably arsenic, copper, mercury, nickel, lead and zinc. Lindane is the only PAH to be found at high levels in ESR V sediments. These are all considered likely to cause adverse biological effects if made bioavailable (see **Section 9.5.4**). In terms of the organic contaminants, mitigation measures will be undertaken to reduce levels of contamination. Sediments with high organic components will not be placed back in the water body, due to the high potential for re-suspension(1). Where possible, sediments of similar grain size will be used to refill the trench. Peat and other organogenic sediments are only present in small quantities in the dredging area and will be mixed with mineral sediments during removal. This will only result in a small increase in the organic component of mineral dredging materials.

In terms of inorganic pollutants, while the surface sediments of the seaward pipelines' route have low levels of nutrient and pollutant contamination, high concentrations of heavy metals, as well as DDT, occur in surface sediments down to depths of around 20 cm, in combination with substrates with low grain sizes(1). Seabed intervention works such as dredging and sheet piling, as well as anchor handling, are likely to cause significant re-suspension and spreading of such sediments, as discussed above. The associated **negative**, **direct** impact of release of contaminants is **short-term** in duration, since most of the contaminants are immobilised

(1) Institut für Angewandte Ökologie (IfAÖ). 2009. Umweltverträglichkeitsstudie (UVS) zur Nord Stream Pipeline von der Grenze der deutschen Ausschließlichen Wirtschaftszone (AWZ) bis zum Anlandungspunkt.

(precipitated) within hours after the disturbance. The Oder flood in 1997 introduced significant amounts of heavy metals to the Pomeranian Bay, but had no significant impact(1),(2). The impact operates on a **regional** scale and is **reversible** over time. It is of **medium** intensity, however due to its temporary nature, the impact magnitude is considered to be **low**. Overall, since the receptor value is considered to be **low**, the impact significance is considered to be **minor** overall.

*Physical alteration of the seabed*

Re-suspension and spreading of sediments is likely to occur as a result of two seabed preparation activities: wreck removal and boulder removal. Wreck removal will involve the lifting of one wreck from the seabed. This will be carried out slowly, minimising re-suspension of sediments, and it is not expected that re-suspension of sediments will occur over a wide area as a result of the relocation. In terms of boulder removal, this will involve a relatively small number of boulders and will affect a very small length of the pipelines' route. It is not expected that notable re-suspension of sediments will occur as a result of these works. The removal of the wreck from the seabed will also leave a depression on the seabed. An even seabed surface is likely to be restored over time due to gravity and movement of currents near the seabed, however the length of time this takes will depend on the depth of the depression. In terms of boulder removal, any boulders removed in ESR V will be replaced with rocks of similar size, after the pipelines have been laid, reducing the impact on the seabed. Therefore, the impact from seabed preparation activities in terms of physical alteration of the seabed in ESR V is considered to be **insignificant**.

Physical alteration of the seabed in ESR V is likely to result from dredging due to the creation of mounds of sediment, as well as from dredging due to the re-suspension and spreading of sediments. In order to reduce the physical alteration of the seabed due to the creation of mounds of sediment, construction activities in ESR V aim to restore the originally existing relief conditions on the seabed once intervention is complete, through the temporary removal and storage of sediment, and the subsequent refilling process. This also aims to avoid changes to the type of surface sediments, although the geological stratification (to the extent that it is present) will be destroyed as a result of the sediment mixing (1). Any glacial till removed to build the pipelines' trenches will be replaced with sandy dredged materials upon refilling. This is likely to result in a decrease in grain size (2), which could increase the number of benthic species and individuals (see **Section 9.7.7**). Following the refilling process, the settling of sediment on the seabed, and the action of normal waves and currents will create a more uniform seabed floor

(1) Pohl, C., Hennings, U., Siegel, H. and Bachor, A. 2002. Trace metal impact into the Baltic Sea during the exceptional Oder flood in summer 1997. Marine Chemistry. 79.

(2) Witt, G. and Siegel, H. 2000. The consequences of the Oder flood in 1997 on the distribution of Polycyclic Aromatic Hydrocarbons (PAHs) in the Oder river estuary, Marine Pollution Bulletin. 40 (12).

which will be similar to the original conditions, meaning that over time, any construction-related changes will be compensated for, to some degree, by natural sediment dynamics.

The impact of dredging, in terms of re-suspension and spreading of sediments is limited in comparison to natural disturbance of the seabed brought about by waves and current action (storms). In the Pomeranian Bay, research has shown that wave-induced re-suspension (four to six times per month) takes place up to depths of 16 m(1). The short duration for which suspended sediment remains in the water column, and the frequent re-suspension events suggest that the seabed is frequently reworked. Since the cofferdam will restrict the level of interaction between the dredging and surrounding environment, it may help to reduce the amount of spreading of sediments within ESR V.

In ESR V, following the mitigation measures described above, dredging is predicted to have a residual **direct negative** impact on the seabed, which is **reversible** in the long-term, in terms of the structure of the seabed. Impacts act on a **local** to **regional** scale. Impacts are **short-term** (in terms of the re-suspension and spreading of sediments) to **long-term** (in terms of intrusive seabed intervention) and in the absence of mitigation measures would be considered of low intensity for the sections without changes to the substrates (sands), and medium to high intensity for sections with silty sands and till sediments. However, if mitigation measures and monitoring are carried out as proposed, the structure and function of these hard substrates can be restored in the medium term and the impact intensity is rated **low** to **medium** as a result(2). The impact magnitude is considered to be **medium**, since the impact may bring about an order of magnitude change in the quality or functionality of the seabed, however, the impact does not threaten the long-term integrity of the seabed or any receptor or process dependent on it. Therefore, due to the **low** value of the seabed (as described in **Section 8.11.2**), the significance of impacts on the seabed from dredging are deemed to be **minor**.

Sheet piling will also cause physical alteration of the seabed in ESR V, during the construction of the cofferdam, and cofferdam removal will cause further physical alteration of the seabed. The cofferdam will have an offshore length of 550 m, have three walls in its offshore section, and be driven 2.5 m below the seabed surface. Sheet piling is not expected to cause large amounts of re-suspension and spreading of sediments, since vibration will be used to drive in the piles and sediment disturbance will not occur at high levels. The construction of the cofferdam by sheet piling, and its removal, is predicted to have a **direct negative** impact on the seabed, which is **reversible** in terms of the structure of the seabed. Impacts act on a **local**

(1) Christiansen, C., Edelvang, K., Emeis, K., Graf, G., Jähmlich, S., Kozuch, J., Laima, M., Leipe, T., Löffler, A., Lund-Hansen, L.C., Miltner, A., Pazdro, K., Pempkowiak, J., Shimmield, G., Shimmield, T., Smith, J., Voss, M., Witt, G., 2002. Material Transport from the nearshore to the basinal environment in the Southern Baltic Sea: Processes and mass estimates, Journal of Marine Systems. 35.

(2) Institut für Angewandte Ökologie (IfAÖ). 2009. Umweltverträglichkeitsstudie (UVS) zur Nord Stream Pipeline von der Grenze der deutschen Ausschließlichen Wirtschaftszone (AWZ) bis zum Anlandungspunkt.

scale, are **short-term** in duration and of **high** intensity. Impact magnitude is considered to be **medium**. Due to the **low** value of the seabed, the significance of impacts in terms of physical alteration of the seabed from construction and removal of the cofferdam are deemed to be **minor**.

Anchor handling in ESR V is likely to cause physical alteration of the seabed, due to controlled positioning of anchors in the seabed, as described in **Section 9.3.4**. While it is expected that depressions will be refilled due to the redistribution of sediments mobilised by currents and waves, this **negative** impact is expected to cause **local** impacts of **low** intensity. As discussed in **Section 8.11.2**, the seabed is considered to be of **low** value/sensitivity. Impacts will be **short-term** in duration. The magnitude of the impact is considered to be **low**. Impacts will also be **reversible** over time. The **direct** impact on the seabed in ESR V in terms of physical alteration of the seabed as a result of anchor handling is therefore considered to be **minor.**

**Impacts during the Operational Phase**

Since the pipelines are buried throughout ESR V, impacts on the seabed from the operational phase in ESR V are limited to physical alteration of the seabed due to routine inspections and maintenance and temperature change and the release of pollutants from anti-corrosion anodes resulting from pipeline presence.

*Physical Alteration of the Seabed*

Physical alteration of the seabed may also occur during the operational phase. Routine inspections and maintenance of the pipelines may involve occasional seabed disturbance, but this will occur infrequently and vessel movements will be restricted to the pipelines' route. Routine maintenance works are more likely to result in localised disturbance to the seabed, primarily due to the re-suspension and spreading of sediments. However, the extent of physical alteration of the seabed due to routine maintenance will be far smaller than that of dredging and sheet piling during the construction phase, and works will be shorter in duration and of low frequency. Therefore, routine inspections and maintenance works are anticipated to have an **insignificant** impact on the seabed in ESR V.

*Temperature change*

As discussed in **Section 9.3.3**, the difference in temperature between the gas and the surrounding water column or sediment may result in a temperature change in the seabed. In ESR V, the pipelines will be colder than the surrounding area. However, since the pipelines will be buried in the sediment, cooling effects at the seabed surface will be negligible and marine benthos on the seabed above the pipelines is not likely to be affected by the temperature decrease. Therefore, the structure and function of the seabed will not be affected by the temperature change and the impact of temperature change from pipeline presence on the seabed in ESR V is considered to be **insignificant**.

*Release of pollutants from anti-corrosion anodes*

During the 50-year lifetime of the pipelines, some of the sacrificial anodes will dissolve. The pipelines are buried throughout the length of ESR V. For the two pipelines in German territorial waters, an input of an estimated 160 tonnes of aluminium into the sediment and water is expected over the 50-year lifetime(1), however it should be noted that only part of the German territorial waters are in ESR V. Unless the pipelines are removed during decommissioning, the release of these pollutants is likely to result in **long-term** local concentrations of high intensity in the sediment, at depths of below two metres below the seabed surface. This **negative**, **direct** impact will be **irreversible**. The impact will operate on a very **local** scale but will be of **low** intensity. Therefore, the impact magnitude is considered to be **low**. Overall, since the receptor value is considered to be **low**, the impact significance is considered to be **minor**.

**Impact Summary**

The impacts on the seabed identified and assessed in ESR V are summarised in **Table 9.79**.

(1) Institut für Angewandte Ökologie (IfAÖ). 2009. Umweltverträglichkeitsstudie (UVS) zur Nord Stream Pipeline von der Grenze der deutschen Ausschließlichen Wirtschaftszone (AWZ) bis zum Anlandungspunkt.

**Table 9.79 ESR V impact summary table for the seabed**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Seabed - Ecological Sub-Region V | Release of Contaminants | Seabed intervention works, Anchor handling | Negative | Direct | Regional | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | Physical alteration of the seabed | Boulder removal, Wreck removal | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Dredging | Negative | Direct | Local - Regional | Short-term - Long-term | Low-Medium | Medium | Low | Reversible | **Minor** |
| | | Sheet piling | Negative | Direct | Local | Short-term | High | Medium | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Temperature change | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of pollutants from anti-corrosion anodes | Pipeline presence | Negative | Direct | Local | Long-term | Low | Low | Low | Irreversible | **Minor** |

### 9.7.5 Physical Environment – Atmosphere

**Overview**

The atmosphere is considered to have a **low** sensitivity, for reasons described in **Section 8.5.1**. As described in **Section 9.2.1**, impacts from pollutant release are most likely to arise from the construction phase and, to a lesser extent, the operational phase. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Seabed intervention works and pipe-laying activities resulting in:
  - Emissions of pollutant gases

*Pre-commissioning and commissioning phase*

- Pressure-test water discharge and pipeline drying resulting in:
  - Emissions of pollutant gases

*Operational phase*

- Routine inspections and maintenance works resulting in:
  - Emissions of pollutant gases

**Impacts during the Construction Phase**

During the construction phase for ESR V, seabed intervention works (dredging and sheet piling) and pipe-laying have associated pollutant emissions which will potentially contribute to acidification, eutrophication and climate change, with associated negative impacts on marine and terrestrial receptors, as discussed in **Section 9.3.5**. In ESR V, emissions during seabed intervention works are likely to arise from dredging machinery, as well as from vessel movement and welding equipment used during pipe-laying along the length of ESR V.

*Emissions of pollutant gases*

As for the other ESRs, pollutant gases and particulate matter emissions from seabed intervention works and pipe-laying activities, due to the diesel and heavy fuel oil used by the construction fleet (both delivery and maintenance vehicles on land and marine traffic), can contribute to acidification, eutrophication and climate change. However, as described in **Section 9.3.5,** and as shown in **Table 9.8**, emissions associated with Project activities are predicted to be most intense during the construction phase, contributing 1.9, 1.4 and 0.44 % to the annual emissions of $CO_2$, $NO_x$ and $SO_2$ respectively for all activities (mainly shipping traffic) in the Baltic Sea.

As for the other ESRs, and as described in **Section 9.3.5** it is expected that there will be a **cumulative negative** impact on atmospheric $CO_2$ levels from construction activities, operating on a **national** to **transboundary** scale and over a **long-term** duration. Impacts are **irreversible**. However, since emissions levels relating to the Project are low compared to those from existing shipping traffic, impact intensity is considered to be **low**, and impact magnitude is considered to be **low**. As the atmosphere is considered to have a **low** sensitivity the significance of this impact in ESR V, and for the length of the pipelines as a whole, is expected to be **minor**.

**Impacts during the Pre-commissioning and Commissioning Phase**

Pressure-test water discharge and pipeline drying will involve the use of compressors in ESR V, which will have associated emissions of pollutant gases.

*Emissions of pollutant gases*

The amounts of pollutant gases from the pumps used during the pre-commissioning and commissioning phase will be small compared to other engine operation during the construction and operational phases, as described in **Section 9.3.5** and as shown in **Table 9.8**, with pre-commissioning activities in Germany contributing <0.05 % to the annual emissions of $CO_2$ and $NO_x$ and <0.01 % to the annual emissions of $SO_2$ for all activities (mainly shipping traffic) in the Baltic Sea. Almost all these emissions will occur in ESR I and ESR V; however the majority will occur in ESR I. Due to the small contribution of this phase of the Project to annual emissions in the Baltic Sea, the impact on the atmosphere from these activities in ESR V is considered to be **insignificant**.

**Impacts during the Operational Phase**

During the operational phase in ESR V, routine inspections and maintenance works will have associated pollutant emissions, as for the construction phase, which will also potentially contribute to acidification, eutrophication and climate change, with associated negative impacts on marine and terrestrial receptors.

*Emissions of pollutant gases*

During the operational phase, the type of impacts on the atmosphere in ESR V will be similar to those during construction (emissions from vessels associated with routine inspections and maintenance), with routine pipeline venting emissions of natural gas or nitrogen ($N_2$). As shown in **Table 9.8**, emissions associated with the operational phase of the Project are expected to contribute 0.13, <0.05 and <0.05 % to the annual emissions of $CO_2$, $NO_x$ and $SO_2$ respectively for all activities (mainly shipping traffic) in the Baltic Sea. The impact is considered to be **insignificant**.

**Impact Summary**

The impacts on the atmosphere identified and assessed in ESR V are summarised in **Table 9.80**.

**Table 9.80 ESR V impact summary table for the atmosphere**

| Atmosphere – Ecological Sub-Region V | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Emissions of pollutant gases | Seabed intervention works, Pipe-laying | Negative | Cumulative | National - Transboundary | Long-term | Low | Low | Low | Irreversible | **Minor** |
| | | Pressure-test water discharge, Pipeline drying | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.7.6 Biological Environment – Plankton

#### Overview

Values/sensitivities for plankton in ESR V are detailed in **Chapter 8** and summarised in **Table 9.81**.

**Table 9.81 Value/sensitivity of plankton in Ecological Sub-Region V**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Plankton** | | | | | | | | | | | | |
| Phytoplankton | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Zooplankton | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |

Given that plankton drift in the water column, there is no potential for the Nord Stream Project to change the abundance or distribution of plankton in general in the ESR. Seabed interventions in ESR V will result in the re-suspension of nutrients from sediments, in particular, phosphorous. Since nitrogen for plant growth is the limiting factor for plankton in summer in the Greifswald Bodden(1), construction work is not expected to stimulate plankton algae growth. Similar to ESR I, potential impacts on plankton as a result of the Project are expected to be **insignificant** in ESR V.

(1) Institut für Angewandte Ökologie (IfAÖ). 2009. Umweltverträglichkeitsstudie (UVS) zur Nord Stream Pipeline von der Grenze der deutschen Ausschließlichen Wirtschaftszone (AWZ) bis zum Anlandungspunkt.

### 9.7.7 Biological Environment – Marine Benthos

#### Overview

ESR V consists of the German landfall which falls within the Natura 2000 site Greifswalder Boddenrandschwelle and the larger Greifswalder Bodden. The Greifswalder Bodden has a rich macrophyte diversity with communities of submerged macrophytes found from the drift line to 2.5 m depth. In waters less than 2 m deep, the macrophyte community is dominated by green algae and at deeper depths by brown and red algae. There is a pondweed belt of *Potamogeton pectinatus* at approximately 1-2 m at the landfall. Below this level, the high turbidity of the water reduces light penetration and there are few floral species. In the north of Greifswalder Bodden and to the south-east of the island of Rügen, the light conditions are better than in the shallow coastal areas. The central areas of Greifswalder Bodden are largely free of flora. Flora in the Bay of Pomerania is also limited. In the Bodden marginal well, flora such as eelgrass (*Zostera marina*) and fennel pondweed (*Potamogeton pectinatus*) are generally found to approximately 3 m deep but were also found during surveys up to 5.4 m deep. On hard substrates, red and brown algae were found up to 6 m deep. A number of the species of flora found within ESR V are on the Red List including three species considered to be ‘critically endangered’.

There are approximately 70 species of benthic fauna in the Greifswalder Bodden. High abundance and biomass was observed during surveys in 2007 and 2008. On sandy substrates, in waters up to approximately 2 m deep there is a small number of species with low biomass and abundance. In deeper waters, blue mussels dominate and much higher abundances and biomass are exhibited.

In the Bay of Pomerania, in sediments with poor structure and low nutrient levels, annelids are the dominant group and are characterised by the polychaetes *Pygospio elegans*, *Hediste diversicolor* and members of the genus *Marenzelleria*. Many of the larger crustaceans are absent but a few species, largely associated with sandy substrates, are found within the Bay of Pomerania including the sand digger shrimp (*Bathyporeia pilosa*) and the common shrimp (*Crangon crangon*). Molluscs such as the blue mussel (*Mytilus edulis*), laver spire shell (*Hydrobia ulvae*) and the cockle, *Cerastoderma glaucum* make a large contribution to the biomass of benthic fauna in the area.

The scoping and impact identification exercise described in **Chapter 7** identifies interactions between marine benthos in ESR V and the Nord Stream Project that could give rise to potential impacts. Values/sensitivities for marine benthos are detailed in **Section 8.11.4** and summarised in **Table 9.82**.

**Table 9.82 Value/Sensitivity of marine benthos in Ecological Sub-Region V**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Benthos** | | | | | | | | | | | | |
| Macroalgae and aquatic vegetation | | | | | | | | | | | | |
| Macroalgae | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Pondweed | Low | Low | Low | Med | Med | Med | Med | Med | Med | Med | Low | Low |
| Seagrass beds | High | High | High | High | High | High | High | High | High | High | High | High |
| Zoobenthos | | | | | | | | | | | | |
| Soft-bottom community | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Mussel beds | Med | Med | Med | Med | Med | Med | Med | Med | Med | Med | Med | Med |

This section identifies and assesses the potential impacts on marine benthos in ESR V during the construction, pre-commissioning and operational phases of the Project. The activities and the related impacts that are assessed in this section are as follows:

*Construction phase*

- Dredging, sheet piling and pipe-laying resulting in:
  - Increase in turbidity
  - Release of contaminants
  - Physical loss of seabed habitats
- Wreck removal, dredging, sheet piling and pipe-laying resulting in:
  - Smothering
- Dredging and sheet piling resulting in:
  - Release of nutrients
  - Noise and vibration
- Construction and support vessel movement resulting in:
  - Introduction of non-indigenous species (due to the transport and release of ballast water and via biofouling of ship hulls)

*Pre-commissioning and commissioning phase*

- Pipeline flooding and pressure-test water discharge resulting in:
  - Noise and vibration

*Operational phase*

- Routine and inspections and maintenance works resulting in:
  - Physical alteration of the seabed
- Pipeline presence resulting in:
  - Introduction of secondary habitats
  - Temperature change
  - Release of pollutants from anti-corrosion anodes

**Impacts during the Construction Phase**

During the construction phase, impacts upon the marine benthos are limited to an increase in turbidity, the release of nutrients and contaminants (heavy metals & organic pollutants), an increase in noise and the physical loss of seabed habitats, as a result of seabed intervention works and pipe-laying.

*Increase in turbidity*

Construction activities will cause re-suspension of sediments which will increase turbidity that can clog the feeding organs of filter feeding species preventing feeding(1) and cause a reduction in light levels that can prevent or reduce photosynthesis by flora in ESR V. This potential impact is discussed in detail in **Section 9.3.7** but within ESR V, the greatest impact will be caused by dredging. The mitigation measures given in **Section 9.3.3** and **9.3.7** will help to minimise the amount of sediment re-suspension although no specific mitigation measures are possible at the landfall area. Details of sediment modelling for ESR V are given in **Section 9.7.3**. The Greifswalder Bodden is a highly dynamic area with naturally high turbidity levels. As a result, the benthic community is likely to be adapted to these conditions. The impact as a result of increased turbidity will be **negative** and **direct**, and for both dredging and pipe-laying offshore, will be limited to a **local** area surrounding the pipelines' route. Dredging is expected to have a greater impact than pipe-laying, however the impact of both these activities is expected to be

(1) Tait, R.V. & Dipper, F. R. V. 1998. Elements of Marine Ecology: An Introductory Course. Butterworth-Heinemann.

**short-term**, as the benthic community are expected to be adapted to high turbidity levels in ESR V and will recover quickly.

The health of benthos at the individual level has the potential to be affected by increased turbidity, but the naturally high turbidity levels in ESR V mean that the impact from construction activities will be of **low** intensity. The magnitude of the impact is also likely to be **low** as the impact will act on localised groups within the larger population. The impact will be **reversible** as the majority of benthos are expected to survive and will recover with time. The majority of the benthic community is considered to be of **low** sensitivity and therefore increased turbidity is expected to have an overall impact on this group of marine benthos, and the mussel beds within ESR V, of **minor** significance. However, the pondweed community in the littoral areas of the landfall, and the mussel beds found with patchy distribution largely within the Boddenrandschwelle, are of **medium** sensitivity, and seagrasses found in the shallower regions of ESR V are considered to be of **high** sensitivity. Although large parts of the pipelines' route within ESR V are devoid of submerged vegetation or macroalgae, particularly between Lubmin and Boddenrandschwelle, the area of the Boddenrandschwelle that supports seagrasses will be impacted by turbidity from the construction of the Project so the overall significance here will be **moderate**. A monitoring programme should be initiated to determine the extent of damage to the seagrasses and their subsequent recovery.

Sheet piling will be used to create a three-walled cofferdam at the landfall. The cofferdam will be used during installation of the pipelines to keep sediment that has been removed from one half of the cofferdam during dredging within the confines of the other half of the cofferdam. Details of this process are provided in **Chapter 4**. Cofferdam construction is expected to minimise the amount of sediment lost to erosion as well as minimising and localising the risk of smothering to the benthos as a result of sediment re-suspension. The cofferdam will be installed using vibration piling which will reduce the amount of sediment that is displaced during construction. Increased turbidity due to sheet piling is therefore likely to be limited to a very **local** area at the landfall. The impact on benthos due to dredging, sheet piling and pipe-laying at the landfall site will be **negative** and **direct**. It is expected to have a **short-term** impact until the area is recolonised and is therefore also **reversible**. It is likely to cause a **low** intensity impact as the individual benthos may be damaged but the high levels of natural turbidity at the landfall suggest the population as a whole will not be affected. The impact magnitude is expected to be **low** as the inherent mitigation measures described above should minimise this impact so that only a small number of individuals are affected. As described earlier, the sensitivity of the majority of benthos at the landfall in ESR V is **low** except for pondweed, which is considered to be of **medium** sensitivity. The overall significance of the risk of smothering of benthos during cofferdam installation, dredging and pipe-laying at the landfall is therefore **minor**.

*Release of contaminants*

Activities that disturb the seabed and cause re-suspension can also result in the release of contaminants that can have toxic effects on the benthos. This impact is described in detail in **Section 9.3.7**. As described in **Section 9.7.3**, the release of contaminants from the seabed during intervention works is likely to be insignificant impact on the water column within ESR V, however, a limited amount of released contaminants will re-settle on the seabed where they may impact on benthos. The impact on benthos from contaminants released during seabed intervention works and pipe-laying will be **negative** and **direct**. Increased turbidity caused by construction activities is likely to affect a very **local** area but have a **long-term** impact on benthos as contaminants will be present in the surface of sediments for many years. Changes are predicted to be near the limit of detection and so have a **low** intensity. The impact from contamination on the benthos is expected to have a **low** magnitude affecting a small group of individuals within a larger population. This impact is **reversible** as particle-bound contaminants will be present in the surface layers of the sediment for many years but the population will eventually recover once the contaminants become increasingly immobilised and toxicity of the sediment is reduced. The benthos in ESR V is generally of **low** to **medium** sensitivity so the overall impact to these receptors is **minor**. However, as the seagrass beds within ESR V are of **high** sensitivity the overall significance to seagrass is **moderate**. As described above for turbidity impacts, areas of seagrass affected by contaminants should be re-seeded to promote recovery of this habitat.

*Release of nutrients*

As described in previous sections (**Section 9.3.7** and **9.4.7**), seabed intervention works will disturb the sediment releasing nutrients. This impact is discussed in greater detail in **Section 9.7.3** and the effects on the benthos are discussed in **Section 9.3.7**. It is unknown exactly how much nutrient will be released from sediments within ESR V but modelling of nutrient release suggests the effects may be slightly greater in enclosed coastal regions such as Greifswalder Bodden than in the open water of the Baltic Proper. However, this small predicted increase in nutrients is still expected to have an **insignificant** impact on benthos within ESR V.

*Noise and vibration*

Dredging and sheet piling at the German landfall are likely to produce higher noise levels than construction activities at the Russian landfall. However, the level of noise will attenuate quickly away from the source of noise and so the impact is likely to be local. As detailed in **Section 9.3.7**, noise from dredging and sheet piling is expected to have an **insignificant** impact on marine benthos including the benthos within ESR V.

*Physical loss of seabed habitats*

Prior to construction in ESR V, one of the wrecks from the Schiffssperre will be removed. The wrecks are covered in rubble at present and are likely to act as a habitat for a variety of benthic species that require shelter from predators or a hard substrate to attach to. Removing one of the wrecks will physically remove the habitat and associated benthos and is likely to cause a physical loss of habitat in the immediate surrounding area resulting in a **direct** and **negative** impact. Physical loss of the habitat is likely to be restricted to a **local** area. The stretch of pipelines that will replace the wrecks will act as another hard substrate habitat although it is likely to encourage a slightly different community of benthos to colonise to that which inhabited the wooden wreck. Initial recolonisation of the pipelines is expected to be rapid as species from the surrounding wrecks migrate; however, the community is likely to change with time as species better adapted to the pipelines begin to colonise. Therefore although initial recolonisation of the area is likely to occur in the short-term, the impact of removing the wreck and replacing it with pipelines is expected to have a **long-term** but **reversible** effect. The intensity of the impact is expected to be **low** as the whole habitat and its associated benthos will be removed but only a small portion of the benthic population will be affected. This impact is expected to have a **low** magnitude effect as a localised group of individuals will be affected. The benthos living on these wrecks have not been specifically surveyed but the majority of the benthos is likely to be of **low** sensitivity. The impact significance, in terms of these species, is considered to be **minor**. However, the Schiffssperre is within an area of seagrass which are of **high** sensitivity. Seagrasses are not expected to grow on the ship itself but may be found growing around it and may therefore be lost from the area immediately surrounding the wreck. The impact significance, in terms of impacts on seagrass, is therefore considered to be **moderate**.

Offshore dredging is likely to have potential impacts on the benthos as a result of loss of seabed habitat. The entire pipelines' route within ESR V will require dredging. Dredging will cause greater disturbance to the seabed than post-lay trenching activities. The footprint from dredging activities in ESR V is likely to be larger than the footprint created during trenching in the other ESRs. However, dredging is only likely to cause a **local** impact which will be **negative** and **direct**. The impact will also be **short-term** although likely to have slightly longer-term effects than trenching as more sediment will be displaced and overturned bringing anoxic sediment to the surface layers, covering the thin aerobic surface layer of sediment. The impact is expected to have a **medium** intensity as the habitat within the footprint will be physically lost and the benthos will be damaged but the entire population will not be affected. The impact is likely to have a **low** magnitude as a small localised group of individuals will be affected. As described above, most of the benthic community within the deeper regions of ESR V is expected to be of **low** sensitivity. The overall impact significance is therefore **minor**. The exception is for the seagrass areas that will be crossed near the Schiffssperre which are of **high** sensitivity. The loss of this habitat will have a **moderate** significance.

Dredging and sheet piling at the landfall will also result in a physical loss of seabed and potential destruction of benthos within the pipelines' corridor. The sheets of the 9.5 m wide cofferdam will be installed using a vibratory piling method which will impact a smaller area of sediment than methods such as hammer driven piling. In the short-term, sheet piling will cause vibrations that will cause the sediment to become more fluid and could cause a loss of or damage to flora and fauna within the vicinity of the cofferdam. The area within the walls of the cofferdam will be dredged thereby resulting in a physical loss of habitat. This **short-term** impact is **direct** and **negative**. Flora and fauna within the footprint of the cofferdam are likely to be destroyed and there will be a physical loss of habitat within this area. Further loss of habitat outside this area is unlikely so this is a **local** impact with a **medium** intensity. The impact magnitude is expected to be **low** as only a localised group of individuals will be affected. This impact is likely to be **reversible** as the cofferdam will be removed once construction has finished and the trench backfilled allowing the benthos to recolonise the habitat. The majority of the benthic species in the landfall area are predicted to be of **low** sensitivity, however, pondweed is likely to be found at the landfall which is considered to be of **medium** sensitivity from April to October. In the autumn the pondweed is grazed by migratory birds and is damaged by weather conditions. In the spring the pondweed community recovers. The overall significance of this impact on the benthic community at the landfall is **minor**.

*Smothering*

Removal of the wreck in the Bodden marginal well is likely to result in the displacement of sediment which may smother benthos in the surrounding area. The wreck has been in place since 1715 and a considerable volume of sediment is likely to have accreted onto and around the wreck in the following years. Removing this structure may destabilise the associated substrate resulting in a collapse of material associated with the wreck thereby smothering the benthos. This is likely to result in a much smaller impact than smothering as a result of dredging and is likely to affect a **local** area. It will be a **negative** and **direct** impact. The impact is likely to have a **short-term** to **long-term** effect on the benthos as immobile species will remain covered with sediment until new individuals settle in the area. A **medium** intensity impact will be the most likely result as some benthos are likely to be damaged or destroyed but the entire community is unlikely to be affected. A **low** magnitude impact is expected as the community attached to the wreck itself are not at risk of smothering but the surrounding community is likely to be at risk. The impact will be **reversible**. The impact is therefore limited to a localised group of individuals within a larger population. The majority of this benthos is of **low** sensitivity but the seagrass beds are of **high** sensitivity. This means that the overall impact significance is **minor** to **moderate** depending on whether the seagrass are affected.

Dredging in the offshore sections of ESR V will result in the resuspension of sediment into the water column which subsequently could result in the smothering of benthos. The impact will be **negative** and **direct**. Sediment from dredging activities are expected to be mobilised over relatively short distances from the pipelines and is therefore expected to have a **local** impact.

The effect of smothering on the benthos as a result of slumped sediments during dredging activities is expected to have a **short-term** to **long-term** effect depending on the thickness of deposited material. A **low** intensity impact is predicted as the naturally high turbidity levels in ESR V suggest that any blanketing effect as a result of dredging may be reduced by strong water movements causing greater suspension of the material. In addition, the benthic community is expected to be adapted to these high turbidity levels. The impact magnitude is therefore considered to be **low**. Impacts will be **reversible**. In the deeper areas of ESR V that do not include the Schiffssperre area the benthos is considered to be of **low** sensitivity except for any mussel beds that may be found along the pipelines' corridor which would be of **medium** sensitivity. The overall impact significance is therefore **minor**.

Lateral slumping at the landfall due to dredging will be minimised using the three-walled cofferdam. This will help prevent movement of sediments piled up during dredging from blanketing the surrounding area. Details on the construction of the cofferdam are given in **Chapter 5**. As the cofferdam will provide effective mitigation against lateral slumping at the landfall, the potential risk to the benthic community from dredging is considered **insignificant**.

*Introduction of non-indigenous species*

The diversity and composition of benthos may be affected by invasive species that enter the Baltic system through biofouling of the ship hull of any vessels involved in the construction. Similarly, the vessel movements related to the construction of the pipelines, may aid in spreading invasive species that are already present in one to another area within the Baltic. The use of antifouling paints, careful cleaning of hulls, tanks and drilling and dredging equipment before use prior to entering the Baltic will limit the potential introduction of invasive species. The risk of intra-Baltic spread of formerly introduced species in one part of the Baltic to ESR V is negligible in comparison to existing maritime activities such as fisheries and commercial shipping. Differences in environmental conditions between the various ESRs of the Baltic Sea also constrain the spread of the invasive species from one area to another. ESR V is more saline than ESR I and thus unlikely to be invaded by freshwater invasive species that are already present in ESR I. The unintentional introduction of invasive species into the Baltic Sea or from one area of the Baltic to another poses a negligible risk. Consequently, the residual impacts of the construction phase on benthic communities in ESR IV will be **insignificant**.

**Impacts during the Pre-commissioning and Commissioning Phase**

During the pre-commissioning and commissioning phase, potential impacts on benthos are limited to noise and vibration impacts associated with pipeline flooding, pressure-test water discharge and gas movement in the pipelines during commissioning.

*Noise and vibration*

Activities during construction such as dredging produce much greater noise levels than will be associated with pipeline flooding, pressure-test water discharge and commissioning. Impacts from noise during the pre-commissioning and commissioning phase are expected to be below the limit of detection and are therefore predicted to have an **insignificant** impact on marine benthos.

**Impacts during the Operational Phase**

*Physical alteration of the seabed*

Routine inspections of the pipelines will be required but will be infrequent and impacts to the benthos will be restricted to the pipelines. This is expected to result in a low level of disturbance to the seabed resulting in an **insignificant** impact to the benthos. Routine maintenance works may be required which could result in localised disturbance to the seabed, direct loss of benthic species and smothering as a result of re-suspension of the sediment. This impact would be **negative** and **direct**. The impact is likely to be restricted to the pipelines and is therefore **local** in scale. The effects are expected to be **short-term** as the turbidity in the water column will return to background levels shortly after any repair or improvement works cease. It is expected that impacts will be **low** in intensity and in magnitude as only a limited number of individuals are expected to be impacted. Impacts will be **reversible** as impacted areas are expected to be recolonised within a few years. The majority of this benthos are of **low** sensitivity but the seagrass beds are of **high** sensitivity. Impacts to the majority of ESR V are therefore likely to be of **minor** significance, however in the seagrass areas the overall significance is expected to be **moderate**.

*Introduction of secondary habitats*

The impact from the physical presence of the pipelines to benthos within ESR V is expected to be similar to the impact on benthos within ESR I. As described in **Section 9.3.7**, solid surfaces that are placed in marine environments often become colonised by marine organisms , possibly including invasive species previously introduced in the Baltic. The pipelines will form a hard surface in what is a predominantly sand and coarser sediments area and will therefore encourage a different community of species to develop on the pipelines to the surrounding area. An overall increase in localised biodiversity and abundance may result. As this is a protected area, any change to the composition of the community is considered to be a **negative** impact. This **direct** impact is expected to have a **local** effect as it is expected to be restricted to the pipelines' structure. It is likely to have a **long-term** duration as the benthos is expected to use the pipelines as a habitat for as long as the pipelines are in place. This impact is **irreversible** unless the pipelines are removed during decommissioning. The impact intensity is expected to be **medium** as the impact will be greater than the limit of detection but will not affect the function of the benthos entirely, with a **low** magnitude as only a localised group of individuals within a generally **low** to **medium** sensitivity population will be affected resulting in a **minor** impact to the benthos. The seagrass within ESR V are not expected to be directly affected by the introduction of the pipelines as a habitat.

*Temperature change*

Modelling of temperature differences between the pipelines and surroundings was conducted for ESR V as is described in detail in **Section 9.7.3**. No temperature change is expected on the seabed due to pipeline presence in ESR V and therefore the impact on benthos is considered to be **insignificant**.

*Release of pollutants from anti-corrosion anodes*

Aluminium anodes will be used to protect the pipelines within ESR V. The anodes will release small amounts of contaminants to the water column. However, only a very small amount of contaminants is expected to be released from the aluminium anodes which are expected to have an **insignificant** impact on the benthos.

**Impact Summary**

The impacts identified and assessed in ESR V on marine benthos are summarised in **Table 9.83**.

**Table 9.83 Impact summary table for marine benthos in ESR V**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Marine Benthos - Ecological Sub-Region V | Increase in turbidity | Dredging, Pipe-laying (offshore) | Negative | Direct | Local | Short-term | Low | Low | Low - Medium/ High* | Reversible | **Minor/ Moderate*** |
| | | Dredging, Sheet piling, Pipe-laying (landfall) | Negative | Direct | Local | Short-term | Low | Low | Low - Medium | Reversible | **Minor** |
| | Release of contaminants | Seabed intervention works, pipe-laying | Negative | Direct | Local | Long-term | Low | Low | Low - Medium/ High* | Reversible | **Minor/ Moderate*** |
| | Release of nutrients | Seabed intervention works | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Dredging, Sheet piling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline flooding , Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | Physical loss of seabed habitats | Wreck removal | Negative | Direct | Local | Long-term | Low | Low | Low / High* | Reversible | **Minor/ Moderate*** |
| | | Dredging, Pipe-laying (offshore) | Negative | Direct | Local | Short-term | Medium | Low | Low / High* | Reversible | **Minor/ Moderate*** |
| | | Dredging, Sheet piling, Pipe-laying (landfall) | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | Smothering | Wreck removal | Negative | Direct | Local | Short-term - Long-term | Medium | Low | Low - High | Reversible | **Minor to Moderate** |
| | | Dredging, Pipe-laying (offshore) | Negative | Direct | Local | Short-term - | Low | Low | Low - Medium | Reversible | **Minor** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | | | | | | Long-term | | | | | |
| | | Dredging (landfall) | - | - | - | - | - | - | - | - | **Insignificant** |
| | Introduction of non-indigenous species | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | Physical alteration of the seabed | Routine inspections | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine maintenance | Negative | Direct | Local | Short-term | Low | Low | Low / High* | Reversible | **Minor/ Moderate*** |
| | Introduction of secondary habitats | Pipeline presence | Negative | Direct | Local | Long-term | Medium | Low | Low - Medium | Irreversible | **Minor** |
| | Temperature change | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of pollutants from anti-corrosion anodes | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

* Values apply to the section of the pipelines' route which passes through the Boddenrandschwelle seagrass area

### 9.7.8 Biological Environment – Fish

#### Overview

This project has the potential to impact fish primarily through activities resulting form the construction phase of the Project. Noise generated from project related activities as well as the re-suspension of sediments by seabed intervention works are predicted to cause the largest impacts to fish.

The fish community in ESR V is composed of freshwater, marine and euryhaline species. The community is dominated by perch, flounder, eelpout (*Zoarces viviparous*), pike and herring, most of which are species of commercial importance in the Greifswalder Bodden. There are several species which inhabit ESR V that are listed as Annex II species in the Habitats Directive. These include river lamprey, sea lamprey, salmon and asp (*Aspius aspius*). The average depth of the Greifswalder Bodden is 5.8 m and this lagoon is an important habitat for fish feeding and spawning.

Values/sensitivities for fish in ESR V are detailed in **Section 8.11.5** and summarised in **Table 9.84**. In some cases, the sensitivity of a particular species may be higher or lower and impacts have then been assessed on a species-specific basis.

**Table 9.84 Seasonal values/sensitivities of fish in Ecological Sub-Region V**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fish** | | | | | | | | | | | | |
| Pelagic fish (herring) | Low | Low | Med | Med | Med | Low | Low | Low | Low | Low | Low | Low |
| Demersal fish | Low | Med | Med | Med | Med | Med | Med | Low | Low | Low | Low | Low |
| Freshwater fish community | Low | Low | Low | Med | Med | Med | Low | Low | Low | Low | Low | Low |
| Diadromous species | Low | Low | Low | Low | High | High | High | High | High | High | High | Low |

Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Construction and support vessel movement and the re-suspension and spreading of sediments from boulder removal, seabed intervention works, pipe-laying and anchor handling will result in:

- Increase in turbidity
- Release of contaminants
- Noise and vibration
- Visual/physical disturbance

*Pre-commissioning and commissioning phase*

- Pipeline flooding during pressure testing resulting in:
  - Noise and vibration

*Operational phase*

- Routine inspections and maintenance and pipeline presence resulting in:
  - Noise and vibration
  - Physical alteration of the seabed
  - Temperature change

**Impacts during the Construction Phase**

The main activities that are expected to impact fish in ESR V are those that take place during the construction phase. **Atlas Map PR-3a** shows the seabed intervention works planned for ESR V. These involve dredging along the entire route (approximately 27 km) of this ESR. Construction work will be restricted to take place between mid May and December for the conservation area within the Greifswalder Bodden and approximately 10 km beyond the Boddenrandschwelle (i.e. from KP 1,222.5 (shoreline) to KP 1,196.7).

Impacts upon fish during the construction phase are anticipated as a result of the construction of a Cofferdam, the presence of dredgers and vessels and the re-suspension and spreading of sediments from dredging and anchor handling resulting in physical and visual disturbance from vessels, noise and vibration.

*Increase in turbidity*

Re-suspension of sediments and consequent increases in turbidity will result from boulder removal, wreck removal, seabed intervention works, pipe-laying and anchor handling. Dredging in particular will result in a significant re-suspension of sediment. High levels of increased turbidity potentially could cause physiological damage to fish however, they will move away from turbid waters if disturbed. Lower levels of turbidity resulting from the Project may impact eggs by starving them of oxygen and larvae by clogging their gills.

Sediment dispersion modelling was carried out in 2008 by the Institut für Geodatenverarbeitung (IFGdV) to predict the potential concentrations of suspended matter and sedimentation rates that may result from project related activities in German waters. In ESR V, the sediments comprise of sand, mud and hard clays (see **Atlas Map GE-2**). In general, sediments with a low tendency for re-suspension such as sand reached maximum suspended matter concentrations of those shown in the **Table 9.85** at various distances from the dredger and/or barge.

**Table 9.85 Predicted turbidity for sands at various distances from dredger and/or barge**

| m from source | mg/l |
|---|---|
| < 100 | 1,700 |
| 100 | 1,000 |
| 150 | 500 |
| 200 (300 m in some cases) | 300 |
| 500 | 100 |
| 1,000 (but usually less than 500 m) | 50 |

If suspended matter concentrations exceed background turbidity of 50 mg/l (running average of measured values) within 500 metres of the disturbance area (unlikely), dredging will slow down, move elsewhere or cease, or silt screens will be introduced (see **Section 9.7.3**). Peak values should not exceed 100 mg/l within 500 metres of the disturbance area. During extreme sea conditions naturally occurring suspended matter concentrations can reach up to 100 mg/l for short periods.

The Greifswalder Bodden and the rest of ESR V is an important spawning ground for many fish species, many of which are commercially important and/or of conservational concern (see **Chapter 8**). These include the perch, goby (*Pomuloschislus* spp.), flounder, bleak (*Alburnus alburnus*) and three-spined stickleback.

ESR V is important for the three-spine stickleback which is a species of conservational concern that spawns in the coastal waters of ESR V. This species is a migratory fish, but few individuals swim upstream to spawn with most preferring to stay in brackish bays.

The reproductive success of these species will be affected by increased turbidity as a result of construction works at the seabed and will impact spawning in the following ways:

- Re-settling sediment may smother eggs and larvae and prey items.

- High suspended sediment concentrations may displace adults away from their natural spawning areas.

Boulders and stones in ESR V that may interfere with construction activities are to be removed and replaced. Boulders and stones fields are located within the Boddenrandschwelle. The removal of boulders may result in a very localised increase in turbidity. However, re-suspended sediment is not expected to substantially affect current turbidity levels, which are generally quite high, and thus this impact on fish is regarded as being **insignificant**.

The removal of a ship wreck and subsequent re-suspension and spreading of sediment from the Boddenrandschwelle will result in an increase in localised turbidity. As the process for wreck removal will be slow to protect the wreck, the disturbance of the seabed will be kept to a minimum. The removal of the ship wreck will result in a limited increase in turbidity and therefore the impact on fish is considered to be **insignificant**.

As described in ESR I (**Section 9.3.8**), fish eggs and larvae are more sensitive to increased turbidity than juvenile and adult fish themselves. Sediment concentrations of just milligrams per litre can be lethal to fish eggs and larvae, whereas the lethal concentration for juvenile and adult specimens is in the g/l range[(1),(2)]. The eggs of most pelagic spawning fish have a protective layer which protects them against physical damage from increased turbidity. However if suspended material is deposited on or sticks to the fish eggs, the spawn becomes heavier and may sink to deeper waters.

Some fish species including herring, garpike (*Belone belone*) and three-spined stickleback use the macrophyte and algae belt in the Greifswalder Bodden as a spawning substrate. Similar habitats exist in the shallow-water areas along the proposed route such as the Boddenrandschwelle and an area adjacent to Lubmin. The Boddenrandschwelle consists of hard substrates covered with vegetation which is used for herring spawning. If the pipelines were laid during the herring spawning season there would be a significant impact on herring recruitment. As mentioned previously, spring herring sub-population finish spawning in May. In ESR V, in order to reduce, mitigate or eliminate impacts on fauna and flora in ESR V, construction work will be limited to between mid May and December, preventing herring spawning from being impacted. However, as a result of increased turbidity, larvae may be affected if construction takes place immediately after the spawning season. This may also lead to reduced recruitment to the adult population.

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(1) Engel-Sørensen and Skyt. 2001. Evaluation of the Effect of Sediment Spill from Offshore Wind Farm Construction on Marine Fish. – Report to SEAS, Denmark.

(2) Clarke and Wilber. 2000. Assessment of potential impacts of dredging operations due to sediment resuspension, DOER Technical Notes Collection (ERDC TN-DOER-E9), U.S. Army Engineer Research and Development Center, Vicksburg, MS. www.wes.army.mil/el/dots/doer (accessed January 15th 2008).

The eggs and larvae of goby and perch are likely to be impacted from increased turbidity as they are abundant in water column during the summer months.

It should be noted that migratory fish species pass through ESR V and could potentially be impacted by increased turbidity. One such fish is the river lamprey which undergoes regular migration to spawning grounds at Peenestrom. The river lamprey is listed in Annex II of the Habitats Directive. ESR V is an important area for river lamprey during their migratory period, and increased turbidity in autumn may impact migration of this highly sensitive species. Twaite shad migrate through ESR V to spawn in tidal rivers in May or early June. Adults may return to the rivers several times during spawning season. Similarly Atlantic salmon and sea trout may also pass through ESR V during their spawning migrations. These species may be affected in a similar manner to that of river lamprey.

The linear nature of the construction site along then proposed pipelines' route could possibly result in a temporary restriction to migration movements of fish between the south-west Pomeranian Bight, Greifswalder Bodden and Peenestrom. This has the potential to significantly impact fish spawning activity and the migration routes of protected species. However if suspended matter concentrations exceed a background turbidity of 50 mg/l (running average of measured values) within 500 m of the disturbance area, one or more of the following mitigation measures will be carried out; dredging will slow down, move elsewhere or cease, or silt screens will be introduced. As discussed earlier peak values should not exceed 100 mg/l within 500 metres of the disturbance area.

Thus the impact of increased turbidity as a result of seabed intervention works on fish in ESR V is expected to be **negative**, **direct**, **short-term** and on a **local** scale. The impacts will be of **medium** intensity, will have a **low** magnitude and will be **reversible**. As salmon and sea trout may pass through the ESR, the sensitivity values for fish that could potentially be impacted by increased turbidity range from **low** to **high**. The impact is therefore anticipated to be of **minor** to **moderate** significance.

Throughout the construction phase, anchors belonging to the lay-barge and associated support vessels will have to be constantly repositioned. This and drifting anchors and chains dragging across the seabed and the impact of ship propellers in these shallow waters will give rise to increased turbidity. However, in comparison to turbidity caused as a result of fishing and trawl nets, the impact of anchor handling is considered to be minimal and therefore **insignificant**[(1)].

*Release of contaminants*

The sediments in ESR V contain elevated levels of heavy metals, with particularly high arsenic and copper levels (see **Section 8.11.2**). Fish exposed to elevated concentrations of

(1) Institut für Angewandte Ökologie (IfAÖ). 2009. Umweltverträglichkeitsstudie (UVS) zur Nord Stream Pipeline von der Grenze der deutschen Ausschließlichen Wirtschaftszone (AWZ) bis zum Anlandungspunkt.

contaminants will absorb contaminants through their gills, accumulating it within the liver, stomach, and gall bladder, which can lead to long-term, sub-lethal effects. However as adult fish are mobile they generally are able to detect heavily contaminated areas(1) and move away from areas of increased contamination or areas of low water quality. All fish species have the potential to be affected by elevated concentrations of dissolved contaminants. In ESR V, the period of exposure could potentially be considerable. However, these effects are often short lived as once fish move away from the source of contamination they can potentially metabolise pollutants and cleanse themselves within weeks of exposure(2),(3).

As previously discussed a much greater threat to fish populations is posed through exposure of eggs and larvae as they can not actively move away from contaminated areas. High levels of contamination may cause eggs and larvae to experience increased mortality rates, potentially affecting later recruitment to the adult population. Even low concentrations of contaminants can have marked effects on the proportions of eggs which hatch and cause sub-lethal effects on larval stages, affecting their growth rates and development. Many of these sub-lethal effects may eventually lead to mortality and reduction in recruitment to adult populations.

In ESR V there are several fish species that spawn on/in the seabed or within macrophyte communities e.g. herring, garpike and three-spined stickleback. As described in the sections above, these species will not be significantly impacted if caution is taken to avoid construction during spawning seasons.

The following mitigation measures are planned to be carried out where possible, to address or reduce the significance of the identified potential impacts associated with dredging on spawning fish:

- In order to reduce the volume of re-suspended sediments, the pipelines' route has been optimised to reduce the extent of dredging required therefore to minimise the affected surface area:
    - A 3-walled cofferdam will be constructed in order to limit the extent of dredging required and minimise the spreading of sediment
    - The pipelines will be installed in 'one' installation season

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(1) International Petroleum Industry Environmental Conservation Association (IPIECA). 2000. Biological Impacts of Oil Pollution - Fisheries. IPIECA Report Series. 8.

(2) Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP). 1993. (IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution). Impact of Oil and Related Chemicals and Wastes on the Marine Environment. GESAMP Reports and Studies. 50.

(3) Heath, A.G., 1995. Water Pollution and Fish Physiology. Second ed. Lewis Publishers. Boca Raton. FL.

- A single very narrow trench will be created to limit the affected surface area.

- Anchor handling where practically possible, will be kept to a minimum to reduce sediment disturbance. Anchors will be raised rather than dragged through the seabed during relocation.

Consequently the residual impacts of seabed intervention works resulting in the release of contaminants on fish species during the construction phase is expected to be **negative** and **direct,** on a **local** scale and of **short-term** duration to a **low** to **high** sensitivity receptor. These impacts will be of **low** intensity and will be of a **low** magnitude. The impact will be **reversible**. Impact significance is expected to be **minor** to **moderate**.

*Noise and vibration*

A potential impact to fish in ESR V will be from increased levels of underwater noise and vibration as a result of construction. The nature and magnitude of the impacts of noise on fish vary greatly between species due to their differing hearing abilities and resultant sensitivity to noise. The frequencies that different fish species are able to hear vary substantially from species to species (as described in **Section 9.3.8**). Underwater noise and vibration could arise from a number of activities during the construction phase, particularly from seabed intervention works, pipe-laying and construction and support vessel movement.

Tissue damage can arise from the differential rate of transmission of sound pressure waves through tissues of varying densities. Tissue damage is only likely to occur when fish are in the immediate vicinity of loud, sudden noises such as those caused by piling activity. The peak noise levels during dredging and sheet piling are significantly greater than the hearing thresholds of most fish including herring and studies have reported injuries of this species due to noise exposure at sound levels of 153 to 180 dB re 1µPa[(1)]. Pile driving has been shown to cause severe injury or mortality of fish in the direct vicinity of the piling (10-12 m). However, the species inhabiting the pipelines' route are likely to move away from noise levels which exceed background levels, such as noise associated with dredging and sheet piling, reducing the impact of these activities on fish. In addition, sheet piling will be performed by vibration rather than by hammering. This will do much to reduce noise levels.

The behavioural impact zone is considerably larger than the area in which severe injury can occur and studies have shown that fish may be able to detect noise of the frequency and magnitude described above at distances of more than 10 km. Most fish species will be able to move away from areas of excessive noise and for the majority of species this temporary displacement will not affect the size or integrity of the population. However, displacement of fish

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(1) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

away from their usual spawning grounds during the spawning season could have a significant impact on recruitment to the adult population.

In ESR V, herring are the most sensitive species to noise impacts (see **Section 9.3.8**). Herring are demersal spawners, depositing their eggs on coarse sand, gravel, stones and rock throughout ESR V. The Greifswalder Bodden is an internationally important spawning and nursery ground for the spring spawning herring sub-population of the Baltic herring, in the area around Rugen Island. From February onwards, herring move from the deeper regions of the western Baltic via the Strelasund and the eastern sill into the Greifswalder Bodden to spawn. Spawning is completed in May, when herring return to the Baltic Proper.

This area also hosts some autumn spawners, such as the North Sea autumn herring. Autumn spawners are not restricted to the Greifswalder Bodden and are known to mostly spawn along the British coast[(1),(2)] They have an extended spawning period which lasts from September to January[(3)]. Increased noise levels in these areas will impact spawning success rates of herring if construction is carried out during the spawning seasons[(4)].

In order to reduce, mitigate or eliminate impacts on fauna and flora in ESR V, construction work will be limited to the period of mid May to December in the offshore section of the pipelines' route within the designated Natura 2000 site. Therefore there will be no impact on the spring herring. Since construction will take place during the autumn herring spawning period (September to January), noise emitted from seabed intervention works may result in disturbance to the spawning of this species. This impact could lead to reduced recruitment to the adult phase.

As detailed for ESR I (**Section 9.3.8**), salmon spawning will not be impacted by noise generated from project related activities as salmon spawn upstream in rivers. Salmon migrating through ESR V and feeding in the area of the pipelines construction activities will be able to move away from any area of excessive noise and vibration and therefore there will be no impact on salmon.

Cod have excellent hearing, being able to hear up to 38 kHz, and they are particularly sensitive to noise at frequencies of between 150 and 160 Hz. In contrast, turbot, flounder and plaice are relatively insensitive to sound and hear over a range of frequencies similar to that of the dab

(1) Burd, A. C. 1978. Long term changes in North Sea herring stocks. Rapport Permanentverbeaux Réunion Conseil International pour l'Exploration de la Mer. 172.

(2) Zijlstra, J. J. 1969. On the racial structure of North Sea Autumn spawning herring. du Conseil International pour l'Exploration de la Mer. 33.

(3) International Council for the Exploration of the Sea (ICES) –CIEM. ICES-Fish Map. Herring. http://www.ices.dk/marineworld/fishmap/ices/pdf/herring.pdf (accessed August 29, 2008).

(4) Finnish Game and Fisheries Research Institute. Herring (Clupea harengus) http://www.rktl.fi/english/fish/fish_atlas/herring/ (accessed September 29, 2008).

(*Limanda limanda*), between 30 and 250 Hz. Studies show the hearing threshold of the dab is 89 dB re µPa at 110 Hz and this species is representative of other flatfish that do not possess a swim bladder[(1)]. Perch are regarded as being hearing generalists and are not sensitive to noise[(2)]. As loud noise usually initiates an avoidance response, fish in ESR V will move away from the pipelines while construction is carried out and return once construction works have completed.

The overall impact of noise generated from seabed intervention works, pipe-laying and anchor handling on fish in ESR V will be **negative**, **direct** and **regional**. However the mitigation measures proposed will ensure that the impacts will be **temporary** and of **low** to **medium** intensity. Overall the residual impact will be reversible, of **low** magnitude so therefore will be of **minor** to **moderate** significance, as fish impacted have a **low** to **high** sensitivity value (diadromous fish in ESR V have a **high** sensitivity during certain times of the year). It should be noted that an impact of noise will have a **moderate** significance on autumn herring.

During the construction phase of the Project, the construction and support vessel movement may have some impact on pelagic demersal and benthic fish present in the area, as the average water depth in the Greifswalder Bodden is 5.8 m. The impact will be **negative** and **direct**, will act on a **local** scale, and will be of **short-term** duration and of **low** intensity and magnitude. Impacts will be **reversible**. As fish of **low** to **high** sensitivity are found in the area, the impact from construction and support vessel movement is expected to be of **minor t**o **moderate** significance.

*Visual/physical disturbance from vessels*

Dredging will be carried out throughout most of ESR V and thus will involve the presence of a vessel loaded with a dredger and additional support vessels. The presence and passage of such vessels will have an impact on pelagic fish in the area, such as perch, pike and herring as the levels of vessel traffic will be at their highest. However, it is envisaged that fishing activities will be temporarily prohibited around the pipe-laying barge and within the planned protection area around the German landfall during construction. Therefore, vessel traffic associated with construction is unlikely to be a significant increase over existing background levels. The presence of a deep lay vessel at any one location along the pipelines' route in ESR V will be for a prolonged duration in comparison to the other ESRs as only approximately 350 m of pipelines will be laid per day. The impact of construction and support vessel movement will be indistinguishable from background levels of vessels in the Baltic Sea and is therefore anticipated to be **insignificant**.

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(1) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

(2) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

**Impacts during the Pre-commissioning and Commissioning Phase**

During the pre-commissioning and commissioning phase potential impacts upon fish may result from noise and vibration as a result of the movement of water in the pipelines during pipeline flooding and pressure-test water discharge, and from the movement of gas in the pipelines during commissioning.

*Noise and vibration*

Impacts on fish during the pre-commissioning and commissioning phase may result from underwater noise and vibration. However these impacts will be smaller than those associated with the construction phase, as pre-commissioning activities will be carried out over a much smaller geographical area and over a shorter duration, and are therefore considered to be **insignificant**.

During the pre-commissioning and commissioning phase of the Project, the presence and passage of support vessels may, however, have some impact on pelagic demersal and benthic fish present in the area, as the average water depth in the Greifswalder Bodden is 5.8 m. The presence and passage of support vessels will have a **negative** and **direct** impact. This impact will be on a **local** scale, of **short-term** duration and of **low** intensity and magnitude. The presence and passage of support vessels during the pre-commissioning and commissioning phase is therefore expected to be an impact of **minor** to **moderate significance** and **reversible** as fish of **low** to **high** sensitivity are found in the area of impact.

**Impacts during the Operational Phase**

Potential impacts that may arise throughout the operational phase are anticipated to result from noise and vibration and temperature change along the pipelines' route. However, the whole of both pipelines in ESR V will be buried in ESR V.

*Noise and vibration*

Routine inspections and maintenance works on the pipelines are assumed to have an **insignificant** impact in terms of noise on fish in ESR V, as inspections and works will be infrequent and restricted to the immediate pipelines' route.

The noise levels of natural gas movement through a pipeline has been known to range between 0.030 and 0.100 kHz(1), which is at the lowest levels detectable by many fish species. However, the pipelines for the most part will be buried in ESR V, thus reducing noise levels even further. After the initial movement away from the noise sources, fish will return and may even become habituated to the noise level if they are continuous over a significant period of time.

(1) Martec Limited. 2004. Effects of Pipelines/Gathering Lines on Snow Crab and Lobster.

Noise sensitive fish species potentially may be capable of hearing gas movement from the pipelines. However, other than an initial startle response it is unlikely that any fish species will be adversely affected by the sounds emitted from the pipelines. Those fish that are capable of hearing the noise emitted by the pipelines will naturally become acclimatised to it over time and therefore it is expected that noise emitted during the operational phase will have no lasting impact on the distribution of fish and therefore no specific mitigation measures are proposed. Fish within ESR V that can detect the noise such as the noise sensitive herring will quickly become habituated to it in a similar manner to habituation to shipping noise. The impact of noise resulting from gas movement in the pipelines is therefore considered to be **insignificant**.

*Temperature change*

The temperature of the gas at the receiving facilities in Germany is expected to be between -4ºC and 8ºC, depending on the pressure of the gas and time of year, with lowest temperatures expected in winter. Modelling has shown that there will be no cooling effect of the waters and sediments surrounding the pipelines as a result of pipeline presence. Subsequently, there will be a negligible impact on fish in ESR V which will be **insignificant**.

**Impact Summary**

The impacts identified and assessed in ESR V for fish are summarised in **Table 9.86**.

**Table 9.86 ESR V impact summary table for fish**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Fish– Ecological Sub-Region V | Increase in turbidity | Boulder removal | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Wreck removal | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Seabed intervention works | Negative | Direct | Local | Short-term | Medium | Low | Low- High | Reversible | **Minor-Moderate** |
| | | Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of contaminants | Seabed intervention works | Negative | Direct | Local | Short-term | Low | Low | Low-High | Reversible | **Minor-Moderate** |
| | Noise and vibration | Seabed intervention works, Pipe-laying, Sheet-piling, Anchor handling | Negative | Direct | Regional | Temporary | Medium | Medium | Low- High | Reversible | **Minor-Moderate** |
| | | Construction and support vessel movement | Negative | Direct | Local | Short-term | Low | Low | Low-High | Reversible | **Minor-Moderate** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Visual/ physical disturbance | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | Temperature Change | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |

## 9.7.9 Biological Environment – Sea Birds

### Overview

The pipelines' route through the Greifswalder Bodden in ESR V is in shallow water with an average depth of 5.8 m and a maximum of 13.6 m. The Boddenrandschwelle, which serves as the boundary between the Greifswalder Bodden and the Bay of Pomerania has depths of 2-3 m. This highly productive habitat complex supports internationally important numbers of birds during the winter and spring/autumn migration period and many species reach their highest densities in this area, especially during the herring spawning season.

The Greifswalder Bodden has to be understood within the context of the wider area, especially the Pomeranian Bay, as many species undertake local migrations between these two sites depending on, for example, the availability of preferred food resources. The Greifswalder Bodden (which is also a part of the Szczecin and Vorpommern lagoon which extends from the Darss lagoon in Germany to the Szczecin lagoons in Poland) forms the most important site for wintering birds in the Baltic Sea. It is also an important foraging ground for sea bird species wintering at the adjacent Pomeranian Bay during particular times of the year.

The Greifswalder Bodden and Pomeranian Bay support internationally important populations of wintering and staging birds including great-crested grebe (*Podiceps cristatus*), Slavonian grebe (*Podiceps auritus*), mute swan (*Cygnus olor*), pochard (*Aythya farina*), tufted duck (*Aythya fuligula*), greater scaup (*Aythya marila*), black scoter (*Melanitta nigra*), velvet scoter (*Melanitta fusca*), common goldeneye (*Bucephala clangula*), red-breasted merganser (*Mergus serrator*), goosander (*Mergus merganser*), coot (*Fulica atra*) and smew (*Mergellus albellus*). The latter species together with wintering diver (Gavia spp.), avocet (*Recurvirostra avocetta*) and staging tern species (*Sterna* spp.) are of high ecological value as they are listed in Annex I of the EC Birds Directive.

Benthic surveys carried out as part of the Environmental Impact Statement in the German EEZ showed high densities of molluscan biocoenoses especially within the area of the Boddenrandschwelle which explains the abundance of benthic feeding sea birds within the Greifswalder Bodden[(1)]. The proportion of piscivorous species increases considerably during the herring spawning season and large numbers of divers, scoter species and other diving ducks migrate from the Pomeranian Bay into the Greifswalder Bodden in order to feed on herring spawn.

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(1) Institut für Angewandte Ökologie (IfAÖ). 2009. Umweltverträglichkeitsstudie (UVS) zur Nord Stream Pipeline von der Grenze der deutschen Ausschließlichen Wirtschaftszone (AWZ) bis zum Anlandungspunkt.

Species diversity and densities are considerably lower during the summer months as only small numbers breed within the area of the Greifswalder Bodden. Key species include breeding little tern (*Larus minutus*), a species protected under the EC Birds Directive and which is also listed in the HELCOM list of threatened and/or declining species and biotopes/habitats in the Baltic Sea area[(1)]. The Greifswalder Bodden also supports Germany's largest breeding colony of cormorants (*Phalacrocorax carbo*)[(2)] and foraging birds reach high densities within the area of the Boddenrandschwelle. Values/sensitivities for sea birds in ESR V are detailed in **Chapter 8** and summarised in **Table 9.87**. In some cases, the sensitivity of a particular species may be higher or lower and impacts have then been assessed on a species-specific basis.

**Table 9.87 Values/Sensitivities of Sea birds in Ecological Sub-Region V**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Birds** | | | | | | | | | | | | |
| Breeding birds | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |
| Wintering birds | High | High | High | Med | Low | Low | Low | Low | Low | Med | High | High |
| Migratory birds | Low | Med | High | High | High | Low | Low | Low | High | High | High | Low |

The main activities that are expected to impact on sea birds are those that take place during the construction phase.These include activities resulting in direct habitat loss, increased noise levels and visual and also physical disturbance impacts which are predicted to be the main impact upon the sea birds in ESR V. No impacts are expected during pre-commissioning as the uptake of seawater and subsequent discharge of pressure-test water is to occur at the Russian landfall in ESR I.

*Construction phase*

- Boulder removal, wreck removal, seabed intervention works, pipe-laying and anchor handling, resulting in:
  - Increase in turbidity
  - Loss of seabed habitat

(1) HELCOM. 2007. Baltic Sea Environmental Proceedings, No. 113.

(2) Institut für Angewandte Ökologie (IfAÖ). 2009. Umweltverträglichkeitsstudie (UVS) zur Nord Stream Pipeline von der Grenze der deutschen Ausschließlichen Wirtschaftszone (AWZ) bis zum Anlandungspunkt.

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- Noise and vibration

- Boulder removal, wreck removal, seabed intervention works, pipe-laying and anchor handling resulting in:

  - Visual/physical disturbance

*Operational phase*

- Routine inspections and maintenance works and associated vessel movement resulting in:

  - Increase in turbidity

  - Noise and vibration

  - Visual/physical disturbance

**Impacts during the Construction Phase**

During the construction phase, boulder removal, wreck removal, seabed intervention works, pipe-laying and anchor handling are likely to result in noise and vibration, the re-suspension and spreading of sediments and direct loss of seabed habitat. Vessel movement may also lead to physical and visual disturbance to sea birds.

*Increase in turbidity*

Boulder removal, wreck removal, seabed intervention works, pipe-laying and anchor handling can result in a temporary increase in turbidity, which can have direct and indirect negative impacts on birds.

As discussed in **Section 9.7.3**, impacts on the water column in terms of an increase in turbidity due to boulder removal and wreck removal are insignificant. Since the increase in turbidity due to these activities will also not have a significant impact on fish (**Section 9.7.8**), it is considered that sea birds will suffer very little impact, indirectly or directly, as a result of increased turbidity due to these construction phase activities, and impacts are therefore considered to be **insignificant**.

The re-suspension and spreading of sediments (and organic matter) due to seabed intervention works is expected to be greatest during dredging and trench backfilling (see **Section 9.7.3**). If suspended matter concentrations exceed background turbidity of 50 mg/l (running average of measured values) within 500 metres of the disturbance area (unlikely), dredging will slow down, move elsewhere or cease, or silt screens will be introduced. Peak values should not exceed 100 mg/l at a distance beyond 500 m. As a concentration of 15 mg/l or more sediment is considered as being problematic for the eyesight of diving sea birds such as divers, terns, cormorants and sea ducks[1] the area affected may be larger depending on the weather conditions such as wind speed. Increased turbidity may cause **negative direct** impacts on cormorant throughout the year. The Greifswalder Bodden supports Germany's largest breeding colony, which is concentrated in the area of the Peenemunde and Niederhof. Increased turbidity may cause temporary negative effects on foraging birds particularly along the Boddenrandschwelle which supports large concentrations of this species during the breeding and non-breeding season.

Diving ducks and terns are also particularly sensitive to increased levels of suspended solids in the water column and sensitive species include greater scaup (*Aythya marila*), goldeneye (*Bucephala clangula*), goosander (*Mergus merganser*), Red-breasted merganser (*Mergus serrator*) and smew (*Mergus albellus*). High numbers of these species occur predominantly during the spring/autumn migration period and during the winter. Further species of note such as velvet scoter and black scoter reach peak densities within the area of the Oder Bank in ESR IV and are only present in ESR V during the herring spawning season[2]. Densities of birds are considerably lower during the summer.

The increase of suspended solids in the water may also impact upon fish resources in ESR V and may cause locally decreased numbers of fish in areas with increased levels of suspended solids in the water column. This may cause **indirect** impacts on bird species which forage on fish, such as divers and terns. The Greifswalder Bodden is also an important herring spawning site which provides an important food resource for a number of species such as the velvet scoter (*Melanitta fusca*), greater scaup (*Aythya marila*) and long-tailed duck (C*langula hyemalis*). The densities of these species within the Greifswalder Bodden increases during the herring spawning season and large numbers migrate from the Pomeranian Bay into the Greifswalder Bodden.

Impacts are **short-term** and of **local** or **regional** scale and will be **reversible** within a few days as sediment settles to the seabed. The intensity of the impact is considered to be **low** as a short-term increased of the water column is not expected to bring about a change in abundance or a reduction in the distribution. Impact magnitude is also **low**.

The short-term increase of suspended solids is not considered to be a large threat to the long-term abundance and favourable conservation status of common and internationally protected sea bird species. Turbidity limits will not exceed 50 mg/l (peak 100 mg/l) within a distance of 500m to either side of the pipelines and therefore increased turbidity will affect a small area in comparison to the overall area available for foraging sea birds. The turbidity of the water will be monitored during the construction of the pipelines and mitigation measures (regulation of dredging speed, interruption of dredging during times of high wind speed) will be implemented if

(1) Ramboll. 2008. Environmental Study – Nord Stream pipelines in the Swedish EEZ.

(2) Institut für Angewandte Ökologie (IfAÖ). 2009. Umweltverträglichkeitsstudie (UVS) zur Nord Stream Pipeline von der Grenze der deutschen Ausschließlichen Wirtschaftszone (AWZ) bis zum Anlandungspunkt.

the limit of 50 mg/l (peak 100 mg) in 500 m is exceeded. Construction activities in the area of the landfall will be carried out outside the herring spawning season in order to minimise impacts on this, for migratory birds, important food resource. The majority of birds species within ESR V are widespread and common throughout the Baltic Sea and are species of least concern as identified by the IUCN[1]. Therefore they have a **low** value/sensitivity. Impacts on these species, are considered to be **minor**.

However, little terns (of **high** value/sensitivity) are present during the summer months and increased turbidity may result in impacts of **moderate** significance on foraging of this species. This internationally protected species forages over extensive ranges and the temporary loss of a very small area of foraging habitat is not predicted to result in negative affects on the long-term abundance of these species.

The amount of suspended solids during pipe-laying and anchor handling is expected to be comparable to the effects of bottom trawling activities, a normal activity in the Baltic Sea, and would therefore not result in an increase above the baseline environment. These impacts are therefore considered to be **insignificant**.

*Noise and vibration*

Noise and vibration impacts on sea birds due to seabed intervention works and construction and support vessel movement may be direct due to the short-term displacement of birds or indirect due to the displacement of fish and the subsequent redistribution of piscivorous species of birds.

Comparatively little is known about direct impacts of noise and vibration on sea bird populations. It is generally expected that the extent of visual disturbance impacts is larger than the extent of noise impacts. As construction noise offshore is almost exclusively associated with the presence of vessels resulting in visual impacts it is often impossible to distinguish between impacts caused by increased noise levels and visual/physical impacts caused by the presence of vessels as both impacts occur simultaneously.

As described in **Section 9.3.9**, the sensitivity of sea birds to noise impacts is species-specific and also appears to depend on the flock size of sea birds. Diving sea birds such as long-tailed ducks, velvet scoter and divers (*Gavia* spp.) are particularly sensitive to vessel movements and associated noise[2],[3], at typical distances of 1 to 2 km for the more sensitive bird species such

(1) International Union for Conservation of Nature http://www.iucnredlist.org/ (accessed September 24, 2008).

(2) Kube, J. & H. Skov. 1996. Habitat selection, feeding characteristics, and food consumption of long-tailed ducks, *Clangula hyemalis*, in the southern Baltic Sea. Meereswiss. Ber., Warnemünde. 18: 83-100.

(3) Bellebaum, J., Diederichs, A., Kube, J., Schulz, A. & G. Nehls. 2006. Flucht- und Meidedistanzen überwinternder Seetaucher und Meeresenten gegenüber Schiffen auf See. Ornithologische Rundbrief für Mecklenburg-Vorpommern Orn. Rundbrief Mecklenburg-Vorpommern 45, Sonderheft 1 (Tagungsbd. 5. deutsches See- und Küstenvogelkolloquium).

as divers and scoters, and to a lesser extent cormorants, but other species such as gulls and terns are likely to be less affected(1),(2). Studies on coastal birds have shown that noise impacts can result in various different types of response, including birds being startled or showing a "heads up" response to small scale movements and also birds leaving the affected area altogether(3),(4).

Indirect negative impacts are primarily caused by the short-term displacement of fish. As outlined in **Section 9.7.8**, the highest magnitude of impact is expected during underwater dredging activities, causing the displacement of fish and subsequently the short-term redistribution of piscivorous sea birds. However, as construction will only take place between mid May and December indirect impacts on wintering birds will affect birds only over a short period of time.

Sensitive species likely to be affected by noise and vibration comprise piscivorous and benthic feeding species including divers (*Gavia* spp.) and grebes such as Slavonian grebe (*Podiceps auritus*). Both species are protected under the EC Birds Directive. The species-specific extent of noise impacts on Slavonian grebes is largely unknown. This species occurs predominantly within the area of the Oder Bank and along the northern edge of the Pomeranian Bay and only occurs within the area of the Boddenrandschwelle during the herring spawning season. The construction of the pipelines will only take place during the summer months and no significant impacts on Slavonian grebes are predicted as this species leaves its wintering ground in April. Divers occur predominantly offshore and reach highest densities within the western part of the Bay. The importance of the Greifswalder Bodden for wintering divers is very low as these species occur further offshore. Noise and vibration impacts on divers are therefore **insignificant**.

Noise and vibration may affect coastal species of the genus *Charadriidae* including ruff, golden plover, avocet, red-necked phalarope and bar-tailed godwit. Little is known about the stand-off areas of these species, however, research has shown some wader species to be tolerant of relatively high levels of noise. It is likely that these species will maintain a stand-off distance from the landfall works during the short construction period in this area.

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(1) Ruddock, M. & Whitfield, D.P. 2007. A Review of Disturbance Distances in Selected Bird Species, A report from Natural Research (Projects) Ltd to Scottish Natural Heritage.

(2) Skov, H., Durinck, J., Leopold, M.F. and Tasker, M.L. 2007. A quantitative method for evaluating the importance of marine areas for conservation of birds. Biology Conservation. 36(3).

(3) Institute of Coastal and Estuarine Studies (ICES). 1999. Avifaunal Disturbance Assessment: Flood Defence Works, Salt End. Report to the Environment Agency.

(4) Smit, C.J. & G.J.M. Visser. 1993. Effects of Disturbance on Shorebirds: A Summary of Existing Knowledge from the Dutch Wadden Sea and Delta Area. WSG Special Report.

The short-term displacement of fish may affect piscivorous species of sea birds such as divers and cormorants. The assessment of Project impacts on fish identified a potential for temporary displacement of fish from the local area which may indirectly affect piscivorous species of sea birds such as divers and grebes during the winter and spring/autumn migration period. Cormorant will be affected throughout the year. Further, the pipelines in ESR V will cross an important herring spawning site. Sea bird surveys carried out as part of the Environmental Impact Statement for the German EEZ(1) have shown that herring and herring spawn appear to provide an important food resource for many species of diving ducks such as long-tailed ducks, common scoter and velvet scoter. However, construction will not be carried out during the herring spawning season in order to avoid impacts on spawn feeding sea birds. Impacts on fish occurring predominantly during dredging activities may result in the short-term displacement of some species of fish. Long-term impacts on fish are not predicted as the construction of the pipelines will be carried out outside the spawning season. The temporary displacement of fish will therefore have an **insignificant** impact on sea birds.

Noise impacts, **direct**, **indirect** and **short-term**, are of **local** to **regional** scale. The impact intensity is **low**. Direct noise impacts will be of **low** magnitude as changes in abundance or distribution of sea birds over one generation or more is highly unlikely. Taking into account the careful timing of construction activities and seasonal restrictions, impacts are predicted to affect only small numbers of birds in ESR V. The significance of impacts varies and depends on the conservation status of the species present. Significance has therefore been identified on a species-specific basis.

**Minor** significant impacts will primarily affect common species of diving ducks and cormorants (of **low** value/sensitivity), especially within the area of the Boddenrandschwelle. Cormorants are present throughout the year and noise impacts may affect this species during the breeding season. However, based on the fact that increased noise levels will affect a comparatively small area, long term changes in the species distribution in the Greifswalder Bodden are not predicted.

Impacts of **moderate** significant on species protected under the EC Birds Directive (of **high** value/sensitivity) will be minimised by the careful timing of the construction period. Therefore, the majority of protected sea birds will not be affected as species such as smew, diver, Slavonian grebes and Bewick's swans occur only during the winter and/or spring/autumn migration. **Moderate** significant impacts may also result on breeding little tern but are likely to affect only a very small number of birds and long-term impacts on the species abundance and distribution are highly unlikely.

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(1) Institut für Angewandte Ökologie (IfAÖ). 2009. Umweltverträglichkeitsstudie (UVS) zur Nord Stream Pipeline von der Grenze der deutschen Ausschließlichen Wirtschaftszone (AWZ) bis zum Anlandungspunkt.

*Loss of seabed habitat*

The construction of the pipelines will result in the long-term loss of seabed habitat as described in **Section 9.7.7**, due to boulder removal, wreck removal, seabed intervention works, pipe-laying and anchor handling, which may result in direct and indirect impacts on sea birds. The Greifswalder Bodden supports large numbers of benthic feeding birds such as diving ducks which may be affected due to the loss of foraging habitat. Habitats of note comprise macrophyte vegetation and dense populations of blue mussel especially along the Boddenrandschwelle which provide an important food resource for a large number of species such as long-tailed ducks and scoter species. The macrophyte vegetation along the pipelines' route is of particular importance for fish and is also an important spawning habitat for herring and the long-term loss of this habitat, if it would subsequently affect predominantly piscivorous species of sea birds. Some species reach their highest densities within the area of the Boddenrandschwelle, such as long-tailed ducks, greater scaup, velvet scoter and common scoter.

The loss of seabed habitat will cause **long-term direct** and **indirect negative** impacts on sea birds due to a **local** decrease in the amount of foraging habitat. Although impacts of moderate significance on marine benthos were identified as described in **Section 9.7.7**, the loss of seabed habitat is unlikely to cause a threat to the favourable conservation status or abundance of benthic feeding birds within ESR V. The impact will be **long-term** but of **low** intensity as the basic structure of sea bird populations will be retained. The impact will affect only localised individuals of sea birds but is not predicted to bring about a change in abundance or a reduction in distribution. The magnitude of impact is therefore considered to be **low**. It is expected that macrophyte vegetation will recover within three years and the impact is therefore **reversible**. Sensitive benthic feeding species such as common scoter occur almost exclusively within the area of the Oder Bank and no significant impacts on this species are predicted to occur in ESR V. The loss of habitat affecting a receptor of **low** value/sensitivity is considered to be of **minor** significance. The loss of habitat affecting a receptor of **high** value/sensitivity is considered to be of **moderate** significance.

*Visual/physical disturbance from vessels*

The main source of visual and physical impacts will be construction and support vessel movements and heavy machinery during the construction process of the Project, especially within the area of the landfall. The distance from which different species of birds are affected by this type of disturbance varies between species, and depends on the nature of a vessel's movement. The pipe-laying vessels for the Project will move slowly in ESR V at a rate of 350 m per day. Generally, birds are less sensitive to slow moving vessels than fast moving vessels.

The sea birds in the Greifswalder Bodden are particularly sensitive during the autumn/spring passage and during the winter. Areas of shallow water within the landfall area of Lubmin support predominantly dabbling ducks, waders and swans, including Bewick's swans (*Cygnus columbianus*), a species listed in Annex I of the EC Birds Directive. Species of sea birds that are likely to be sensitive to visual and physical disturbance comprise diving species such as diving ducks, divers and cormorants. Flight distances of some birds for which studies have been carried out generally vary between one and two kilometres and the birds may avoid an area of 1-2 km either side of each pipeline trench.

Red-throated diver (*Gavia stellata*) and black-throated diver (*Gavia arctica*) occur only in low densities within the Greifswalder Bodden while the highest densities are reached within the Pomeranian Bay. Impacts on divers in ESR V are temporary and largely restricted to the herring spawning season in March and April when this species migrates from the Pomeranian Bay into the Greifswalder Bodden.

Visual and physical disturbance impacts by vessels are not predicted to result in negative effects on the abundance and favourable conservation status of birds if carried out outside the spring/autumn migration period and during the winter which also includes the herring spawning season when sea bird densities within the Bodden are highest. The majority of birds within this area are likely to be accustomed to vessel movements due to the existing level of ship movements through the Greifswalder Bodden. The scale of **negative**, **direct** visual impacts is predicted to be on a **local** to **regional** level and **short-term**. The intensity of impact is **low** as any permanent changes to the structure of bird populations in ESR V are highly unlikely. Visual impacts affect only localised groups of bird populations and long-term impacts on population sizes and species diversity are not predicted to occur. The impact intensity and magnitude are therefore considered to be **low**. Impacts will be **reversible**. Given that the construction period will be restricted to a six month period and will not be carried out during the winter and spring/migration period, visual and physical disturbance impacts will only affect species of **high** value/sensitivity species as Bewick’s swans, whooper swans and smews over a very short period of time. These species will experience an impact of **moderate** significance. Impacts on common birds of **low** value/sensitivity will be **minor**.

**Impacts during the Operational Phase**

During the operational phase, vessel movement associated with routine inspections and maintenance are likely to result in an increase in turbidity, low-level noise and vibration, and low-level physical and visual disturbance to sea birds.

*Increase in turbidity*

Routine inspections and maintenance works have limited impact upon sea birds. Impacts will be restricted to the pipelines’ route and will be occasional, infrequent and are expected to be far lower in both magnitude and duration than for the construction phase. For the operational phase, these impacts are considered to be **insignificant**.

*Noise and vibration*

Noise generation during routine inspections and maintenance works is assumed to have a limited impact upon sea birds, since activities will be restricted to the pipelines' route. Generated noise is not expected to exceed the current baseline environment as routine inspections would only result in a few extra vessel sailings. The impacts on birds in terms of noise and vibration are expected to be far lower in both magnitude and duration than for the construction phase and impacts for the operational phase are considered to be **insignificant**.

*Visual/physical disturbance*

Routine inspections and maintenance works are only expected to result in a few extra vessel sailings. Vessel movements will be restricted to the pipelines' route. The pipelines will follow highly used shipping routes and impacts will therefore be indistinguishable from the background. Impacts will be far lower in both magnitude and duration than for the construction phase and impacts for the operational phase are considered to be **insignificant**.

**Impact Summary**

The impacts identified and assessed in ESR V on sea birds are summarised in **Table 9.88**.

**Table 9.88 ESR V impact summary table for sea birds**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Sea Birds - Ecological Sub-Region V** | Increase in turbidity | Boulder removal, Wreck removal | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Seabed intervention works | Negative | Direct and indirect | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| | | Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Seabed intervention works, Construction and support vessel movement | Negative | Direct and indirect | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Loss of seabed habitat | Boulder removal, Wreck removal, Seabed intervention works, Pipe-laying, Anchor handling | Negative | Direct and indirect | Local | Long-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| | Visual/physical disturbance | Construction and support vessel movement | Negative | Direct | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.7.10 Biological Environment – Marine Mammals

#### Overview

Following the undertaking of a scope and impact identification exercise, several interactions between marine mammals in ESR V and the Project have been identified, which could give rise to potential impacts. This section identifies and assesses the potential impacts on marine mammals in ESR V during the construction, pre-commissioning and commissioning, and operational phases of the Project in terms of the methodology presented in **Chapter 7**.

In ESR V, there are three marine mammal species present: one cetacean and two species of seal:

- Harbour porpoise (*Phocoena phocoena*)
- Harbour seal (*Phoca vitulina*)
- Grey seal (*Halichoerus grypus balticus*)

Each of these marine mammals has been described as a threatened and/or declining species of the Baltic Sea by HELCOM. Values/sensitivities for each marine mammal are presented in detail in **Section 8.11.7** and summarised in **Table 9.89**. Harbour porpoise and seals are not that common in ESR V with sighting being on the individual level. There are no known ringed seal colonies within the ESR (**Atlas Map MA-3**). Ringed seal presence is rare.

**Table 9.89 Values/sensitivities of marine mammals in Ecological Sub-Region V**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Marine mammals** | | | | | | | | | | | | |
| Harbour porpoise | Med | Med | Med | High | High | High | High | High | High | Med | Med | Med |
| Harbour seal | Med | Med | Med | Med | Med | High | High | High | High | Med | Med | Med |
| Grey seal | Med | High | High | Med | High | High | Med | Med | Med | Med | Med | Med |

The main activities, which are expected to impart an impact on marine mammals, include those that take place during the construction phase. Impacts during the pre-commissioning and commissioning, and operational phases are expected to be minimal by comparison. Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Boulder removal, wreck removal, seabed intervention works, pipe-laying, anchor handling and construction and support vessel movement resulting in:
  - Noise and vibration
- Re-suspension and spreading of sediment due to boulder removal, wreck removal, seabed intervention works, pipe-laying and anchor handling resulting in:
  - Increase in turbidity
  - Release of contaminants
- Construction and support vessel movement during winter resulting in:
  - Ice breaking

*Pre-commissioning and commissioning phase*

- Pipeline flooding and commissioning resulting in:
  - Noise and vibration

*Operational phase*

- Pipeline presence resulting in:
  - Noise and vibration (due to movement of natural gas in the pipelines)
- Routine inspections and maintenance works resulting in:
  - Increase in turbidity
  - Noise and vibration

**Impacts during the Construction Phase**

Impacts upon marine mammals during the construction phase to noise and vibration, an increase in turbidity and the release of contaminants due to boulder removal, wreck removal, seabed intervention works, pipe-laying, anchor handling and vessel movement. Ice breaking may occur due to vessel movement should pipe-laying take place during the winter months in ESR V, however this is not planned.

*Increase in turbidity*

An increase in turbidity due to the re-suspension of sediments, and associated contaminants, due to boulder removal, wreck removal, seabed intervention works, pipe-laying and anchor handling will occur along the entire pipelines' route in ESR V. The seabed sediments in ESR V are predominantly sandy in texture. Small sections of glacial till (hard bottom) are also present. Despite the type of intervention works planned for ESR V (dredging), which will disturb of the seabed, these sediments are not prone to prolonged re-suspension like those of a finer texture. Therefore, it is assumed that any sediment that is placed in suspension due to construction works will settle rapidly (the extent and duration of an increase in turbidity is detailed under the water column in **Section 9.7.3**). The western part ESR V is located in a coastal area and it is thus expected that turbidity levels will be high and any sediments that are placed into suspension will not contribute significantly to existing levels. Mitigation measures are proposed to reduce the extent of sediment spread in the coastal area. Overall, any increase in turbidity levels is expected to be of short duration (**Section 9.7.3**). As marine mammals use their hearing ability for navigation, as well as for hunting, an increase in turbidity is expected to yield an **insignificant** impact on individuals. Other marine fauna, on which marine mammals would feed, may vacate the construction area due to noise and an increase in turbidity. This may temporally affect feeding areas but the associated impact is expected to be **insignificant** as marine mammals are able to hunt over large distances and would typically avoid the construction areas.

*Release of contaminants*

An increase in contaminant concentration in the water column due to the release of contaminants from the re-suspension and spreading of sediments during boulder removal, wreck removal, seabed intervention works, pipe-laying and anchor handling could theoretically raise the concentration of contaminants in the food chain and subsequently in mammal tissue. However, as per **Section 9.7.3** the release of contaminants will be minimal and any impacts on marine mammals would be **insignificant**. In general, marine mammals are expected to vacate the construction area due to noise.

*Noise and vibration*

Noise and vibration will be generated during construction in ESR V as a result of boulder removal, wreck removal, seabed intervention works (sheet piling and dredging), pipe-laying, anchor handling and construction and support vessel movement. Noise and vibration may impact on marine mammals.

The harbour and grey seal, as well as the harbour porpoise, communicate by emitting sounds that pass through the water column. These sounds can be detected across considerable distances and construction noise may influence the behaviour of these mammals. An increase in background noise or the introduction of specific sound sources may affect marine mammals in that they may be prevented from detecting important sounds (masking), their behaviour may be altered, temporary or permanent hearing loss may be experienced or damage to tissue may occur. These potential effects are further elaborated upon in **Section 9.3.10** under ESR I. The hearing ability of the marine mammals in the Baltic Sea is detailed in **Section 8.6.6**.

No direct measurements are available for the noise generated during boulder removal, wreck removal, pipe-laying and anchor handling. The primary source of noise is expected to be the movement of anchors. The presence of heavy machinery on board the pipe-laying vessel is expected to generate low frequencies below 100 Hz. It should be noted that in ESR V pipe-laying will take place at a rate of 350 metres a day and thus the source of noise will move along the pipelines' route and will not remain fixed at one point for an extended period of time. Noise generated is expected to be on a par with normal shipping and fishing activities to which marine mammals have habituated and thus the impact of pipe-laying and anchor handling is expected to be **insignificant**.

Marine mammals can perceive underwater noise generated by vessel movements (0.01-10 kHz with source levels between 130-160 dB), and the use of equipment at sea, a number of kilometres from a source. Such noise has a zone of responsiveness for marine mammals of 200-300 m(1). As the pipelines' route in ESR V is largely within or close to normal shipping lanes it is expected that seals and harbour porpoises in the area have already habituated to the noise and vibration generated by vessel movement and thus the impact is **insignificant**.

Seabed intervention works, which include sheet piling and dredging will take place in ESR V (**Atlas Maps PR-3a** and **3b**). These activities will generate noise and vibration at the level that exceeds that generated by other construction activities. Sheet piling is generally expected to generate the most noise. However, sheet piling at the German landfall will be carried out via vibration and not hammering. This is expected to have a minimal impact on marine mammals and would be restricted to the immediate landfall area. Dredging is expected to generate the most noise, which may impact upon marine mammals. Dredging (frequencies of 0.020 and 1 kHz, with a peak of approximately 0.020 - 2 kHz) noise is expected to have a zone of influence (behaviour and masking) on the harbour porpoise and seals of approximately 2-3 kilometres and 1 kilometre respectively. In most cases marine mammals would vacate the construction area at the first instance of a foreign sound or change in background noise. The harbour porpoise and grey seal, which breed in ESR V could also potentially be affected should construction coincide with the breeding season. However, harbour seals tend to concentrate in the coastal areas away from the pipelines' route. No seal colonies exist in close proximity to the pipelines' route (<5 km), however, ESR V has been designated as a conservation area for both the harbour and grey seal.

Impacts as a result of noise and vibration during sheet piling and dredging, are both **negative** and **direct**, will be on a **regional** scale around the source of impact but of **short-term** duration

(1) ENERGI E2. 2006. EIA Report - Marine mammals. Horns Rev 2, offshore wind farm.

during construction and will be of **low - medium** intensity as function and structure may be affected. Impact magnitude is **low** and value/sensitivity ranges from **medium** to **high**. Therefore, impact significance is expected to be **minor** to **moderate** (if harbour porpoise and grey seals are disrupted during the breeding season – this is not planned). Impacts are **reversible**.

*Ice breaking*

ESR V has an ice coverage probability in the region of 50 % during normal to severe winters. It is expected that most ice coverage will be restricted to the coastal areas during mild winters. The grey seal breeds (gives birth to pups) offshore on the ice and thus has the potential to be impacted upon should construction activities take place during their breeding season. The critical time for breading is during February and March. Furthermore, the pipelines' route passes through a conservation area for grey seals (and harbour seals, which are not that common). Vessel movements during winter would result in ice breaking in the southern sections of ESR V and thus the potential to affect seal breeding habitats would be high. However, construction is expected to take place outside of these periods and thus the possibility of ice breaking is minimal. Furthermore, as most of the pipelines' route falls within or very close to normal shipping lanes, it is expected that should ice breaking be required, the potential for impacts on seals would be minimal (**Atlas Map SH-1**). Seals do not typically dwell in areas where ice breaking is a regular occurrence. Nevertheless, during winter, sections of the pipelines' route identified as breeding areas should be avoided where possible.

If the construction schedule is followed, no ice breaking will be required and thus there will be **no impact**. However, in the highly unlikely event that ice breaking should be required and if breeding areas are affected; the impact (**negative, direct** and **secondary**) is expected to be **regional** along the pipelines and vessel routes, of **short-term** duration and of **medium** intensity. Impact magnitude is **medium** and value/sensitivity is **high** (during the breeding season). Impact significance is therefore expected to be **moderate** for the grey seals if the ice breaking activities disrupt breeding areas. Impacts are **reversible** within a few generations in a worst case scenario.

**Impacts during the Pre-commissioning and Commissioning Phase**

The intake of seawater and subsequent discharge of pressure-test water during pre-commissioning is restricted to the Russian landfall (ESR I). As such, the only activities that will generate an impact in ESR V are pipeline flooding during pressure testing, pressure-test water discharge and the input of gas during commissioning. These activities are likely to result in the generation of noise and vibration.

*Noise and vibration*

The movement of pressure-test water in the pipelines during pipeline flooding and pressure-test water discharge and the input of gas during commissioning will generate some noise and vibration. The noise generated is expected to be on a par with, if not slightly higher than, normal gas movement within the pipelines (see section on the operational phase impacts). As such, generated noise is expected to have an **insignificant** impact on marine mammals in ESR V. No mitigation is required.

**Impacts during the Operational Phase**

Impacts upon marine mammals during the operational phase are limited to noise and vibration from gas movement within the pipelines as well as from routine inspections and maintenance works. An increase in turbidity is expected to coincide with maintenance works should they interact with the seabed.

*Increase in turbidity*

Routine inspections and maintenance works may be required on the pipelines or on the supporting seabed to ensure that the pipelines have a stable base. These works may result in localised re-suspension and spreading of sediments and a subsequent increase in turbidity and the release of contaminants. The following mitigation measures will be implemented to reduce the impacts:

- Any seabed intervention work, such as rock placement, required during operation will be kept to a minimum
- Disturbance of seabed sediments will be kept to a minimum
- Any surveys will avoid encounters with marine mammals wherever possible

As these works are not expected to occur on a regular basis and will be localised, the impacts on marine mammals are expected to be **insignificant**.

*Noise and vibration*

Routine inspections would include external inspections of the pipelines by means of ROV and internal inspections using pigs (**Section 9.2.3**). Maintenance works are not expected but may include possible repair works on the pipelines or on the seabed where required. Routine inspections and maintenance works are expected to generate very little noise and are thus assumed to have an **insignificant** impact upon marine mammals and will be restricted to the pipelines' route and be infrequent (i.e. not constant).

As per the studies[(1),(2)] described under ESR I for marine mammals (**Section 9.3.10**), the noise generated by the movement of gas within the pipelines falls below the levels detectable by the marine mammals (~1 kHz for the harbour porpoise) present in ESR V. As such, it is expected that gas movement in the pipelines would have little to no impact on marine mammals at both an individual and population level. On the contrary, the pipelines are expected to become artificial habitats for other marine fauna and may thus become a hunting ground for certain marine mammals. The impact is deemed to be **insignificant**.

**Impact Summary**

The impacts on marine mammals identified and assessed in ESR V are summarised in **Table 9.90**.

(1) Lommer, M. and Lemaire, G. 2008. Ødegaard & Danneskiold-Samsøe A/S. Noise along the Nord Stream pipelines in the Baltic Sea.

(2) Martec Limited. 2004. Effects of Pipelines/Gathering Lines on Snow Crab and Lobster.

**Table 9.90  ESR V impact summary table for marine mammals**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Marine Mammals - Ecological Sub-Region V | Increase in turbidity | Boulder removal, Wreck removal, Seabed intervention works, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Release of contaminants | Boulder removal, Wreck removal, Seabed intervention works, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Boulder removal, Wreck removal, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Seabed intervention works | Negative | Direct | Regional | Short | Low - Medium | Low | Medium – High | Reversible | **Minor - Moderate** |
| | | Construction and support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | | Pipeline flooding, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Ice breaking | Construction and support vessel movement | -/ Negative | -/Direct, Secondary | -/ egional | - /Short | -/Medium | -/Medium | -/High | -/Reversible | **No impact/ Moderate** |

## 9.7.11 Biological Environment – Nature Conservation Areas

### Overview

This section identifies and assesses the potential impacts on nature conservation areas in ESR V during the construction, pre-commissioning and commissioning and operational phase of the Project.

In ESR V the pipelines' route passes through Greifswalder Bodden – a highly protected European site with a number of nature conservation designations. Due to the international significance of Greifswalder Bodden, the majority of these protected areas are Natura 2000 sites, which are considered in detail in **Chapter 10** and not in this section. The pipelines' route does not cross any other nature conservation areas in ESR V, but passes within 20 km of two nature conservation areas: the Island of Usedom National Park and Nature Reserve and the South-east Rügen UNESCO biosphere reserve. The impact of the Nord Stream pipelines on these nature conservation areas has previously been considered for ESR IV, where the pipelines' route passed within 3 km of South-east Rügen and 14 km of the Island of Usedom National Park. In ESR V, the pipelines' route is closer to these sites, passing within 0.75 km of the South-east Rügen UNESCO biosphere reserve as the route enters into Greifswalder Bodden, and within 0.2 km of the Island of Usedom National Park and Nature Reserve at the German landfall site, as listed in **Table 9.91**.

UNESCO and BSPA sites are illustrated on **Atlas Map PA-5**.

**Table 9.91 Nature conservation areas within 20 km of ESR V**

| Nature Conservation Area | Designation | Protected Habitats and Species | Distance to Pipelines (km) |
|---|---|---|---|
| Island of Usedom | National Park, Nature Reserve | Beaches and coastline, dunes, eutrophic lakes, beech forests and moorland. Important for breeding bird colonies and for migrating ducks and geese including cormorant (*P. carbo*), whooper swan (*C. cygnus*), bean goose (*A. fabalis*), white-fronted goose *(A. albifrons*), tufted duck (*A. fuligula*), scaup (*A. marila*), goldeneye (*B. clangula*), smew (*M. albellus*) and goosander (*M. merganser)* | 0.2 |
| South-east Rügen | UNESCO biosphere reserve, Nature Reserve | Temperate broadleaf forests, moraine landscapes with beech forest, coastal beech communities, sand dunes, salt meadows, beaches, shallow inlet waters and salt reed banks. Important breeding and staging area for birds, including the Caspian tern (*S. caspia*), white-tailed eagle (*H. albicilla*) and migrating greylag goose (*A. anser*) and white-fronted goose (*A. albifrons*). Spawning area for cod and Baltic herring. | 0.75 |

The scope of this assessment is limited to the particular impacts on features for which the conservation areas have been designated, including protected habitats in the areas. Impacts on floral and faunal receptors (fish, mammals, sea birds and benthos) are assessed in the other sections in this Report. However where these species are specifically protected by the nature conservation designation, consideration will be given here as to the significance of potential impacts on these species in each conservation area, from the installation of the pipelines' route in ESR V. As nature conservation areas are of national and international importance, their values/sensitivities are rated as **high**.

Both the Island of Usedom National Park and the South-east Rügen UNESCO biosphere reserve have the potential to be affected by the Nord Stream pipelines' Project in ESR V as they are both coastal and incorporate islands, and therefore have protected coastal habitats which may be impacted by the installation of the pipelines. The main habitats of importance (as shown in **Table 9.91**)[1] are beaches and coastline, sand dunes, coastal beech communities, salt meadows, salt reed banks and shallow inland waters. Breeding and migrating sea and water birds are also protected within the nature conservation areas in ESR V, along with spawning areas for cod and herring, which also have the potential to be affected by the construction, pre-commissioning and commissioning and operation of the pipelines.

The main activities anticipated to affect nature conservation areas in ESR V are those occurring during the construction phase of the Project, such as pipe-laying, seabed intervention works and anchor handling. The impacts which are likely to affect these sites are limited to those which can operate away from the source, including noise and vibration, visual/physical disturbance and the re-suspension and spreading of sediments.

Impacts during the pre-commissioning and commissioning and operational phase are expected to be comparatively small, due to the less invasive nature of the activities in these phases, and the smaller scale on which these activities will operate.

Activities and the associated impacts that are assessed in this section are as follows:

*Construction phase*

- Boulder removal, wreck removal, seabed intervention works, pipe-laying, anchor handling and construction and support vessel movement resulting in:
  - Noise and vibration
- Re-suspension and spreading of sediments due to boulder removal, wreck removal, seabed intervention works, pipe-laying and anchor handling resulting in:
  - Increase in turbidity
  - Physical alteration of the seabed
- Construction and support vessel movement resulting in:
  - Visual/physical disturbance

*Pre-commissioning and Commissioning phase*

- Pipeline flooding resulting in:
  - Noise and vibration

(1) Nord Stream AG & Ramboll. 2007. Memo 4.3G -Protected Areas.

- Construction and support vessel movement resulting in:
  - Visual/physical disturbance

*Operational phase*

- Routine inspections and maintenance works and construction and support vessel movement resulting in:
  - Increase in turbidity
  - Noise and vibration
  - Physical alteration of the seabed
  - Visual/physical disturbance
- Pipeline presence resulting in:
  - Noise and vibration

**Impacts during the Construction Phase**

Potential impacts during the construction phase upon nature conservation areas in ESR V include impacts on fauna from turbidity impacts, noise and vibration and visual/physical disturbance due to boulder removal, wreck removal, seabed intervention works and pipe-laying activities.

*Increase in turbidity*

Increases in turbidity in the water column due to the re-suspension and spreading of sediments will result from the construction process, in particular through seabed intervention works including dredging and sheet piling (using vibration), and through pipe-laying and anchor handling activities. As discussed in previous sections, this can potentially cause physiological damage to faunal species such as fish (**Section 9.7.8**), or smothering of important benthic communities (**Section 9.7.7**). However, impacts will only affect the habitats or species of the nature conservation areas for a short duration, as sediment will settle within a few days, and will occur within a relatively localised area surrounding the pipelines. Modelling of the predicted re-suspension and spreading of sediments during dredging in ESR V predicts significant increases in turbidity within 1 km of the pipelines' route[(1)].

(1) Institut für Geodatenverarbeitung. 2008. Assessment of the turbidity in connection with pipe-laying work in the Greifswald Bodden - Nord Stream Pipeline Project.

South-east Rügen biosphere reserve is situated within 0.75 km of the pipelines' route, and the Island of Usedom National Park is located within 0.2 km of the works. Therefore, the nature conservation areas are both expected to be impacted by an increase in turbidity. #However, the greatest impact in terms of sedimentation will occur along the 50 m corridor to either side of the pipelines' route during the construction process, with less significant impacts occurring over the wider area. In addition, turbidity levels will be naturally high in the coastal regions of the conservation areas, reducing the impact of an increase in turbidity, which is less likely to contribute significantly to existing levels. Mitigation measures are proposed to reduce the extent of sediment spread in the coastal area (as detailed in **Section 9.7.3**) to prevent the re-suspension of sediment from harming flora or fauna of the conservation areas. The impact of an increase in turbidity in the water column on nature conservation areas will be **negative**, **direct** and **short-term** and on a **regional** scale. Impacts will be **reversible** as impacts on flora and fauna associated with the project will cease to be evident, either immediately or following an acceptable period of time, after termination of project activity. The increase in turbidity will be for a **short-term** duration, impact intensity will be **medium** as the basic structure and function of the conservation areas and their communities will be retained along with a **medium** impact magnitude. As the sensitivity of nature conservation areas is **high**, impact significance is expected to be **moderate**.

Seabed intervention works are expected to generate the most re-suspended sediment while pipe-laying and anchor handling are expected to contribute very little to the water column. As such, the impact to conservation areas by way of flora and fauna due to pipe-laying and anchor handling are considered to be **insignificant**.

*Noise and vibration*

The activities during construction that are likely to cause noise and vibration disturbance in ESR V are boulder removal, wreck removal, seabed intervention works (dredging and sheet piling), pipe-laying, anchor handling and construction and support vessel movement. Dredging and sheet piling at the German landfall area are expected to cause the most noise and vibration disturbance in this ESR. The impact of sheet piling will be reduced by using vibration techniques, rather than hammering to reduce noise disturbance.

The significance of any noise and vibration impacts on nature conservation areas will depend upon the distance between the source of the impact (originating from within the vicinity of the pipelines) and the conservation areas themselves and the extent of noise emitted. Potential receptors for impacts from noise and vibration are limited to marine mammals, fish, sea birds and some marine benthos. Of these groups of fauna, only sea birds and spawning sites of the Baltic herring and the Rugen spawners are specifically protected in the nature conservation areas near the pipelines in ESR V.

In terms of sea birds, as discussed in **Section 9.7.9**, comparatively little is known about the impacts of noise and vibration on these species. However, the noise generated at sea surface-level will be of comparable volume to that for other shipping activity in the Baltic Sea, which birds in the region will be habituated to. In addition, in ESR V pipe-laying will take place at a rate of 350 metres a day, so the source of noise will move along the pipelines' route and will not remain fixed at one point for an extended period of time. The distance for visual and noise disturbance from boats is typically 1 – 2 km for the more sensitive species such as divers and scoters and to a lesser extent cormorant, but other species such as gulls and terns are likely to be less affected(1),(2). As the Island of Usedom National Park is only 0.2 km away and is known to support cormorants, it is likely that some disturbance to birds associated with these nature conservation areas will result from the works, with slightly less disturbance at South-east Rügen which is 0.75 km at the closest distance from the pipelines' route.

Fish can also be impacted by noise and vibration and herring is particularly sensitive to noise impacts, as detailed in **Section 9.7.8**. Fish in ESR V are already likely to be habituated to vessel noise and other activities in the Baltic Sea, due to the large amount of ship traffic in the sea. Increased noise levels may impact on spawning success but construction will not be carried out during the spawning season in Greifswalder Bodden in order to prevent disturbance to this species. Indirectly, noise and vibration may lead to temporarily lower densities of fish in the region, which are an important foraging resource for the sea birds of the area and hence may have a temporary influence on sea bird distribution as a result.

Impacts due to seabed intervention works will be **negative** and **direct** but **temporary** in duration, and on a **regional** scale. Effects will be **reversible** as impacts will cease to be evident after termination of a noise and vibration generated from project activities. Impact intensity and magnitude are expected to be **low** for fish and up to **medium** intensity and magnitude for sea birds. As the sensitivity of nature conservation areas is **high**, the overall impact significance is expected in ESR V to be **moderate**.

There are no specific noise level estimates available for the noise generated during boulder removal, wreck removal, pipe-laying or anchor handling, but less noise is expected than during dredging activities and therefore impacts from these activities for conservation areas taking into consideration associated flora and fauna are considered to be **insignificant**.

(1) Ruddock, M. & Whitfield, D.P. 2007. A Review of Disturbance Distances in Selected Bird Species, A report from Natural Research (Projects) Ltd to Scottish Natural Heritage.

(2) Skov, H., Durinck, J., Leopold, M.F. and Tasker, M.L. 2007. A quantitative method for evaluating the importance of marine areas for conservation of birds. Biology Conservation. 36 (3).

*Physical alteration of the seabed*

Physical alteration of the seabed is likely to occur during construction due to dredging, pipe-laying and anchor handling. However, since the pipelines do not pass directly through any of the nature conservation areas in ESR V, physical alteration of the seabed is not predicted to occur and impacts on the nature conservation areas are deemed to be **insignificant**.

*Visual/physical disturbance*

Visual or physical disturbance from the movement of vessels during the construction phase may affect sea bird populations that are protected in South-east Rügen biosphere reserve and the Island of Usedom National Park. These nature conservation areas hold important populations of breeding and feeding waders and sea birds, including internationally important migrant populations (as detailed in **Section 9.7.9**). As noted above, the approximate distance at which disturbance occurs varies between species and depends on the nature of the vessel movement, but for the more sensitive species is typically 1 – 2 km whilst other species are much less affected. Pipe-laying is expected to progress at the rate of 350 m/day, therefore vessel movement will be relatively slow and the risk of disturbing sea birds will be low. In addition, sea birds will be used to vessel movement in this part of the Baltic Sea, as the pipelines follow an established shipping route.

As the Island of Usedom National Park and South-east Rügen biosphere reserve lie within 0.2 and 0.75 km of the pipelines' route respectively, the pipe-laying process is likely to cause some disturbance to flocks. However, the majority of bird species listed as occurring in these nature conservation areas are not sensitive to disturbance, and will be accustomed to vessel movements due to the busy shipping lanes in the Greifswalder Bodden. Disturbance to birds protected within the nature conservation areas may also occur when the birds are out of the boundary of the protected site. The majority of birds are not sensitive to disturbance. Cormorants, which are listed as present in South-east Rügen, are more sensitive(1). However, studies have shown that birds such as common scoter (which are also sensitive to disturbance) tend to avoid channels with high frequencies of shipping activity, even when these areas hold a high prey biomass(2). Overall, the impact of vessel movement on sea birds associated with the nature conservation areas in ESR V will be **negative** and **direct**, but **short-term** project construction and on a **local** to **regional** scale. Impacts will be **reversible** as it is expected they will cease after termination of disturbance from construction. Intensity will be **low as no** permanent change in the structure and the function of the conservation areas is concerned and

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(1) Garthe, S. and Hüppop, O. 2004. Scaling possible adverse effects of marine wind farms on sea birds: developing and applying a vulnerability index. J.ournal of Applied Ecology. 41.

(2) Kaiser, M.J., Galanidi, M., Showler, D.A., Elliot, A.J., Caldow, R.W.G., Rees, E.I.S., Stillman, R.A. and Sutherland, W.J. 2006. Distribution and behaviour of Common Scoter Melanitta nigra relative to prey resources and environmental parameters. Ibis. 148

the impact magnitude expected to be **low**. As nature conservation areas have a **high** value/sensitivity, impact significance is expected to be **moderate** for the two nature conservation areas in ESR V.

**Impacts during the Pre-commissioning and Commissioning Phase**

Potential impacts upon nature conservation areas in ESR V during the pre-commissioning and commissioning phase are limited to noise and vibration impacts on fauna generated by pipeline flooding, pressure-test water discharge and commissioning.

*Noise and vibration*

Noise and vibration generated by the movement of pressure-test water within the pipelines during pipeline flooding and pressure-test water discharge, and by the movement of gas in the pipelines during commissioning, will only cause potential impacts on fauna in the immediate vicinity of the pipelines. However, as discussed in **Sections 9.7.7, 9.7.8** and **9.7.10**, impacts on marine benthos, fish species and marine mammals in the immediate area of the pipelines have been shown to be insignificant, therefore noise and vibration during pipeline flooding is also expected to have an **insignificant** impact on nature conservation areas within ESR V.

**Impacts during the Operational Phase**

In general, impacts during the operational phase will be similar to those during the construction phase, but to a much lesser extent. Potential impacts upon nature conservation areas in ESR V during the operational phase from natural gas movement in the pipelines are limited to noise and vibration. Impacts as a result of routine inspections and maintenance works include noise and vibration, re-suspension and spreading of sediments and physical alteration of the seabed. Visual and physical disturbance may also occur as a result of vessel movement.

*Increase in turbidity*

The re-suspension of sediments in the water column is possible in association with routine inspections and maintenance work. Routine inspections are not likely to cause any significant impacts, however maintenance work may require seabed intervention works of some nature. The extent of these impacts are likely to be much smaller than for the construction phase, but it is not possible to predict the frequency with which maintenance works will be required, nor the extent of seabed disturbance from these activities. However, as these works are likely to be short-term and localised, and much less pronounced than those of the construction phase, an increase in turbidity related to routine maintenance works will have an **insignificant** impact on the nature conservation areas of ESR V and its associated flora and fauna.

*Noise and vibration*

Routine inspections and maintenance works are expected to have an **insignificant** impact on nature conservation areas in terms of noise and vibration, since the scale of operations will be much smaller than that of the construction phase, and marine fauna are unlikely to be negatively affected.

As for the pre-commissioning and commissioning phase, noise and vibration generated by the movement of gas in the pipelines is expected to have an **insignificant** impact on the nature conservation areas in ESR V and its associated flora and fauna since impacts on marine fauna in the immediate area of the pipelines have been shown to be insignificant, as discussed in **Sections 9.7.7**, **9.7.8** and **9.7.10**.

*Physical alteration of the seabed*

Physical alteration of the seabed is also possible, associated with routine inspections and maintenance work, and again the extent of these impacts will be smaller than for the construction and pre-commissioning and commissioning phases. Since both of the nature conservation areas are not within the pipelines' route, physical alternation of the seabed is expected to have an **insignificant** impact on the conservation areas in ESR V and its associated flora and fauna.

*Visual/physical disturbance*

There will be a low level of vessel movement associated with routine inspections and maintenance work which may result in low level visual or physical disturbance to the sea birds associated with the nature conservation areas in ESR V. Routine inspections are considered to have a limited impact upon sea birds associated with the conservation areas, especially as vessel movement is common in the area. As these works will be infrequent, and on a much smaller scale than that of the construction phase, the impact on these birds associated with the nature conservation areas in ESR V is deemed **insignificant**.

**Impact Summary**

The impacts identified and assessed in ESR V on nature conservation areas are summarised in **Table 9.92**.

**Table 9.92 Impact summary table for nature conservation areas in ESR V**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Nature Conservation Areas - Ecological Sub-Region V | Increase in turbidity | Seabed intervention works | Negative | Direct | Regional | Short-term | Medium | Medium | High | Reversible | **Moderate** |
| | | Pipe-laying | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | Noise and vibration | Boulder removal, Wreck removal, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Seabed intervention works | Negative | Direct | Regional | Temporary | Low - Medium | Low - Medium | High | Reversible | **Moderate** |
| | | Pipeline flooding, Pressure-test water discharge, Commissioning | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | - | - | - | - | - | - | - | - | **Insignificant** |
| | Physical alteration of the seabed | Seabed intervention works, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Routine inspections and maintenance | - | - | - | - | - | - | - | - | **Insignificant** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Visual/physical disturbance | Construction and support vessel movement | Negative | Direct | Local – Regional | Short-term | Low | Low | High | Reversible | **Moderate** |
| | | Support vessel movement (Routine inspections and maintenance) | - | - | - | - | - | - | - | - | **Insignificant** |

**Table 9.93 Summary of significant impacts for ESR V**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Water Column** | Increase in turbidity | Seabed intervention works | Negative | Direct | Local - Regional | Short-term | Medium | Medium | Low | Reversible | **Minor** |
| **Seabed** | Release of contaminants | Seabed intervention works, Anchor handling | Negative | Direct | Regional | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | Physical alteration of the seabed | Dredging | Negative | Direct | Local - Regional | Short-term - Long-term | Low - Medium | Medium | Low | Reversible | **Minor** |
| | | Sheet piling | Negative | Direct | Local | Short-term | High | Medium | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| | Release of pollutants from anti-corrosion anodes | Pipeline presence | Negative | Direct | Local | Long-term | Low | Low | Low | Irreversible | **Minor** |
| **Atmosphere** | Emissions of pollutant gases | Seabed intervention works, Pipe-laying | Negative | Cumulative | National - Transboundary | Long-term | Low | Low | Low | Irreversible | **Minor** |
| **Marine Benthos** | Increase in turbidity | Dredging, Pipe-laying (offshore) | Negative | Direct | Local | Short-term | Low | Low | Low – Medium/ High* | Reversible | **Minor/ Moderate*** |

| Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Dredging, Sheet piling, Pipe-laying (landfall) | Negative | Direct | Local | Short-term | Low | Low | Low - Medium | Reversible | **Minor** |
| Release of contaminants | Seabed intervention works, Pipe-laying | Negative | Direct | Local | Long-term | Low | Low | Low - Medium/ High* | Reversible | **Minor/ Moderate*** |
| Physical loss of seabed habitats | Wreck removal | Negative | Direct | Local | Long-term | Low | Low | Low / High* | Reversible | **Minor/ Moderate*** |
| | Dredging, Sheet piling, Pipe-laying (landfall) | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | Dredging, Pipe-laying (offshore) | Negative | Direct | Local | Short-term | Medium | Low | Low/High* | Reversible | **Minor/ Moderate*** |
| Smothering | Wreck removal | Negative | Direct | Local | Short-term - Long-term | Medium | Low | Low/High* | Reversible | **Minor/ Moderate*** |
| | Dredging, Pipe-laying (offshore) | Negative | Direct | Local | Short-term - Long-term | Low | Low | Low - Medium | Reversible | **Minor** |
| Physical alteration of the seabed | Routine maintenance | Negative | Direct | Local | Short-term | Low | Low | Low/High* | Reversible | **Minor/ Moderate*** |
| Introduction of secondary habitats | Pipeline presence | Negative | Direct | Local | Long-term | Medium | Low | Low - Medium | Irreversible | **Minor** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Fish** | Increase in turbidity | Seabed intervention works | Negative | Direct | Local | Short-term | Medium | Low | Low-High | Reversible | **Minor-Moderate** |
| | Release of contaminants | Seabed intervention works | Negative | Direct | Local | Short-term | Low | Low | Low-High | Reversible | **Minor-Moderate** |
| | Noise and vibration | Seabed intervention works, Pipe-laying, Anchor handling | Negative | Direct | Regional | Temporary | Low - Medium | Medium | Low-High | Reversible | **Minor-Moderate** |
| | | Construction and support vessel movement | Negative | Direct | Local | Short-term | Low | Low | Low-High | Reversible | **Minor-Moderate** |
| **Sea Birds** | Increase in turbidity | Seabed intervention works | Negative | Direct and indirect | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| | Noise and vibration | Seabed intervention works, Construction and support vessel movement | Negative | Direct and indirect | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| | Loss of seabed habitat | Boulder removal, Wreck removal, Seabed intervention works, Pipe-laying, Anchor handling | Negative | Direct and indirect | Local | Long-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Visual/physical disturbance | Construction and support vessel movement | Negative | Direct | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| **Marine Mammals** | Noise and vibration | Seabed intervention works | Negative | Direct | Regional | Short-term | Low-Medium | Low | Medium – High | Reversible | **Minor - Moderate** |
| | Ice breaking | Construction and support vessel movement | -/ Negative | -/Direct, Secondary | -/Regional | -/Short-term | - /Medium | -/Medium | -/High | -/ eversible | **No impact/ Moderate** |
| **Nature Conservation Areas** | Increase in turbidity | Seabed intervention works | Negative | Direct | Regional | Short-term | Medium | Medium | High | Reversible | **Moderate** |
| | Noise and vibration | Seabed intervention works | Negative | Direct | Regional | Short-term | Low - Medium | Low - Medium | High | Reversible | **Moderate** |
| | Visual/physical disturbance | Construction and support vessel movement | Negative | Direct | Local - Regional | Short-term | Low | Low | High | Reversible | **Moderate** |

* Values apply to the section of the pipelines' route which passes through the Boddenrandschwelle seagrass area

## 9.8 The Social and Socioeconomic Environment

This section considers the potential impacts of the Project upon the social and socioeconomic environment of the Party of Origin (PoO) countries, as described in **Chapter 8.** Potential impacts are identified on a Baltic Sea level and (where relevant) specific impacts to countries are outlined because the ESR concept adopted for the assessment of physical and biological impacts does not lend itself to the assessment of social and socioeconomic factors.

The project description (**Chapter 4**) has provided the basis for identifying potential sources of impact, while **Section 8.12** has been the source for identifying social and socioeconomic receptors and resources that may be impacted. The methodology for assessing the significance of social and socioeconomic impacts is as set out in **Chapter 7**.

Only those social and socioeconomic receptors that are sensitive to change and therefore may potentially be impacted by the Project have been included. These are:

- Fisheries
- Shipping and Navigation
- Tourism and Recreation
- Cultural Heritage
- Offshore Industry
- Military Operations

Regarding munitions on the sea floor, details concerning the location, type and number of munitions are provided in **Section 8.12.7**. However, in the context of this assessment of social and socioeconomic impacts, munitions are not considered as a discrete receptor sensitive to change, and are therefore not included in this assessment of social and socioeconomic impacts. The expected impacts from the planned detonation of munitions on all potential resources/receptors (e.g. impacts to fisheries, tourism and recreation as well as cultural heritage) are discussed in **Sections 9.8.1-9.8.6**. Potential unplanned (accidental) interactions with munitions are discussed in **Section 9.10.3.**

The main activities that will potentially impact on the social and socioeconomic environment will occur during the construction (i.e. munitions clearance, seabed intervention works and pipe-laying) and in the operational phases (i.e. routine inspections and maintenance) of the Project. The Project is not expected to have any significant impacts on the social and socioeconomic environment as a result of pre-commissioning activities, due to the short duration and very local scale of impacts. Impacts associated with decommissioning (see **Section 9.11**) are not addressed in this section owing to current uncertainty concerning the concept that will eventually be adopted for decommissioning (the project is committed to undertaking a specific assessment of impacts as part of the process for selecting the preferred decommissioning option).

During construction and operational phases, most social and socioeconomic impacts are anticipated to be of low (minor or insignificant) significance. This is due to the substantial body of experience gained from implementation of major subsea developments worldwide and the incorporation by Nord Stream of mitigation measures into the design and implementation of the Project. For example, Nord Stream will issue a ‘Notice to Mariners’ on the Project’s installation activities to the national coast guards throughout the construction period. This will allow ships and fishermen to plan ahead and avoid impacts from construction activities.

### 9.8.1 The Social and Socioeconomic Environment – Fisheries

**Overview**

Fishing is a culturally and commercially important activity for many communities around the Baltic Sea. It is regarded as both an important part of community identity and source of food and income. The industry is shaped by a number of factors including the species caught, fluctuations in stock size, seabed morphology, demographic and socioeconomic patterns, technological innovations and the management regime (see **Section 8.12.1** for further information).

The Baltic fishing industry is transnational. Publically available information on the geographical focus and the fishing patterns of each of the fleets of the Baltic countries has been updated from ICES data where available and through studies commissioned by the Project. However, the adaptability of fishermen to alter their fishing patterns to accommodate the presence of the two Nord Stream pipelines on the seabed is currently not well understood. Compensation for economical loss to fishermen caused by temporary fishing restrictions and damage to vessels and gear in described in the construction and operation phases below.

To understand the adaptability of the fishermen better, Nord Stream has embarked on a consultation programme with fisheries’ representatives to delineate the level of constraint that the pipelines will impose on current commercial fishing patterns and practices and the extent to which these can be adapted to accommodate the permanent presence of the pipelines. This current uncertainty concerning an activity that is practiced throughout the Baltic Sea calls for a precautionary approach to be adopted towards the assessment of the significance of the associated impacts.

Activities and associated impacts that have been assessed are as follows:

*Construction phase*

- Munitions clearance, construction activities and imposition of exclusion zones resulting in:
  - Restriction on navigation for fishing vessels
  - Disruption of current fishing patterns

*Operational phase*

- Vessel movements associated with routine inspections and maintenance resulting in:
  - Restriction on navigation for fishing vessels
  - Disruption of current fishing patterns
- Pipelines' presence on the seabed resulting in:
  - Disruption of current fishing patterns
  - Damage to fishing equipment

**Impacts during the Construction Phase**

A combination of both natural and anthropogenic influences and in particular, pressures from fisheries has lead to a situation where most of the fish stocks in the Baltic Sea are exploited to the limit or in some cases beyond the limit, resulting in uneconomically sustainable populations. The cumulative effects of these influences and the addition of the impacts of the construction phase of the Nord Stream Project may potentially contribute to negative effects on commercially important species in the Baltic Sea.

*Restriction on navigation for fishing vessels*

Project construction activities, including pre-lay surveys, munitions clearance, seabed interventions works, pipe-laying and hyperbaric tie-ins, will result in increased vessel movements along the pipelines' corridor. These Project vessels may potentially hamper the normal passage of trawlers and other fishing vessels as they travel to and from their target stocks.

All identified conventional munitions that lie within 25 metres of the planned pipeline's route will be cleared by detonation. In this regard, it is planned to clear 31 conventional munitions identified in the Finnish EEZ and one munition identified in the Swedish EEZ, most likely in the first or second quarters of 2009. Munitions surveys are currently ongoing in the Russian EEZ, and it is assumed that some munitions will be identified for clearance. These munitions will be cleared using the most proven methods available, mirroring those methods currently used to dispose of munitions in the Baltic Sea, as operated by the navies of Sweden, Finland and Estonia.

A single vessel (approximately 50 m long) will be employed to undertake the work with the assistance of an ROV (Remotely Operated Vehicle). During the munitions clearance process, the ROV will be used to lay an explosive charge next to the device. The vessel will then retreat to a safe distance (approximately 500 m) before detonating the munitions. An exclusion zone will be put into affect around munitions clearance sites and is expected to extend 3.5 km (approximately 2 nautical miles) from the detonation point. All exclusion zones in the Gulf of Finland will be coordinated through Gulf of Finland Mandatory Reporting System (GOFREP). This exclusion zone will result in a limited **direct** and **negative** impact on the fishing vessel navigation. The duration of impact at any single clearance site is predicted to be **short-term** (a few hours) and the scale of the impact will be **regional** as the exclusion zone will have a radius of greater than 500 m. The impact will be **reversible** since there will be no noticeable effect once munitions clearance is complete. The intensity of the impact is considered to be **low** as there will be no permanent change in passage and most fishing vessels will be able to avoid the exclusion zone without significant deviation from their passage. The magnitude is therefore considered to be **low**. Taking into consideration that the value/sensitivity of the fishing industry in the Baltic Sea is **medium,** the imposition of the proposed munitions clearance exclusion zone is expected to have a **minor** impact on fishing vessel navigation. On occasion the exlusion zone around muntions clearance sites in the Gulf of Finland will extend into the Estonia EEZ.

Seabed intervention works will comprise a number of discrete activities that will be carried out before and after the laying of the pipelines, such as trenching, rock-placement and the laying of special support structures (see **Section 4.5**). Typically, one to two vessels are involved in these activities, depending upon the scale of the intervention at any particular time. Pipe-laying operations will involve a lay barge which will either be anchored or dynamically positioned as it progresses along the pipelines' route. Anchor-positioned lay barges will be supported by two to six anchor laying vessels which will operate between one and two kilometres from the pipe laying barge. In addition, the lay barges will require the support of a number of surveying vessels and a single supply vessel. During pipe-laying, the barge will proceed at a speed of approximately two to three kilometres per day. It will take approximately six months for each pipeline to be laid.

To ensure minimum interference with construction operations from other sea traffic, an exclusion zone will be established around the lay vessel, typically extending 2.5 to 3 km from the lay barge. Unauthorised ship traffic, including fishing vessels, will not be permitted to enter this zone. This exclusion zone might therefore further hamper the passage of fishing vessels navigating to and from their target fish stocks. This exlusion zone will extend into the Estonian EEZ at some locations in the Gulf of Finland.

Nord Stream will issue a "Notice to Mariners" on the Project installation activities to national coast guards throughout the period of construction. The maritime authorities will be kept continuously informed on the progress of installation. The coast guard will inform vessels, including fishing vessels, of ongoing activities and traffic limitations, such as exclusion zones, through various media, e.g. broadcasts on Navtext. This will enable fishing vessels to plan ahead and avoid construction activities, ensuring that any disruptions are within the range of normal navigational conditions that would typically be experienced in shipping routes.

These navigational impacts are anticipated to occur anywhere along the pipelines' route, but are likely to be more frequent in the vicinity of where the pipelines' route crosses the main approach channels to the target fishing areas. The impact will be **direct** and **negative**. The duration of impact at any single location is predicted to be **short-term** as the lay barge will progressively traverse along the pipelines route at a rate of 2-3 km per day (passing each location twice for installation of the two pipelines) and the scale of the impact will be **regional** as the exclusion zone will have a radius of up to 3 km from the lay barge**.** The impact will be **reversible** since there will be no noticeable effect once the lay barge has moved on. The intensity of the impact is considered to be **low** as there will be no permanent change in passage and most fishing vessels will be able to avoid the exclusion zone without significant deviation from their passage. The magnitude is considered to be **low** as the changes will not lead to long term and widespread damage to fishermen or fish stocks. The value/sensitivity is **medium** reflecting the importance of the fishing industry to the Baltic Sea states. The presence of project vessels and the imposition of the proposed exclusion zone are therefore considered to have a **minor** impact on fishing vessel navigation.

*Disruption of current fishing patterns*

The cumulative effect of natural and anthropogenic influences and the addition of any impacts resulting from the operation phase of the Nord Stream Project may contribute to negative effects on commercially important species in the Baltic Sea. During construction, Nord Stream will arrange compensation for economical loss caused by temporary fishing restrictions.

As described above, seabed intervention works will comprise a number of discrete activities that will be carried out before and after the laying of the pipelines, such as trenching, rock-placement and the laying of special support structures (see **Section 4.5**). Other construction phase works that will disturb the seabed will comprise munitions clearance, offshore pipe laying and anchor handling. These activities will give rise to a range of impacts that are described for each ESR in **Sections 9.3** to **9.5**. Impacts to fish are assessed in detail in these sections and the principal implications for fisheries are summarised as follows.

As identified above, 31 conventional munitions will be cleared by detonation in Finland, while one such device will be cleared in Sweden. Munitions surveys are currently ongoing in Russia. As discussed in **Sections 9.3** to **9.5**, based on research undertaken by the Swedish Defence

Research Agency, the shock waves associated with munitions clearance are anticipated to result in significant kills of Baltic herring, sprat and cod within a radius of up to 1.5 km from the detonation, whereas salmon and sea trout are only expected to be affected in the close vicinity of the detonation. This has resulted in impacts to fish from munitions clearance events being assessed to be of minor to moderate significance. However, these impacts will be restricted to a discrete number of detonations in Finland and Sweden. In each case the affected area will be a maximum of 1.5 km radius of the detonation event and fish are expected to return to the area following the event. Fishermen will therefore be able to resume normal fishing activities in the area soon after the event and the effect on catches are not expected to be significant. The impact of munitions clearance on fishing patterns is therefore assessed to be **insignificant**.

As discussed in **Sections 9.3** to **9.7**, noise and vibration and increased turbidity associated with seabed interventions works, pipe-laying and anchor handling and hyperbaric tie-in activities will lead to avoidance reactions in fish which will result in minor to moderate impacts on fish in the immediate vicinity of the pipelines' corridors during the short period of construction activity. However, fish will return to the area once the disturbance has ceased and turbidity has returned to normal (a matter of one or two days). The area affected will be limited to the pipelines' corridor and the duration of the disturbance at any single location will be short. Impacts to fish spawning will be limited because of the precautionary measures that will be taken to avoid such areas during the spawning seasons. Fishermen will therefore be able to avoid construction activity areas without significant disruption to their normal fishing patterns and the impact of pipeline construction activities on fishing patterns has therefore been assessed to be **insignificant.**

**Impacts during the Operational Phase**

*Restriction on navigation for fishing vessels*

It is possible that survey vessel movements and maintenance and repair operations on the pipelines' foundations during the operational phase will restrict the passage of fishing vessels. During the first few years of operation, a survey vessel will conduct an external inspection of the pipelines once every one or two years. The vessel will be equipped with various types of sensors, such as cameras and scanners, to inspect the general condition of the pipelines and to detect leaks. It is possible that these inspections will lead to intervention works to ensure that the pipelines remain stably grounded on the seabed. Passage of fishing vessels may be interrupted during these activities. However, due to the small-scale and infrequent nature of these operations, their impact on navigation and passage of fishing vessels will be **insignificant**.

*Disruption of fishing patterns*

Maintenance and repair operations will cause avoidance reactions in fish. However, as described above for the construction phase, these impacts will be temporary, reversible and localised in nature. In addition, it is likely that any repair operations will be small-scale and infrequent. This means that the impacts on fishing patterns of operational phase inspection and maintenance activities will be **insignificant**.

The International Council for the Exploration of the Sea (ICES) is responsible for assessing the state of the Baltic Sea's commercial fish stocks. It is generally accepted that hydrographic-climatic variability i.e. low frequency of inflows from the North Sea, warm temperatures, as well as heavy fishing during the past 10 to-15 years have led to a shift in the fish community from cod to clupeids (herring and sprat) by first weakening cod recruitment and subsequently generating favourable recruitment conditions for sprat(1).

As discussed for the biological environment above, aggregations of commercial fish species around the pipelines may lead to increased fishing along the pipelines' route in order to create a more profitable fishery. This change in fishing patterns may subsequently result in overexploitation of commercial fish species along the pipelines' route. There has been, to date, little direct study of this phenomenon in the Baltic Sea. However, a study carried out along pipelines in the North Sea showed no measurable aggregation effect on commercial fish species along the pipelines(2). This would suggest that impacts to commercially important fish populations are unlikely to occur in the Baltic Sea as a result of the presence of the pipelines.

The presence of the pipelines on the seabed will permanently exert some form of restriction on fishing activities where the pipelines traverse through areas where bottom trawling is practised. Impacts will essentially be limited to bottom trawling activities as the use of passive gear such as gill nets, pound nets, Danish seine and longlines will allow the fishermen to select specific areas, even near the pipelines, without the risk of incidence or obstruction. Pelagic trawlers will be able to avoid the free spans by allowing sufficient distance between free span sections of the pipelines and the towed net.

The impact will only occur at those locations within the pipelines corridors where trawling vessels sweeping across the pipelines will need to lift their gear (those vessels sweeping in a traverse pattern across the pipeline corridors may need to lift their gear frequently) to avoid interaction with the pipelines. Experiences with numerous offshore pipelines in the North Sea have shown that fisheries and offshore pipelines are compatible. However, the pipelines in the North Sea only measure up to 42" in diameter and owing to the prevailing conditions tend to become partially buried. Also, the trawling equipment in the North Sea is different. Beam trawls are used for bottom trawling with boats that have a higher engine power and stronger pulling wires (trawl warps).

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(1) International Council for the Exploration of the Sea (ICES). ICES Journal of Marine Science Advice. 2008. http://www.ices.dk/committe/acom/comwork/report/asp/advice.asp (accessed December 17, 2008).

(2) Statoil. 1998. Tråltest over steinfyllinger på Sleipner kondensatrørledning 06.-14. juli 1998. (In Norwegian only)

Earlier studies into the risk of nets snagging behind pipelines[(1),(2),(3)] suggest a limited overtrawlability of the pipelines. A scale model study[(4)] in a flume tank at Sintef in Hirthals, Denmark by Ramboll commissioned by Nord Stream confirmed the results of these previous assessments. The overtrawlability of the pipelines depends on the angle and speed of crossing, type of trawl gear and the level of free span (distance between seabed and pipeline) available.

Apart from a risk of hooking fishing gear, there is also the issue that the vessels used in the Baltic Sea are not strong enough to trawl their gear over the pipelines. This forces them to lift their gear every time they cross the pipelines. If fishermen do not take precautions in these areas, they risk getting their gear hooked, or worse, losing it. The scale model results indicate that the pull-over forces when approaching the pipeline in a perpendicular manner are unacceptably high. The required pull-over forces depend on the top of the pipeline level relative to the seabed, board dimension and the angle of approach.

It is Nord Stream’s intention to minimise any potential impact on fishery activities in the vicinity of the pipelines. Therefore, within its framework of safety management, Nord Stream plans to educate and train fishermen in safe dealing with the pipelines and sensitive areas in their vicinity. Restriction zones will likely have to be imposed and will be permanent. In areas, where restrictions to fishing have to be imposed, mitigation measures are warranted. Nord Stream will follow the respective regulations regarding this issue and discuss them with fishermen’s associations and authorities.

Normal trawling practice is certainly disrupted in those areas where the pipelines’ protrusion (free span) above the seabed is in excess of 0.5 m (see **Figure 9.15** to **Figure 9.18** for the distribution of free spans along the pipelines’ route). The impact will only occur at those locations within the pipelines’ corridors where trawling vessels sweeping across the pipelines will need to lift their gear (those vessels sweeping in a traverse pattern across the pipeline corridors may need to lift their gear frequently) to avoid interaction with the pipelines. The results of the studies seem to indicate that the pipelines can pose an obstacle to bottom trawling when placed on the seabed. This disruption of normal trawling practice is expected to occur not only in areas where the pipelines’ protrusion (free span) above the seabed is in excess of 0.5 m but possibly also in areas with less free span or even where they lie on the seabed. Many of the locations destined for free spans are in any event currently unsuitable for bottom trawling

(1) Ministry of Petroleum and Energy (MPE). 1999. Summary of the Findings of a Norwegian Assessment Programme. Oslo.

(2) Valdemarsen, J.W. 1993.Tråling over 40” rørledning – virkninger på trålredskap. Trawling across 40” pipeline – effects on trawl gear. Havforskningsinstituttet. Fisken og Havet.

(3) Lange, K. 1995. Schleppversuche mit Grundschleppnetzen an der Gasleitung „Zeepipe“ im Bereich des deutschen Festlandsockels der Nordsee.

(4) SINTEF. 2008. Overtrawlability test on Nord Stream Pipeline in the Baltic Sea.

because of the rocky substrate inherent at these locations. This serves to constrain the scale of the impact.

The capacity of bottom trawling fishermen to adapt to the barrier effect of the pipelines' free spans is currently difficult to anticipate. A precautionary approach, based on this uncertainty, has led to an assessment of a **negative, direct** impact that is **irreversible.** The duration is **long-term** since, although it will be intermittent in nature, it is anticipated that it will be repeated at least for the operational life of the pipelines. The scale is **regional** to **national** reflecting the wide distribution of free spans along the overall length of the pipelines' route. The intensity is considered to be **medium** reflecting that trawling will be disrupted but not prevented from occurring in the area. The impact magnitude is therefore judged to be **low** since bottom trawler fishermen will be able to continue their method of catch and, provided that they know the exact location, anticipate the presence of a potential obstruction. However, taking into account the high level of uncertainty regarding the capacity of bottom trawler men to adapt to the barrier effect this magnitude could extend to **medium**. The impact, taking into account that the value/sensitivity of fisheries in the Project area is **medium** (see **Section 8.12.1**) is considered to be of **minor** to **moderate** significance.

Nord Stream's current fisheries consultation initiative aims to better delineate the extent of the impacts along the pipelines route and to identify any interventions that may be made to minimise impacts on commercial fishermen. In addition to the awareness campaign mentioned above, the preliminary mitigating measures considered include adaptation of the trawling gear, adjustment of pipeline design and restriction zones. In areas where restrictions to fishing have to be imposed, appropriate compensation for the respective economical loss may be necessary. Nord Stream will follow the respective regulations regarding this issue and discuss them with fishermen's associations and authorities.

*Damage to fishing equipment*

Experience gained from the extensive network of marine pipelines in the North Sea where intensive fishing in the presence of subsea pipelines has taken place over many years indicates that the occurrence of significant incidents involving fishing equipment and anchors snagging on pipelines is rare, since in most cases nets and anchors will be pulled over the pipelines without serious damage to either the pipelines or the fishing gear[1]. However, the situation in the Baltic Sea is different as explained in the preceding section. The studies commissioned by Nord Stream seem to indicate that the Baltic Sea pipelines will have a limited impact on fishery activities. Where trawl nets are pulled over a pipeline under certain angles and speeds, the gear may become snagged underneath one of the pipelines, thereby resulting in potential damage to fishing gear, disruption of the fishing vessel's course and, conceivably in the case of a snagged

(1) Institute of Marine Research. 2003. Trawling across 40" pipeline - effects on trawl gear.

anchor, potential loss of the vessel. A case in point is the ‘Westhaven’ incident in UK waters in 1997, when an attempt to retrieve hooked gear ended up with the loss of vessel and its crew.

In case of exceptional circumstances, compensation measures will have to be introduced for loss of catch or trawling equipment. These compensations should be paid regardless of the imposition of restrictions. Typical cases could be where:

- Fishing gear is damaged when trawling over the pipeline, although there is no fishing restriction
- Fishing gear is damaged or lost in a free span due to an unplanned event, i.e. engine failure leads to lowering of pelagic fishing equipment, which gets stuck under the pipeline

Nord Stream will establish a fund with the purpose of providing compensations in case of loss or damage of trawling equipment. The payments out of the fund will follow regulations set up by Nord Stream in co-operation with national fishing authorities.

In the event that fishing gear gets snagged and cannot be retrieved, the remaining ghost nets will have to be disentangled and removed. This ensures that a smooth surface of the pipeline is maintained. Incidents not be reported to Nord Stream will be detected during regular monitoring of the pipelines and will be resolved.

As discussed above, impacts are essentially limited to bottom trawling activities. The use of passive gear such as gill nets, pound nets, Danish seine and longlines will allow the fishermen to select specific areas, even near the pipelines, without the risk of incidence or obstruction. Pelagic trawlers will be able to avoid the free spans by allowing sufficient distance between free span sections of the pipelines and the towed net.

The sections of the pipelines’ route that are characterised by a large number of frees pans do not generally represent important fishing areas for bottom trawling because of the rugged terrain that is prevalent where most free spans are to be located. The approximate free spans have been mapped (see **Figure 9.15** to **Figure 9.18**). In these maps, the collection of light blue dots signifies the free spans.

The highest densities of free spans are planned in the Gulf of Finland and the pipelines’ corridors running alongside Gotska Sandön. Because of the undulating seafloor in these areas, supports will have to be constructed to support sections of the pipelines. In those sections, the pipelines lie intermittently in excess of 0.5 m above the seabed over considerable lengths. It is noted that no free spans are to be located near the favoured fishing areas around and south of Bornholm.

The alignments of the pipelines will be identified on admiralty charts, as will the locations of free spans. Vessels will therefore be able to minimise the likelihood of snagging their fishing gear (or anchors) on the pipelines by either avoiding trawling in the vicinity of free spans or by ensuring that nets and anchors are lifted when free span locations are approached. This notwithstanding, the pipelines may also attract fishermen to fish in the vicinity of the pipelines, because of the perceived higher abundance of commercial fish near the pipelines or rock fill as fish are known to aggregate near artificial structures on the seabed. For this reason, the Project may apply for permanent exclusion zones to be created around the free spans. The overall significance of the impact of the exclusion zones would ultimately depend on their size which would be set by the relevant National Authorities for each of the PoO. However, it is anticipated that impact significance would be similar in nature to the impacts caused by exclusion zones due to, for example, construction activities described elsewhere in this section. The main difference in the case of free spans is that restrictions due to construction would be temporary rather than permanent.

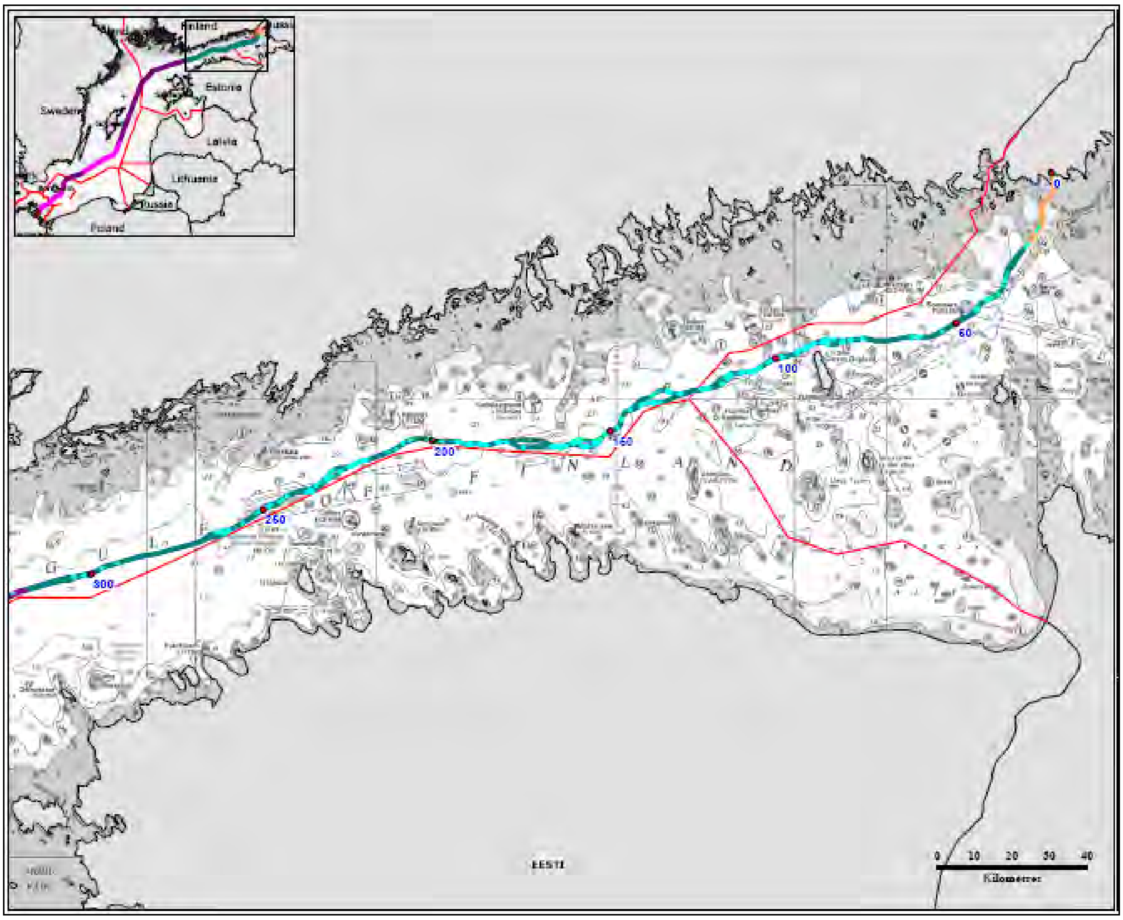


**Figure 9.15 Locations of pipeline free spans in the Russian and Finnish EEZs**

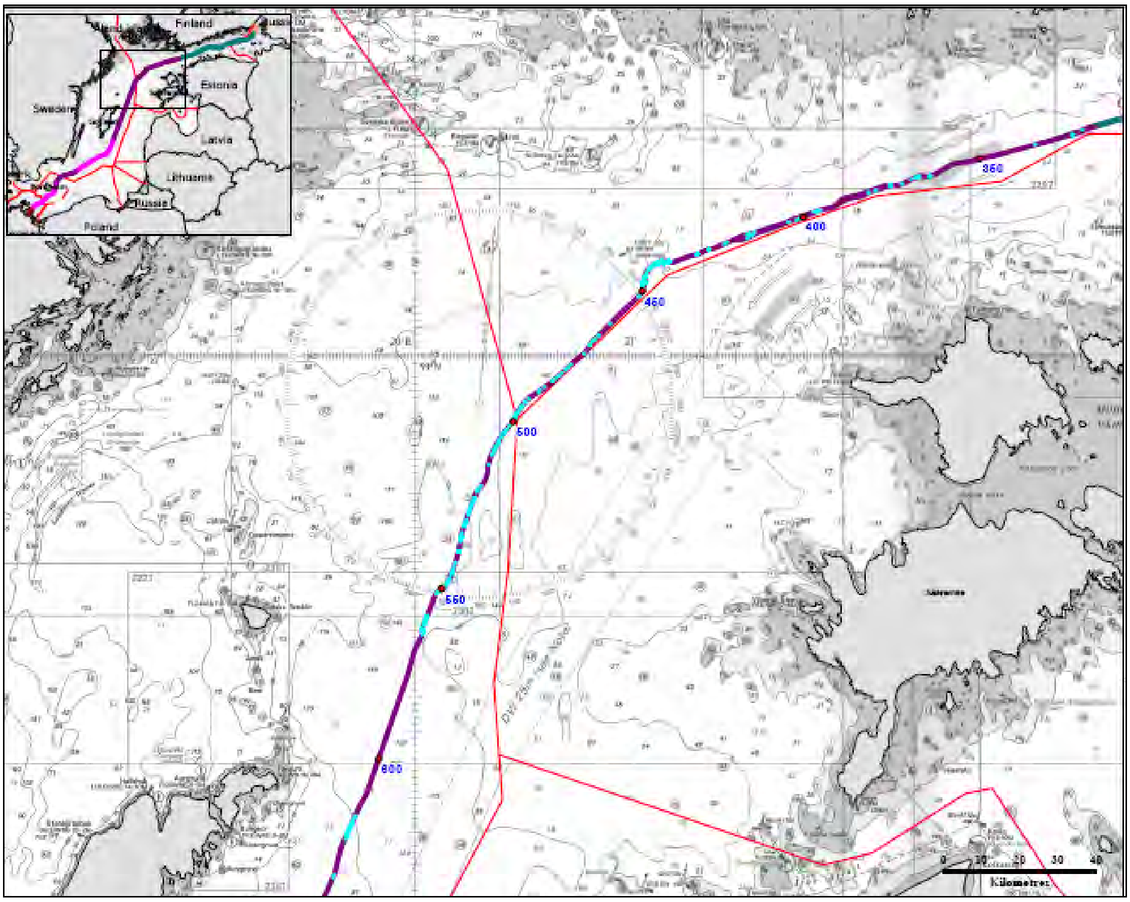


**Figure 9.16    Locations of pipelines free spans in the Finnish and Swedish EEZs**

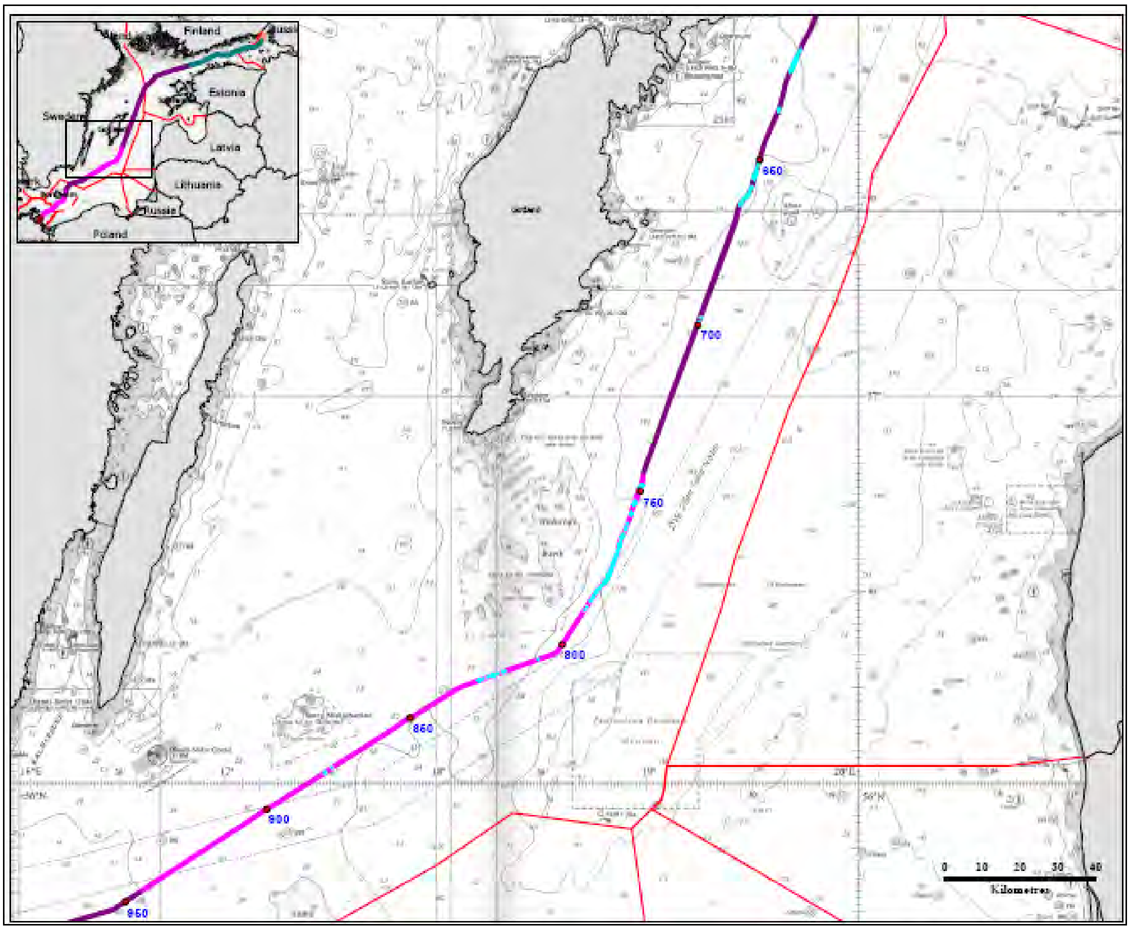


**Figure 9.17 Locations of pipelines free spans in the Swedish EEZ**

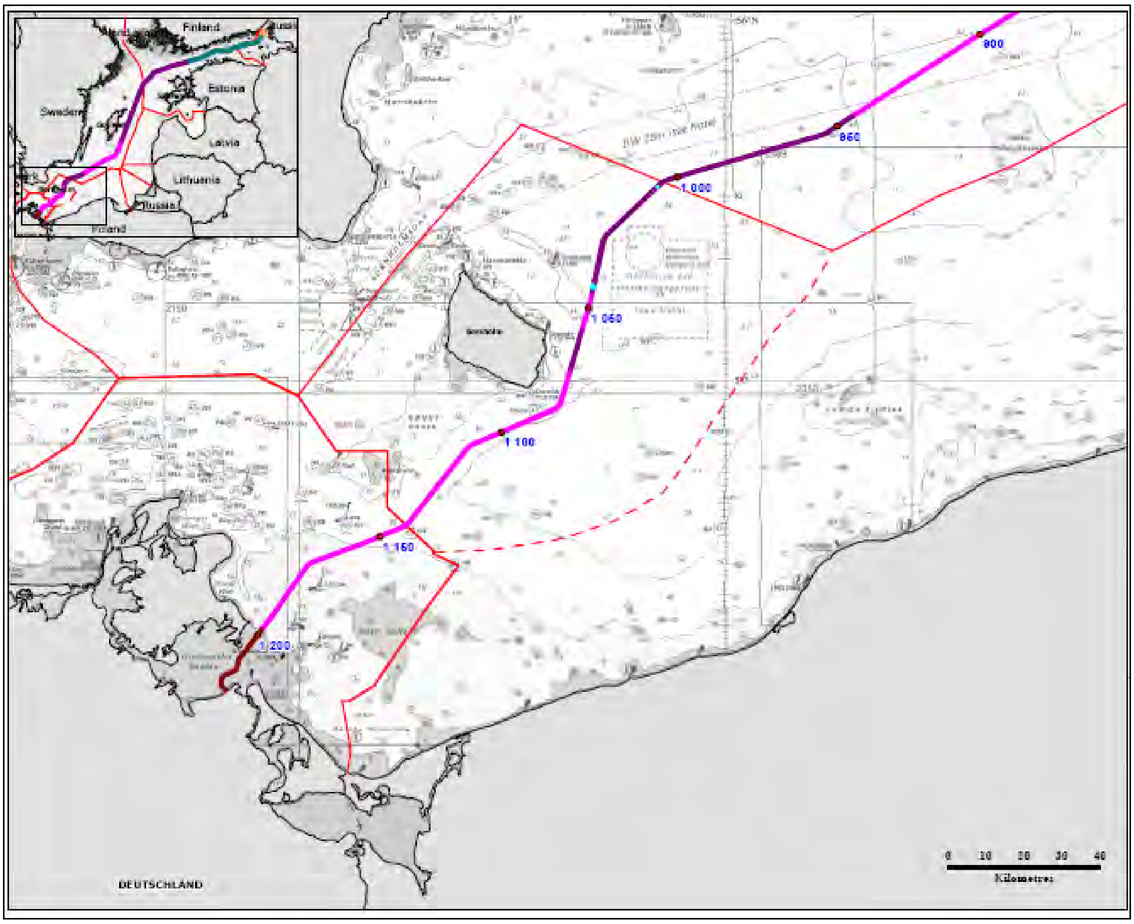


**Figure 9.18 Locations of pipelines free spans in the German and Danish EEZs**

The impact on fisheries as a result of damage to fishing gear will be **direct** and **negative** as it is possible that trawl nets (or anchors) may snag underneath the pipelines or support structures. The scale of the impact is **regional** but increased to **national** in Finland as it will affect bottom trawling activities in a large number of locations along the pipelines' route. The impact will be **irreversible** and the duration is **long-term** or **permanent** as the impact will persist for the operational life of the pipelines or beyond depending on the future decommissioning strategy. The impact intensity is **low** as the free spans have been marked and will be put on charts so that they should be avoided by the fishermen. The magnitude is **low** as the damage to the fishing gear will have only a temporary effect on the fishing activity (requirement for gear to be repaired or replaced). The value/sensitivity is judged to be **medium** since the value of damage caused will not be extensive. The overall impact therefore is considered to be **minor.**

### Impacts Summary

The impacts identified and assessed on fisheries are summarised in **Table 9.94**.

**Table 9.94 Impact summary table for fisheries**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Social and Socioeconomic Environment – Fisheries** | Restriction on navigation for fishing vessels | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Medium | Reversible | **Minor** |
| | | Construction and support vessel movements and Imposition of exclusion zone | Negative | Direct | Regional | Short-term | Low | Low | Medium | Reversible | **Minor** |
| | | Operations Phase support vessel movement (routine inspections and maintenance) | - | - | - | - | - | - | - | - | **Insignificant** |
| | Disruption of current fishing patterns | Munitions clearance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Construction and support vessel movement and Imposition of exclusion | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Operations Phase support vessel movement (routine inspections and maintenance) | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipeline presence | Negative | Direct | Regional – National | Long-term | Medium | Low-Medium | Medium | Irreversible | **Minor-Moderate** |
| | Damage to fishing equipment | Pipeline presence | Negative | Direct | Regional – National | Long-Term-Permanent | Low | Low | Medium | Irreversible | **Minor** |

## 9.8.2 The Social and Socioeconomic Environment – Shipping and Navigation

**Overview**

In terms of shipping movements, the Baltic Sea is one of the busiest seas in the world, connecting littoral States and countries beyond the Baltic Sea through the constant movement of commercial vessels, passenger ferries and leisure boats. On average, there are approximately 1,800 vessels in the Baltic Sea at any one time. There is little variation in levels of commercial shipping traffic throughout the year, although there is an increase in passenger ferries movements from June to August.

Shipping and navigation routes have been considered in the design and routing of the pipelines. These considerations include, to the extent feasible, the avoidance of known shipping lanes and anchorages so as to minimise the potential for disruption to shipping or increased risks of accidental vessel collisions or damage of the pipelines. In total, the pipelines cross eight Baltic Sea shipping routes. The ship movements on these routes vary from approximately 1000 to 53,000 vessels annually.

Project activities and associated impacts are assessed as follows:

*Construction phase*

- Munitions clearance, vessel movements associated with construction activities and imposition of exclusion zones resulting in:
  - Restriction on navigation for shipping vessels

*Operational phase*

- Vessel movements associated with routine inspections and maintenance resulting in:
  - Restriction on navigation for shipping vessels

**Impacts during the Construction Phase**

*Restriction on navigation for shipping vessels*

As identified in **Section 9.8.1**, 31 conventional munitions will be cleared by detonation in Finland, while one device will be cleared in Sweden. Munitions surveys are currently ongoing in the Russian EEZ. Clearance of these munitions will require the imposition of an exclusion zone, which will extend 3.5 km (approximately 2 nautical miles) from the clearance site for the duration of each detonation event. There is the potential, particularly in the Gulf of Finland, for this short duration exclusion zone to impact on shipping lanes, thereby requiring ships to divert their routes to avoid the exclusion zone. All exclusion zones in the Gulf of Finland will be coordinated through Gulf of Finland Mandatory Reporting System (GOFREP). The imposition of an exclusion zone will result in a limited **direct** and **negative** impact on the shipping vessel navigation. The duration of impact at any single clearance site is predicted to be **short-term** (a few hours) and the scale of the impact will be **regional** as the exclusion zone will have a radius greater than 500 m. The impact will be **reversible** since there will be no noticeable effect once munitions clearance is complete. The intensity of the impact is considered to be **low** as there will be no permanent change in passage and most vessels will be able to avoid the exclusion zone without significant deviation from their passage. The magnitude is therefore considered to be **low**. Taking into consideration that the value/sensitivity of shipping in the Baltic Sea is **medium** to **high** (Gulf of Finland), the imposition of the proposed munitions clearance exclusion zone is expected to have a **minor** to **moderate** impact on shipping vessel navigation. On occasion the exlusion zone around muntions clearance sites in the Gulf of Finland will extend into the Estonia EEZ.

Project related vessel movements and the imposition of the exclusion zone around the lay barge will impact on shipping and navigation during the construction period. The factors giving rise to these impacts are discussed in **Section 9.8.1** under the discussion on restricted navigation for fishing vessels. However, while the factors affecting impacts to shipping may be similar in principle to those affecting navigation of fishing vessels, there are certain distinct differences in how these factors contribute to impact significance. These are elaborated upon in **Box 9.2**.

**Box 9.2 Disruption to shipping traffic movements**

Disruption to shipping traffic movements may include:

- When the exclusion zone around the slow-moving lay vessel and the vessel carrying out trenching occupies a sailing route for background traffic, the ships will have to change course to keep clear of the exclusion zone.
- When the exclusion zone around the slow-moving lay vessel occupies a sailing route for background traffic, the ships will have to communicate with the fleet of service vessels accompanying the lay vessel and analyse their movements in order to avoid collision with these vessels.
- When a sailing route for the background traffic is located between the construction vessels and the project supply harbour, the background ship traffic will have to communicate with and analyse the movements of the fleet of service vessels accompanying the construction vessels in order to avoid collision with these vessels when they sail to and from the supply harbour.
- When commercial ship traffic leaves or visits ports in Bornholm, it will have to change course to keep clear of the exclusion zone around the pipe-lay vessel.

In addition, the contractor during construction will pay special attention to areas where shipping lanes and other heavy traffic areas are crossed. Certified pilots will be onboard the pipe-laying vessel during installation to monitor all third-party shipping. Standby vessels will perform watch duties. The anchor-handling tug may perform this activity and experienced crew will be available for watch duty at all times. The standby vessel will alert other vessels in the vicinity of the activities taking place and provide details of the exclusion zone coordinates. Any unexpected vessels "entering a closest point of approach radius" will be monitored closely, and actions will be taken to avoid incidents.

These navigational impacts are anticipated to occur principally where the pipelines route crosses or approaches the main shipping channels. The impact will be **direct** and **negative**. The duration of impact at any single location is predicted to be **short-term** as the lay barge will progressively traverse along the pipelines route at a rate of 2-3 km per day (passing each location twice for installation of the two pipelines) and the scale of the impact will be **regional** as the exclusion zone will have a radius of up to 3 km from the lay barge**.** The impact will be **reversible** since there will be no noticeable effect once the lay barge has moved on. The intensity will be **low** as shipping activity will be able to continue. The magnitude of the impact is considered to be **low** as there will be no permanent change in passage and most shipping will be able to avoid the exclusion zone without significant deviation from their passage. The value/sensitivity is considered to be **medium,** increasing to **high** in the Gulf of Finland, as the effective and unhindered passage of vessels in shipping lanes is of prime commercial and safety importance. The presence of project vessels and the imposition of the proposed exclusion zone are therefore considered to have a **minor** impact on shipping and navigation, increasing to a **moderate** impact in the Gulf of Finland. This exlusion zone will extend into the Estonian EEZ at some locations in the Gulf of Finland.

**Impacts during the Operational Phase**

*Restriction on navigation for shipping vessels*

Limited navigation due to increased vessel numbers may disrupt shipping traffic movements during the Operational phase of the Project and is described more fully in the 'Impacts on fisheries' section. This impact is considered to be **insignificant** due to the small-scale and infrequent nature of inspection and maintenance vessel activities.

As discussed in **Section 9.8.1**, it is possible that survey vessel movements and maintenance and repair operations on the pipelines' foundations during the operational phase will restrict the routing of shipping. During the first few years of operation, a survey vessel will conduct an external inspection of the pipelines once every one or two years. It is possible that these inspections will lead to intervention works to ensure that the pipelines remain stably grounded on the seabed. Where such activities take place within, or in the vicinity of, shipping lanes, the routing of shipping may be interrupted during these activities. However, due to the small-scale and infrequent nature of these operations, their impact on shipping and navigation will be **insignificant**.

**Impacts Summary**

The impacts identified and assessed for shipping and navigation are summarised in **Table 9.95**.

**Table 9.95 Impact summary table for shipping and navigation**

| Social and Socioeconomic Environment – Shipping and Navigation | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Restriction on navigation for shipping vessels | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Medium-High | Reversible | **Minor-Moderate** |
| | | Construction and support vessel movement and Imposition of exclusion zone | Negative | Direct | Regional | Short-term | Low | Low | Medium-High | Reversible | **Minor - Moderate** |
| | | Operational phase support vessel movement (routine inspections and maintenance) | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.8.3 The Social and Socioeconomic Environment – Tourism and Recreation

**Overview**

Tourism in the Baltic region is predominantly focussed on beaches, national parks, historic sites and coastal resorts offering recreational activities such as fishing and sailing. For several of the Baltic countries, tourism has seen rapid development in recent years. Further investment is planned and the growth of this sector is predicted to continue.

Activities and the associated impacts that have been assessed are as follows:

*Construction phase*

- Munitions clearance, construction activities and support vessel movements resulting in:
    - Noise and vibration
    - Restriction on navigation for tourism related vessels
- Re-suspension and spreading of sediments due to dredging resulting in:
    - Visual/physical disturbance

**Impacts during the Construction Phase**

*Noise and vibration*

The Project does not expect to have to carryout the clearance of munitions in close proximity to any tourist areas (see **Figure 9.19**). The Gulf of Finland (where 31 munitions that are identified for removal are located) is a popular tourist region, with many summer cottages located along the coast line. The munitions destined for removal in the Gulf of Finland are all located at a sufficient distance from the shoreline that their clearance will have an **insignificant** impact on tourism in that area.

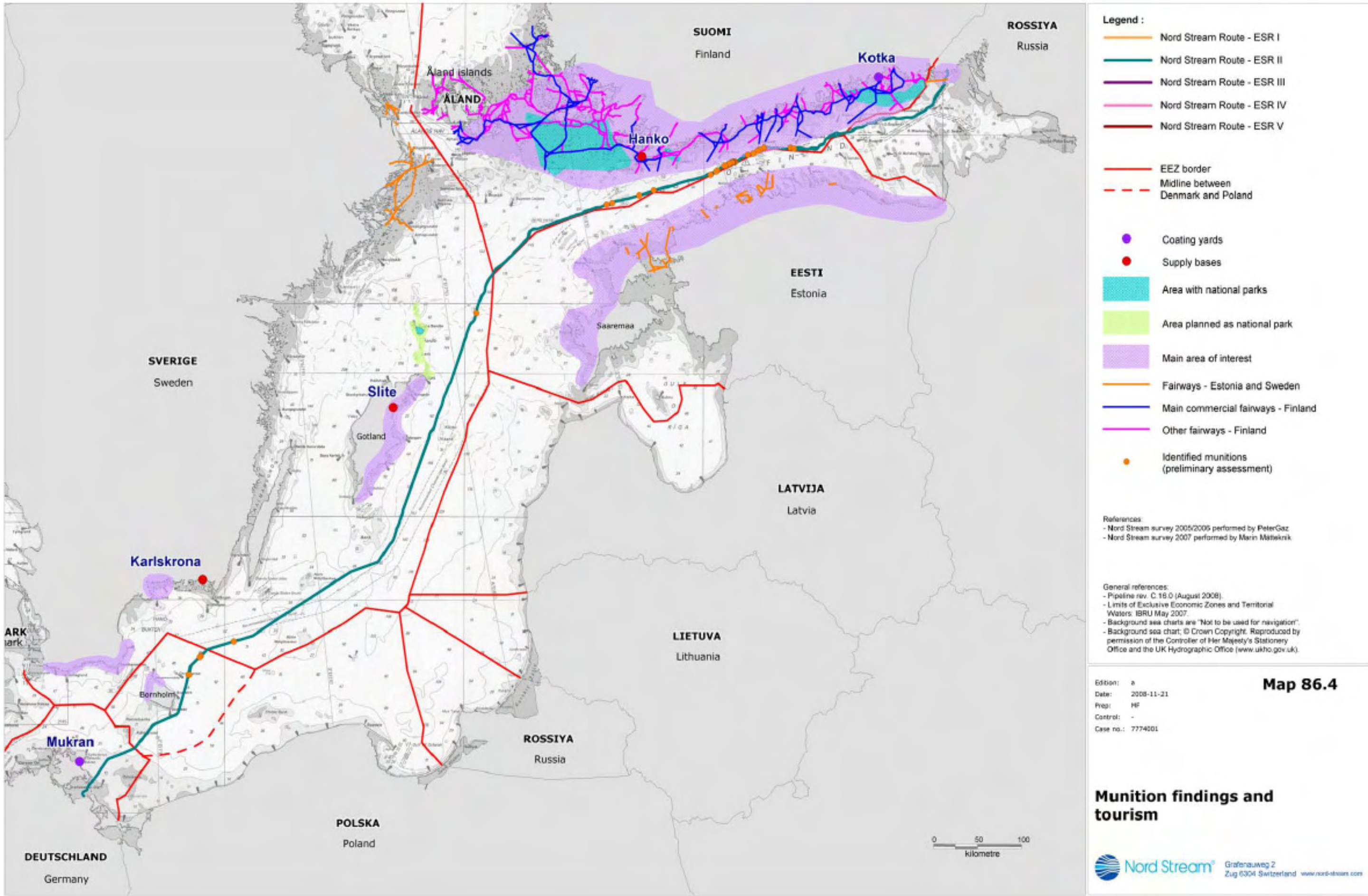


Figure 9.19 Munitions and tourism map

The Baltic Sea is associated with a high density of fishing, shipping and recreational boat users. Due to the high residual levels of vessel traffic in the Baltic Sea, the increased vessel traffic associated with the Project is expected to have an insignificant impact on existing background levels at sites of tourism interest. The guidelines used by some Danish municipalities on noise limits for construction works includes a noise limit for night time noise of 40 dB (A). As pipe-laying will take place on a 24 hour basis, this limit will be exceeded by approximately 1 dB at Snogebæk.

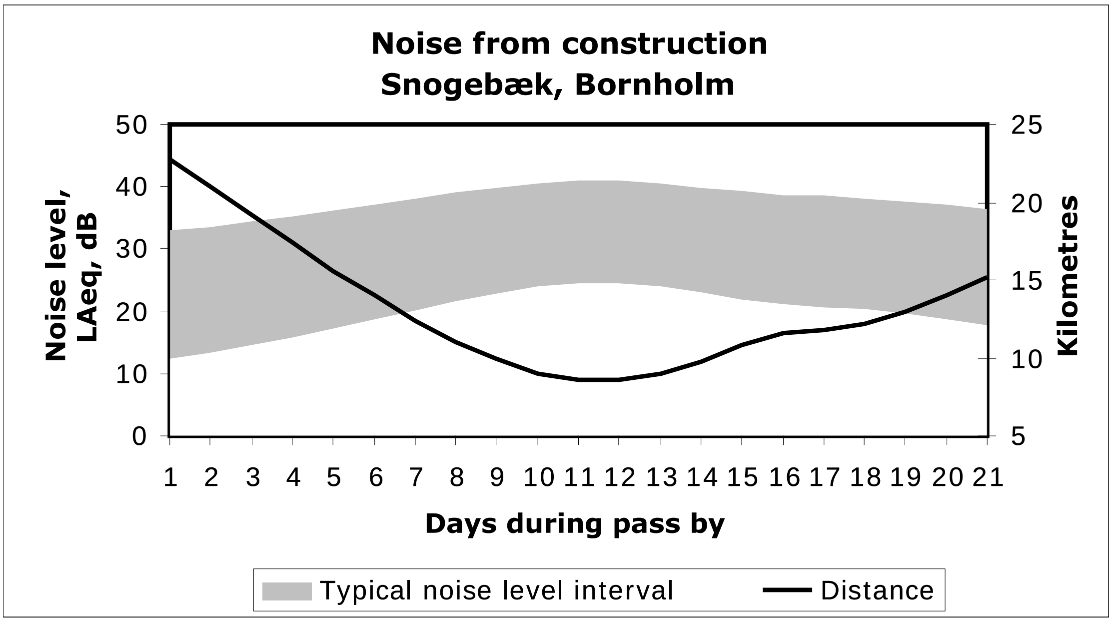


**Figure 9.20 Noise from construction activities**

The decibel strength range is shown gray as a spectrum. The thin line is the distance from the shore. “Days during pass by” refers to the time elapsed as the pipe-laying vessel associated support vessels move past a single point on the shoreline.

At all other locations on-shore in Russia, Finland, Denmark, Sweden and Germany (including Greifswalder Bodden) noise impact will be well below all identified local and national guideline limits on noise from construction works. Therefore the noise disturbance to recreation and tourism for the pipeline as a whole is considered to be **insignificant**.

*Visual/physical disturbance*

The residential area that is closest to the pipelines’ route, at a distance of 1.7 km is Thiessow, on the Island of Rügen, in the Greifswalder Bodden. The pipelines’ route will come in close proximity to various other residences and human settlements in the Baltic Sea, notably in the

Greifswalder Bodden and on the Island of Bornholm. The extent of increased concentrations of suspended matter resulting from Project activities in near shore sea areas of interest for recreation and tourism was assessed at the Russian landfall site and in the Bornholm basin, two locations where the pipelines approach areas of touristic interest.

Dredging at the Russian landfall site will have an adverse impact on the beaches and tourism as a result of an increase in sediment concentrations in near shore seawater. The sediment concentration is expected to exceed 10 mg/l for a period of 13 hours. Dredging in the Bornholm basin is not expected to have any adverse impacts on the beaches of Bornholm as the water in the basins is very deep and the sediments will not travel back to the beaches. This increase in sedimentation from construction activities is therefore expected to have an **insignificant** impact on tourism.

*Restriction on navigation for recreational vessels*

A potential impact upon tourism may result form the creation of a temporary exclusion zone around the Project vessels, which may negatively impact recreational boats and ferries that use the area. The Project exclusion zone will result in only a temporary area of exclusion as discussed in **Section 9.8.1** for fisheries and **Section 9.8.2** for shipping and navigation. Since notification will be provided in advance to port and shipping authorities, it is unlikely to have an impact on either ferries or tourist/sailing boats. The impact on navigation of recreational vessels is therefore considered to be **insignificant**.

**Impacts Summary**

The impacts identified and assessed for tourism and recreation are summarised in **Table 9.96**.

**Table 9.96 Impact summary table for tourism and recreation**

| Social and Socioeconomic Environment – Tourism and recreation | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Noise and vibration | Munitions clearance | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Construction activities and Support vessel movement | - | - | - | - | - | - | - | - | **Insignificant** |
| | Visual/physical disturbance | Seabed intervention works (dredging) | - | - | - | - | - | - | - | - | **Insignificant** |
| | Restriction on navigation for recreational vessels | Construction and support vessel movements and Imposition of exclusion zone | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.8.4 The Social and Socioeconomic Environment – Cultural Heritage

**Overview**

Sites of cultural heritage are those sites which represent a record of past or present human activity which are finite, irreplaceable and non-renewable. Cultural heritage sites have been considered in the design and routing of the pipelines. Cultural heritage sites potentially present in the Project area generally fall into two categories: ship wrecks and submerged stone age settlements and landscapes. The environmental conditions representative of the Baltic Sea (low salinity, temperature and oxygen content) are such that objects often decompose at a slow rate and usually remain well-preserved (see **Section 8.12.4**).The sensitivity of the cultural heritage in the Baltic Sea region is therefore considered to be **high** (see **Section 8.12.4**). Extensive surveys have been carried out along the pipelines' route to determine the presence, if any of submerged Stone Age settlements and landscapes (**Section 8.12.4**). None such settlements or landscapes were found and therefore the impacts of the Project on these will not be addressed in this section.

Activities and associated impacts assessed are as follows:

*Construction phase*

- Munitions clearance, wreck removal, seabed intervention works, pipe-laying, hyperbaric tie-ins and anchor handling activities resulting in:
    - Damage to shipwrecks

*Operational phase*

- Routine inspections and maintenance support vessel movement resulting in:
    - Damage to shipwrecks

**Impacts during the Construction Phase**

*Damage to shipwrecks*

Through a process of expert review and assessment, and the generation of dedicated ship wreck reports, the Project has been able to accurately identify the location of wrecks. Relevant authorities have been involved in these assessments and have been notified of the locations. The route of the pipelines has been optimised to minimise interactions with ship wrecks where necessary. The Project will employ specialised construction procedures, such as controlled-lay, to minimise effects on ship wrecks during construction. Nord Stream has also implemented a chance find procedure (**Box 9.3**) which outlines the process and protocol that will be followed in the unlikely event that an unexpected wreck is discovered during construction.

Due to the extensive surveying and close consultation with the relevant authorities in Germany and Russia the possibility of finding a previously undiscovered cultural heritage artefact is highly unlikely. Detailed survey data from within the Russian and German near shore areas, where dredging will be carried out has been provided to the relevant authorities for their own evaluation. This led to smaller re-routings in Russia whereas in Germany no re-routing was required. In Germany several areas of potential archaeological interest had been identified and were surveyed in detail.

During dredging at the landfall areas excavated sediment will be transferred to barges. If chance finds are made during the dredging works, the relevant authorities will be informed immediately. In some areas the pipelines will be trenched (by a plough) into the seabed. Any artefacts that become stuck in construction equipment will be hauled onboard to be catalogued and referenced. In addition, the relevant authorities will be informed.

**Box 9.3 Chance finds procedure**

All wrecks that have been identified during surveys have been mapped. The proposed pipelines' route has been selected to avoid all identified shipwrecks except for two; one in the German EEZ and one in the Finnish EEZ. The German Agency for Preservation of Monuments of the State of Mecklenburg-Western Pomerania has ruled that the shipwreck in German waters may be relocated once it has undergone careful documentation. The Project will finance the Agency's relocation of the ship to a lake in Germany of the Agency's choosing (see **Section 8.12.4**). The Finnish National Board of Antiquities has deemed that the wreck in Finnish waters is not of significant archaeological value. Therefore once documented, the wreck can be disturbed and the Project can continue with construction.

In Finnish waters the closest distance between a wreck and a known conventional munition is 530 meters. In Denmark the distance between a wreck and a known munition is more than 1200 metres. Therefore it is considered that there will be no impacts on wrecks associated with seabed intervention works, pipe-laying and anchor handling activities, or munitions clearance and therefore this impact will be **insignificant**.

The completion of an anchor corridor survey will help to further minimise impacts on cultural heritage. As set out in **Section 8.12.4**, the survey, which commenced in November 2008 and is ongoing in 2009, is necessary to ensure that neither placement of anchors nor sweep of the anchor wires will interact with cultural heritage artefacts on the seabed. During this survey, if an artefact of potential cultural value is detected then the following procedure will apply:

1. The location of the artefact will be mapped, and, if necessary, the object will be scanned and visually inspected by ROV.

2. In liaison with the relevant local authorities, the artefact under investigation will be identified and its cultural value determined.

3. The Project will take steps to avoid the cultural heritage artefact so that it is not damaged by construction and operation activities, such as seabed intervention works, pipe-laying and anchor-handling activities.

**Impacts during the Operational Phase**

*Damage to shipwrecks*

In the area South of Ertholmene the pipelines need to be inserted into the seabed by ploughing in order to protect the pipelines. If unacceptable free spans develop during the operational phase then seabed maintenance works may be required, and it cannot be excluded that placement of fill material will have to be carried out. Any kind of seabed intervention works, either intrusive (ploughing) or constructive (aggregate placement) may cause an impact on cultural heritage artefacts, if any such exist in the affected area.

Increased vessel traffic due to maintenance of the pipelines during the operational phase is expected to have no impact on cultural heritage. The maintenance vessels will not be anchoring in unsurveyed territory and all of the wrecks in the Pipeline Zone have been mapped. This impact is therefore **insignificant**.

**Impacts Summary**

The impacts identified and assessed for cultural heritage are summarised in **Table 9.97.**

**Table 9.97 Impact summary table for cultural heritage**

| Social and Socioeconomic Environment – Cultural heritage | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Damage to shipwrecks | Munitions clearance, Wreck removal, Seabed intervention works, Pipe-laying, Hyperbaric tie-ins, and Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Support and maintenance vessels (routine inspections) | - | - | - | - | - | - | - | - | **Insignificant** |

## 9.8.5 The Social and Socioeconomic Environment – Offshore Industry

### Overview

Existing and planned infrastructure in the Baltic Sea discussed in this section includes:

- Existing telecommunications power cables and pipelines
- Offshore wind farms
- Exploitation of natural resources, including mineral extraction, and exploration and production of new oil and gas resources

Existing telecommunications and energy cables exist on the seabed of the Baltic Sea and the proposed Nord Stream pipelines' route will cross several of these. Offshore industry has been considered in the design and routing of the pipelines. Reconnaissance surveys were conducted along the pipelines' routes by PeterGaz in 2005 and detailed ROV surveys undertaken as part of the detailed design were completed by Marin Mätteknik (a survey company specialized in high resolution marine survey) and DOF (a subsea engineering contractor) in 2008. A total of 18 distinct cables cross the pipelines' route (see **Section 8.12.5**).

A number of the Baltic countries have granted permission to developers to begin construction of offshore wind farms, although there are currently no existing wind farms in operation near the pipelines' route. The locations of the wind farms proposed for construction in the vicinity of the pipelines' route are identified in **Section 8.12.5.**

The Baltic Sea contains valuable mineral resources, including marine aggregates and oil and gas deposits. Several countries have issued permits for the extraction of aggregates or have identified areas with valuable natural resources in the vicinity of the pipelines' route. However, large-scale extraction of resources in these areas is yet to start.

Activities and associated impacts assessed in this section are as follows:

*Construction phase*

- Munitions clearance, seabed intervention works, pipe-laying, hyperbaric tie-ins and anchor handling activities resulting in:
    - Damage to existing cables on the seabed
    - Restrictions to current/future offshore developments

*Operational phase*

- Pipeline presence resulting in:
    - Restrictions to future offshore developments

**Impacts during the Construction Phase**

*Damage to existing cables on the seabed*

Potential impacts upon offshore industries during the construction phase as a result of munitions clearance, seabed intervention works, pipe-laying and anchor handling are mainly limited to potential impacts on those communication and electricity cables that currently cross the pipelines' route.

There are currently no munitions in close proximity to any identified existing or planned offshore industry sites or infrastructure (cables, wind farms, or aggregate extraction areas, see

**Figure 9.21**) and therefore the clearance of munitions is not expected to have any impact on this infrastructure. As a result of the surveys conducted by the Project (see **Section 8.12.5**) and careful route planning, cables have been avoided where possible and where this has not been possible they will be protected by cushioning[(1)] built around the pipelines. For this reason, the impact of the Project during the construction phase on underwater cables is considered to be **insignificant**.

(1) The technical solutions for protecting the cables and pipelines are discussed in **Section 4.5.3**. Crossings will be constructed to ensure that pipelines and cables remain a safe distance from each other. At most crossings, cables on the seabed will be covered/buried, and pipelines will be elevated and supported by concrete mattresses or rock berms.

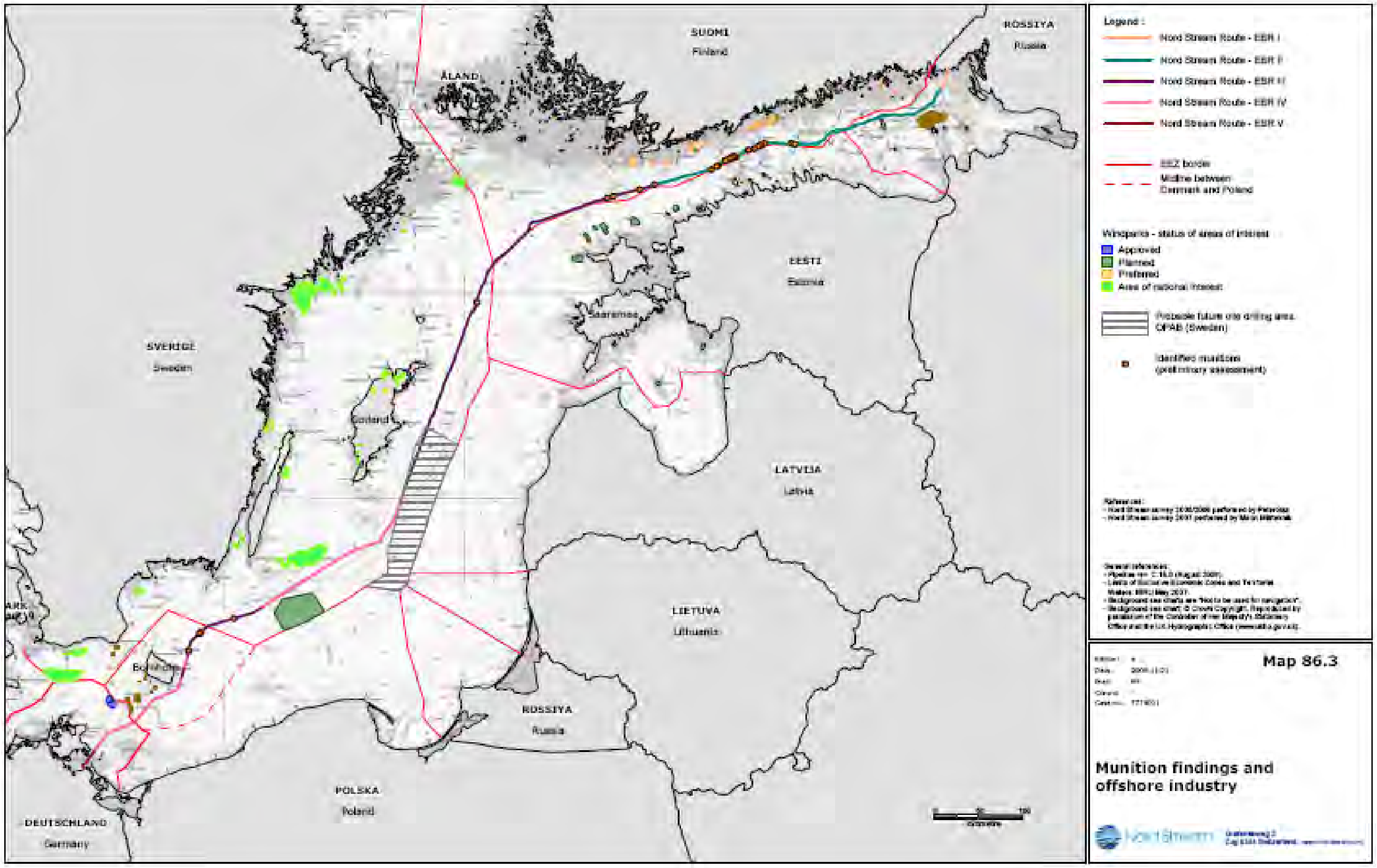


**Figure 9.21 Munitions findings and offshore industry**

*Restrictions to current/future offshore developments*

It is possible that construction activities will result in disruption to current and future mineral exploration and wind farm development. Presently, as can be seen in **Figure 9.21** there are no interactions expected between construction of the pipelines and existing mineral explorations and windfarms. There is also little mineral exploration activity taking place in the Baltic Sea within the vicinity of the pipelines' route (see **Section 8.12.5**). Project construction activities will be temporary and for this reason, the impact of the Project on oil and gas exploration, mineral extraction and wind farm development is considered to be **insignificant**.

**Impacts during the Operational Phase**

*Restrictions to future offshore developments*

Pipeline presence during the operational phase may also cause disruption to any planned future developments associated with oil and gas or mineral exploration. However, as discussed above, there is relatively little oil and gas exploration activity occurring in the Baltic Sea within the vicinity of the pipelines at present. Therefore disruption of future oil and gas or minerals extraction or new oil and gas pipelines due to the pipelines' presence is expected to be **insignificant.**

**Impacts Summary**

The impacts identified and assessed for offshore industry are summarised in **Table 9.98.**

**Table 9.98 Impact summary table for offshore industry**

| Social and Socioeconomic Environment – Offshore industry | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Damage to existing cables on the seabed | Munitions clearance, Seabed intervention works, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | Restrictions to current and future offshore developments | Munitions clearance, Seabed intervention works, Pipe-laying, Anchor handling | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Pipelines presence | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.8.6 The Social and Socioeconomic Environment – Military Operations

**Overview**

The Baltic Sea has long been a focus of military operations for Baltic nations and a strategically important arena for national and international security. As a consequence, the Baltic Sea is an important training ground for national military activities of many of the Baltic countries and therefore military operations are considered a receptor (see **Section 8.12.6**). None of the munitions that need to be removed are located in military practice areas.

Military operations are considered to be a receptor of **low** sensitivity due to the fact that they occur relatively infrequently, and military organisations will be able to plan around potential disruptions caused by the Project.

Activities and associated impacts assessed in this section are as follows:

*Construction phase*

- Construction and support vessel movements and imposition of exclusion zone resulting in:
  - Restriction of navigation for naval vessels
  - Damage to pipelines

*Operational phase*

- Routine inspections and maintenance support vessel movement resulting in:
  - Disruption of military operations
  - Damage to pipelines

**Impacts during the Construction Phase**

*Restriction of navigation for naval vessels*

During construction, the presence of construction related vessels could impede the undertaking of military training exercises in the vicinity of the pipelines routes. However, with careful forward planning it will be possible to avoid conflicting use of water space between the Project and the military. In addition, the potential for conflicts of water space in any single location will be of limited duration as the lay barge progresses along the pipelines corridor. For these reasons, the impact of seabed intervention works and pipe-laying activities on military operations is considered to be **insignificant**.

Another possible impact upon military operations during the construction phase could result from restricted movement of naval ships as a result of the imposition of the exclusion zone around the lay barge. Again, with careful forward planning it will be possible to avoid conflicting use of areas between the Project and the military. The impact of the exclusion zones on military operations is therefore considered to be **insignificant**.

*Damage to pipelines*

In each of the PoO countries, the respective militaries use parts of the Baltic Sea as firing ranges for bombing, torpedo launching and missile exercises. Due to the fact that the pipelines presence will put on admiralty charts and consultation will be carried out with each of the respective militaries, the impact is expected to be **insignificant.**

**Impacts during the Operational Phase**

*Disruption of military operations*

Impacts upon military operations during the operations phase of the Project could potentially occur due to disruptions caused by inspection vessels and seabed maintenance activities. As discussed previously in **Section 9.8.1** for similar disruption to fishing vessel navigation, the impacts are likely to be infrequent and **insignificant.**

*Damage to pipelines*

As with the construction phase, due to the pipelines' presence on admiralty charts and consultation with each of the respective militaries, the impact of damage to the operation of the pipelines from military activities is expected to be **insignificant.**

**Impacts Summary**

The impacts identified and assessed for military operations are summarised in **Table 9.99.**

**Table 9.99 Impact summary table for military operations**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Social and Socioeconomic Environment – Military operations** | Restricted navigation for naval vessels | Construction and support vessel movements | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Imposition of exclusion zone | - | - | - | - | - | - | - | - | **Insignificant** |
| | Damage to pipelines | Presence of pipelines | - | - | - | - | - | - | - | - | **Insignificant** |
| | Disruption of military operations | Operations Phase support vessel movement (routine inspections and maintenance) | - | - | - | - | - | - | - | - | **Insignificant** |

**Table 9.100 Summary of significant impacts on the social and socioeconomic environment**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Fisheries** | Restriction on navigation for fishing vessels | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Medium | Reversible | **Minor** |
| | | Construction and support vessel movements and imposition of exclusion zone | Negative | Direct | Regional | Short-term | Low | Low | Medium | Reversible | **Minor** |
| | Disruption of current fishing patterns | Pipeline presence | Negative | Direct | Regional–National | Long-term | Medium | Low-Medium | Medium | Irreversible | **Minor – Moderate** |
| | Damage to fishing equipment | Pipeline presence | Negative | Direct | Regional – National | Long-term Permanent | Low | Low | Medium | Irreversible | **Minor** |
| **Shipping and Navigation** | Restriction on navigation for shipping vessels | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Medium-High* | Reversible | **Minor Moderate** |
| | | Construction and support vessel movement and imposition of exclusion zone | Negative | Direct | Regional | Short-term | Low | Low | Medium - High* | Reversible | **Minor Moderate** |

* Values apply to the section of the pipelines' route which passes through the Gulf of Finland

## 9.9 Cumulative Impacts

### 9.9.1 Overview

This section discusses the potential for cumulative impacts associated with the Nord Stream Project. As detailed in **Section 7.4.2** and for the purposes of this discussion, cumulative impacts are defined as:

> *"Impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the Project (e.g. the combined effect of other pipelines in the general area – Baltic Sea)".*

Cumulative impacts from concurrent activities within the scope of the Nord Stream Project (e.g. cumulative impacts from pipe-lay and support vessels or from the fact that the proposed Project consists of two pipelines that will be built consecutively) are discussed as appropriate in **Sections 9.3** to **9.8**. This section focuses on the potential for cumulative impacts arising from the Nord Stream Project in conjunction with other third party activities in the Baltic Sea.

### 9.9.2 Cumulative Impacts from Construction of Third Party 'Static' Developments

**Section 9.8.5** has investigated the extent of third party activities in the Baltic Sea proposed or currently underway, which could be a source of cumulative impacts along with the Nord Stream Project. It has highlighted several proposed third party 'static' developments in the region that could be potential sources of cumulative impacts depending on the extent to which their construction phase overlaps with that of the Nord Stream Project:

- *Construction of new telecommunications, power cables and pipelines:* In addition to the 21 existing telecommunications and energy cables that exist on the bottom of the Baltic Sea, there are plans to run a fibre optic cable from Russia to Poland, through the Gulf of Finland. If this cable is approved, and depending on the extent to which the location of the cable route and the construction period coincides with the location and construction period of the Nord Stream Project, cumulative impacts associated with pipeline/cable installation on the seabed could arise. This could result, for example, in cumulative increases in turbidity levels in certain areas, or cumulative impacts from noise and vibration caused by the two projects. The significance of these impacts would, however, be dependent on the sensitivity of the particular resources/receptors in the affected area as well as the specific nature of the Projects' activities.

- *Development of offshore wind farms:* Although there are currently no existing offshore wind farms in operation close to the pipelines' route, a number of Baltic Sea countries have been given permission to begin construction of planned wind farms. Several of these wind farms will be built in the vicinity of the pipelines' route and therefore the potential for cumulative impacts exists. For example, infrastructure installation activities taking place alongside the Nord Stream Project could result in impacts to marine fauna from increased noise and vibration. As noted above, the significance of any potential cumulative impacts would, however, depend on the particular resources/receptors affected and the nature and location of the activities causing these potential impacts.

- *Exploitation of natural resources:* Several countries have issued permits for the extraction of aggregates or have identified areas in the Baltic Sea with valuable natural resources in the vicinity of the pipelines' route. However, large-scale extraction in these areas is yet to commence. Depending on the nature and location of these potential extraction activities, and the extent to which their construction could overlap with the Nord Stream Project's construction phase, cumulative impacts to resources/receptors could also occur in a similar manner to those mentioned above, e.g. in relation to increased noise and vibration and increased turbidity levels.

As outlined in **Section 9.8.5**, the potential for cumulative impacts to arise with these potential future developments is low on the basis that these developments are yet to take place, and thus can be designed to take the Project pipelines into consideration.

### 9.9.3 Cumulative Impacts on Shipping and Navigation

In addition to considering 'static' third party activities which could contribute to cumulative impacts alongside the Nord Stream Project, cumulative impacts could also occur in relation to shipping and navigation.

As discussed in **Section 9.8.2**, the Baltic Sea is one of the busiest seas in the world, with 1,800 vessels on average in the Baltic Sea at any one time. Shipping and Navigation is considered to be of low sensitivity in relation to the Nord Stream Project. It is, however, assessed as a more important issue during construction than operation due to the numbers of vessels required by the Project to service the construction process, which are considerably higher than those associated with activities once the pipelines are in operation.

However, if increases in shipping vessels related to Nord Stream occurred concurrently with increases associated with other developments, cumulative impacts could occur. This could be relevant, for example, if the Nord Stream construction exclusion zone overlaps with the exclusion zone of another project under construction or if an important fishing area is impacted by both developments at the same time. Such potential cumulative impacts will need to be taken into account at an appropriate time when the impacts to shipping and navigation from future third party activities are better understood.

### 9.9.4 Cumulative Impacts on $CO_2$ Emissions

The vessels used during the Nord Stream Project will produce emissions, contributing to atmospheric $CO_2$ levels. Such impacts are most likely to arise from the construction phase of the Project due to the larger numbers of vessels involved in comparison to the operational phase.

These potential cumulative impacts will occur on a transboundary scale and over a long duration. However, the significance of atmospheric emissions from the Project as a whole in comparison to existing emissions in the Baltic Sea is expected to be **minor**. Potential cumulative impacts are likely to be of similar significance.

## 9.10 Unplanned Events

### 9.10.1 Introduction

This section identifies the potential unplanned events associated with the Nord Stream Project together with an assessment of their respective impacts on the receiving environment. All unplanned events are described and the impacts of such events on resources/receptors in the physical, biological, social and socioeconomic environment are then assessed as per the methodology presented in **Section 7.4.8.**

In addition to the impacts associated with normal construction, pre-commissioning and commissioning, and operational activities, which are tightly controlled, impacts may also arise from unplanned or accidental events. These events are less predictable and may be damaging to the localised and wider environment when they occur.

The most significant potential unplanned events that are considered include:

- Fuel/oil spills
- Disturbance of munitions
- Pipeline failure

Unplanned events may be associated with normal activities during the three main phases of the Project. A fuel/oil spill can occur due to a malfunction or failure of equipment during bunkering or refuelling operations of Project vessels; or in a worst case scenario a large spill may occur due to a collision between a Project and a third party vessel. The disturbance of munitions that, despite the extensive surveys, have not been detected could result in the detonation of munitions or the release of chemical warfare agents into the water column. Damage to a pipeline that results in pipeline failure and subsequent gas release is a highly unlikely event, but nevertheless the possibility that it may occur during construction and operation still exists.

There is a potential for fishing gear to become snagged underneath the pipelines, resulting in potential damage to fishing gear, disruption of the fishing vessel's course and, conceivably in the case of a snagged anchor, potential loss of the vessel. The pipelines' locations on the seabed will be known to fishermen, and those who continue to fish along the pipelines' route will be aware of the potential impacts to fishing equipment. Therefore this issue has been addressed in the fisheries section of planned events (**Section 9.8.1**).

The pipelines have been designed and will be operated according to DNV OS-F101, *Submarine Pipeline Systems*, issued by Det Norske Veritas (DNV), Norway. This standard is currently used for many oil and gas marine pipeline designs in Danish and Norwegian North Sea developments and is also being used extensively on a global basis. The thickness of the pipelines' wall varies between 26.8 mm and 41.0 mm which, together with the three-layer polyethylene anti-corrosion coating and concrete coating (60 to 110 mm thick), means the pipelines can withstand all but the most severe impacts.

Unplanned impacts are considered in much the same way as predicted impacts, however, impacts are assessed by using an impact's significance (as for planned impacts) which is termed 'consequence' in this respect, and introducing the concept of probability to determine an impacts overall significance (see **Table 7.11**). As described in **Chapter 7** probability describes the likelihood of an event or incident actually occurring (e.g. likelihood of a fuel spill from construction vessels occurring) and the likelihood of a receptor and/or resource being present during the event or incident (e.g. the probability of fish being present in the impact area during an unplanned event or incident). The probability of an event occurring is classified as being low, medium or high based upon the data used in the risk analysis, **Chapter 5**. Impacts are assessed after any applicable mitigation has been implemented. In this section unplanned events are examined in terms of their impacts on all resources/receptors indentified in the Espoo Report.

### 9.10.2 Fuel/Oil Spill

**Overview**

Oil is present in shipping either because it is used for fuel or because it is transported in bulk. Oil in bulk comprises either oil products (e.g. diesel and petrol) or crude oil, which are mainly transported out of the Baltic Sea region. Smaller vessels are typically fuelled by diesel and larger ships by heavier fuel oils. Products used for propulsion are generally found in smaller quantities than oil in bulk. The quantity of oil used for the propulsion of a tanker is small compared with its bulk capacity. Nord Stream vessels will be fuelled by diesel. The pipe-laying vessel Castoro Sei has a fuel capacity of 3,122 $m^3$ diesel. Third party vessels (existing traffic) will be fuelled by both diesel and other classes of marine fuel oil. The term ‘fuel’ will be used when specifically referring to oil products, such as diesel.

An oil spill is most likely to arise during the construction of the pipelines when vessel movement is at its greatest. Potential incidents causing such an oil spill during construction include refuelling operations and accidental damage to vessels.

*Refuelling operations*

Spillage of fuel can occur through a malfunction or failure during bunkering/refuelling operations by a supply vessel, or through a damaged fuel tank. The transfer of fuel between supply and construction (pipeline installation) vessels offshore carries with it a risk of a spill due to either equipment failure (e.g. rupture of loading hose), or human error.

The most likely spill scenario involves a small volume of fuel released during loading operations. All such spills are relatively small and disperse naturally with minimal environmental impact. Although there is a probability of such an event occurring, Nord Stream will undertake measures to reduce the likelihood of such an event. The likelihood of such event occurring will be minimised by conducting refuelling operations in calm weather conditions and monitoring refuelling operations. The regular maintenance of storage tanks, hoses, valves and couplings, to ensure their fulfilment of all regulatory requirements for offshore use, will further minimise the probability of rupture or leaks.

*Accidental damage to vessels*

Major marine oil spills predominantly occur from the accidental damage of vessels. Nord Stream conducted assessments to establish the risk to the environment from third party vessel collisions with construction vessels, the grounding of construction vessels and vessel fires (**Chapter 5**).

Some construction vessels present along the pipelines’ route during the construction period have a limited manoeuvrability e.g. lay barges. This will in principle increase the probability of ship collision during the construction period and subsequently increase spill potential. In the event that the collision involves an oil tanker, there is clearly the potential, albeit of **low** probability, for a major oil spill. However, numerous measures to manage these risks will be implemented and these are discussed in **Chapter 5**. One such measure is the use of exclusion zones enforced around the construction vessels.

*Typical behaviour of oil spilled at sea*

Processes related to oil spills are very complex. The magnitude of the consequences will depend on the type (fuels will mostly evaporate and light crudes will spread fast to form a thinner film) and volume of oil that is spilled. The environmental settings determine the conditions under which oil is transported and degraded. The two major factors determining the fate of oil spilled at sea are meteorological parameters (air temperature, wind, sunshine, etc.) and hydrographical parameters (water temperature, currents, waves, etc.).

The following processes determine the fate of a spill:

- Spreading: After release, the oil spreads due to currents and wind. Typically spreading occurs to its greatest extent in the first few hours after a spill and after 24 hours is no longer an important factor in the behaviour of the spilled oil. In terms of containment and recovery, the maximum advantage is gained by an early response before the slick has spread to a large surface area and whilst its thickness is greatest

- Evaporation: The volatile fractions of the oil evaporate. The content of volatile fractions, the temperature and the wind speed are of importance. Crude oils consist of a mixture of many different hydrocarbons, usually with a high percentage of volatile components. Typically, the majority of aromatics (up to $C_9$) and n-alkanes (up to $C_{11}$) are lost in the first 10 hours by evaporation

- Emulsification: Most oil can absorb water and form a water-in-oil emulsion. The processes increase with energy input, meaning wave intensity. The stability of the emulsion depends on the asphaltaene content. If the content is higher than 0.5%, the emulsion tends to be stable

- Dispersion: Due to turbulence and wave activity, the oil will break up into droplets. The smallest droplets will be suspended over the entire water column. The process is also called oil-in-water emulsion

- Dissolution: The light components of the oil are soluble in water. However, they are also subject to evaporation, which is typically 10 to 100 times faster

- Oxidation: Oxidation due mainly to solar radiation can break down large molecules into smaller ones[(1)]

- Sedimentation: As the light components of the oil evaporate or dissolve in water, the density of the remaining portion increases. The oil also absorbs particulate material, which increases density. If the density of the oil exceeds the density of the ambient water, the oil

(1) International Maritime Organization. 2005. Manual on Oil Pollution. Sec. IV. Combating Oil Spill. London.

will sediment. This process is more often observed in fresh or brackish water since the density is lower than salt water

- Biodegradation: The oil can be degraded by microorganisms utilising the oil as a source of carbon or energy. This process depends on temperature and availability of oxygen and nutrients (nitrogen/phosphorus)

The relative importance of each process is shown in **Figure 9.22** - the width indicates the significance of the process against an indicative timescale.

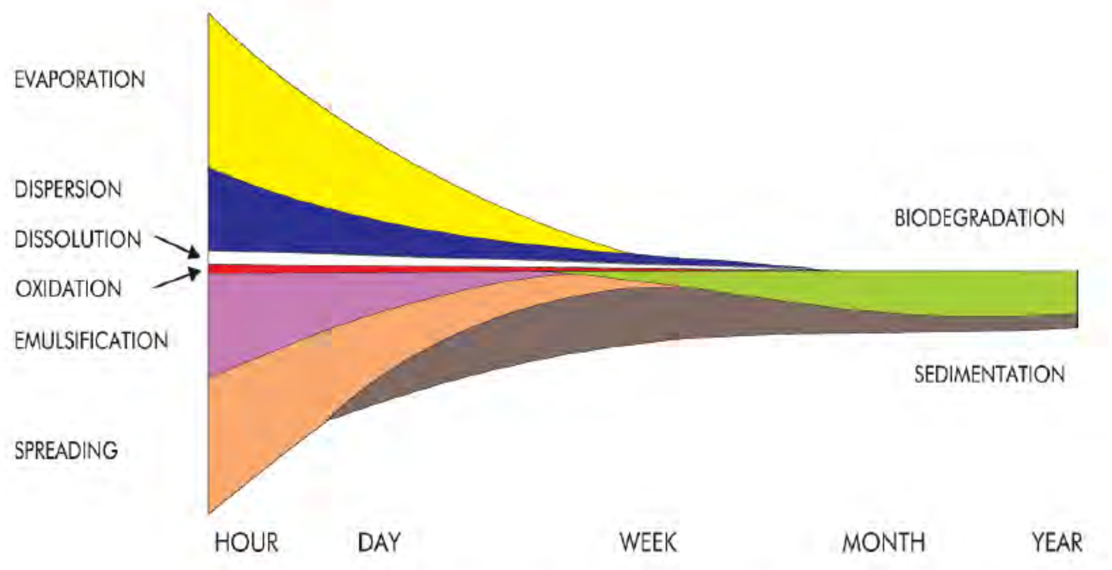


**Figure 9.22 Schematic presentation of the relative importance of processes acting on crude oil(1)**

*Oil spill modelling*

Although history suggests that oil spills from ship collisions are infrequent events, the possibility that an inadvertent oil spill could happen should not be ignored.

Oil spill trajectory modelling aids in understanding the fate of an oil spill and can be used to investigate a spill at a given location. The usefulness of the model will depend in part on its ability to simulate currents, wind and waves and oil weathering characteristics reliably. It also depends on the assumptions underlying a spill event, the type of oil released, when it is released, where and at what depth, and under what ambient conditions (e.g. weather, temperature and salinity).

(1) The International Tanker Owners Pollution Federation Ltd. 2002. Fate of Marine Oil Spills. Technical Information Paper. no 2.

To this end, Nord Stream commissioned Ramboll to undertake a study with the aim of identifying where oils spills are most likely to reach the land[(1)]. The premise of the stochastic modelling approach utilised is that:

- Those areas most at risk are the five points where the pipelines' route intersects with major shipping lanes
- An oil slick will last for up to two days after it is assumed that, in agreement with HELCOM Recommendation 11/13[(2)], the slick will be either contained, dispersed or picked up
- The probability of occurrence of a slick is calculated as the number of times that an oil slick is present at the end of two days in a particular grid point (measuring 1 nm by 1 nm) out of 100,000 slick trajectories modelled

The model assumed that oil spills occur at these five points, every five minutes. The spills were modelled as particles, which move according to average wind and current conditions. The model was run to represent a period of one year, over which time more than 100,000 oil spill scenarios were considered at each of the source locations. This drift analysis modelling was not carried out for a specific type of oil.

The model output suggests that under the assumptions made, there are a number of locations where spills of crude and fuel oil could actually reach the shore under adverse weather conditions (that occur on average between 1%-10% of an average year). These are:

- Rügen (east coast of Germany)
- Northern and Eastern shore of the Danish island of Bornholm

In addition to drift, it is also important to consider the decay of an oil spill. Spill scenarios were adopted (i.e. 20 $m^3$ and 500 $m^3$ diesel, 900 $m^3$ heavy fuel oil[(3)] and 2,000 $m^3$ crude oil) to identify the fate of an oil slick taking into account the predominant decay processes (evaporation, emulsification and dispersion). For this purpose, ADIOS2 software developed by NOAA[(4)] was used. While the validity of the models and the underlying assumptions can be debated the results indicate that up to 63% and 90% of the crude oil and heavy fuel oil respectively are still present in the water after 48 hours. The majority of the diesel, up to 93%, disperses and a minor

(1) Nord Stream AG & Ramboll. 2007. Memo 4.3A-7 - Accidental oil spill during construction.

(2) Helsinki Commission. HELCOM Recommendation 11/13 concerning the "Development of national ability to respond to spillages of oil and other harmful substances" adopted 14 February 1990.

(3) This spill volume corresponds to the actual spill volume of the Fu Shan Hai Bulk Carrier that sank after collision with another ship in 2003.

(4) US National Oceanic and Atmospheric Administration (NOAA). National Ocean Service, Office of Response and Restoration. http://response.restoration.noaa.gov (accessed October 5, 2007).

amount evaporates. Floating diesel will not be present 48 hours after the release. Diesel would not reach the shore owing to its high degree of dispersion and the typically smaller quantities in which it is released.

Probability of a major oil spill occurring is **low** based on the data provided in the **Chapter 5**. In the following sections, the unplanned event of a major oil spill is assessed for the physical, biological and social and socio-economic environment.

**Physical Environment**

In the following section the impact of fuel/oil spills on the physical environment is assessed for each of the following resources/receptors:

- Physical processes
- Water column
- Seabed
- Atmosphere

*Physical processes*

**No impacts** to the physical processes of the Baltic Sea (e.g. underwater current flows and water exchange) will result from the occurrence of a fuel/oil spill.

*Water column*

Fuel/oil spills have a **direct** and **negative** impact on the water column. A spill on the sea surface disperses from the source and starts to degrade. Some components of the spill would evaporate, losing part of its mass and causing the remainder to become denser and more viscous(1). A small percentage of water soluble components of the spill may dissolve in the water column. The residual spill can disperse almost invisibly in the upper water column or form a thick mousse. Parts of the spill may sink with suspended particulate matter and the remainder may eventually congeal into sticky tar balls. Over time, the spill deteriorates and disintegrates by means of photolysis and biodegradation. The rate of biodegradation depends on the availability of nutrients, oxygen and microorganisms, as well as temperature. The physical characteristics of the product spilled also determine the rate of degradation. Diesel for example, degrades at a greater rate than heavy fuel oil. Impacts associated with a major oil spill on the water column are expected to be of **national** scale and of **short-term** duration based upon the modelling undertaken (refer to **Section 9.10.2**). Impact intensity is likely to be **medium**, depending on the amount and type of oil released as well as the amount of dispersal and degradation that takes

(1) Nord Stream AG & Ramboll. 2007. Memo 4.3A-7 - Accidental oil spill during construction.

place. Impact magnitude is, therefore, **medium** and the overall value/sensitivity of the water column is **low** (**Chapter 8**). Impacts are **reversible**. Impact consequence is **minor.** Taking into consideration that the probability of a major oil spill occurring is **low**, the overall significance of an oil spill on the water column is **low**.

*Seabed*

The seabed can be negatively affected by sedimentation of fuel/oil from spills. As noted previously in the overview of **Section 9.10.2**, this occurs when lighter components of the fuel/oil evaporate, leaving denser components in the water column. However, while evaporation of a fuel/oil spill occurs at low levels, this process is also more often observed in fresh or brackish water since the density is lower than salt water [(1)]. Whilst it is unlikely that sedimentation of oils will occur, a very large oil spill, particularly in coastal areas with freshwater input, may cause sedimentation of oils e.g. in ESR I and V. It is also possible that a low level of oil sedimentation may occur due to oil adsorbing to sediment particles, however this is also not expected to occur at levels that are likely to cause notable damage to the seabed structure or function. Therefore, overall, the impact of fuel/oil spills on the seabed is expected to be **insignificant** since the sedimentation process is relatively unlikely.

*Atmosphere*

Fuel/oil spills can have a **negative cumulative** impact on the atmosphere due to evaporation of fuel or oil from the sea surface. Studies have shown that only a minor fraction (7%-15%) of diesel evaporates, with the remainder dispersing. Similarly, only 6%-7% of heavy fuel oil evaporates, with the majority dispersing or remaining in the water[(1)]. Evaporated hydrocarbons can have a negative impact on air quality and indirect negative impacts on a range of ecosystems through deposition in rainfall. However, the evaporated hydrocarbons will disperse over a larger area within a fairly short timescale, reducing the impact on the atmosphere's function. It is not expected that oil spills would be mitigated by controlled burning, as this would have a greater impact on the atmosphere than evaporation alone. Large spills (assessed to be of **low** probability) are expected to have impacts on a **national** scale and of **short-term** duration [(1)]. Impact intensity will be **low** due to the low levels of evaporation of the oil types used by ships associated with pipeline construction. Impact magnitude is **medium,** due to the scale on which the impact would operate. Impacts would also be also **reversible**, since air quality will return to its original level following dispersal of evaporated hydrocarbons. The environment will revert back to pre-impact status once the impact ceases. The value/sensitivity of the atmosphere is **low** (see **Chapter 8**). According to the criteria described in **Section 7.4.8**, impact consequence is **minor.** Since the probability of a major oil spill occurring is **low**, and the consequence is also considered to be **minor**, the overall significance of an oil spill on the atmosphere is **low**.

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(1) Nord Stream AG & Ramboll. 2007. Memo 4.3A-7- Accidental oil spill during construction.

**Biological Environment**

In the following section the impact of fuel/oil spills on the biological environment is assessed for each of the following receptors:

- Plankton
- Marine benthos
- Fish
- Sea birds
- Marine mammals
- Nature conservation areas

*Plankton*

The dynamics of the plankton community in the Baltic Sea are highly variable and occur on a large scale across the ESRs. The presence of contaminants in the water column as a result of a fuel/oil spill has the potential to affect plankton. Oil contains a variety of polynuclear aromatic hydrocarbons (PAHs) which are of particular concern, as plankton can take up PAHs and accumulate them and other contaminants in oil in their tissue(1). The potential effects to both zooplankton and phytoplankton are a function of the type of contaminant and the duration of exposure. Following a spill, both diesel and fuel oil will float to the surface of the water and a small fraction will sink to the seabed, as previously described. Plankton will be most at risk from toxicity as the contaminants associated with the fuel pass through the water column. However, diesel will evaporate relatively quickly from the surface and the impact to plankton will be less severe than that of oil which takes longer to evaporate.

Oil spills can limit the amounts of light absorbed by planktonic algae, killing off their cells. The declining quantities of microalgae reduce the amount of food available for zooplankton and other marine organisms(2). These changes may then be reflected further up the food chain e.g. in fish. The effects of oil pollution on plankton will be short-term in duration as these organisms can regenerate rapidly when conditions improve. A long-term study on plankton communities pre and post oil spills was carried out off the Galician coast. It showed an immediate decline in

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(1) Kelly, L.D., McGuinness,L.R., Hughes, J. E., Wainright, S.C. 1999. Effects of Phenanthrene on Primary Production of Phytoplankton in Two New Jersey Estuaries. Bulletin of Environmental Contamination and Toxicology. 63.

(2) Finnish Environnent Institute. The impacts of oil on the marine environment. http://www.ymparisto.fi/default.asp?contentid=170579&lan=en#a1 (accessed November 14, 2008).

plankton communities following spills[(1)], however, no long-term decline in abundance, diversity, or change in plankton community structure. Another study has shown that oil spills are typically followed by rises in bacterial and yeast numbers, temporary falls in zooplankton densities and increases in phytoplankton; however no lasting damage to planktonic ecosystems caused by oil were observed[(2)].

Spills of all types of oil and oil products will have a **direct** and **negative** impact on the plankton communities. Impacts associated with a small spill will have no significant impact on plankton as the fuel/oil will quickly disperse. Any impact on plankton as a result of a large oil spill is expected to be of **national** scale and of **short-term** duration. Impact intensity is **low** as no permanent change to the Baltic Sea's planktonic community is anticipated. Impact magnitude is **medium**. The value/sensitivity of plankton is **low** (see **Chapter 8**). Impact consequence is therefore **minor**. Impacts are **reversible**. Subsequently, the overall **significance** of an oil spill on plankton is **low**.

*Marine benthos*

In the event of a fuel/oil spill, only a small fraction of the fuel/oil spilled at the surface is ever likely to come into contact with the seabed and its associated benthos. Once the aromatic components (such as polycyclic aromatic hydrocarbons (PAH)) have evaporated, only the heavier fractions will remain in the water. These fractions could disperse or dissolve over the entire water column, or become oxidised, sediment out of the water column and become degraded by microorganisms. Diesel that dissolves or becomes an oil-in-water emulsion could cause toxic effects to the benthos and the emulsion could clog feeding organs of filter and suspension feeders.

The most likely spill to occur will be of a small volume of diesel during refuelling (approximately 5 - 10 $m^3$). Very little of this fuel is ever likely to sediment out of the water column so as to cause a detectable effect and therefore this impact is considered insignificant. However, a large oil spill (which is considered to have a **low** probability of occurring) may result in a much larger volume of oil oxidising and sedimenting out of the water column. If this was to occur, it is possible that the benthos could become smothered. Details of this type of impact are given in **Section 9.3.7**. The greatest effect of smothering to the benthos is likely to be from the resulting anoxic conditions and toxicity as a result of direct contact with the oil causing a **negative** and **direct** effect on the benthos. A large oil spill has the potential to generate an impact on a **national** scale. If smothering were to occur, sessile benthos would remain covered by the oil until it degraded. In this case, the benthic community would not recover until new individuals migrated

(1) Mendes, J.C., Johns, D.G., Richardson, A.J. 2005. Assessing the impact of oil spillages on plankton using the Continuous Plankton Recorder (CPR) survey.

(2) Davenport, J. 1982. Oil and planktonic ecosystems. Philosophical Transactions of the Royal Society. London. B297.

into the area resulting in a **long-term** impact on the benthos. Smothered fauna will have difficulty obtaining oxygen and will be affected by the toxicity of the oil. However, the entire benthic population is not expected to be affected. Benthos within a national area would be expected to suffer a **high** intensity impact as the result of a large oil spill, and this impact is predicted to have a **high** magnitude effect on the benthos, given the large area over which the impact would operate. However, the impact is expected to be **reversible** as the oil will eventually degrade. The value/sensitivity of the benthos is **low** to **high** depending on the area of the Baltic Sea affected, although the majority of benthos along the pipelines' route is expected to be of **low** sensitivity. The potential consequence of this impact is predicted to be **moderate** to **major**. The overall significance of the impact from smothering if a large oil spill did occur would be **low** to **moderate**.

*Fish*

Fish species in the Baltic Sea may be impacted by oil spills in all ESRs, in shallow zones, intermediate depth zones and in surface waters. However of all wildlife, fish are the least likely to be harmed by spills because they are mobile and are generally able to detect heavily contaminated areas and have the ability to move away from an area of pollution, therefore being either unaffected or affected only briefly. There is no definitive evidence to suggest that fish are affected by oil in open water and in open water oil contamination below the slick is generally low (only a few ppm or below)[(1)]. This concentration generally decreases with time and depth in chemically dispersed oil[(2)]. Fish can also rapidly metabolise and excrete oil products that have built up in their tissues due to an effective Mixed Function Oxygenase system[(3)]. However, fish kills may occur as a result of high exposure to emulsified oil in shallow waters and gross oil pollution may clog fish gills causing asphyxiation. At the population level, effects can be short lived due to the death of affected individuals and the persistence of healthy individuals unaffected by contamination.

Non-lethal negative effects are more usual and fish can be substantially affected in some circumstances, especially when oil spills into shallow or confined waters such as in the Greifswalder Bodden (ESR V). Fish exposed to elevated concentrations of hydrocarbons absorb contaminants though their gills, accumulating it within the liver, stomach, and gall bladder, which can lead to long-term, sub-lethal effects. These include morphological damage, reduced rates of reproduction, reduced immunological competence, loss of stamina, difficult respiration, and altered feeding habits. However, these effects are often short lived and once fish move away

(1) International Petroleum Industry Environmental Conservation Association (IPIECA). 2000. Biological Impacts of Oil Pollution - Fisheries. IPIECA Report Series. 8.

(2) International Petroleum Industry Environmental Conservation Association (IPIECA). 1993. Biological Impacts of Oil Pollution: Mangroves. IPIECA Report Series. 6.

(3) Law, R. J., & J. Hellou. 1999. Contamination of fish and shellfish following oil spill incidents. Environmental Geosciences. 6.

from the source of contamination they can metabolise the pollutants and cleanse themselves within weeks of exposure. Spilled oil poses a much greater threat to fish eggs and larvae, which cannot actively avoid or escape a pollution event. Fish eggs and larvae are mostly present in the upper planktonic layers, and hence are affected by all early stages of a spill and many cleanup techniques(1),(2) with heavy mortalities often result. Demersal spawners and egg guarding species are more likely to be affected in shallow waters and enclosed areas once the oil has dispersed through the water column. Even low concentrations of hydrocarbons can have marked effects on the proportions of eggs which hatch and on the growth rates and development of larvae. Many of these sub-lethal effects may eventually lead to mortality due to reduction in feeding rates and the impairment of respiration. Lethal effects on the population as a whole are rare but long term, sub-lethal effects are possible, particularly if a major spawning area such as Bornholm or Gotland Deep is affected.

Areas of ESR I and V have been identified among the critical habitats of the Baltic Sea mainly because of the presence of important macrophyte communities. These shallow areas are crucial habitats for invertebrates as well as feeding areas for fish. Thus, oil spills in these areas will have serious implications for localised populations, particularly breeding adults, eggs and larvae.

The impact of an oil spill in the deep waters of ESR III on fish will be much lower as adult fish will also be able to move to uncontaminated areas and avoid any sub-lethal effects or mortality. As a result the likely impact of an oil spill to adult populations of fish is likely to be low. Effects on eggs and larvae are greater than those on the adults and exposure to oil results in decreases in hatch rates, deformities and mortality of larvae. The likelihood and severity of these impacts will depend on the type of oil, the location of the spill and the species affected. Egg and larvae exposed to any form of contamination from a spill are likely to experience negative impacts.

In terms of toxicity to water column organisms, diesel is considered to be one of the most acutely toxic oil types(3). Fish that come in direct contact with a diesel spill may be killed.

(1) Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP). 1993. (IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution). Impact of Oil and Related Chemicals and Wastes on the Marine Environment. GESAMP Reports and Studies. 50.

(2) International Petroleum Industry Environmental Conservation Association (IPIECA). 2000. Biological Impacts of Oil Pollution - Fisheries. IPIECA Report Series. 8.

(3) US National Oceanic and Atmospheric Administration (NOAA). Small Diesel Spills (500-5000 Gallons). http://response.restoration.noaa.gov/book_shelf/974_diesel.pdf (accessed September 28, 2008).

However, small spills in open water are so rapidly diluted that fish kills have never been reported(1).

The impacts of an oil spill will therefore have more of an impact on eggs and larvae than on adult fish. Oil spills have a **direct** and **negative** impact on fish. Impacts associated with a large spill are expected to be of **national** scale and of **short-term** duration. Impact intensity ranges from **low** to **medium** depending on the life stage of the fish present. Impact magnitude is **medium** and the value/sensitivity of fish ranges from **low** to **high**, depending on the spawning season, or on the economical or conservational value of fish present in the area of the spill. Subsequently, a **minor** to **major** consequence would result. Impacts are **reversible**. Taking into consideration that the probability of a major oil spill occurring and migrating to breeding and coastal areas is **low**, the overall significance of an oil spill on fish is **low** to **moderate**.

*Sea birds*

Sea birds may be affected, to a greater or lesser extent, by fuel/oil spills throughout the entire pipelines' route. Oiling of feathers, the ingestion of fuel/oil into the digestive system through grooming and feeding and the oiling of nesting materials can cause significant physical damage and may be lethal. Spills can also cause indirect impacts on birds, particularly on piscivorous species due to the consumption of contaminated food, and may cause a decline of fish which is an important foraging resource. The effects of spills on bird populations can become significant when spills happen in areas supporting dense populations of wintering, staging or breeding birds(2). The probability of significant impacts to coastal birds is generally lower as the majority of important breeding colonies or areas supporting dense populations of wintering birds are well away from the pipelines' route and immediate emergency response measures will reduce the risk of significant impacts to these species. A higher probability of significant impacts has been identified for species of sea birds that occur further off-shore such as auks, which are distributed over large ranges along the pipelines' route.

As the pipelines' route passes in close proximity or crosses though areas supporting dense populations of sea birds such as the area of Dolgy Reef and Bolshoy Fiskar Archipelago (IBA RU224), the Nature Protection Area Ingermanlandsky, Hoburgs Bank (IBA SE065), North and South Midsjö Bank (IBA SE066), Pomeranian Bay (IBA DE040) and the Greifswalder Bodden (IBA DE044), birds in these areas are at a high risk to impacts associated with an oil spill. Furthermore, Oderbank, which forms a part of the Pomeranian Bay, supports populations of

(1) US National Oceanic and Atmospheric Administration (NOAA). Small Diesel Spills (500-5000 Gallons). http://response.restoration.noaa.gov/book_shelf/974_diesel.pdf (accessed September 28, 2008).

(2) Larsson, K. & Tydén, L. 2005. Effekter av oljeutsläpp på övervintrande alfågel Clangula hyemalis vid Hoburgs bank i centrala Östersjön mellan 1996/97 och 2003/2004. Ornis Svecica 15: 161-171 (with extensive English summary).

moulting birds which are particularly sensitive as they could potentially lose their ability to fly and would therefore be unable to vacate the areas affected.

Major significant impacts on sea birds will be avoided by careful timing of the construction period of the pipelines especially within the area of the Hoburgs Bank, North and South Midsjö Banks, Pomeranian Bay and the Greifswalder Bodden. The off-shore section of the pipelines in these areas will therefore be constructed during the summer months when the majority of sensitive sea birds such as divers, diving ducks and the majority of terns are absent. Due to the extent of ice cover in the Gulf of Finland it may not be possible to eliminate birds being affected if an oil spill occurs. However, the majority of Important Bird Areas (IBAs) in the Gulf of Finland are located well away from the pipelines' route and immediate emergency response measures will minimise impacts of higher consequence. Within the area of Dolgy Reef and Bolshoy Fiskar Archipelago and Ertholmene oil spills may have a medium intensity on auks, gulls and diving ducks and on cormorants within the Pomeranian Bay and Greifswalder Bodden.

As outlined in **Chapter 5,** a number of emergency response measures will ensure that the consequence of an oil spill will be reduced significantly. This includes the immediate implementation of emergency oil spill procedures and associated equipment that will be provided on board all construction vessels.

Oil spills have both **direct** and **indirect negative** impacts on sea birds. The intensity of the impact as a result of oils spills is likely to vary depending on the scale of impact and the species present and therefore ranges from **low** to **high**. Impacts associated with a large spill are expected to be of **national** scale and of **short-term** duration. Impact magnitude is **high** and the value/sensitivity is **low** to **high** depending on the protection status and time of the year when birds are present. The consequence of impact varies and oil spills may result in impacts of **moderate** to **major** consequence for breeding birds protected under the EC Birds Directive breeding on Dolgy Reef and Bolshoy Fiskar Archipelago due to the close vicinity. Impacts of **moderate** consequence may affect cormorant within the Pomeranian Bay, razorbill and common guillemot breeding on Ertholmene in ESR V and gulls and auk species breeding within the area of Dolgy Reef and Bolshoy Fiskar Archipelago. Impacts of high consequence will be avoided as no construction will be carried out during the winter within the area of Hoburgs Banks and North and South Midsjö Banks in ESR IV and the Pomeranian Bay and Greifswalder Bodden in ESR V. Impacts are **reversible**. Taking into consideration that the probability of a major oil spill occurring and migrating to breeding and coastal areas is **low**, the overall significance of an oil spill on birds is **low** to **moderate**.

*Marine mammals*

The direct impacts of accidental fuel/oil spills on marine mammals can be severe. They may be harmed by fuel/oil floating on the surface of the water, through the contamination of their fur (seals) or skin (porpoise), the ingestion or consumption (with their food) of fuel/oil or the inhalation of Volatile Organic Compounds (VOC) associated with fuel/oil. Fuel/oil contamination affects the water-repellent properties of a seal's fur, reducing its thermal insulation capacity, which would lead to temperature control problems and ultimately the death of the animal concerned if large areas of the fur were affected. The harbour porpoise is less at risk, because very little fuel/oil adheres to the skin. Marine mammals can ingest fuel/oil, which can lead to various negative physiological impacts. Continued exposure to toxic VOCs can also pose a health risk. An indirect impact of a spill is the pollution of the environment, loss of prey and hence loss of marine mammal body mass in severe cases.

Most species show no avoidance reactions to fuel/oil contamination, either because they do not notice it or they do not regard it as a danger(1). However, it is expected that, should a spill occur, it would originate in the construction area and thus typical construction noise would ensure that most marine mammals would have vacated this area (the source of impact). Spills do, however, migrate from the source but only large spills (assessed to be of **low** probability) are expected to affect a large area before dispersion, evaporation and human intervention reduce the bulk of the spill. Fuel/oil spills have a **direct** and **negative** impact on marine mammals. Impacts associated with a large oil spill on marine mammals are expected to be of **national** scale from the spill area and of **short-term** duration as per the modelling undertaken (refer to **Section 9.10.2**). Impact intensity ranges from **medium** to **high** depending on the marine mammals present and the degree to which an individual is affected. Receptor structure and function may be affected. It is expected that impacts would be on the individual level except in highly unlikely cases of an oil spill occurring near a colony or conservation area. Impact magnitude is **medium**. Impacts are **reversible**. Marine mammal value/sensitivity is **medium** to **high** (breeding season) as per **Chapter 8**. Impact consequence is **moderate** to **major**. Taking into consideration that the probability of a major oil spill occurring and migrating to breeding and coastal areas is **low**, the overall significance of an oil spill on marine mammals is **low** to **moderate**.

*Nature conservation areas*

Accidental fuel/oil spills may impact on nature conservation areas within 20 km of the pipelines' route if protected habitats are contaminated or through potential impacts to the protected species associated with each designated site. These impacts may be direct or indirect.

As detailed in the above sections, spills have diverse negative impacts on the marine environment. The direct impacts of an accidental spill can be severe, resulting in fouling or poisoning, which can significantly impact on local populations of sea birds, seals, fish or marine benthos. The spill may wash up on a protected coastal area, impacting on local habitats. Contaminated shorelines may act as a secondary source of exposure for marine animals, exposing them to direct contact with the washed up fuel/oil spill.

(1) van Bernem, C. and Lübbe,T. 1997. Ól im Meer (Oil in the Sea). Wissenschaftliche, Buchgesellschaft, Darmstadt.

All of the nature conservation areas in the vicinity of the pipelines' route, including Natura 2000 sites, Ramsar sites, UNESCO sites, Baltic Sea Protection Areas (BSPAs) and Protected Areas in the Russian part of the Baltic Sea (descriptions given in **Chapters 8** and **10**) will be sensitive to the effects of an accidental spill, through both direct and indirect impacts. A fuel/oil spill has the potential to affect adversely both the protected habitats and the species which are the qualifying interests of the Natura 2000 sites and other protected areas. A spill is likely to have widespread effects as it disperses, increasing the risk of affecting a protected site. The majority of the nature conservation areas within 20 km of the pipelines' route are designated to protect flora and faunal communities, which could be severely impacted by a spill (as detailed in the above sections). Areas where these species congregate (such as seal haul-out areas or Important Bird Areas) will be at greater risk. Timing is also a consideration, as there are sensitive periods during which species are more vulnerable, such as during the seal breeding period or when birds form moulting rafts.

Those sites that are bisected by the route (Greifswalder Bodden, Pomeranian Bay and Western Pomeranian Bay) will be especially vulnerable to the effects of a spill, as they will be immediately affected and the spill response procedure will not avoid site contamination. Similarly, where the pipelines pass close to coastal areas or islands there will be a greater risk of the protected habitats of a nature conservation area being impacted. Oil spill modelling conducted by Ramboll suggests that the locations with the highest probability of contamination at the coastline (>1% under adverse weather conditions) are at Rügen (east coast of Germany), and on the northern and western coasts of the Danish island of Bornholm[(1)], both of which have component nature conservation areas.

The impacts associated with such a spill are expected to be **negative, direct** of a **national** scale and **short-term** duration, but **reversible** (as detailed in **Section 9.10.2**). Impact intensity and magnitude will depend on the extent of the oil or fuel spill and the distance to the nearest nature conservation areas and will therefore range from **low** to **high**. The sensitivity of nature conservation areas in the vicinity of the pipelines' route is **high** (as detailed in **Chapter 8**). The impact consequence of an oil or fuel spill is expected to range between **moderate** and **major.** As the probability of a major oil spill occurring is **low**, (as predicted in **Section 9.10.2**) the overall significance of an oil/fuel spill on nature conservation areas is expected to be **low** to **moderate**, depending on the scale of the incident and its proximity to a nature conservation area.

**The Social and Socioeconomic Environment**

In the following section the impact of fuel/oil spills on the social and socioeconomic environment is assessed for each of the following receptors:

- Fisheries

(1) Nord Stream AG & Ramboll. 2007. Memo 4.3A-7 - Accidental oil spill during construction.

- Shipping and navigation
- Tourism and recreation
- Cultural heritage
- Offshore industry
- Military operations and munitions

*Fisheries*

A fuel or oil spill can adversely affect the fishing industry through the creation of exclusion zones around the pollution source, thus limiting the ability of fishing vessels to track and capture target fish. A large crude oil spill would have a **direct negative** impact on the fisheries in the region. A large crude oil spill has a **low** probability of occurring. Impacts associated with a large oil spill on the fishing industry are expected to be of a **national** scale from the spill area and of **short-term** duration. Impact intensity would be **high** depending on the importance of the area to fisheries where the spill occurred. Impact magnitude would be **high** due to the fact that a relatively large area of sea would be affected. The impact of an oil slick would be **reversible**. The sensitivity of the fishing industry is **medium** (see **Chapter 8**). Impact consequence would be **moderate**. Since the probability of the impact occurring is **low**, the overall significance is **low**.

*Shipping and navigation*

A fuel or oil spill has the potential to disrupt shipping and navigation if it is very large, and can disrupt shipping and navigation routes if vessels are banned from entering the polluted area.

A major oil spill is likely to have a **direct negative** impact on shipping and navigation. The scale of a large oil spill is **national** and its duration **short-term**. Impact intensity is **low** as a spill would not lead to permanent changes to the industry. Impact magnitude is **medium**. The value/sensitivity of the shipping and navigation industry is **medium** (see **Chapter 8**). The impact consequence is **moderate** due to the fact that a relatively large area of sea would be affected. The impact is **reversible**. The probability of a Project vessel causing a major crude oil spill is **low**, mainly because of the establishment of an exclusion zone around construction vessels. The overall significance is therefore **low**.

*Tourism and recreation*

A fuel or oil spill can have an adverse effect on tourism. This can occur through a direct impact on coastal areas where tourists are present, or through a perception amongst tourists that the Baltic Sea region is no longer a desirable location due to a strong industry presence.

An oil spill will have a **direct negative** impact on tourism and recreation in the Baltic Sea region. The scale of the impact is **national** and of **short-term** duration. The impact intensity of a spill directly striking the coastline is **medium** because the tourism industry might take time to recover financially, but in the medium term the impact is **reversible**. Impact magnitude is **medium**. The value/sensitivity of the tourist industry is considered to be **low**. Impact consequence is **minor** due to the fact that a relatively large area of sea would be affected. The probability of a major crude oil spill occurring in an area important for tourism (such as a coastal area) is **low**. The overall significance is therefore **low**.

*Cultural heritage*

The majority of the pollution from a fuel or oil spill would be situated in the surface of the water column, while ship wrecks and submerged Stone Age settlements are found on the seabed or sea shore. An oil spill would therefore have an **insignificant** impact upon cultural heritage.

*Offshore industry*

The only elements of offshore industry in the Baltic Sea that would be potentially affected by a fuel or oil spill are vessels associated with oil and gas exploration and extraction industries. The value/sensitivity of the offshore industry receptors is considered to be **low** in the Baltic Sea. A major crude oil spill would have a **direct negative** effect on the movement of ships in that area potentially preventing exploration or operational works from being carried out. The impact may take place on a **national** scale and will be **reversible**, and of **short-term** duration. Impact intensity is **low** as the fuel spill is not expected to impact on the offshore industry itself and the magnitude is **medium.** The impact consequence is thus considered to be **minor**. It is considered that a major crude oil spill will have an overall **low** impact significance on offshore industry as the probability of this impact occurring is **low**.

*Military operations*

The movements of military vessels would potentially be disrupted by a fuel or oil spill. A major crude oil spill would have a direct negative impact on military operations as there may be areas within which the ships are excluded from travelling. Due to the reversible and temporary nature of the impact it is therefore considered insignificant. A fuel oil spill would be **insignificant** on military operations due to the small quantities of pollution typically produced.

**Table 9.101 Impact summary table for an unplanned fuel/oil spill**

| | Resource/Receptor | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Consequence | Probability | Overall significance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Scale | Duration | Intensity | Magnitude | | | | | |
| Fuel/oil spill | Physical processes | - | - | - | - | - | - | - | - | - | - | **No impact** |
| | Water Column | Negative | Direct | National | Short-term | Medium | Medium | Low | Reversible | Minor | Low | **Low** |
| | Seabed | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Atmosphere | Negative | Cumulative | National | Short-term | Low | Medium | Low | Reversible | Minor | Low | **Low** |
| | Plankton | Negative | Direct | National | Short-term | Low | Medium | Low | Reversible | Minor | Low | **Low** |
| | Marine benthos | Negative | Direct | National | Long-term | High | High | Low - High | Reversible | Moderate - Major | Low | **Low - Moderate** |
| | Fish | Negative | Direct | National | Short-term | Low - Medium | Medium | Low - High | Reversible | Minor - Major | Low | **Low - Moderate** |
| | Sea birds | Negative | Indirect and Direct | National | Short-term | Low - High | High | Low - High | Reversible | Moderate - Major | Low | **Low - Moderate** |
| | Marine mammals | Negative | Direct | National | Short-term | Medium - High | Medium | Medium - High | Reversible | Moderate - Major | Low | **Low - Moderate** |
| | Nature conservation areas | Negative | Indirect and Direct | National | Short-term | Low - High | Low - High | High | Reversible | Moderate - Major | Low | **Low - Moderate** |
| | Fisheries | Negative | Direct | National | Short-term | High | High | Medium | Reversible | Moderate | Low | **Low** |
| | Shipping and navigation | Negative | Direct | National | Short-term | Low | Medium | Medium | Reversible | Moderate | Low | **Low** |
| | Tourism and recreation | Negative | Direct | National | Short-term | Medium | Medium | Low | Reversible | Minor | Low | **Low** |
| | Cultural heritage | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Offshore industry | Negative | Direct | National | Short-term | Low | Medium | Low | Reversible | Minor | Low | **Low** |
| | Military operations | - | - | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.10.3 Disturbance of munitions

**Overview**

As described in **Section 8.12.7**, discarded chemical and conventional munitions can be found throughout the Baltic Sea due to historic and current military operations in the area.

**Conventional munitions**

Conventional munitions found in the Baltic Sea include depth bombs, aerial bombs, and submarine combating rockets, torpedoes and grenades (see **Section 8.12.7**). Other munitions present include naval mines. Extensive surveys were carried out to identify munitions along the pipelines' route and 30 munitions were found in Finland and one in Sweden. The main environmental effect of an underwater explosion is the passage of a water-borne pressure wave(1),(2). The impact from a pressure wave depends on the charge weight, the distance to the receptor, the water depth where the charge is detonated and the occurrence of reflecting objects e.g. hard bottoms and the water surface(3).

**Chemical munitions**

As described in **Section 8.12.7**, approximately 11,000 tonnes of active chemical warfare agents (CWAs)(4) were dumped in the Baltic following the end of the Second World War (WW II). The Bornholm Basin received more than half of Germanys CWA arsenal, with another 1,000 tonnes being dumped at a site south-east of Gotland. These sites are shown in **Atlas Map MU-1**.

Viscous mustard gas is found as lumps on the seabed or buried in the sediments. The disruption of dumped CWA in the sediment has the potential to release toxic chemicals into the water column for a short period of time before settling on the seabed. Most warfare agents tend to break down relatively quickly into less toxic, water-soluble substances under ambient conditions experienced in the Baltic Sea(5). Thus, CWA do not exist in high concentrations in the water

(1) Keevin, T. M. & G. L. Hempen. 1997. The environmental effects of underwater explosions with methods to mitigate impacts. U.S. Army Corps of Engineers St. Louis District.

(2) Karlsson, R-M., Almström, H. & R. Berglind. 2004. In Swedish: Environmental effects of underwater explosions – a literature review: FOI- Swedish Defence Research Agency report.

(3) Keevin, T. M. & G. L. Hempen. 1997. The environmental effects of underwater explosions with methods to mitigate impacts. U.S. Army Corps of Engineers St. Louis District.

(4) Helsinki Commission. 1995. Final Report of the ad hoc Working Group on Dumped Chemical Munition. http://www.helcom.fi/stc/files/Publications/OtherPublications/CHEMUFinalReport1995.pdf (accessed August 14, 2008).

(5) Danish Environmental Protection Agency. 1994. Report to the 15th Meeting of Helsinki Commission 8 - 11 March 1994 from the Ad Hoc Working Group on Dumped Chemical Munitions (HELCOM CHEMU).

column for an extended period of time. However, there are exceptions and some compounds show an extremely low solubility and slow degradability. These are viscous mustard gas, Clark I and Adamsite which tend to occur in a viscous form in the sediment of the dumping areas, although some chemical munitions also occur outside of the areas.

There will therefore be no detonation if chemical munitions come into contact with one of the pipelines. Chemical munitions could, however, contaminate pipe-laying equipment and Project vessel anchors. Special cleaning procedures will have to be followed during pipeline installation to ensure no human exposure to mustard gas.

As described in **Section 8.12.7** chemical munitions were identified at three locations along the pipelines' route close to Bornholm during the munitions screening survey. As the chemical munitions do not pose an explosive risk, Nord Stream intends to leave them in place on the seabed and not to install the pipelines within 10 m of them. Guidance is awaited from the Danish Admiralty Fleet in terms of any specific additional precautions or actions.

CWA in the Baltic Sea have been the subject of studies carried out by the National Environmental Research Institute (NERI) of Denmark and the Finnish Institute for Verification of the Chemical Weapons Convention (VERIFIN)[(1),(2),(3)] . These studies show that the majority of the CWA have decayed to a harmless state since being dumped in 1947, although many of the mustard gas bombs remain on the seabed as lumps that have not yet decayed. The disturbance of these munitions during operation (for example by maintenance vessels) could result in the re-suspension of toxic chemicals, therefore resulting in impacts to marine life. There is however little information available as to the ecological and eco-toxicological effects of CWA.

### Surveys

Munitions screening surveys have been carried out (see **Section 8.12.7**) to determine the presence of unexploded munitions and/or CWA that could constitute a danger for the pipelines or the environment during the installation works and the operational life of the pipeline system along the pipelines' corridor[(4)]. The 'security corridor' examined for munitions was 25 m either side of the pipelines' route. These dimensions were based on detailed analysis of the

(1) Sanderson, H & Fauser, P. 2008. Risk screening of chemical warfare agents towards humans and the fish community resulting from sediment perturbation from construction of the planned Nord Stream offshore pipelines through risk area 3 (S-route) in the Baltic Sea. NERI report.

(2) Sanderson, H & Fauser, P. 2008. Historical and qualitative analysis of the state and impact of dumped chemical warfare agents in the Bornholm basin from 1947-2008 NERI report.

(3) Vanninen, P., Söderström, M., Björk, H., Kostiainen, O., and Kuitunen, M. 2008. Chemical Analysis of Sea-dumped Chemical Warfare Agents in Sediment and Pore Water Samples. VERIFIN report.

(4) Snamprogetti. 2008. Effects of Underwater Explosions.

effects of underwater explosions[1], to ensure that any exploding munitions on the edge of the corridor would not damage the pipelines. Potential explosives and munitions found in the security corridor will be cleared prior to the construction phase of the Project. Nord Stream is currently planning the clearance of munitions in association with the relevant national authorities.

Along most of the pipelines' route the probability of disturbing chemical munitions (warfare agents), for example during anchor placement and the sweeping of anchor cables across the seabed, is **low**. However the pipelines' route does cross Risk Zone 3 dumping areas around Bornholm and to the south of Gotland and the probability of disturbing warfare agents here is slightly higher, but still deemed to be **low** (see **Section 8.12.7**). As the pipelines' route will be cleared of conventional munitions prior to construction the probability of unplanned disturbance to conventional munitions is **low** (see **Chapter 5**). Descriptions of the surveys that have been carried out and the sites that have been determined as locations of munitions are discussed in **Section 8.12.7**.

**Physical Environment**

In the following section the impact of the disturbance of both chemical and conventional munitions on the physical environment is assessed for each of the following receptors:

- Physical processes
- Water column
- Seabed
- Atmosphere

*Physical processes*

The unplanned disturbance of chemical munitions is expected to have **no impacts** on the physical processes of the Baltic Sea.

The explosion resulting from the accidental detonation of conventional munitions will lead to the formation of an underwater pressure wave. Pressure waves in the water will be very short lived and only affect the water currents in close proximity to the point of detonation. Therefore the impacts on the physical processes in the Baltic Sea will not be affected by the accidental detonation of conventional munitions.

(1) Snamprogetti. 2008. Effects of Underwater Explosions.

*Water column*

The disruption of dumped CWA in the sediment has the potential to release toxic chemicals into the water column. Along the pipelines' route, the probability of disturbing dumped CWA is **low**. Any disturbed CWA are expected to be re-suspended in the water column for a short period of time before settling on the seabed. CWA break down at varying rates into less toxic, water-soluble substances. As noted earlier, some compounds show an extremely low solubility and slow degradability (viscous mustard gas, Clark I and II and Adamsite). Elevated levels of Clark I, Adamsite or mustard gas in viscous form might occur in the sediment in dumping areas. The impact (**negative** and **direct**) on the water column, in terms of CWA concentration (contaminant) is expected to be largely of **temporary** duration, as disturbed munitions are expected to settle quickly to the seabed, and on the **local** scale. Impact intensity is expected to be **low** as re-suspended CWA are not expected to cause any major change to the water column characteristics. Impact magnitude is **low** and the overall value/sensitivity of the water column is **low**. Impact consequence is, therefore, expected to be **minor**. Impacts are **reversible**. Taking into consideration that the probability of disrupting CWA is **low**, the overall significance is **low**.

The accidental (**low** probability) detonation of conventional munitions encountered along the pipelines' route post survey and munitions clearance is expected to have a limited negative impact on the water column. Impacts are expected to be on a par with, if not less than, those experienced during munitions clearance as described under the construction phase (to take place in ESR I, II and III – **Sections 9.3.3, 9.4.3** and **9.5.3**). As munitions are generally in place on or submerged within the seabed, an accidental detonation would result in the re-suspension and spreading of sediments resulting in an increase in turbidity, the release of contaminants and nutrients. The amount of re-suspension and spreading is dependent upon the amount and type of residual explosive, the seabed type and its susceptibility to re-suspension, the amount of sediment that would be disturbed and the extent of underwater currents in close vicinity to the seabed. Suspended sediments are expected to settle within a few days in line with the modelling conducted for seabed intervention works. The impacts (**negative** and **direct)** on the water column, in terms of a change in background levels, are expected to be of **short-term** duration before suspended sediments settle on the seabed, of **local** to **regional** (in a worst case scenario) scale and of **low** intensity as no permanent change in structure and function is envisaged. Impact magnitude is **low** and the overall value/sensitivity of the water column is **low**. Impact consequence is therefore expected to be **minor**. Taking into consideration that the probability of accidentally detonating previously undiscovered munitions is **low** the overall significance is **low**. Impacts are **reversible** over a few days at most.

*Seabed*

The disturbance of chemical munitions on the seabed is not expected to cause notable alteration of the seabed in terms of the re-suspension and spreading of sediments or alteration of seabed structure or function. Therefore, the impact of unplanned chemical munitions disturbance on the seabed is considered to be **insignificant**.

The disturbance of conventional munitions on the seabed is expected to cause physical alteration of the seabed, and the re-suspension and spreading of sediments, with associated release of contaminants and nutrients from the seabed. As discussed in the overview of this section, munitions disturbance (**negative** and **direct**) is expected to cause **local** impacts of **medium** intensity. However, the seabed is considered to be of **low** value/sensitivity, and impacts will be **temporary** in duration. The magnitude of the impact is considered to be **low** to **medium**, depending on factors such as the location (e.g. munitions disturbance near to any submarine geological or sessile features such as coral reefs). Impacts will also be **reversible** over a long time scale. The consequence of disturbance of munitions on the seabed is therefore expected to be **minor**. Taking into consideration that the probability of conventional munitions disturbance is **low** along the pipelines' route, the overall significance of munitions disturbance on the seabed is **low**.

*Atmosphere*

Although there will be a release of a minor amount of toxic gases to the atmosphere from a possible detonation of conventional munitions at the seabed, the quantities of gases emitted are not expected to cause damage to any ecosystem receptors. Chemical munitions are not expected to have any notable impact on the atmosphere due to the physical nature of these CWA. The consequence of disturbance of munitions on the atmosphere is therefore expected to be **insignificant**, since significant impacts on the environment from detonation at the seabed would be restricted to receptors such as the water column(1), as well as marine life in the immediate vicinity of the detonation(2).

**Biological Environment**

In the following section the impact of the disturbance of both chemical and conventional munitions on the biological environment is assessed for each of the following receptors:

- Plankton
- Marine benthos
- Fish
- Sea birds
- Marine mammals

(1) Swedish Environmental Research Institute (IVL). 2008. Complementary IVL background report: Environmental aspects of dumped ammunition and remaining sea mines in the Baltic Sea.

(2) Nord Stream AG & Ramboll. 2007. Memo 4.91- Chemical and conventional munitions in the Baltic Sea.

- Nature conservation areas

*Plankton*

Plankton could potentially be impacted from the disturbance of CWA, which could lead to dispersion of these agents in the water column. However as CWA cannot exist in high concentrations in the water column for an extended period of time, and due to the seasonality and large scale geographic distribution of the plankton community in the Baltic Sea, the impact on plankton as a result of the unplanned disturbance to chemical munitions is anticipated to be **insignificant**. Similarly, due to plankton dynamics in the Baltic Sea, there will be an **insignificant** impact on plankton from the detonation of conventional munitions.

*Marine benthos*

Sampling of the sediment in the vicinity of the pipelines has shown that most of the CWA present have decayed to a harmless state. However, chemical munitions that are still buried in the seabed may still retain their toxicity. If chemical munitions were disturbed they would likely affect a **regional** area. Impacts, both **negative** and **direct,** from the toxicity of the chemical munitions may continue to affect the benthos in the **short-term** to **long-term**. The intensity of the impact could be **low** to **high** depending on the toxicity of the contaminant to the affected benthos. This could vary depending on the chemical type (e.g. Adamsite, mustard gas etc.) and on how degraded the chemical material has become. Therefore a **low** to **high** magnitude is predicted. As previously discussed, the value/sensitivity of the benthos is **low** to **high** depending on the area of the seabed affected and the time of year. The impact would be **reversible** over time as the benthos would recover once exposure to the CWA has stopped. Overall a **minor** to **major** consequence is predicted. However, any disturbance of intact chemical munitions has the potential to cause degradation of health or even death of some individuals within the benthic community although the entire community is unlikely to be affected. The probability of munitions disturbance is **low**. Therefore the overall impact significance is predicted to be **low** to **moderate** as the probability of disrupting CWA is **low**.

A shockwave will result from any unplanned detonation of conventional munitions. The shockwave may disrupt sensitive benthic fauna, particularly large mobile species. The distance a shockwave will travel following a detonation is not known but is likely to have a **local** impact. The effect is expected to be **direct**, **negative** and **reversible**. The impact would be likely to be **temporary** as the shockwave will quickly lose power with distance and time. This is likely to lead to a **low** to **medium** intensity impact since benthos is expected to receive low level tissue damage. As the size of the resulting shockwave is unknown, it is difficult to assess the magnitude of the impact; however it is considered likely to be a **low** magnitude impact, which would affect a **low** to **high** value/sensitivity receptor. The consequence is therefore expected to be **moderate** and the overall significance of the impact of noise and vibration from munitions on marine benthos in is expected to be **low** as the probability of conventional munitions disturbance is **low**.

*Fish*

As surveys conducted by NERI and VERIFIN have shown, the majority of the CWA that exist in the Baltic have decayed to a harmless state since being dumped in 1947[(1)],[(2)]. Within sediments elevated levels of slightly soluble Clark, Adamsite or mustard gas may occur in a viscous form in the immediate vicinity of the chemical munitions. Increased turbidity resulting from Project activities may cause an increased concentration of these substances in the water column. However, these dissolved CWA cannot occur in high concentrations in water, so a wide-scale threat to the marine environment can be ruled out[(3)]. Along the pipelines' route the probability of disturbing dumped CWA is **low**. However, should fish come into contact with disturbed CWA it could be fatal. An impact to fish that come into contact with the warfare agents will be **negative** and **direct** and is expected to be of **short-term** duration and on the **local** scale (disturbance area of construction). Impacts are **reversible**. Impact intensity is expected to be **medium** to **high** depending on the presence of fish in the vicinity of contamination. Impact magnitude is **medium** and fish value/sensitivity is **low** to **high** depending on species present. Impact consequence is expected to be **moderate**. The probability of disrupting CWA is **low** and therefore the overall significance is **low**.

The accidental detonation of conventional munitions may result in ruptures of the swim bladder, haemorrhages, and ruptures to internal organs such as the kidneys or the liver[(4)]. The peak noise levels during such an event are significantly greater than the hearing thresholds of most fish in the Baltic, including herring and sprat and studies have reported injuries of this species due to noise exposure at sound levels of 153 to 180 dB re 1µPa[(5)] . Fish with a swim bladder such as cod, herring and sprat are more sensitive than fish that lack swim bladders (e.g. flatfish).

(1) Vanninen, P., Söderström, M., Björk, H., Kostiainen, O., and Kuitunen, M. 2008. Chemical Analysis of Sea-dumped Chemical Warfare Agents in Sediment and Pore Water Samples. VERIFIN report.

(2) Sanderson, H & Fauser, P. 2008. Risk screening of chemical warfare agents towards humans and the fish community resulting from sediment perturbation from construction of the planned Nord Stream offshore pipelines through risk area 3 (S-route) in the Baltic Sea. NERI report.

(3) Stock,T. Sea dumped chemical weapons under the CWC- more questions than answers. DYNAsafe Germany GmbH. http://www.pugwash.org/reports/cbw/52nd-workshop-2007/9-Stock.pdf (accessed October 7, 2008).

(4) Wright, D.G and Hopky, G.E. 1998. Guidelines for the use of explosives in Canadian fisheries waters. Canadian Technical Report of Fisheries and Aquatic Sciences. 2107.

(5) Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

Tissue damage or death is likely to occur when fish are in the immediate vicinity of loud, sudden noises such as that caused by the accidental explosion of munitions. The impacts of an explosion which cause the most harm to fish is caused by the differential rate of transmission of pressure waves(1). Studies have shown that smaller species of fish are more sensitive to explosive charges than larger species(2). A study carried out in the Baltic Sea by the Swedish Defence Research Agency showed that following a planned detonation of a mine, at a depth of 70 m, with an explosive charge of 3 tonnes all Baltic herring, sprat and cod within a 1.5 km radius were instantly killed. Salmon and sea trout were affected only within the immediate vicinity of the explosion. An area of water 150 m wide was lifted approximately one metre into the air following the detonation and resulted in increased turbidity(3).

Increased turbidity from the re-suspension of sediments could result in the re-suspension of contaminants associated with the sediment. Hydrogen sulphide is naturally present in extremely hypoxic conditions on the ocean bottom; therefore it is found in greatest quantities in ESR III (see **Atlas Map WA-10**). However there are few demersal fish present in these areas. $H_2S$ is exceptionally toxic to fish and, on release into the water column, any fish that come into contact with as little as 7 µg/l of this contaminant are very likely to die. Adult fish, any eggs and larvae spawned in the area and fish food resources will suffer from increased rates of mortality. However, the rate at which mortality rates decrease will depend on how quickly the $H_2S$ concentration decreases, the volume of $H_2S$ re-suspended and the environmental conditions present. When $H_2S$ is released from the sediment, it will react rapidly with any oxygen in the water forming $H_2SO_4$, making it less toxic to marine life and generally mortality will decrease with increasing distance from the detonation. In shallow water the presence of spawning, feeding and nursery areas will increase the impact of $H_2S$, with the loss of eggs, larvae, food resources and spawning adults. In deeper water, where there are no spawning grounds, the density of fish is much lower and adult fish can move away from the contaminated area.

As the clearance of conventional munitions along the pipelines' route is to be carried out prior to construction, there is a **low** probability of the unplanned detonation of munitions encountered along the pipelines' route post construction. The impacts on fish as a result of such an event will be **temporary** in duration and on a **local** scale, as only fish in the immediate vicinity of the disturbed munitions will be impacted. The impact will be **negative** and will **directly** impact fish. The impact intensity is expected to be **low** to **high** depending on the fish present in the area of the detonated munitions. Impact magnitude is **low** to **medium**. The value/sensitivity of fish

(1) Wright, D.G and Hopky, G.E. 1998. Guidelines for the use of explosives in Canadian fisheries waters. Canadian Technical Report of Fisheries and Aquatic Sciences. 2107.

(2) Yelverton, J.T., Richmond, D.R., Hicks, W., Saunders, K. and Fletcher, E.R. 1975. The relationship between fish size and their response to underwater blast. Topical Report DNA 3677T. Department of Defence, Washington, D.C.

(3) Karlsson, R-M., Almström, H. & R. Berglind. 2004. In Swedish: Environmental effects of underwater explosions – a literature review: FOI- Swedish Defence Research Agency report.

varies between species and ranges from **low** to **high.** Impact consequence is expected to be **minor** to **moderate** (if specific species of fish are disrupted during the spawning or migratory periods). Taking into consideration that the probability of accidently detonating munitions is **low**, overall significance is **low**. Impacts may be **irreversible** if fish are in the immediate vicinity of the detonation.

*Sea birds*

Negative impacts on birds can be either **direct** due to physical disturbance to birds either breeding or foraging in close vicinity or **indirect** due to the consumption of contaminated food or temporary displacement of fish. The highest intensity of impact will result if foraging birds are in the immediate vicinity of the detonation point causing the loss of birds. The temporary increase in turbidity in the water column may also affect the eyesight of diving birds such as benthic and piscivorous species, leading to decreased foraging success. The extent of impacts is not known but is expected to be on a local scale.

The disturbance of chemical warfare agents may primarily result in **negative indirect** impacts on sea birds due to the consumption of contaminated food such as fish and the highest risk of significant impacts has therefore been identified for piscivorous species of sea birds. The majority of diving sea birds feed between the water surface and 50 m water depth. Due to the fact that the two primary chemical munitions dumping sites in the Baltic occur in excess of 50 m, direct effects on birds are unlikely. Most warfare agents tend to break down relatively quickly and the probability that birds are directly affected by toxic chemicals in the water is low. Furthermore, the dumping site to the south-east of Gotland is well away from the closest Important Bird Area (40 km). However, a **low** probability of the disturbance of CWA has been identified for the area to the north of Bornholm, which may impact upon birds. The pipelines pass in close proximity to Ertholmene, an Important Bird Area that supports breeding colonies of three species; common eider, razorbill and common guillemot. The disturbance of CWA will have a **negative**, **indirect** and **short-term** affect on birds that will occur on a **local** scale, with the highest risk identified for bird populations breeding on the islands of Ertholmene. It is not known how far the consumption of contaminated fish may be lethal for birds as this may depend largely on the amount of released toxic chemicals. Impacts will be **reversible**. The intensity is expected to be **low** to **high** depending on the level of interaction between the bird species and the type of CWA concerned. The magnitude of impact will be **medium** as it may affect a portion of a population during a critical stage of its annual life cycle which may bring about a change of the local breeding population. The consequence of the disturbance of CWA is **moderate** and impacts are **reversible**. The probability that chemical munitions will be encountered is **low**. Impact significance is therefore **low**.

The disturbance of conventional munitions resulting in accidental detonation will primarily result in **direct negative** impacts on birds. particularly within the area of the Pomeranian Bay and Greifswalder Bodden in the German EEZ where dense populations of sea birds are present and in the Gulf of Finland where conventional munitions are most common. The detonation of conventional munitions may affect birds directly. The probability of negative impacts is higher for piscivorous species and diving sea birds in general as these species occur over a larger range concentrated within areas of shallow water. The re-suspension of sediment may also affect the eyesight of diving birds, decreasing the foraging success of piscivorous species.

Impacts (**direct** and **negative**) on sea birds are **temporary** and of **medium** to **high** intensity if birds occur in the vicinity of the detonation causing a loss of individuals. Sea bird value/sensitivity is **low** to **high**. Impacts are **reversible** and occur on a **local** scale. The magnitude of the impact is expected to be **low,** as only small numbers will be affected and long-term impacts on sea bird populations are highly unlikely. The impact consequence is **minor** to **moderate** depending on the species affected. The construction of the off-shore section of the pipelines within the Pomeranian Bay and Greifswalder Bodden will take place during the summer months when sea birds occur in lower densities and the majority of protected species are absent. Impacts of **moderate** consequence may affect cormorants and auks within the area of Dolgy Reef and Bolshoy Fiskar Archipelago. However, the probability that conventional munitions are disturbed is **low**. Therefore, overall impact significance is **low**.

*Marine mammals*

The disruption of dumped CWA in the sediment has the potential to release toxic chemicals into the water column, which may impact upon marine mammals should they come into contact or ingest such warfare agents. A further impact is that disturbed CWA may be encountered by marine mammals foraging in the seabed. The probability of disturbing dumped warfare agents along the pipelines' route is **low**. No known seal colonies are present in close vicinity to the pipelines' route near the Risk Zone 3 dumping areas around Bornholm and to the south of Gotland. Any disturbed CWA are expected to be re-suspended in the water column for a short period of time before settling on the seabed. No incidents with any major ecotoxicological consequences on marine mammals have been documented within the Baltic Sea as a result of the disruption of warfare agents. However, should marine mammals come into contact with disturbed CWA it could be fatal. Most dumped chemical munitions take place in deep waters and it is expected that, for the most part, marine mammals would not be present at the disturbance site. The impact (**negative** and **direct**) on marine mammals at an individual level is expected to be of **short-term** duration and on a **local** scale (disturbance in area of construction). Impact intensity is expected to be **medium** to **high** depending on the level of interaction between the marine mammal and the CWA concerned. Impact magnitude is **medium** and marine mammal value/sensitivity is **medium** to **high** (breeding season). Impacts will be **reversible**. Impact consequence is expected to be **moderate** to **major**. Taking into consideration that the probability of disrupting chemical warfare agents is **low**, the overall significance is **low** to **moderate**.

The accidental (**low** probability) detonation of conventional munitions encountered along the pipelines' route post survey and munitions clearance is expected to have a **negative, direct** impact on marine mammals. Noise generated during detonation is expected to be the most significant impact and takes the form of an initial shock pulse followed by a succession of oscillating bubble pulses[(1)]. Pulses at high peak levels have the potential to cause tissue damage should an individual mammal be in close proximity to the source of impact [(1)]. The expected level of noise generated is not known but would be dependent on the amount and type of residual explosive. The impact, in terms of noise and vibration generation is expected to be of **temporary** duration (initial detonation). Harbour porpoises and seals may be affected by the sudden increase in noise and vibration up to 10 km and 2 - 3 km away from the source respectively. The impact will thus be on a **regional** scale. As marine mammals are expected to avoid the construction area due to construction noise it is expected that only behavioural changes and masking would occur. However, some individuals may encroach on the construction area. Impact intensity is expected to be **medium** to **high** (worst case scenario) depending on marine mammals present. Impact magnitude is **medium**. Marine mammal value/sensitivity is **medium** to **high** (breeding season) as per **Chapter 8**. Impact consequence is expected to be **minor** to **moderate** (if marine mammals are disrupted during the breeding season). Taking into consideration that the probability of accidentally detonating previously undiscovered munitions is **low**, the overall significance is **low**. Impacts may be **irreversible** if tissue damage or hearing loss occurs.

*Nature conservation areas*

The disturbance of dumped CWA has the potential to result in the re-suspension of toxic chemicals into the water column which may impact negatively on nature conservation areas if the habitats and/or species associated with each designated site are affected. The probability of disturbing chemical munitions is **low**.

There is little information available as to the ecological effects of CWA. Two studies carried out on chemical munitions in the Baltic Sea have shown that most of the CWA have decayed to a harmless state since being dumped in 1947[(2),(3)] . However, the disturbance of these munitions may result in the re-suspension of toxic chemicals, which, as detailed in the above sections, has the potential to negatively affect marine benthos, fish, sea birds and marine mammals should they come into contact with the chemicals, either directly (through contact) or indirectly (e.g. by

(1) Richardson, W.J., Greene, C.R., Malme, C.I., and Thomson, D.H. 1995. Marine Mammals and Noise. Academic Press, San Diego and London.

(2) Sanderson, H & Fauser, P. 2008. Risk screening of chemical warfare agents towards humans and the fish community resulting from sediment perturbation from construction of the planned Nord Stream offshore pipelines through risk area 3 (S-route) in the Baltic Sea. NERI report

(3) Sanderson, H. & Fauser, P. 2008. Historical and qualitative analysis of the state and impact of dumped chemical warfare agents in the Bornholm basin from 1947-2008 NERI report.

consumption of contaminated food). Direct contact may be fatal to these species. The impact of the disturbance of chemical munitions is predicted to be **negative** and **direct**. The re-suspended chemicals will quickly settle on the seabed. In addition, many of the chemicals will break down into less toxic, water-soluble substances. Therefore impacts will be of a **short-term** duration and are expected to occur on a **local** scale. Impact intensity will range between **low** and **high**, depending on the proximity of designated species to the disturbed munitions. Impact magnitude is expected to be **low** to **medium**. As the sensitivity of nature conservation areas is **high**, impact consequence is expected to be **moderate**. Since the probability of disrupting CWA is **low** the overall significance will be **low**. Impacts will be **reversible**.

An unplanned detonation of conventional munitions in the vicinity of the pipelines' route has the potential for negative impacts on nature conservation areas if the protected habitats and/or species associated with each designated site are affected by the blast. Noise and pressure waves generated will cause the most severe impacts, having the potential to affect fish, protected marine mammals and sea birds in the region. Grey seals, harbour seals, harbour porpoises and sea birds are protected in many of the identified nature conservation areas, as are some species of fish, and effects on these species will impact negatively on the designated sites. The re-suspension of sediments and associated contaminants will also impact on local fish density.

As a comprehensive munitions survey has been undertaken[(1)] and known munitions will be cleared prior to construction, there is a **low** probability of such an event occurring. The sensitivity of nature conservation areas in the vicinity of the pipelines' route is **high** (as detailed in the baseline in **Chapter 8**). The impact of an unplanned disturbance of conventional munitions has the potential to adversely affect both the protected habitats and species which are the qualifying interests of the nature protected area and is predicted to be **negative**, **direct** and of **temporary** duration, as a result of noise impacts and the re-suspension of sediment in the vicinity of the disturbance (as detailed in the above sections for benthos, fish, sea birds and marine mammals). The impact is expected to be on a **regional** scale and impact intensity will be **medium** to **high**. Impact magnitude will be **medium** and impacts will be **reversible**. Impact consequence is expected to range between **moderate** and **major**. As the probability of an unplanned detonation occurring is **low**, the overall impact significance is expected to be **low** to **moderate**, depending on the proximity of the munitions to a nature conservation area or its associated protected species.

### The Social and Socioeconomic Environment

In the following section the impact of the disturbance of both chemical and conventional munitions on the social and socioeconomic environment is assessed for each of the following receptors:

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(1) Nord Stream AG & Ramboll. 2007. Memo 4.9-1 - Chemical and conventional munitions in the Baltic Sea.

- Fisheries
- Shipping and navigation
- Tourism and recreation
- Cultural heritage
- Offshore industry
- Military operations

*Fisheries*

As a result of Project activities on the seabed, there is the possibility that munitions will be displaced to new areas, or buried munitions uncovered, thus making them more likely to be snagged and brought up in fishing nets. Due to the increasing rarity of munitions being found this occurrence is expected to have an **insignificant** impact on fisheries.

*Shipping and navigation*

Chemical munitions will have an **insignificant** unplanned impact on shipping and navigation. This is because chemical munitions are located on the Baltic Sea seabed and it is highly unlikely that they would come into contact with a cargo or passenger ship.

The pipelines' corridor will be cleared before construction begins, and shipping will be kept away from Project activities due to the exclusion zone. This means that there is very little chance of a conventional bomb or mine damaging a vessel. The unplanned impacts on shipping and navigation by conventional munitions are expected to be **insignificant**.

*Tourism and recreation*

The probability of chemical munitions causing unplanned impacts on the tourist sector is very low. The munitions are located on the bottom of the Baltic Sea and far from the coastal regions where tourism is the most popular. The unplanned impact of chemical munitions on tourism is therefore **insignificant**.

The pipelines' corridor will be cleared of conventional munitions before pipeline construction begins, and all vessels will be kept away from Project activities due to the exclusion zone. This makes it extremely unlikely that a vessel carrying tourists will be affected by an unintended detonation. There is a very low probability that tourists will be deterred from visiting the Baltic area if an unplanned detonation of a conventional bomb or mine occurred as a result of the project. However, this impact is also considered to be insignificant due to the very minor chance of such an occurrence. The unplanned impacts on tourism and recreation by conventional munitions are **insignificant**.

*Cultural Heritage*

Chemical warfare agents that may be disturbed during seabed intervention work are not expected to have any impact on cultural heritage artefacts in the Baltic Sea as they are considered relatively stable. Pipeline construction and maintenance activities will generally avoid sites of cultural heritage as the proposed pipelines route has been selected to avoid these receptors. Therefore, the likelihood of undiscovered conventional munitions detonating and damaging a ship wreck or submerged human settlement is very remote. Therefore the overall impact significance is **insignificant**.

*Offshore industry*

Chemical munitions have not been found near any offshore industry so it is unlikely that it will be impacted by the chemical warfare agents. The pipelines' corridor will be cleared of conventional munitions before pipeline construction begins, and the pipelines have been routed to avoid any offshore extraction installations. It is therefore highly unlikely that munitions would explode close to the seabed within the vicinity of any offshore industry. For this reason the overall impact significance is **insignificant**.

*Military operations*

It is not expected that there will be any interaction between military operations and chemical munitions. The preferred pipelines' corridor will be cleared of conventional munitions before pipeline construction begins. There is not expected to be any unplanned consequence of munitions on Military operations. The munitions clearance will be carried out by experts. The overall significance is expected to be **insignificant.**

**Table 9.102 Impact summary table for disturbance of munitions**

| | Resource/ Receptor | Munitions type | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversi-bility | Conse-quence | Proba-bility | Overall significance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | | | |
| Disturbance of munitions | Physical processes | Chemical | - | - | - | - | - | - | - | - | - | - | **No impact** |
| | | Conventional | - | - | - | - | - | - | - | - | - | - | **No impact** |
| | Water Column | Chemical | Negative | Direct | Local | Temporary | Low | Low | Low | Reversible | Minor | Low | **Low** |
| | | Conventional | Negative | Direct | Local-regional | Short-term | Low | Low | Low | Reversible | Minor | Low | **Low** |
| | Seabed | Chemical | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Conventional | Negative | Direct | Local | Temporary | Medium | Low - Medium | Low | Reversible | Minor | Low | **Low** |
| | Atmosphere | Chemical | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Conventional | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Plankton | Chemical | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Conventional | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Marine benthos | Chemical | Negative | Direct | Region al | Short-term – long-term | Low-High | Low- High | Low - High | Reversible | Minor - Major | Low | **Low - Moderate** |
| | | Conventional | Negative | Direct | Local | Temporary | Low-Medium | Low | Low - High | Reversible | Moderate | Low | **Low** |
| | Fish | Chemical | Negative | Direct | Local | Short-term | Medium – High | Medium | Low - High | Reversible | Moderate | Low | **Low** |
| | | Conventional | Negative | Direct | Local | Temporary | Low-High | Low - Medium | Low - High | Irreversible | Minor - Moderate | Low | **Low** |
| | Sea birds | Chemical | Negative | Indirect | Local | Short-term | Low-High | Medium | Low - High | Reversible | Moderate | Low | **Low** |

| | Resource/ Receptor | Munitions type | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversi-bility | Conse-quence | Proba-bility | Overall significance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | | | |
| | | Conventional | Negative | Direct | Local | Temporary | Medium-High | Low | Low - High | Reversible | Minor - Moderate | Low | **Low** |
| | Marine mammals | Chemical | Negative | Direct | Local | Short-term | Medium - High | Medium | Medium - High | Reversible | Moderate-Major | Low | **Low-Moderate** |
| | | Conventional | Negative | Direct | Regional | Temporary | Medium - High | Medium | Medium - High | Irreversible | Minor - Moderate | Low | **Low** |
| | Nature conservation areas | Chemical | Negative | Direct | Local | Short-Term | Low - High | Low - Medium | High | Reversible | Moderate | Low | **Low** |
| | | Conventional | Negative | Direct | Regional | Temporary | Medium - High | Medium | High | Reversible | Moderate - Major | Low | **Low - Moderate** |
| | Fisheries | Chemical | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Conventional | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Shipping and navigation | Chemical | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Conventional | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Tourism and recreation | Chemical | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Conventional | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Cultural heritage | Chemical | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Conventional | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Offshore industry | Chemical | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Conventional | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Military operations | Chemical | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Conventional | - | - | - | - | - | - | - | - | - | - | **Insignificant** |

### 9.10.4 Pipeline failure

#### Overview

Another potential unplanned event may result from the pipelines themselves. Pipelines can be damaged, which may result in pipeline failure. The term ‘pipeline failure’ refers to an event that affects the functionality of the pipelines, e.g. a pipeline failure may result from dents or buckling of a pipeline or from ship traffic related interference. Pipeline failure occurs when a pipeline is unable to work under normal conditions e.g. in the case where a Pipeline Inspection Gauge (PIG) launcher provided for pipeline inspections and maintenance purposes is unable to successfully move through the pipeline due to an indentation of the pipeline. Significant damage to a pipeline may lead to the rupturing of a pipeline, resulting in a subsequent release of gas.

The probability of a pipeline failure or rupture occurring is very **low** based upon the engineering principles and techniques employed in the pipelines’ design (see **Chapter 5**). Pipeline damage and rupture are considered as highly unlikely events, but nevertheless the possibility that they may occur during operation still exists. The risk assessment has estimated that the frequency of pipeline rupture events is equivalent to one event in every 20,000 years (see **Chapter 5**). Pipeline failure or rupture may result during operation as a consequence of damage to the pipelines caused by interactions with vessels in the Baltic. Potential interactions and additional information on these interactions is provided below.

- *Dropped objects and dropped or dragged anchor* - Depending on the size and type of a dropped object from ships crossing or travelling along the pipelines’ route, there is a risk of indentation and possible failure. However, no gas release is expected in the case of dropped objects or dropped anchors. For dragged anchors, 30% of the damage cases are assumed to result in gas release (all full bore ruptures) (see **Chapter 5**).

- *Sinking and grounding ships* - The Baltic Sea is one of the busiest seas in the world in terms of vessel traffic from commercial and passenger vessels. As the entire pipelines’ route coincides with or crosses many shipping routes (see **Atlas Map SH-1**) there is a potential risk of ships sinking, and subsequently impacting the buried or unburied pipelines. Any damage from sinking or grounding ships is assumed to result in gas release, the majority resulting in full bore rupture. However, in the shallow waters at the landfalls where grounding of ships can occur (in ESR I and V), the pipelines will be buried in water depths that are sufficient to prevent grounding ships impacting the pipelines. Therefore the probability of the pipelines being impacted is low.

- *Trawling* - Trawling will continue to be carried out in areas around the pipelines during normal pipeline operation. In the areas where the pipelines are buried, or where rock dumping has been undertaken, trawling gear is not expected to interfere with the pipelines.

> However, there is a potential for the trawl equipment to become snagged under a pipeline and result in damage to a pipeline in areas where the pipelines are not buried (see **Chapter 5**). This only occurs where there are large free span heights, and therefore will not be an issue where fishing activity is greatest, in the Danish or German EEZs. Where the pipelines rest on the seabed, analysis of trawling has shown the pipelines can withstand trawl gear interaction in terms of initial impact and being pulled over the pipelines[(1)].

These interactions with the pipelines which could lead to pipeline rupture with the subsequent release of gas are estimated to occur only as a result of dragged anchors and sinking ships impacting the pipelines. As the pipelines have been designed and will be operated according to the DNV OS-F101 Submarine Pipeline Systems standard, this will help to minimise or eliminate such potential unplanned impacts described above.

As described, damage to the pipelines may result in gas leaks. If the pipelines rupture, the gas will disperse into the water, forming a gas plume in the water column, see **Figure 9.23**. From here, the gas will disperse into the atmosphere. The nature of the dispersion (gas cloud) will depend on the molecular weight and the meteorological conditions. A full-bore pipeline rupture is estimated to occur once every 20,000 years (as described **Chapter 5)** and hence such an event is extremely unlikely to occur in the lifetime of the pipelines.

Modelling has been carried out to assess the fate of the gas and extent of gas movement following a pipeline rupture at various points along the pipelines' route[(2),(3),(4)]. The underwater dispersion of gas from the release point to the surface can be split into three distinct regions (see **Figure 9.23**). It is likely that a significant gas release from the pipelines would result in fatal impacts on fish life or marine mammals located in the immediate vicinity of the plume of gas, primarily as a result of pressure released and a local reduction in oxygen. This is likely to be very limited in extent however, as the vast majority of pelagic marine species would immediately vacate the area. The rupture of a pipeline poses more of a serious problem to fishing vessels than to marine life however. The modelling illustrates the fate of gas released from three holes of different sizes; pinhole, hole or full bore rupture. It was concluded that depending on the size of a hole in a pipeline, a distance of between a few meters up to 1,200 m from the source should be avoided as an 'unsafe zone'. Vessels should not enter these zones as it will increase the risk of destabilisation of buoyancy and thereby result in the sinking of the vessel involved.

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(1) Snamprogetti. 2008. Pipe/Trawl Gear Interaction Study.

(2) Snamprogetti. 2008. Risk assessment report for Finnish area- Operational phase.

(3) Snamprogetti. 2008. Risk assessment report for Denmark area (south of Bornholm) - Operational phase.

(4) Snamprogetti. 2008. Risk assessment report for Sweden area- Operational phase.

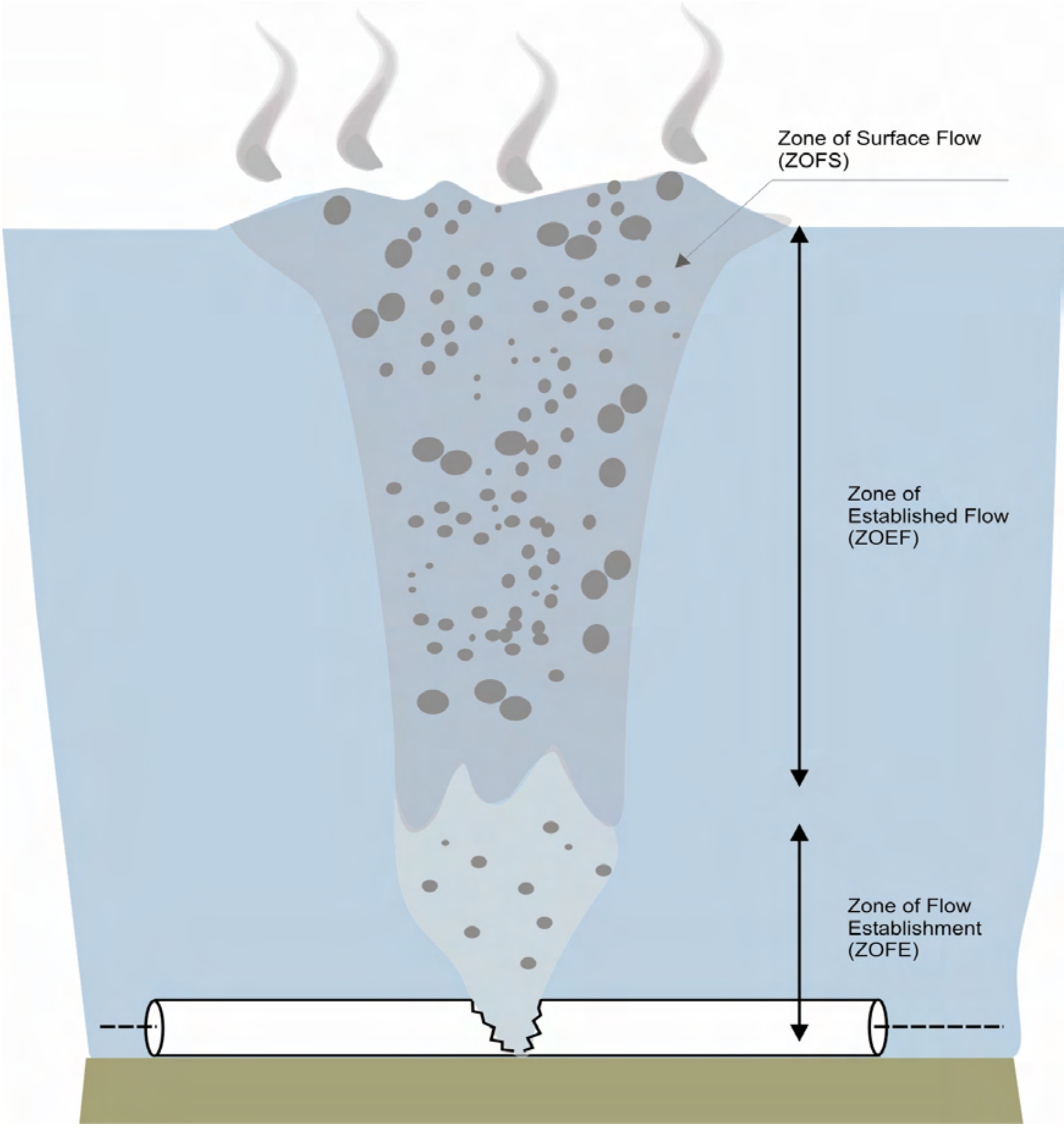


**Figure 9.23 Schematic drawing of release of gas from an offshore pipeline**

In the event of a full-bore pipeline rupture, the pipeline inlet valve would be closed, and as much gas as possible would be removed from the pipeline via the outlet valve. Based upon the engineering principles and techniques employed in the pipelines' design, to protect them from potential risks (**Chapter 5)** it has been estimated that the total frequency of pipeline failure (including the possibility of pipeline rupture) is approximately one failure every 20,000 years (see the Risk Assessment, **Chapter 5**). Therefore, the probability of pipeline rupture is **low**. The pipelines are at greater risk of pipeline rupture in areas where the pipelines are unburied and in areas where ship traffic density is greatest.

Considering the pipelines have been designed to withstand pressures well above normal operating pressure, and that this will be tested extensively during pre-commissioning, the likelihood of a leak or rupture of the pipelines is considered extremely remote. In the case of a pipeline failure occurring, the section of the pipeline damaged may require replacing and potential impacts include increased in turbidity, the increased presence of maintenance vessels and increased noise and vibration.

**Physical environment**

In the following section the impact of pipeline failure on the physical environment and the repair works associated with a pipeline failure are assessed for each of the following receptors:

- Physical processes
- Water column
- Seabed
- Atmosphere

*Physical processes*

**No impact** to the physical processes of the Baltic Sea (e.g. underwater current flows and water exchange) will result from a pipeline rupture or from repair works associated with pipeline failure as the gas will disperse into the water, forming a gas plume and subsequently disperse into the atmosphere.

*Water column*

Pipeline failure refers to an event that affects the functionality of a pipeline. At the lower end of the scale pipeline failure may include dents or buckling of a pipeline. At the upper end, a pipeline rupture would result in the loss of gas to the water column and the atmosphere. The impacts of a pipeline rupture are considered for the water column together with the impacts associated with the repair work on the seabed in general.

In the event of a pipeline rupture and subsequent release of natural gas to the water column, natural gas will rise to the water surface and disperse rapidly in to the atmosphere. The probability of a pipeline rupture occurring is **low** based upon the engineering principles and techniques employed in its design to protect it from potential risks (**Chapter 5**). Natural gas exhibits negligible solubility in water, and thus has little effect on water quality in the event of an underwater leak. A temperature drop caused by gas expansion (Joule-Thomson effect) may occur in the surrounding water. A possible indirect impact on water column is the updraft of bottom water. This could cause bottom water to be mixed with surface water, which may impact on salinity, temperature and oxygen conditions. This would only occur during large ruptures. The updraft of bottom water could also disrupt seabed sediment resulting in an increase in turbidity. A further impact may be a change in buoyancy of the water column. With the release of gas from a pipeline rupture, the density of the water through which the gas moves would be reduced. This would reduce the buoyancy of the water column, which may have an indirect impact on small vessels should they be present in the immediate area. A worst case scenario would be such that the reduction in water buoyancy could sink a small vessel (see **Fisheries**). Generally, all these impacts are expected to be on the **local** scale around the rupture point and of **temporary** duration as the water column is expected to rapidly revert to pre-impact conditions. The impacts will be **negative** and **direct**. Impact intensity is **low** as no major change in structure or function is expected**.** Impact magnitude is **low** and the overall value/sensitivity of the water column is **low**. Impact consequence is therefore **minor**. Taking into consideration that the probability of a pipeline rupture is **low**, the overall significance of the impacts on the water column is **low**. Impacts are **reversible.**

Repair works to the pipelines on the seabed may result in the disruption of sediments and the subsequent increase in turbidity and the release of contaminants and nutrients. These disruptions are expected to be on the local scale and temporary and no significant change is expected in the water column. As such the impact is expected to be **insignificant**.

*Seabed*

Pipeline rupture is only likely to impact the seabed if a rupture of significant size occurs. In these circumstances, a large volume of natural gas will come into contact with the seabed, causing contamination and anoxia. Heavy gas movement may also cause currents, leading to re-suspension and spreading of sediments and changes to the seabed structure. This impact will, however, be temporary and conditions will revert to their previous state over time. It is therefore not expected that this will have any significant impact on the seabed or the ecosystems it supports. The impact of a pipeline rupture on the seabed is therefore considered to be **insignificant**.

The disruption of sediments and the subsequent increase in turbidity may result from repair works associated with pipeline failure. These disruptions are expected to be less severe than those during the construction phase as only a small area of the seabed will be disturbed during repair works and as such the impact is expected to be **insignificant**.

*Atmosphere*

As described in **Chapter 5**, at the settle out pressure, there will be the equivalent (at atmospheric pressure) of 210 million cubic metres of gas in the enclosed pipelines. The mass of gas in the pipelines (at 165 bar) is around 148,000 tonnes, at the temperature of the Baltic seafloor (5ºC). Assuming all gas leaked would enter the atmosphere, this would be equivalent to the release of 3.7 million tonnes of carbon dioxide in terms of global warming potential. In terms of national carbon dioxide emissions, this is equivalent to less than one quarter of one percent of Russia's annual emissions, less than 0.5% of Germany's annual emissions, but equivalent to 7.0% of Denmark or Sweden's annual emissions. In terms of global warming potential, the methane released in a pipeline rupture would be equivalent to approximately 9% of the annual carbon dioxide emissions from total shipping traffic using the Baltic Sea. On this basis, pipeline rupture would be expected to cause **transboundary** impacts of **high** intensity. These impacts would be **negative** and **direct**. The magnitude of the impact would therefore be considered to be **high**, and impacts would be **reversible** over a long time scale. However, the atmosphere is considered to be of **low** value/sensitivity, and impacts would be **temporary** in duration. Therefore, the consequence of pipeline rupture on the atmosphere would be expected to be **moderate**. However, there is a **low** probability of such an event occurring (for all critical pipeline sections together, equivalent to approximately one failure every 20,000 years). Therefore, the average annual mass released from a full bore rupture equates to 185 tonnes per year, or 0.00045% of the annual carbon dioxide emissions of shipping in the Baltic (described in more detail in **Chapter 5**). On this basis, the impact of pipeline rupture on the atmosphere is expected to be of **low** significance.

Repair works to the pipelines on the seabed will require the presence of vessels and machinery which emit emissions. However, the magnitude of impacts on the atmosphere will be much lower than for the construction phase and extremely low compared to the annual level of emissions from existing ship traffic in the Baltic Sea. Therefore, the impact of repair work on the atmosphere is considered to be **insignificant**.

**Biological environment**

In the following section the impact of pipeline failure on the biological environment and the repair works associated with a pipeline failure are assessed for each of the following receptors:

- Plankton
- Marine benthos
- Fish
- Sea birds
- Marine mammals
- Nature conservation areas

*Plankton*

Plankton will not be impacted by the rare event of a pipeline rupture as the released gas will immediately rise to the water surface and disperse into the atmosphere. Therefore the impact to plankton is anticipated to be **insignificant**.

The impacts of seabed related works during the construction phase have been predicted to be insignificant. Any repair works will be minimal in comparison and impacts on plankton from repair work are therefore also anticipated to be **insignificant**.

*Marine benthos*

If a pipeline ruptures, a plume of natural gas will rise to the surface of the water, taking the gas away from the seabed. The impact to the benthos is therefore expected to be limited. However, if a rupture of significant size occurred, a high volume of natural gas may come into brief contact with the seabed and the benthos which could cause contamination of the benthos and create anoxic conditions. Benthos in the immediate vicinity of the pipelines could be exposed to a large volume of natural gas for a very short period of time. It is considered unlikely that the toxicity of the natural gas or the anoxic conditions caused by it could have a significant impact on the benthos. The impact of a pipeline rupture on the benthos is therefore considered to be **insignificant**.

During repairs works, sections of the pipelines may need to be replaced as a result of pipeline failure and this may result in the disturbance of marine benthos. The impacts are expected to be minimal in comparison to those caused during the construction phase, as only a very localised area of the seabed will be impacted. Therefore the impact will be **insignificant.**

*Fish*

The rupture of a pipeline resulting in the release of natural gas will not have any significant impact on fish as the gas released will immediately rise to the water surface and disperse into the atmosphere. The pressure of the gas released may result in death of fish located in the immediate vicinity of the plume as a result of pressure released from the gas leak. Some noise is expected to result from a pipeline rupture, which similarly would result in the temporary displacement of fish that occur in the immediate area. However, the vast majority of pelagic marine species will immediately vacate the area and thus will not be significantly impacted by noise. Given the ability of fish to move away from areas of disturbance, impacts (**negative** and **direct**) associated with a pipeline rupture are expected to be on the **local** scale and of **temporary** duration. Impact intensity ranges from **low** to **high** and depends on the presence of fish in the vicinity of the pipelines. Fish value/sensitivity is **low** to **high,** depending on the species of fish present. Impact magnitude is **low** (see **Chapter 8**). Impact consequence is **minor** to **moderate**. Impacts are **reversible** and the overall significance is **low**.

Sections of the pipelines may need to be replaced as a result of pipeline failure. This will have similar effects on fish as the construction phase; increased turbidity, noise, vibration and localised disturbance, however these will be minimal in comparison. The impacts are expected to be **insignificant** as the probability of a pipeline failure is low, and the repair works will be short-term and localised.

*Sea birds*

A pipeline failure with the subsequent release of small amounts of natural gas is unlikely to result in significant impacts on birds along the pipelines' route. However, the rupture of the pipelines in shallow water resulting in noise and vibration, increased turbidity and visual and physical disturbance may cause negative direct and indirect impacts on wintering and staging birds in the area of the Greifswalder Bodden, the Pomeranian Bay and North and South Midsjö Banks whereas breeding and staging populations of sea birds may be primarily impacted upon within the Gulf of Finland. The remaining sections of the pipelines are mainly located in deeper water in excess of 50 m outside the typical foraging water depth of sea birds and the likelihood that sea birds are using these areas is very low. Impacts on sea birds will be **insignificant**.

Where a section of pipe requires replacement as a result of pipeline failure, impacts on birds will be minimal in comparison to the intervention works planned for the construction phase. Evidently the magnitude of the impact will depend on the extent of the works required and the presence of birds in the area. As these works are likely to be an isolated event, short-term and localised, and much reduced from that of the construction phase, impacts are expected to be **insignificant**.

*Marine mammals*

Pipeline failure refers to an event that affects the functionality of a pipeline. At the lower end of the scale pipeline failure may include dents or buckling of the pipeline. On the upper end, a pipeline rupture would result in the loss of gas to the water column and the atmosphere. The impacts of a pipeline rupture are considered for marine mammals together with the impacts associated with the repair work on the seabed in general.

In the event of a pipeline rupture and subsequent release of natural gas to the water column, natural gas will rise to the water surface and disperse rapidly. The probability of a pipeline rupture occurring is **low** based upon the engineering principles and techniques employed in its design to protect it from potential impacts (**Chapter 5**). Natural gas rising through the water column is not expected to have an impact on marine mammals. However, should marine mammals be present at the point of rupture, this could be fatal. This is deemed to be unlikely as the noise associated with an incident resulting in a pipeline rupture would result in the displacement of marine mammals.

Some noise is to be expected should a pipeline rupture take place. This would result in the temporary displacement of marine mammals that occur in the immediate area. Once the gas has reached the sea surface it will disperse into the atmosphere where it will have no impact on marine mammals. Impacts (**direct** and **negative**) associated with a pipeline rupture are expected to be on the **local** scale around the rupture point and of **short- term** duration until the rupture is addressed. Impact intensity is **low** as no impact on structure or function is envisaged and depends largely on marine mammal presence. Impact magnitude is **low**. Marine mammal value/sensitivity is **medium** to **high** (breeding season) as per **Chapter 8**. Impact consequence is **minor** to **moderate** (during the breeding season). Taking into consideration that the probability of a pipeline rupture is **low**, the overall **significance** of the impacts on marine mammals is **low**. Impacts are **reversible.**

Repair work to the pipelines on the seabed may result in the disruption of sediments and the subsequent increase in turbidity and the release of contaminants and nutrients. These disruptions are expected to be on the local scale and temporary and no significant change is expected in the water column. Furthermore, marine mammals use their hearing ability for navigation, as well as for hunting, and thus a small increase in turbidity would have no effect. The impact on marine mammals from the disruption of sediments is expected to yield an **insignificant** impact on individuals. Repair work will also result in the generation of noise that may exceed background levels. No direct measurements are available but it is assumed that the noise generated will be on a par with normal shipping and fishing activities to which marine mammals have habituated and thus the impact is expected to be **insignificant**.

*Nature conservation areas*

A pipeline failure such as a rupture and subsequent gas release has the potential to impact on nature conservation areas in the vicinity of the pipelines' route if the protected habitats and/or species associated with each designated site are affected. The probability of a pipeline failure or rupture occurring is **low** as a result of the preventative measures employed to protect the pipelines (as described in the overview of **Section 9.10.4**).

As detailed in the above sections, a pipeline rupture would lead to a plume of gas rising to the water surface and then dispersing into the atmosphere, which is only likely to result in toxic effects on fish, birds and marine mammals in the immediate vicinity of the gas plume. No significant impacts to protected habitats are expected as the gas will quickly rise to the water surface and cause minimal disturbance at seabed level.

The majority of the nature conservation areas in the vicinity of the pipelines' route are designated to protect sea bird and/or seal communities, and many include spawning grounds for fish in their protection. The sensitivity of these nature conservation areas is **high** (as detailed in the baseline in **Chapter 8**). However, toxic effects are likely to be very limited as described for fish, birds and mammals above. The main impact predicted is temporary displacement of fish, sea birds and marine mammals in the immediate area of the pipeline rupture as a result of noise and/or physical disturbance. Impacts (**negative** and **direct**) associated with a pipeline rupture are expected to be **short-term** and on a **local** scale. As marine fauna will move away from the area of a pipeline rupture, impact intensity and magnitude are predicted to be **low**. Therefore impact consequence is expected to be **moderate**. As the probability of a pipeline failure or rupture occurring is **low**, the overall impact significance of a pipeline rupture on nature conservation areas is expected to be **low**. Impacts are **reversible**.

Where a section of pipe requires replacement as a result of pipeline failure, impacts on nature conservation areas will be similar to those impacts during the construction phase, including an increase in turbidity as a result of the re-suspension and spreading of sediments, an increase in noise and vibration and visual/physical disturbance as a result of vessel movement. The level of impact will depend on the extent of works required and the proximity of the site to a nature conservation area, but is likely to be on a much smaller scale than that of the construction phase. As these works are likely to be an isolated event, short-term and localised, and much reduced from that of the construction phase, impacts are expected to be **insignificant**.

**The Social and Socioeconomic Environment**

In the following section the impact of pipeline failure on the social and socioeconomic environment and the repair works associated with a pipeline failure are assessed for each of the following receptors:

- Fisheries
- Shipping and navigation
- Tourism and recreation
- Cultural heritage
- Offshore industry
- Military operations and munitions

*Fisheries*

There would be a **direct** and **negative** impact associated with rising gas plume due to a pipeline rupture on fishing boats. The nature of the impact would be of **short-term** duration and of **local** scale. The impact intensity is **low** to **high** depending on whether the gas plume is sufficiently large to seriously destabilise or even sink a fishing boat (considered to be very unlikely). Impact magnitude is **low** to **medium**. Given these factors the result is an impact of **minor** consequence. The sensitivity of the fishing sector is **low**. Given that the probability of a ship being affected in this way is **low**, the overall unplanned impact significance is **low**. In extreme cases the impact of a gas plume release would be **irreversible**, but is far more likely to be **reversible**.

*Shipping and navigation*

Due to the low probability of a pipeline rupture shipping vessels are highly unlikely to be affected. If there was a rupture ships would have to be in the area immediately above the rupture in the pipeline and therefore above the plume of gas in order to be impacted. This scenario is extremely unlikely to occur and therefore the impact is considered to be **insignificant**. There is however a low probability that shipping routes would be slightly disrupted in the event of a rupture whilst the necessary repairs are made. This would have a very minor impact upon shipping and navigation and is therefore considered to be an **insignificant** unplanned impact.

*Tourism and recreation*

An unplanned pipeline rupture would result in an **insignificant** impact on tourism. This is because tourism and recreational activities are expected to take place close to the shorelines rather than along the pipelines' route. Planned Project related activities are expected to have an insignificant impact on tourism and recreation and therefore any repair works to the pipelines as a result of pipelines failure will also be **insignificant** as they will be on a much smaller scale than those of the construction phase.

*Cultural heritage*

There is a very remote probability of a pipeline rupture occurring within the vicinity of a ship wreck or submerged Stone Age settlement. The plume generated by a rupture would rise upwards meaning that it would be unlikely to interact with objects on the sea floor within the vicinity of the accident. This means that the incident would most likely result in an event of **insignificant** consequence. Planned Project related activities are expected to have an insignificant impact on cultural heritage and therefore any repair works to the pipelines as a result of pipelines failure will also be **insignificant** as they will be on a much smaller scale than those of the construction phase.

*Offshore industry*

Planned Project related activities are expected to have an insignificant impact on telecommunication and power cables, offshore wind farms and the other various offshore infrastructure present in the Baltic Sea and therefore any repair works to the pipelines as a result of pipeline failure will also be **insignificant** as they will be on a much smaller scale than those planned activities.

*Military operations*

A pipeline rupture would have an **insignificant** unplanned impact on military operations. This is because there is a very remote chance that a military vessel would be present within the vicinity of such an occurrence. An **insignificant** impact on military operations is expected as a result of any unplanned pipeline repair works, as planned Project related activities will occur on a much large scale and are expected to have an insignificant on this receptor.

## Table 9.103 Impact summary table for pipeline failure

| | Resource/ Receptor | Event | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Consequence | Probability | Overall significance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | | | |
| Pipeline Failure | Physical processes | Failure | - | - | - | - | - | - | - | - | - | - | **No impact** |
| | | Repair | - | - | - | - | - | - | - | - | - | - | **No impact** |
| | Water Column | Failure | Negative | Direct | Local | Temporary | Low | Low | Low | Reversible | Minor | Low | **Low** |
| | | Repair | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Seabed | Failure | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Repair | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Atmosphere | Failure | Negative | Direct | Trans-boundary | Temporary | High | High | Low | Reversible | Moderate | Low | **Low** |
| | | Repair | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Plankton | Failure | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Repair | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Marine benthos | Failure | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Repair | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Fish | Failure | Negative | Direct | Local | Temporary | Low - High | Low | Low - High | Reversible | Minor - Moderate | Low | **Low** |
| | | Repair | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Sea birds | Failure | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Repair | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Marine mammals | Failure | Negative | Direct | Local | Short-term | Low | Low | Medium - High | Reversible | Minor - Moderate | Low | **Low** |
| | | Repair | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Nature conservation areas | Failure | Negative | Direct | Local | Short-term | Low | Low | High | Reversible | Moderate | Low | **Low** |
| | | Repair | - | - | - | - | - | - | - | - | - | - | **Insignificant** |

| | Resource/ Receptor | Event | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Consequence | Probability | Overall significance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | | | |
| | Fisheries | Failure | Negative | Direct | Local | Short-term | Low - High | Low - medium | Low | Irreversible | Minor | Low | **Low** |
| | | Repair | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Shipping and navigation | Failure | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Repair | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Tourism and recreation | Failure | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Repair | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Cultural heritage | Failure | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Repair | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Offshore industry | Failure | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Repair | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | Military operations | Failure | - | - | - | - | - | - | - | - | - | - | **Insignificant** |
| | | Repair | - | - | - | - | - | - | - | - | - | - | **Insignificant** |

## 9.11 Decommissioning

The design life of the pipelines is expected to be fifty years, although its technical life may be extended through close monitoring of degrading mechanisms such as corrosion and anode consumption and the conducting of additional "fit-for-purpose" assessments. However, the pipelines will eventually reach the end of their life and at that stage decommissioning will be necessary.

### 9.11.1 Legislative Framework and Guidelines

The process of decommissioning is regulated by international agreements as well as national legislation. Legislation regulates both the removal of installations (primarily concerning safety of navigation and other use of the sea) and disposal of materials contained within the structure that is to be decommissioned (primarily aimed at pollution prevention). A framework of international conventions exists which, in turn, influences national legislative requirements. The primary conventions concerned are UNCLOS, the United Nations Convention on the Law of the Seas, 1982 and the 1972 London Convention (and the subsequent 1996 Protocol). In addition, the International Maritime Organisation (IMO) sets standards and guidelines for the removal of offshore installations worldwide.

There are no international guidelines specifically addressing the decommissioning of pipelines. The United Kingdom (UK) has, however, produced national guidelines within this field. Reference is made below to the UK guidelines to illustrate likely factors to be considered when taking the decision on decommissioning methods for the Nord Stream pipelines.

The UK guidelines state that, as a general approach, pipeline decommissioning on the UK continental shelf should be done in accordance with the following.

- The potential for reuse of the pipeline in connection with further hydrocarbon developments should be considered before decommissioning, together with other existing projects (such as hydrocarbon storage). If reuse is considered viable, suitable and sufficient maintenance of the pipeline must be investigated and ensured

- All feasible decommissioning options should be considered and a comparative assessment made

- Any removal or partial removal of a pipeline should be performed in such a way as to cause no significant adverse effects on the marine environment

- Any decision that a pipeline may be left in place should have regard to the likely deterioration of the material involved and its present and possible future effect on the marine environment

- Account should be taken of other uses of the sea

The UK guidelines further state that a decision should always be taken in the context of individual circumstances.

Where it is proposed that a pipeline should be decommissioned by leaving it on the seabed for natural degradation (referred to as *in situ* decommissioning), either wholly or in part, the decommissioning programme should be supported by a suitable study that 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 line, using appropriate data to confirm the current status of the pipeline, including the extent and depth of burial, trenching, spanning and exposure.

Determination of any potential effect on the marine environment at the time of decommissioning should be based upon scientific evidence. The factors to be taken into account should include the effect on water quality and geological and hydrographical characteristics, the presence of endangered or threatened species, existing habitat types, local fishery resources and the potential for pollution or contamination by residual products from, or deterioration of, the pipeline.

As a general guide, pipelines which may be candidates for *in situ* decommissioning are:

- Those that are adequately buried or trenched and are not subject to the development of spans, and likely to remain so

- Those that are not buried or trenched but are likely to self- bury over a sufficient length, within a reasonable time and remain so buried

- Those where burial or trenching of the exposed sections has been undertaken to a sufficient depth and it is likely to be permanent

- Those that are not trenched or buried but may still be candidates for leaving in place (e.g. trunk lines)

- Those, which due to structural damage or deterioration or other cause, cannot be recovered safely and efficiently

Judgements regarding the degree of burial or trenching necessary will be undertaken on a case-by-case basis in light of individual circumstances.

The above reference to the UK guidelines serves as an example of general principles that may be applied during the decommissioning options decision-making process. It merely serves to identify current practices based on experience and planning within the UK, in particular the North Sea as hydrocarbon fields there reach depletion and decommissioning has now become a key consideration in the industry. It is foreseen that more directly applicable international or national guidelines will be developed before the end of the lifetime of the Nord Stream Project and that these will specify additional options to be considered.

### 9.11.2 Decommissioning Options

Although the circumstances of the decommissioning process are currently not known, at present the following options have been identified by Nord Stream:

- Pipeline removal
- Leaving the pipeline in place
- Partial removal of the pipelines

The potential impacts of pipeline removal and in-situ decommissioning (leaving the pipelines in place) are summarised briefly below. Partial removal includes a combination of these two strategies.

*Potential Impacts from Pipeline Removal*

Removal of the pipelines from the seabed would involve the following types of activities:

- Anchor handling
- Seabed intervention works
- Pipeline removal
- Vessel movement

The impacts would therefore be broadly similar in nature to those from the construction phase of the Project, although the impacts are expected to be more significant (i.e. worse) than those anticipated during construction. Additionally, pipeline removal will require a disposal route for the removed sections of pipeline. This is likely to entail recycling for metals recovery.

*Potential Impacts from Leaving the Pipelines in Place*

The following decommissioning activities would be required to enable the pipelines to be left in place:

- De-gasing (depressurisation and inerting to displace hydrocarbon gas)
- Water-filling
- Sealing

Over the long-term, the effect of leaving the pipelines in place would be similar to operational phase impacts, but without the movement of gas in the pipelines. In addition, there would be long-term monitoring carried out. The frequency of monitoring would be determined at the time of decommissioning, in compliance with necessary legislation. Monitoring activities would not be expected to have significant impacts on any receptors. The impacts from decommissioning activities associated with the leave in situ option are predicted to have a significantly lower environmental impact than pipeline removal.

### 9.11.3 Conclusion

Based on current knowledge and expectations, leaving the pipelines in place or in situ is likely to be the preferred option. This opinion may change, however, in line with changed legal, economic, technological and public perception circumstances and expectations prevailing at such a time when decommissioning is required.

# 9.12 Impact Summary

## 9.12.1 Introduction

This section summarises the key findings of the assessment of impacts along the entire length of the pipelines during the construction, pre-commissioning and commissioning, and operational phase of the Project. The assessment has considered impacts arising from all planned activities as well as from reasonably foreseeable unplanned (accidental) events. Impacts are considered collectively for both pipelines and therefore take into consideration sequential pipe-laying and seabed intervention works for both pipelines. The majority of impacts are associated with construction and pre-commissioning and commissioning; such impacts are temporary and transient in nature and will not have long-term effects on the Baltic Sea environment.

Impacts are grouped according to resource/receptor. For each physical, biological or socioeconomic resource/receptor, the significant impacts that have been identified are discussed according to the activity which will give rise to the impact. An indication of the significance of the impacts is provided, and the country in which the initiating event will take place is identified.

This summary of impacts identifies all those impacts which have been assessed in **Sections 9.3** to **9.10** as being 'significant'. Impacts assessed as insignificant are not addressed in this chapter.

As described in **Chapter 7**, a 'significant' impact is an impact that should be taken into account in the decision-making process. Significant impacts arising from planned activities have been assessed to be of **minor** or **moderate** significance; while potential impacts that may arise from conceivable unplanned events are designated as being of **low** or **moderate** significance (the distinction being that the assessment of unplanned events has included the consideration of likelihood of occurrence (probability) in the designation of significance). No impacts have been assessed to be of **major** or **high** significance for planned impacts and unplanned events respectively.

**Box 9.4 Cumulative effects of impacts**

| |
|---|
| The possibility that a number of insignificant impacts may give rise to a significant impact has been considered and no such impacts have been identified. |

### 9.12.2 Physical Environment – Physical Processes

Impacts to physical processes arising from the physical presence of the pipelines on the seabed could result in changes in underwater current flow. No impacts to physical process are anticipated during the construction or pre-commissioning and commissioning phases. During the operational phase, all potential impacts have been assessed to be insignificant and hence **no impacts** to physical processes in the Baltic Sea are anticipated as a result of the physical presence of the pipelines on the seabed.

### 9.12.3 Physical Environment – Water Column

The main activities which are expected to impact on the water column are those that take place during the construction phase, in particular seabed intervention works resulting in the re-suspension and spreading of sediments. The following activities are expected to cause **significant** impacts to the water column:

- **Munitions clearance** (Russia, Finland and Sweden): The clearance of munitions has the potential to cause the re-suspension and spreading of sediments and the release of contaminants, since munitions are generally located on, or submerged within, the seabed. This will result in a regional increase in turbidity and contaminant concentrations in those areas where munitions clearance occurs. This impact has been assessed as being of **minor** significance restricted to those locations where munitions clearance will take place.

- **Seabed intervention works** (Russia, Finland, Sweden, Denmark and Germany): Seabed intervention works on the seabed will result in the disturbance and subsequent re-suspension of sediments together with any compounds that are associated with the sediments. This will give rise to an increase in turbidity levels as well as the release of contaminants in the water column. The increase in turbidity and release of contaminants due to seabed intervention works has been assessed to have a **minor** impact on the water column in the areas where these works take place.

- **Pressure-test water discharge** (Russia): Under the current design concept, seawater abstraction will take place near the Russian landfall and thereafter seawater will be filtered and treated with caustic soda (NaOH) and an oxygen scavenger (sodium bisulphite - $NaHSO_3$). Following completion of pressure testing, pressure-test water will be discharged. NaOH and $NaHSO_3$ are naturally occurring substances in the marine environment. Modelling of the discharge has demonstrated that levels of these substances will not exceed acceptable thresholds and that the situation in Portovaya Bay is expected to return to normal within 12-24 hours after the discharge has stopped (provided this is undertaken during ice free periods). This has been assessed to have a **minor** impact on the water column in Portovaya Bay.

### 9.12.4 Physical Environment – Seabed

Impacts on the seabed will occur in both the construction and operational phases of the Project. The following activities are expected to cause **significant** impacts to the seabed:

- Munitions clearance (Russia, Finland and Sweden): The clearance of munitions has the potential to cause physical alteration of the seabed through altering the structure of the seabed directly and through the re-suspension and spreading of sediments. This impact has been assessed as being of minor significance restricted to those locations where munitions clearance will take place

- Seabed intervention works (Russia, Finland, Sweden, Denmark and Germany): Seabed intervention works will result in the physical alteration of the seabed, which is assessed to be of minor significance wherever these works occur. Dredging and sheet piling in the German EEZ will cause the release of contaminants from seabed sediments, as well as causing physical alteration of seabed. Both these impacts are assessed to be of minor significance

- Anchor handling (Russia, Finland, Sweden, Denmark and Germany): Controlled positioning of anchors in the seabed will cause the physical alteration of the seabed along the pipelines’ route. This impact has been assessed as being of minor significance along the entire pipelines’ route

- Release of pollutants from anti-corrosion anodes (Germany): The release of pollutants from anti-corrosion anodes in the German EEZ is assessed to result in a minor impact to the seabed

### 9.12.5 Physical Environment – Atmosphere

Significant impacts on the atmosphere will occur during the construction phase of the Project only and impact on all countries surrounding the Baltic Sea. General construction activities are expected to result in the emission of pollutant gases such as $CO_2$, $NO_x$ and $SO_2$. The emission of these gases into the atmosphere has been assessed to be of **minor** significance.

### 9.12.6 Biological Environment – Plankton

Given the mobile nature of plankton, there is no potential for the Nord Stream Project to significantly change the abundance or distribution of plankton.

### 9.12.7 Biological Environment – Marine Benthos

The main activities predicted to impact marine benthos are those that take place during the construction phase. Impacts during the pre-commissioning and commissioning as well as operational phases are expected to be minimal. The following construction phase activities are expected to cause **significant** impacts on marine benthos:

- **Munitions clearance** (Russian, Finland and Sweden): Munitions clearance is expected to impact marine benthos through causing an increase in turbidity, release of contaminants, increase in noise and vibration and physical loss of seabed habitats. These potential impacts have been assessed as being of **minor** significance where munitions clearance will take place.

- **Seabed intervention works, pipe-laying and anchor handling** (Russia, Finland, Sweden, Denmark and Germany): Seabed intervention works, including dredging, trenching, rock placement, installation of support structures and hyperbaric tie-ins, as well as pipe-laying and anchor handling, will give rise to a number of impacts on marine benthos. Marine benthos have the potential to become smothered, have filter feeding organs clogged with sediment and light levels may be reduced thereby preventing photosynthesis by flora. An increase in turbidity due to seabed intervention works and pipe-laying will have a **minor** impact on marine benthos along most of the pipelines' route, with anchor handling contributing to this impact in the Swedish, Danish and German EEZs. However, in the areas of the Pomeranian Bay, Oderbank and the Boddenrandschwelle in the German EEZ this impact is **moderate** due to the high sensitivity of benthos species in these areas. Seabed intervention works, pipe-laying and anchor handling will also cause the release of contaminants along the entire pipelines' route, which has been assessed to be of **minor** significance. Along the entire pipelines' route, seabed intervention works, pipe-laying and anchor handling will all contribute to the physical loss of seabed habitats. This impact will be **minor** everywhere except the areas of Pomeranian Bay, Oderbank and the Boddenrandschwelle in the German EEZ, where impacts will be **moderate**. In the German EEZ, the removal of a shipwreck is also assessed to have a **minor** to **moderate** impact on benthos, in terms of the physical loss of seabed habitats since high sensitivity seagrass occurs in the area of the wreck to be removed. Smothering (lateral sediment slumps) will occur as a result of seabed intervention works and pipe-laying in Russian, Swedish, Danish and German EEZs. Impacts will be minor except in the areas of the Pomeranian Bay and Oderbank in the German EEZ where impacts will be **moderate**. Wreck removal will also cause **minor** to **moderate** smothering impacts (moderate impacts affecting high sensitivity seagrass) in the German EEZ.

- **Hyperbaric tie-ins** (Russia, Finland): Hyperbaric tie-ins will contribute to the physical loss of seabed habitats in areas where they occur. The significance of this impact on benthos is assessed to be **minor**.

- **Routine maintenance** (Russia, Finland, Sweden, Denmark and Germany): Routine maintenance works will cause impacts of **minor** significance due to physical alteration of the seabed on marine benthos along the entire pipelines' route, except in the area of Boddenrandschwelle in the German EEZ where impacts on high sensitivity seagrass will be of **moderate** significance.

- **Pipeline presence** (Russia, Finland, Sweden, Denmark and Germany): The positive or negative impact of pipeline presence on benthos due to the introduction of secondary habitats is assessed as being of **minor** significance along the entire pipelines' route, except in the area of the Pomeranian Bay and Oderbank in the German EEZ, where the impact is considered to be negative, and of **moderate** significance.

### 9.12.8 Biological Environment – Fish

The activities that take place during the Project's construction and operational phases are expected to result in significant impacts on fish, in particular, those activities that produce noise and vibration. The following activities are expected to cause **significant** impacts to fish:

- **Munitions clearance** (Russia, Finland and Sweden): Munitions clearance activities may result in tissue damage to fish as well as behavioural changes such as the displacement of fish from their usual spawning grounds during the spawning season. The level of noise generated from munitions clearance is not known but is assessed to impart a **minor** to **moderate** impact on fish in areas where this activity takes place.

- **Seabed intervention works** (Russia, Sweden, Denmark and Germany): Seabed intervention works in the German EEZ are predicted to have a **minor** to **moderate** impact on fish in terms of both an increase in turbidity and the release of contaminants. Dredging and trenching will result in increased noise levels during construction in Russia, Sweden, Denmark and Germany. This impact is assessed to be of **minor** to **moderate** significance. In the Swedish EEZs rock placement is predicted to have a significant impact on fish due to physical alteration of the seabed; this is also assessed to be of **minor** to **moderate** significance.

- **Pipe-laying, anchor handling** (Germany): Pipe-laying and anchor handling in the German EEZ are expected to contribute to the impact on fish in this area due to an increase in noise and vibration. This impact is assessed to be of **minor** to **moderate** significance.

- **Hyperbaric tie-ins** (Finland and Sweden): Hyperbaric tie-ins will impact fish in the Finnish and Swedish EEZs due to noise and vibration disturbance. This impact is considered to be of **minor** to **moderate** significance.

- **Construction and support vessel movement** (Germany): Vessel movement in the German EEZ is also expected to contribute to the impact on fish in this area due to an increase in noise and vibration. This impact is assessed to be of **minor** to **moderate** significance.

- **Pipeline presence** (Russia, Finland, Sweden, Denmark and Germany): Pipeline presence on the seabed will result in a physical alteration of the seabed, and an increase in noise and vibration, along the entire pipelines' route. Impacts to fish along the entire pipelines' route due to pipeline presence have been assessed to be of **minor** to **moderate** significance.

### 9.12.9 Biological Environment – Sea Birds

The main activities that are expected to impact sea birds are those that take place during construction, in particular, those activities that cause an increase in turbidity, produce noise and vibration, or result in visual and physical disturbance. Diving birds in the German EEZ are particularly sensitive. The following activities are expected to cause **significant** impacts to sea birds:

- **Boulder removal, wreck removal** (Germany): Both boulder removal and wreck removal are predicted to have a **minor** to **moderate** impact on sea birds in the German EEZ in terms of the loss of seabed habitat.

- **Munitions clearance** (Russia): Visual and physical disturbance due to munitions clearance is predicted to impact on sea birds in the Russian EEZ. The impact is assessed to be of **minor** to **moderate** significance. Impacts on sea birds are, however, short-term and sea birds will return once the construction of the pipelines is completed in the vicinity (several kilometres) of the detonation point. Long-term changes in the abundance and distribution of sea birds in the Baltic Sea are unlikely. In the Russian EEZ, significant impacts as a result of munitions clearance will be an increase in turbidity and loss of seabed habitats; these impacts are assessed to be of **minor** to **moderate** significance.

- **Seabed intervention works** (Russia, Sweden, Denmark and Germany): Seabed intervention works including dredging, trenching, rock placement, installation of support structures and sheet piling, are predicted to have direct and indirect impacts on sea birds in the Russian, Swedish, Danish and German EEZs. In the Russian and German EEZs, significant impacts will be an increase in turbidity and loss of seabed habitats; these impacts are assessed to be of **minor** to **moderate** significance. Further, in the Swedish, Danish and German EEZs, significant impacts will be due to the impacts of noise and vibration and visual/physical disturbance of sea birds; these will be of **minor** to **moderate** significance.

- **Pipe-laying** (Russia, Sweden, Denmark and Germany): In the Russian EEZ, pipe-laying is predicted to cause a significant impact on sea birds due to the loss of seabed habitat. In the Swedish, Danish and German EEZs, pipe-laying is predicted to have a significant visual/physical impact on sea birds. Impacts will primarily affect populations of diving ducks, auks and other piscivorous species, and are assessed to be of **minor** to **moderate** significance.

- **Anchor handling** (Germany): Anchor handling in the German EEZ is predicted to have an impact of **minor** to **moderate** significance on sea birds due to the loss of seabed habitat.

- **Above-water tie-ins** (Germany): The above-water tie-ins in the German EEZ are predicted to have an impact of **minor** to **moderate** significance on sea birds due to visual/physical disturbance.

- **Construction and support vessel movement** (Russia, Sweden, Denmark and Germany): There will be a significant visual/physical impact on sea birds in the Russian, Swedish, Danish and German EEZs due to the movement of vessels associated with the Project. In the German EEZ, vessel movement will also have a significant impact on sea birds due to the noise and vibration associated with this activity. All impacts are assessed to be of **minor** to **moderate** significance.

### 9.12.10 Biological Environment – Marine Mammals

The main activities that are expected to impact marine mammals are those that take place during the construction and pre-commissioning and commissioning phases, in particular, those activities that produce noise and vibration. Impacts during the operational phase are expected to be insignificant. The following activities are expected to cause **significant** impacts on marine mammals:

- **Munitions clearance (Russia, Finland and Sweden):** Noise and vibration generated during munitions clearance will impact marine mammals up to 10 km away. The level of noise generated is not known but has conservatively been assessed to impart a moderate impact on marine mammals.

- **Seabed intervention works (Russia, Sweden, Denmark and Germany):** Seabed intervention works will result in an increase in noise and vibration or the introduction of specific sound sources that may affect marine mammals. A minor to moderate impact on marine mammals has been identified along the entire pipelines' route where these activities take place.

- **Seawater intake (Russia):** Seawater intake during pre-commissioning will generate some noise and vibration, which will impact on marine mammals. This activity will be undertaken exclusively at the Russian landfall and is assessed to impart minor to moderate impacts on marine mammals.

- **Pressure-test water discharge (Russia):** Following pressure testing, the discharge of pressure-test water at the Russian landfall site will cause a change in water quality. However, all substances used in pressure-test water treatment already exist in seawater and are harmless to the marine environment at natural concentrations. On discharge, these substances will rapidly degrade and break down in the water column though hydrolysis, oxidation, photo degradation and biodegradation. This activity is assessed to impart minor to moderate impacts on marine mammals.

- **Construction and support vessel movement (Russia, Finland, Sweden, Denmark, Germany):** although construction is not planned to take place during the seal breeding season over winter months, if it were to occur during this period, a moderate impact would be imparted on marine mammals along the entire pipelines' route, due to ice breaking as a result of construction and support vessel movement.

### 9.12.11 Biological Environment – Nature Conservation Areas

Impacts to nature conservation areas in the vicinity of the pipelines' route will occur if the protected habitats and/or species, which are the qualifying interests of the designation, are affected. The main activities that are expected to impact nature conservation areas are those occurring during the construction phase of the Project. Impacts during the pre-commissioning and commissioning and operational phases are expected to be comparatively small, due to the less invasive nature of the activities in these phases, and the smaller scale on which these activities will operate. The following activities are expected to cause **significant** impacts on nature conservation areas:

- **Munitions clearance** (Russia): Both an increase in turbidity and noise and vibration are expected as a result of munitions clearance. While no nature conservation area is in the immediate vicinity of any planned clearance in the Russian EEZ, **moderate** impacts may be felt by designated fauna (marine mammals, sea birds and fish) outside the boundary of the protected sites if individuals of these species range closer to the pipelines' route.

- **Seabed intervention works** (Russia and Germany): In the Russian EEZ, seabed intervention works are expected to cause a significant increase in turbidity affecting the nature conservation area of Skala Hally only. This impact is assessed to be of **moderate** significance. In Germany, seabed intervention works will result in both an increase in turbidity and noise and vibration, which are expected to impact on the habitats or fauna associated with a nature conservation area in this EEZ. Impacts of this nature are only expected where the pipelines' route runs within a few kilometres of the protected site. **Moderate** impacts are expected.

- **Pipe-laying and anchor handling** (Russia): Pipe-laying and anchor handling in the Russian EEZ are also predicted to cause an increase in turbidity, which will affect the protected area of Skala Hally only. The impact on this conservation area is assessed to be **moderate**.

- **Construction and support vessel movement** (Germany): Visual or physical disturbance may occur as a result of vessel movement during construction. Disturbance from vessel movement is generally predicted to occur within a few kilometres for marine mammals and sea birds. For the majority of the route, nature conservation areas are distant enough that no significant impacts occur. However, in the German EEZ, vessel movement may affect protected sea bird populations associated with the conservation area in this region. Vessel movement is assessed to cause a **moderate** impact on nature conservation areas.

### 9.12.12 The Social and Socioeconomic Environment

The resources/receptors that have been considered for social and socioeconomic impacts are fisheries, shipping and navigation, tourism and recreation, cultural heritage, offshore industry, and military operations. Impacts on these resources/receptors will occur mainly as a result of construction and support vessel movement and the creation of an exclusion zone around Project vessels. Therefore impacts will be most prevalent during construction and to a much lesser extent, during the operational phase as a result of maintenance activities. Impacts from pipelines presence on the seabed are expected to impact fisheries during the operation phase.

- **Pipeline presence:** Impacts to fisheries may occur as a result of the long-term presence of the pipelines on the seabed. Publically available information on the geographical focus and the fishing patterns of the Baltic fleets is limited and the adaptability of fishermen to alter their patterns to accommodate the presence of the Nord Stream pipelines is currently not well understood. Nord Stream has embarked on a concerted consultation programme with fisheries representatives to better understand the level of constraint that the pipelines will impose on current socioeconomic patterns and practices and the extent to which these can be adapted to accommodate the permanent presence of the two pipelines. The current lack of information has resulted in a precautionary allocation of **minor** to **moderate** impacts to current fishing patterns and a **minor** impact fishing equipment from snagging on the pipelines etc., particularly in areas where the pipelines will have significant free spans above the sea floor.

- **Construction and support vessel movement:** Navigational impacts may occur anywhere along the pipelines' route as a result of increased construction and support vessel movement and the creation of an exclusion zone during construction. These impacts are likely to be more frequent in the vicinity of where the pipelines' route crosses the main approach channels to the target fishing areas. Increased construction and support vessel movements have been assessed to have **minor** impacts on fishing vessels and **moderate** impacts on shipping and navigation.

- **Munitions clearance:** The imposition of an exclusion zone during munitions clearance is anticipated to have a **minor** impact on fishing vessel navigation. The impact of the imposition of this exclusion zone is assessed to have a **minor** impact on shipping vessel navigation, which may extend to **moderate** for vessels in the Gulf of Finland.

All other impacts on these resources/receptors are judged to be **insignificant**. This is because impacts will be temporary and localised, and these resources/receptors all have a high degree of flexibility in their movements and operations. For example, although an exclusion zone will be in operation during the construction phase, this will be publicised in advance through the relevant shipping authorities, thus allowing ships to plan ahead and minimise disruption.

### 9.12.13 Impacts Arising from Unplanned Events

In addition to the impacts associated with normal Project activities, which are carefully planned and tightly controlled, the potential exists for accidental or unplanned events to occur. Some of these could result in significant environmental and social/socioeconomic impacts. Unplanned events are less predictable and may be damaging to the receiving environment when they occur. As described in **Chapter 7,** the concepts of probability and consequence have been included in the assessment to determine the overall significance of potential impacts arising from unplanned events. The unplanned events that have the potential to give rise to a significant impact are as follows:

- **Fuel/oil spills:** Accidental fuel/oil spills are typically associated with the construction phase of the Project but may extend into the operational phase during maintenance activities. Refuelling of vessels at sea and/or accidental damage to vessels could result in spills. Depending on the sensitivity of the resource/receptor affected and the extent of the accidental event, an impact of major consequence could be possible. The consequences of spill scenarios have been determined taking cognisance of oil spill dispersion modelling that includes considerations such as the fate of fuel once spilled. The resultant impacts have been assessed taking into consideration the low probability of a major fuel/oil spill occurring. Impact consequence is expected to range from **minor** to **major** however taking the **low** probability of a spill occurring into consideration, the assessment concludes that impacts to the water column, atmosphere and plankton would be of an overall **low** significance. The impacts to marine benthos, fish and marine mammals and conservation areas could range from **low** to **moderate** significance following a spill depending on the presence of species, habitat etc. affected. Impact consequence is expected to be **moderate** for fisheries and shipping and navigation and **minor** for tourism and recreation. Overall impact significance is expected to be **low** for each of these receptors.

- **Disturbance of chemical munitions**: Dumped chemical munitions (chemical warfare agents) maybe encountered throughout the Baltic Sea. Along most of the pipelines' route the probability of disturbing chemical munitions (warfare agents) is **low**, however the pipelines' route does cross Risk Zone 3 dumping areas around Bornholm and to the south of Gotland and the probability of disturbing warfare agents here is slightly higher, but still deemed to be **low** (see **Section 8.12.7**). Disturbance of chemical munitions may occur during the construction and operational (highly unlikely) phases of the Project. An interaction with chemical munitions could result in toxic chemicals being released into the water column. This could result in impacts of **minor** consequence on the water column and sea birds and of **moderate** consequence on fish, marine mammals and conservation areas. Impact consequence may extend from **minor** to **major** for marine benthos. Taking into consideration the **low** probability of disturbing chemical munitions along the pipelines' route, the overall significance on these resources/receptors is **low** for the water column, fish, sea birds, marine mammals, conservation areas and sea birds but extends to **moderate** for marine benthos. Disturbance of chemical munitions will have an overall **insignificant** impact on the social/socioeconomic environment.

- **Disturbance of conventional munitions**: Conventional munitions found in the Baltic Sea include depth bombs, aerial bombs, submarine combating rockets, torpedoes, grenades and naval mines. As the pipelines' route will be cleared of conventional munitions prior to construction, the probability of accidental disturbance to conventional munitions is **low**. If conventional munitions were to be accidentally disturbed during the construction phase, this could result in impacts similar to those assessed for normal munitions clearance. This would result in impacts of **minor** consequence on the water column and seabed, of **minor** to **moderate** consequence on fish, sea birds and marine mammals, of **moderate** consequence on marine benthos, and of **moderate** to **major** consequence on conservation areas. Taking into consideration that the accidental disturbance and detonation of conventional munitions is **low**, the overall impact significance on these resources/receptors is **low** extending to **moderate** for conservation areas. Accidental disturbance of conventional munitions will have an **insignificant** impact on each of the social/socioeconomic receptors described.

- **Pipeline failure:** Pipeline failure refers to an event that affects the functionality of the pipelines, for example a pipeline failure may result from dents or buckling of a pipeline or from ship traffic related interference. Pipeline failure may only occur during the operational phase of the Project. If complete pipeline failure were to occur (i.e. a full bore pipeline rupture), the subsequent release of natural gas would impact the water column, atmosphere, fish, marine mammals, nature conservation areas and fisheries. The consequence of a pipeline rupture is generally **minor** however may extend to **moderate** in the case of fish, marine mammals and nature conservation areas. Taking into consideration that the probability of pipeline rupture is **low**, the overall significance of the impacts on these specific resources/receptors is **low** and insignificant for all other resources/receptors. Repair works to the pipelines required as a result of pipeline failure are anticipated to have an overall insignificant impact on all resources/receptors.

### 9.12.14 Summary of Impact Tables

Significant impacts identified for each of the Parties of Origin are summarised in **Table 9.104** to **Table 9.108** per resource/receptor. Where more than one ESR falls within the territorial waters and/or the EEZ of a Party of Origin, apparent conflict in terms of impact significance assessed for a specific resource/receptor within that Party of Origin may result. This apparent conflict may occur as a consequence of varying value/sensitivity assigned to the resource/receptor in the individual ESRs. For example, the impacts of noise associated with seabed intervention works on harbour porpoises is deemed to be of minor significance in ESR III and moderate significance in ESR IV and hence the impact significance in Danish waters will be minor to moderate (see **Sections 9.5.10** and **9.6.10**). Harbour porpoise are deemed to be of high value/sensitivity in ESR IV during certain months of the year as the harbour porpoise is particularly sensitive close to the German coast, whereas they are of medium value/sensitivity throughout the year in ESR III. Subsequently, when compiling the impact summary table below for Denmark for example (**Table 9.107**) significance criteria for both ESRs are taken into consideration regardless of national boundaries or particular sensitive locations within an ESR, which thus explains why impact significance may vary for a resource/receptor within one Party of Origin, across ESRs.

All potential significant impacts identified as a result of unplanned events are summarised in **Table 9.109**.

**Table 9.104 Summary of significant impacts for Russia (ESR I and ESR II)**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value / Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Water Column** | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | Release of contaminants | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | Change in water quality | Pressure-test water discharge | Negative | Direct | Regional | Temporary | Low | Low | Low | Reversible | **Minor** |
| **Seabed** | Physical alteration of the seabed | Munitions clearance | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Boulder removal, Seabed intervention works | Negative | Direct | Local-Regional | Long-term | Low | Low | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| **Atmosphere** | Emissions of pollutant gases | Seabed intervention works, Pipe-laying | Negative | Cumulative | National – Transboundary | Long-term | Low | Low | Low | Irreversible | **Minor** |
| **Marine Benthos** | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term - Long-term | Low | Low | Low - Medium | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term - Long-term | Low | Low | Low | Reversible | **Minor** |
| | | Rock placement, Installation of support structures, Pipe-laying | Negative | Direct | Local | Short-term - Long-term | Low | Low | Low - Medium | Reversible | **Minor** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value / Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Release of contaminants | Munitions clearance, Seabed intervention works, Pipe-laying, Anchor handling | Negative | Direct and indirect | Local | Long-term | Low | Low | Low - Medium | Reversible | **Minor** |
| | Noise and vibration | Munitions clearance | Negative | Direct | Local | Temporary | Low - Medium | Low | Low | Reversible | **Minor** |
| | Physical loss of seabed habitats | Munitions clearance | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | | Dredging | Negative | Direct and indirect | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | | Rock placement, Installation of support structures, Pipe-laying | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Low-Medium | Low | Low - Medium | Reversible | **Minor** |
| | Smothering | Dredging, Pipe-laying | Negative | Direct | Local | Short-term - Long-term | Medium | Low | Low | Reversible | **Minor** |
| | Physical alteration of the seabed | Routine maintenance | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | Introduction of secondary habitats | Pipeline presence | Positive or Negative | Direct | Local | Long-term | Medium | Low | Low - Medium | Irreversible | **Minor** |
| **Fish** | Release of contaminants | Munitions clearance, Seabed intervention works | Negative | Direct | Local | Short-term | Low | Low | Low-High | Reversible | **Moderate** |
| | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Medium-High | Medium | Low-High | Reversible | **Minor-Moderate** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value / Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | | Dredging | Negative | Direct | Regional | Temporary | Low | Low | Low-High | Reversible | **Minor-Moderate** |
| | | Pipeline presence | Negative | Direct | Local | Short-term | Low | Low | Low -High | Reversible | **Minor-Moderate** |
| | Physical alteration of the seabed | Pipeline presence | Negative | Direct | Local | Long-term | Medium | Low | Low | Irreversible | **Minor** |
| **Sea Birds** | Increase in turbidity | Munitions clearance, Seabed intervention works | Negative | Direct and indirect | Regional | Short-term | Low | Low | Low - High | Reversible | **Minor-Moderate** |
| | Loss of seabed habitat | Munitions clearance, Seabed intervention works, Pipe laying | Negative | Direct | Local | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| | Visual / physical disturbance | Munitions clearance | Negative | Direct | Local | Temporary | Low - Medium | Low | Low - High | Reversible | **Minor-Moderate** |
| | | Construction and support vessel movement | Negative | Direct and indirect | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor-Moderate** |
| **Marine Mammals** | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Medium - High | Medium | Medium - High | Reversible | **Moderate** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low - Medium | Low | Medium - High | Reversible | **Minor-Moderate** |
| | | Seawater intake | Negative | Direct | Regional | Short-term | Low | Low | Medium - High | Reversible | **Minor-Moderate** |
| | Ice breaking | Construction and support vessel movement | - / Negative | - / Direct, Secondary | - / Regional | - / Short-term | - / Medium | - / Medium | - / High | - / Reversible | **No impact/ Moderate** |
| | Change in water quality | Pressure-test water discharge | Negative | Direct | Regional | Short-term | Medium | Low | Medium - High | Reversible | **Minor-Moderate** |
| **Nature Conser** | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term | Low - Medium | Low - Medium | High | Reversible | **Moderate** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value / Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | | Seabed intervention works, Pipe-laying, Anchor handling | - / Negative* | - / Direct* | - / Regional* | - / Short-term* | - / Low* | - / Low* | - / High* | - / Reversible* | **Insignificant / Moderate*** |
| | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Low - Medium | Low - Medium | High | Reversible | **Moderate** |
| Fisheries | Restriction on navigation for fishing vessels | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Medium | Reversible | **Minor** |
| | | Construction and support vessel movements and imposition of exclusion zone | Negative | Direct | Regional | Short-term | Low | Low | Medium | Reversible | **Minor** |
| | Disruption of current fishing patterns | Pipeline presence and free spans (and potential associated exclusion zones) | Negative | Direct | Regional – National | Long-term | Medium | Low - Medium | Medium | Irreversible | **Minor to Moderate** |
| | Damage to fishing equipment | Pipelines presence and free spans | Negative | Direct | Regional – National | Long term - Permanent | Low | Low | Medium | Irreversible | **Minor** |
| Shipping and Navigation | Restriction on navigation for shipping | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | High | Reversible | **Moderate** |
| | | Construction and support vessel movement and imposition of exclusion zone | Negative | Direct | Regional | Short-term | Low | Low | High | Reversible | **Moderate** |

* Values refer to impacts on the Skala Hally nature conservation area

**Table 9.105 Summary of significant impacts for Finland (ESR II and ESR III)**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Water Column | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | Release of contaminants | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| Seabed | Physical alteration of the seabed | Munitions clearance | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Local | Long-term | Low | Low | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| Atmosphere | Emissions of pollutant gases | Seabed intervention works, Pipe-laying | Negative | Cumulative | National - Transboundary | Long-term | Low | Low | Low | Irreversible | **Minor** |
| Marine Benthos huih | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term - Long-term | Low | Low | Low - Medium | Reversible | **Minor** |
| | | Rock placement, Installation of support structures, Pipe-laying | Negative | Direct | Regional | Short-term - Long-term | Low | Low | Low - Medium | Reversible | **Minor** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Release of contaminants | Munitions clearance, Seabed intervention works, Pipe-laying, Anchor handling | Negative | Direct and indirect | Local | Long-term | Low | Low | Low - Medium | Reversible | **Minor** |
| | Noise and Vibration | Munitions clearance | Negative | Direct | Local | Temporary | Low - Medium | Low | Low | Reversible | **Minor** |
| | Physical loss of seabed habitats | Munitions clearance | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | | Pipe-laying | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | | Rock placement | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | | Hyperbaric tie-ins | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | Physical alteration of the seabed | Routine maintenance | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | Introduction of secondary habitats | Pipeline presence | Positive or Negative | Direct | Local | Long-term | Low - Medium | Low | Low - Medium | Irreversible | **Minor** |
| **Fish** | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Medium-High | Medium | Low-High | Reversible | **Minor-Moderate** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | | Hyperbaric tie-ins | Negative | Direct | Regional | Temporary | Low | Low | Low-High | Reversible | **Minor-Moderate** |
| | | Pipeline presence | Negative | Direct | Local | Short-term | Low | Low | Low-High | Reversible | **Minor-Moderate** |
| | Physical alteration of the seabed | Pipeline presence | Negative | Direct | Local | Long-term | Medium | Low | Low-High | Irreversible | **Minor-Moderate** |
| Marine Mammals | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Medium –High | Medium | Medium – High | Reversible | **Moderate** |
| Marine Mammals | Ice breaking | Construction and support vessel movement | - / Negative | - / Direct, Secondary | - / Regional | - / Short-term | - / Medium | - / Medium | -/ High | - / Reversible | **No impact / Moderate** |
| Fisheries | Restriction on navigation for fishing vessels | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Medium | Reversible | **Minor** |
| Fisheries | Restriction on navigation for fishing vessels | Construction and support vessel movements and imposition of exclusion zone | Negative | Direct | Regional | Short-term | Low | Low | Medium | Reversible | **Minor** |
| Fisheries | Disruption of current fishing patterns | Pipeline presence | Negative | Direct | Regional–National | Long-term | Medium | Low - Medium | Medium | Irreversible | **Minor – Moderate** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Damage to fishing equipment | Pipeline presence | Negative | Direct | Regional – National | Long term - Permanent | Low | Low | Medium | Irreversible | **Minor** |
| **Shipping and Navigation** | Limited navigation for shipping vessels | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | High | Reversible | **Moderate** |
| | | Construction and support vessel movement and imposition of exclusion zone | Negative | Direct | Regional | Short-term | Low | Low | High | Reversible | **Moderate** |

**Table 9.106 Summary of significant impacts for Sweden (ESR III and ESR IV)**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Water Column | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | Release of contaminants | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| Seabed | Physical alteration of the seabed | Munitions clearance | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| | | Seabed intervention works | Negative | Direct | Local – Regional | Long-term | Low | Low | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| Atmosphere | Emissions of pollutant gases | Seabed intervention works, Pipe-laying | Negative | Cumulative | National - Transboundary | Long-term | Low | Low | Low | Irreversible | **Minor** |
| Marine Benthos | Increase in turbidity | Munitions clearance | Negative | Direct | Regional | Short-term - Long-term | Low | Low | Low | Reversible | **Minor** |
| | | Trenching, Rock placement, Pipe-laying, Anchor handling | Negative | Direct | Regional | Short-term | Medium | Low | Low | Reversible | **Minor** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Release of contaminants | Munitions clearance, Seabed intervention works, Pipe-laying, Anchor handling | Negative | Direct and indirect | Local | Long-term | Low | Low | Low | Reversible | **Minor** |
| | Noise and vibration | Munitions clearance | Negative | Direct | Local | Temporary | Low - Medium | Low | Low | Reversible | **Minor** |
| | Physical loss of seabed habitats | Munitions clearance | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | | Trenching, Pipe-laying | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | | Rock placement | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | | Hyperbaric tie-ins | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | Smothering | Dredging, Trenching, Rock placement, Installation of support structures, Pipe-laying | Negative | Direct | Local | Short-term - Long-term | Medium | Low | Low | Reversible | **Minor** |
| | Physical alteration of the seabed | Routine maintenance | Negative | Direct | Local | Short-term | Low - Medium | Low | Low | Reversible | **Minor** |
| | Introduction of secondary habitats | Pipeline presence | Positive or Negative | Direct | Local | Long-term | Medium | Low | Low | Irreversible | **Minor** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Fish | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Medium-High | Medium | Low - High | Reversible | **Minor-Moderate** |
| | | Seabed intervention works, Hyperbaric tie-ins | Negative | Direct | Regional | Temporary | Low | Low | Low - High | Reversible | **Minor-Moderate** |
| | | Pipeline presence | Negative | Direct | Local | Short-term | Low | Low | Low - High | Reversible | **Minor-Moderate** |
| | Physical alteration of the seabed | Rock placement, Pipeline presence | Negative | Direct | Local | Long-term | Medium | Low | Low - High | Irreversible | **Minor - Moderate** |
| Sea Birds | Noise and vibration | Trenching | Negative | Direct and indirect | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| | Visual/physical disturbance | Seabed intervention works, Pipe-laying, Construction and support vessel movement | Negative | Direct | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| Marine Mammals | Noise and vibration | Munitions clearance | Negative | Direct | Regional | Temporary | Medium - High | Medium | Medium - High | Reversible | **Moderate** |
| | | Seabed intervention works | Negative | Direct | Regional | Short-term | Low - Medium | Low | Medium - High | Reversible | **Minor - Moderate** |
| | Ice breaking | Construction and support vessel movement | - / Negative | - / Direct, Secondary | - / Regional | - / Short-term | - / Medium | - / Medium | - / High | - / Reversible | **No impact / Moderate** |
| Fish | Restriction on | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Medium | Reversible | **Minor** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | navigation for fishing vessels | Construction and support vessel movements and imposition of exclusion zone | Negative | Direct | Regional | Short-term | Low | Low | Medium | Reversible | **Minor** |
| | Disruption of current fishing patterns | Pipeline presence | Negative | Direct | Regional– National | Long-term | Medium | Low - Medium | Medium | Irreversible | **Minor – Moderate** |
| | Damage to fishing equipment | Pipeline presence | Negative | Direct | Regional – National | Long term - Permanent | Low | Low | Medium | Irreversible | **Minor** |
| **Shipping and Navigation** | Restriction on navigation for shipping vessels | Munitions clearance | Negative | Direct | Regional | Short-term | Low | Low | Medium | Reversible | **Minor** |
| | | Construction and support vessel movement and imposition of exclusion zone | Negative | Direct | Regional | Short-term | Low | Low | Medium | Reversible | **Minor** |

**Table 9.107 Summary of significant impacts for Denmark (ESR III and ESR IV)**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| **Water** | Increase in turbidity | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| | Release of contaminants | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| **Seabed** | Physical alteration of the seabed | Seabed intervention works | Negative | Direct | Local - Regional | Long-term | Low | Low | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| **Atmosphere** | Emissions of pollutant gases | Seabed intervention works, Pipe-laying | Negative | Cumulative | National - Transboundary | Long-term | Low | Low | Low | Irreversible | **Minor** |
| **Marine Benthos** | Increase in turbidity | Trenching, Pipe-laying, Anchor handling | Negative | Direct | Regional | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | Release of contaminants | Seabed intervention works, Pipe-laying, Anchor handling | Negative | Direct and indirect | Local | Long-term | Low | Low | Low | Reversible | **Minor** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Physical loss of seabed habitats | Trenching, Pipe-laying | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | Smothering | Trenching, Installation of support structures, Pipe-laying | Negative | Direct | Local | Short-term - Long-term | Medium | Low | Low | Reversible | **Minor** |
| | Physical alteration of the seabed | Routine maintenance | Negative | Direct | Local | Short-term | Low - Medium | Low | Low | Reversible | **Minor** |
| | Introduction of secondary habitats | Pipeline presence | Positive or Negative | Direct | Local | Long-term | Low | Low | Low | Irreversible | **Minor** |
| **Fish** | Noise and vibration | Seabed intervention works | Negative | Direct | Regional | Temporary | Low | Low | Low - High | Reversible | **Minor-Moderate** |
| | | Pipeline presence | Negative | Direct | Local | Short-term | Low | Low | Low - High | Reversible | **Minor-Moderate** |
| | Physical alteration of the seabed | Pipeline presence | Negative | Direct | Local | Long-term | Medium | Low | Low - High | Irreversible | **Minor - Moderate** |
| **Sea** | Noise and vibration | Trenching | Negative | Direct and indirect | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Visual/physical disturbance | Seabed intervention works, Pipe-laying, Construction and support vessel movement | Negative | Direct | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| Marine | Noise and vibration | Seabed intervention works | Negative | Direct | Regional | Short-term | Low - Medium | Low | Medium - High | Reversible | **Minor - Moderate** |
| | Ice breaking | Construction and support vessel movement | - / Negative | - / Direct, Secondary | - / Regional | - / Short-term | - / Medium | - / Medium | - / High | - / Reversible | **No impact / Moderate** |
| Fisheries | Restriction on navigation for fishing vessels | Construction and support vessel movements and imposition of exclusion zone | Negative | Direct | Regional | Short-term | Low | Low | Medium | Reversible | **Minor** |
| | Disruption of current fishing patterns | Pipeline presence | Negative | Direct | Regional– National | Long-term | Medium | Low - Medium | Medium | Irreversible | **Minor – Moderate** |
| | Damage to fishing equipment | Pipeline presence | Negative | Direct | Regional – National | Long term - Permanent | Low | Low | Medium | Irreversible | **Minor** |
| Shipping and | Restriction on navigation for shipping vessels | Construction and support vessel movement and imposition of exclusion zone | Negative | Direct | Regional | Short-term | Medium | Low | Medium to High | Reversible | **Minor to Moderate** |

**Table 9.108 Summary of significant impacts for Germany (ESR IV and ESR V)**

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Water | Increase in turbidity | Seabed intervention works | Negative | Direct | Local - Regional | Short-term | Low - Medium | Low - Medium | Low | Reversible | **Minor** |
| | Release of contaminants | Seabed intervention works | Negative | Direct | Regional | Short-term | Low | Low | Low | Reversible | **Minor** |
| Seabed | Release of contaminants | Seabed intervention works, Anchor handling | Negative | Direct | Regional | Short-term | Medium | Low | Low | Reversible | **Minor** |
| | Physical Alteration of the Seabed | Dredging | Negative | Direct | Local - Regional | Short-term - Long-term | Low - Medium | Medium | Low | Reversible | **Minor** |
| | | Sheet piling | Negative | Direct | Local | Short-term | High | Medium | Low | Reversible | **Minor** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Low | Low | Low | Reversible | **Minor** |
| | Release of pollutants from anti-corrosion anodes | Pipeline presence | Negative | Direct | Local | Long-term | Low | Low | Low | Irreversible | **Minor** |
| Atmosphere | Emissions of pollutant gases | Seabed intervention works, Pipe-laying, Above-water tie-ins | Negative | Cumulative | National - Transboundary | Long-term | Low | Low | Low | Irreversible | **Minor** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Marine Benthos | Increase in turbidity | Trenching, Pipe-laying, Anchor handling at Pomeranian Bay and Oderbank | Negative | Direct | Regional | Short-term | Low | Low | High | Reversible | **Moderate** |
| | | Dredging, Sheet Piling, Pipe-laying (landfall) | Negative | Direct | Local | Short-term | Low | Low | Low – Medium | Reversible | **Minor** |
| | | Dredging, Trenching, Pipe-laying, Anchor handling (elsewhere) | Negative | Direct | Local - Regional | Short-term | Low - Medium | Low | Low – Medium / High** | Reversible | **Minor/ Moderate**** |
| | Release of contaminants | Seabed intervention works, Pipe-laying, Anchor handling | Negative | Direct and indirect | Local | Long-term | Low | Low | Low - Medium / High** | Reversible | **Minor/ Moderate**** |
| | Physical loss of seabed habitats | Wreck removal | Negative | Direct | Local | Short-term - Long-term | Medium | Low | Low/High** | Reversible/ Irreversible** | **Minor/ Moderate**** |
| | | Dredging, Sheet piling, Pipe-laying (landfall) | Negative | Direct | Local | Short-term | Medium | Low | Low - Medium | Reversible | **Minor** |
| | | Dredging, Trenching, Pipe-laying (offshore) | Negative | Direct | Local | Short-term | Medium | Low | Low/High*** | Reversible/ Irreversible*** | **Minor/ Moderate***** |
| | | Rock placement | Negative | Direct | Local | Short-term | Medium | Low | Low/High* | Reversible/ Irreversible* | **Minor/ Moderate*** |
| | | Anchor handling | Negative | Direct | Local | Short-term | Medium | Low | Low/High* | Reversible | **Minor/ Moderate*** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Smothering | Wreck removal | Negative | Direct | Local | Short-term - Long-term | Medium | Low | Low/High** | Reversible | **Minor/ Moderate**** |
| | | Dredging, Trenching, Rock placement, Installation of support structures, Pipe-laying (offshore) | Negative | Direct | Local | Short-term - Long-term | Low - Medium | Low | Low - Medium/ High* | Reversible | **Minor/ Moderate*** |
| | Physical alteration of the seabed | Routine maintenance | Negative | Direct | Local | Short-term | Low | Low | Low/High*** | Reversible | **Minor/ Moderate***** |
| | Introduction of secondary habitats | Pipeline presence | Positive or Negative/ Negative* | Direct | Local | Long-term | Medium | Low | Low - Medium/ High* | Irreversible | **Minor/ Moderate*** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Fish | Increase in turbidity | Seabed intervention works | Negative | Direct | Local | Short-term | Medium | Low | Low - High | Reversible | **Minor-Moderate** |
| Fish | Release of contaminants | Seabed intervention works | Negative | Direct | Local | Short-term | Medium | Low | Low - High | Reversible | **Minor-Moderate** |
| Fish | Noise and vibration | Seabed intervention works, Pipe-laying, Anchor handling | Negative | Direct | Regional | Temporary | Low - Medium | Low - Medium | Low - High | Reversible | **Minor-Moderate** |
| Fish | Noise and vibration | Pipeline presence | Negative | Direct | Local | Short-term | Low | Low | Low - High | Reversible | **Minor-Moderate** |
| Fish | Noise and vibration | Construction and support vessel movement | Negative | Direct | Local | Short-term | Low | Low | Low - High | Reversible | **Minor-Moderate** |
| Fish | Physical alteration of the seabed | Pipeline presence (additional of hard substrate) | Negative | Direct | Local | Long-term | Medium | Low | Low - High | Irreversible | **Minor - Moderate** |
| Sea Birds | Increase in turbidity | Seabed intervention works | Negative | Direct and Indirect | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor-Moderate** |
| Sea Birds | Noise and vibration | Seabed intervention works, Construction and support vessel movement | Negative | Direct and Indirect | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |
| Sea Birds | Loss of seabed habitat | Boulder removal, Wreck removal, Seabed intervention works, Pipe-laying, Anchor handling | Negative | Direct and Indirect | Local | Long-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| | Visual/physical disturbance | Seabed intervention works, Pipe-laying, Above-water tie-ins, Construction and support vessel movement | Negative | Direct | Local - Regional | Short-term | Low | Low | Low - High | Reversible | **Minor - Moderate** |

| | Impact | Activity | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scale | Duration | Intensity | Magnitude | | | |
| Marine | Noise and vibration | Seabed intervention works | Negative | Direct | Regional | Short-term | Low-Medium | Low | Medium - High | Reversible | **Minor - Moderate** |
| | Ice breaking | Construction and support vessel movement | - / Negative | - / Direct, Secondary | - / Regional | - / Short-term | - / Medium | - / Medium | - / High | - / Reversible | **No impact/ Moderate** |
| Nature Conservation | Increase in turbidity | Seabed intervention works | Negative | Direct | Regional | Short-term | Medium | Medium | High | Reversible | **Moderate** |
| | Noise and vibration | Seabed intervention works | Negative | Direct | Regional | Short-term | Low - Medium | Low - Medium | High | Reversible | **Moderate** |
| | Visual/physical disturbance | Construction and support vessel movement | Negative | Direct | Local - Regional | Short-term | Low | Low | High | Reversible | **Moderate** |
| Fisheries | Restriction on navigation for fishing vessels | Construction and support vessel movements and imposition of exclusion zone | Negative | Direct | Regional | Short-term | Low | Low | Medium | Reversible | **Minor** |
| Shipping and | Restriction on navigation for shipping vessels | Construction and support vessel movement and imposition of exclusion zone | Negative | Direct | Regional | Short-term | Medium | Low | Medium - High | Reversible | **Minor to Moderate** |

* Values apply to the section of the pipelines' route which crosses the Pomeranian Bay and Oderbank Natura 2000 sites.

** Values apply to the section of the pipelines' route which passes through the Boddenrandschwelle seagrass area.

*** Values apply to the sections of the pipelines' route which cross the Pomeranian Bay and Oderbank Natura 2000 sites and Boddenrandschwelle seagrass area.

**Table 9.109 Summary of significant impacts due to unplanned events**

| Resource/ Receptor | | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Consequence | Probability | Overall significance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Scale | Duration | Intensity | Magnitude | | | | | |
| Fuel/oil spill | Water Column | Negative | Direct | National | Short-term | Medium | Medium | Low | Reversible | Minor | Low | **Low** |
| | Atmosphere | Negative | Cumulative | National | Short-term | Low | Medium | Low | Reversible | Minor | Low | **Low** |
| | Plankton | Negative | Direct | National | Short-term | Low | Medium | Low | Reversible | Minor | Low | **Low** |
| | Marine benthos | Negative | Direct | National | Long-term | High | High | Low - High | Reversible | Moderate - Major | Low | **Low - Moderate** |
| | Fish | Negative | Direct | National | Short-term | Low - Medium | Medium | Low - High | Reversible | Minor - Major | Low | **Low - Moderate** |
| | Sea birds | Negative | Indirect and Direct | National | Short-term | Low - High | High | Low - High | Reversible | Moderate - Major | Low | **Low - Moderate** |
| | Marine mammals | Negative | Direct | National | Short-term | Medium - High | Medium | Medium - High | Reversible | Moderate - Major | Low | **Low - Moderate** |
| | Nature conservation areas | Negative | Direct | National | Short-term | Low - High | Low - High | High | Reversible | Moderate - Major | Low | **Low - Moderate** |
| | Fisheries | Negative | Direct | National | Short-term | High | High | Medium | Reversible | Moderate | Low | **Low** |
| | Shipping and navigation | Negative | Direct | National | Short-term | Low | Medium | Medium | Reversible | Moderate | Low | **Low** |
| | Tourism and recreation | Negative | Direct | National | Short-term | Medium | Medium | Low | Reversible | Minor | Low | **Low** |
| | Offshore Industry | Negative | Direct | National | Short-term | Low | Medium | Low | Reversible | Minor | Low | **Low** |
| Disturbance of munitions | Water Column - Chemical | Negative | Direct | Local | Temporary | Low | Low | Low | Reversible | Minor | Low | **Low** |
| | Water Column - Conventional | Negative | Direct | Local - regional | Short-term | Low | Low | Low | Reversible | Minor | Low | **Low** |
| | Seabed - Conventional | Negative | Direct | Local | Temporary | Medium | Low - Medium | Low | Reversible | Minor | Low | **Low** |
| | Marine benthos - Chemical | Negative | Direct | Regional | Short-term – long-term | Low- High | Low- High | Low - High | Reversible | Minor - Major | Low | **Low - Moderate** |

| Resource/ Receptor | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Consequence | Probability | Overall significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Scale | Duration | Intensity | Magnitude | | | | | |
| Marine benthos - Conventional | Negative | Direct | Local | Temporary | Low-Medium | Low | Low - High | Reversible | Moderate | Low | **Low** |
| Fish - Chemical | Negative | Direct | Local | Short-term | Medium – High | Medium | Low - High | Reversible | Moderate | Low | **Low** |
| Fish - Conventional | Negative | Direct | Local | Temporary | Low- High | Low - Medium | Low - High | Irreversible | Minor - Moderate | Low - Medium | **Low** |
| Sea birds - Chemical | Negative | Indirect | Local | Short-term | Low- High | Medium | Low - High | Reversible | Minor | Low | **Low** |
| Sea birds - Conventional | Negative | Direct | Local | Temporary | Medium-High | Low | Low - High | Reversible | Minor - Moderate | Low | **Low** |
| Marine mammals - Chemical | Negative | Direct | Local | Short-term | Medium - High | Medium | Medium - High | Reversible | Moderate-Major | Low | **Low - Moderate** |
| Marine mammals - Conventional | Negative | Direct | Regional | Temporary | Medium - High | Medium | Medium - High | Irreversible | Minor - Moderate | Low | **Low** |
| Nature conservation areas - Chemical | Negative | Direct | Local | Short-Term | Low - High | Low - Medium | High | Reversible | Moderate | Low | **Low** |
| Nature conservation areas - Conventional | Negative | Direct | Regional | Temporary | Medium - High | Medium | High | Reversible | Moderate - Major | Low | **Low - Moderate** |
| Military operations and navigation - Conventional | Negative | Direct | Local | Temporary | Low | Low | Low | Reversible | Moderate | Low | **Low** |

| Resource/ Receptor | | Nature | Type | Impact Magnitude | | | | Value/ Sensitivity | Reversibility | Consequence | Probability | Overall significance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Scale | Duration | Intensity | Magnitude | | | | | |
| Pipeline Failure | Water Column- Failure | Negative | Direct | Local | Temporary | Low | Low | Low | Reversible | Minor | Low | **Low** |
| | Atmosphere- Failure | Negative | Direct | Trans- boundary | Temporary | High | High | Low | Reversible | Moderate | Low | **Low** |
| | Fish- Failure | Negative | Direct | Local | Temporary | Low - High | Low | Low - High | Reversible | Minor - Moderate | Low | **Low** |
| | Marine mammals- Failure | Negative | Direct | Local | Short-term | Low | Low | Medium - High | Reversible | Minor - Moderate | Low | **Low** |
| | Nature conservation areas- Failure | Negative | Direct | Local | Short-term | Low | Low | High | Reversible | Moderate | Low | **Low** |
| | Fisheries- Failure | Negative | Direct | Local | Short-term | Low - High | Low - medium | Low | Irreversible | Minor | Low | **Low** |

## 9.13 Conclusion

The majority of impacts arising from planned activities associated with construction and operation of the Nord Stream Project have been assessed to be **insignificant**. Of the significant impacts that are associated with planned activities, all have been assessed to be of **minor** or **moderate** significance; no impacts of **major** significance have been identified. The majority of these impacts will not have long-term effects to the Baltic Sea environment.

Of the potential unplanned events that have been identified, in certain circumstances, and depending on the nature, scale and intensity of the unplanned event as well as the sensitivity of the particular resources/receptors that are affected, high magnitude impacts could result. However, taking into account the probability of such events occurring and the degree to which the potential impacts are short-term or reversible, overall potential impacts from unplanned events are ranked **low** to **moderate**.

## 9.14 Reference List

Alerstom, T & Christie, D.A. 1990. Bird Migration. Cambridge University Press.

Amoser, S., Ladich, F. 2005. Are hearing sensitivities of freshwater fish adapted to the ambient noise in their habitats? Journal of Experimental Biology.

Andrejev, O. et al. 2004. Mean circulation and water exchange in the Gulf of Finland – A study based on three-dimensional modelling. Boreal Environmental Research 9.

Australian Pesticides and Veterinary Medicines Authority. 2005. The reconsideration of registrations of arsenic timber treatment products (CCA and arsenic trioxide) and their associated labels. Part 2 – Environmental assessment.

Bellebaum, J., Diederichs, A., Kube, J., Schulz, A. & G. Nehls. 2006. Flucht- und Meidedistanzen überwinternder Seetaucher und Meeresenten gegenüber Schiffen auf See. Ornithologische Rundbrief für Mecklenburg-Vorpommern Orn. Rundbrief Mecklenburg-Vorpommern 45, Sonderheft 1 (Tagungsbd. 5. deutsches See- und Küstenvogelkolloquium).

Burd, A. C. 1978. Long term changes in North Sea herring stocks. Rapport Permanentverbeaux Réunion Conseil International pour l'Exploration de la Mer.

Chapman, C.J., Hawkins, A.D. 1969. The importance of sound in fish behaviour in relation to capture by trawls. FAO Fisheries Reports 62 (3).

Christiansen, C., Edelvang, K., Emeis, K., Graf, G., Jähmlich, S., Kozuch, J., Laima, M., Leipe, T., Löffler, A., Lund-Hansen, L.C., Miltner, A., Pazdro, K., Pempkowiak, J., Shimmield, G., Shimmield, T., Smith, J., Voss, M., Witt, G. 2002. Material Transport from the nearshore to the basinal environment in the Southern Baltic Sea: Processes and mass estimates. Journal of Marine Systems.

Clarke and Wilber. Assessment of potential impacts of dredging operations due to sediment resuspension. DOER Technical Notes Collection. 2000. http://el.erdc.usace.army.mil/dots/doer/ (accessed November 15, 2008).

Council of the European Communities. 1975. Council Directive 76/160/EEC of 8 December 1975 concerning the quality of bathing water.

Danish Environmental Protection Agency. 1994. Report to the 15th Meeting of Helsinki Commission 8 - 11 March 1994 from the Ad Hoc Working Group on Dumped Chemical Munitions (HELCOM CHEMU).

Davenport, J. 1982. Oil and planktonic ecosystems. Philosophical Transactions of the Royal Society. London. B297.

DHI Water & Environment. 2003. Development of Baltic waterbird monitoring strategy, Pilot phase. http://sea.helcom.fi/dps/docs/documents/Nature%20Protection%20and%20Biodiversity%20Group%20(HABITAT)/HABITAT%205,%202003/doc%204-10.pdf. (accessed October 16, 2008).

DHI. 2008. Baseline investigation - Baltic Gas Pipeline: The use of the area northeast of Ertholmene be breeding guillemot *Uria aalge* and razorbill *Alca torda*. Unpublished.

ENERGI E2. 2006. EIA Report - Marine mammals. Horns Rev 2, offshore wind farm.

Engel-Sørensen and Skyt. 2001. Evaluation of the Effect of Sediment Spill from Offshore Wind Farm Construction on Marine Fish. – Report to SEAS, Denmark.

Enger, P.S. 1967. Hearing in Herring. Comparative Biochemistry and Physiology.

European Chemicals Bureau. 2005. European Union Risk Assessment Report Chromium Trioxide, Sodium Chromate, Sodium dichromate, Ammonium Dichromate and Potassium Dichromate.

European Commission. 2003. Technical Guidance Document on Risk Assessment Part II. Institute for Health and Consumer Protection. Ispra, Italy.

European Parliament and Council of the European Union. 2006. Directive 2006/113/EC of the European parliament and of the council of 12 December 2006 on the quality required of shellfish waters. Official Journal of the European Union.

Finnish Game and Fisheries Research Institute. Herring (*Clupea harengus)* http://www.rktl.fi/english/fish/fish_atlas/herring/ (accessed September 29, 2008).

Finnish Game and Fisheries Research Institute. Eel (*Anguilla Anguilla)* http://www.rktl.fi/english/fish/fish_atlas/eel/ (accessed September 29, 2008).

Finnish Environnent Institute. The impacts of oil on the marine environment. http://www.ymparisto.fi/default.asp?contentid=170579&lan=en#a1 (accessed November 14, 2008).

Garthe, S., Hüppop, O. 2004. Scaling possible adverse effects of marine wind farms on sea birds: developing and applying a vulnerability index. Journal of Applied Ecology.

Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP). 1993. (IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution). Impact of Oil and Related Chemicals and Wastes on the Marine Environment. GESAMP Reports and Studies.

Håkanson, L. & Bryhn, A.C. 2008. Tools and criteria for sustainable coastal ecosystem management – with examples from the Baltic Sea and other aquatic systems. Springer, Heidelberg.

Hastings, M. C. and Popper, A. N. 2005. Effects of sound on fish. http://www.dot.ca.gov/hq/env/bio/files/Effects_of_Sound_on_Fish23Aug05.pdf (accessed October 14, 2008).

Hawkins, A. D., Johnstone, A. D. F. 1978. The hearing of the Atlantic salmon (*Salmo salar*). Journal of Fish Biology.

Heath, A.G. 1995. Water Pollution and Fish Physiology. Second ed. Lewis Publishers. Boca Raton. FL.

Helsinki Commission. HELCOM Recommendation 11/13 concerning the ‘Development of national ability to respond to spillages of oil and other harmful substances’ adopted 14 February 1990.

Helsinki Commission. 7 March 2006. Maritime Transport in the Baltic Sea - Draft HELCOM Thematic Assessment in 2006. HELCOM Stakeholder Conference on the Baltic Sea Action Plan Helsinki Finland.

Helsinki Commission. 2007. HELCOM lists of threatened and/or declining species and biotopes/habitats in the Baltic Sea area. Baltic Sea Environmental Proceedings, No. 113.

Helsinki Commission. 1995. Final Report of the ad hoc Working Group on Dumped Chemical Munition. http://www.helcom.fi/stc/files/Publications/OtherPublications/CHEMUFinalReport1995.pdf (accessed August 14, 2008).

Helsinki Commission. 2004. Dioxins in the Baltic Sea.

HLD. 2004. Conoco Phillips Scandinavia AS – Ekofisk Tank Cleaning. Feasibility Study for cover of inner and outer annuli – Cover design and execution methods.

Horridge, G.A. 1996. Some recently discovered underwater vibration receptors in invertebrates. In: Barnes, H. (ed.). Some Contemporary Studies in Marine Science. George Allen and Unwin Ltd. London.

Institut für Angewandte Ökologie (IfAÖ). 2009. Umweltverträglichkeitsstudie (UVS) zur Nord Stream Pipeline von der Grenze der deutschen Ausschließlichen Wirtschaftszone (AWZ) bis zum Anlandungspunkt.

Institut für Geodatenverarbeitung. 2008. Assessment of the turbidity in connection with pipe-laying work in the Greifswald Bodden - Nord Stream Pipeline Project.

Institute of Coastal and Estuarine Studies (ICES). 1999. Avifaunal Disturbance Assessment: Flood Defence Works, Salt End. Report to the Environment Agency.

Institute of Marine Research. 2003.Trawling across 40" pipeline - effects on trawl gear.

International Council for the Exploration of the Sea (ICES) –CIEM. ICES-Fish Map. Herring. http://www.ices.dk/marineworld/fishmap/ices/pdf/herring.pdf (accessed August 29, 2008).

International Council for the Exploration of the Sea (ICES). ICES Journal of Marine Science Advice. 2008. http://www.ices.dk/committe/acom/comwork/report/asp/advice.asp (accessed December 17, 2008).

International Maritime Organization. 2005. Manual on Oil Pollution. Sec. IV. Combating Oil Spill. London.

International Petroleum Industry Environmental Conservation Association (IPIECA). 2000. Biological Impacts of Oil Pollution - Fisheries. IPIECA Report Series.

International Petroleum Industry Environmental Conservation Association (IPIECA). 1993. Biological Impacts of Oil Pollution: Mangroves. IPIECA Report Series.

International Tanker Owners Pollution Federation. 2002. Fate of Marine Oil Spills. Technical Information Paper. no 2.

International Union for Conservation of Nature http://www.iucnredlist.org/ (accessed September 24, 2008).

Kaiser, M.J., Galanidi, M., Showler, D.A., Elliot, A.J., Caldow, R.W.G., Rees, E.I.S., Stillman, R.A. and Sutherland, W.J. 2006. Distribution and behaviour of Common Scoter Melanitta nigra relative to prey resources and environmental parameters. Ibis. 148.

Karlsson, R-M., Almström, H. & Berglind, R. 2004. In Swedish: Environmental effects of underwater explosions – a literature review: FOI- Swedish Defence Research Agency report.

Keevin, T. M. & Hempen, G. L. 1997. The environmental effects of underwater explosions with methods to mitigate impacts. U.S. Army Corps of Engineers St. Louis District.

Kelly, L.D., McGuinness, L.R., Hughes, J. E., Wainright, S.C. 1999. Effects of Phenanthrene on Primary Production of Phytoplankton in Two New Jersey Estuaries. Bulletin of Environmental Contamination and Toxicology.

Knudsen, F.R., Enger, P.S. and Sand, O. 1992. Awareness reactions and avoidance responses to sound in juvenile Atlantic salmon, *Salmo salar* L. Journal of Fish Biology.

Kube, J. & H. Skov. 1996. Habitat selection, feeding characteristics, and food consumption of long-tailed ducks, *Clangula hyemalis*, in the southern Baltic Sea. Meereswiss. Ber., Warnemünde. 18.

Lange, K. 1995. Schleppversuche mit Grundschleppnetzen an der Gasleitung „Zeepipe" im Bereich des deutschen Festlandsockels der Nordsee.

Larsson, K. & Tydén, L. 2005. Effekter av oljeutsläpp på övervintrande alfågel Clangula hyemalis vid Hoburgs bank i centrala Östersjön mellan 1996/97 och 2003/2004. Ornis Svecica 15 (with extensive English summary).

Law, R. J., & J. Hellou. 1999. Contamination of fish and shellfish following oil spill incidents. Environmental Geosciences. 6.

Lommer, M. and Lemaire, G. 2008. Ødegaard & Danneskiold-Samsøe A/S. Noise along the Nord Stream pipelines in the Baltic Sea.

Love, M. S. and York A. 2005. A comparison of the fish assemblages associated with an oil/gas pipeline and adjacent seafloor in the Santa Barbara Channel, southern California Bight. Bulletin of Marine Science. 77 (1).

Lovell, J.M., Findlay, M.M., Moate, R.M. & Yan, H.Y. 2005. The hearing ability of the prawn *Palaemon serratus*. Comparative Biochemistry and Physiology. Part A.

Meager, J.J., Solbakken, T., Utne-Palm, A.C. and Oen, T. 1978. Effects of turbidity on the reactive distance, search time, and foraging success of juvenile Atlantic cod (*Gadus morhua*).

Marine Conservation Society. 2000. Habitats Factsheet: Artificial Reefs.

Martec. 2004. Effects of Pipelines/Gathering Lines on Snow crab and Lobster.

Mendes, J.C., Johns, D.G., Richardson, A.J. 2005. Assessing the impact of oil spillages on plankton using the Continuous Plankton Recorder (CPR) survey.

Ministry of Petroleum and Energy (MPE). 1999. Summary of the Findings of a Norwegian Assessment Programme. Oslo.

Nielsen, R., Kristiansen, A., Mathiesen, L. and Mathiesen, H. 1995. Distributional index of the benthic macroalgae of the Baltic area. In: Acta Botanica Fennica.

Nedwell, J., Howell, D. 2004. A review of offshore windfarm related underwater noise sources.

Nord Stream AG & Ramboll. 2008. Memo 4.3A1 - Assessment of natural seabed erosion caused by high waves / storm in the Gulf of Finland.

Nord Stream AG & Ramboll. 2008. Memo 4.3A-12 - Spreading of sediment and contaminants from clearing of munitions.

Nord Stream AG & Ramboll. 2008. Memo 4.3A-4 – Spreading of sediments during pipeline layout.

Nord Stream AG & Ramboll. 2008. Memo 4.27 - Discharge of test water at Russian coast – environmental assessment.

Nord Stream AG & Ramboll. 2008. Memo 4.3A5 - Spreading of Sediments and Contaminants during Works in the Seabed.

Nord Stream AG & Ramboll. 2008. Memo 4.3A2 - Blocking effects of the pipeline on the seabed causing accretion..

Nord Stream AG & Ramboll. 2008. Memo 4.3S - Materials.

Nord Stream AG & Ramboll. 2008. Memo 4.3P - Air Emissions.

Nord Stream AG & Ramboll. 2007. Memo 4.3G - Protected Areas.

Nord Stream AG & Ramboll. 2007. Memo 4.3A-11 - Seabed erosion during storm events in the Gulf of Finland.

Nord Stream AG & Ramboll. 2007. Memo 4.3A-7 Accidental oil spill during construction.

Nord Stream AG & Ramboll. 2007. Memo 4.91 Chemical and conventional munitions in the Baltic Sea.

Norweigan Oil Industry Association. 2003. A manual for standardised modelling and determination of the environmental impact factor (EIF). Norway.

Patzold, V. 2008. Emission budget for the construction of the Nord Stream gas pipeline through the Baltic Sea.

Pekcan-Hekim, Z. 2007. Effects of turbidity on feeding and distribution of fish. Doctoral dissertation (article-based). University of Helsinki. Faculty of Biosciences. Department of Biological and Environmental Sciences, Aquatic Sciences.

Perttilä, M., Kankaanpää, H., Kotilainen, A., Laine, A., Lehtoranta, J., Leivuori, M., Myrberg, K., and Stipa, T. 2006. Implementation of the north European gas pipeline project — data inventory and further need for data for environmental impact.

PeterGaz. 2006. The north European gas pipeline. Offshore section (The Baltic Sea). Environmental Survey. Part 1. Stage 1. Book 5. Final report. Section 1 Russia's EEZ and territorial waters. Folder 1. Moscow.

Petergaz. 2008. Nord Stream Offshore Gas Pipeline Project (Russian Sector). Volume 8. Environmental Protection Book 1 – Offshore Section. Part 1 Environmental Impact Assessment Doc. No. 36/07-01- TEO-OOS-0801(1)-S3.

Pohl, C., Hennings, U., Siegel, H. and Bachor, A. 2002. Trace metal impact into the Baltic Sea during the exceptional Oder flood in summer 1997, Marine Chemistry. 79.

Railkin, A.I. 2004. Marine Biofouling: Colonization Processes and Defences.

Ramboll. 2008. Environmental Study – Nord Stream pipelines in the Swedish EEZ.

RAMSAR. Information Sheet on Ramsar wetlands. http://www.wetlands.org/reports/ris/3SE008en.pdf (accessed September 23, 2008).

Rassi, P., Alanen A., Kanerva, T.,Mannerkoski, I. 2001. Suomen lajien uhanalaisuus.

Richardson, W.J., Greene, C.R., Malme, C.I., and Thomson, D.H. 1995. Marine Mammals and Noise. Academic Press, San Diego and London.

Ruddock, M. & Whitfield, D.P. 2007. A Review of Disturbance Distances in Selected Bird Species. A report from Natural Research (Projects) Ltd to Scottish Natural Heritage.

Sanderson, H. & Fauser, P. 2008. Risk screening of chemical warfare agents towards humans and the fish community resulting from sediment perturbation from construction of the planned Nord Stream offshore pipelines through risk area 3 (S-route) in the Baltic Sea. NERI report.

Sanderson, H. & Fauser, P. 2008. Historical and qualitative analysis of the state and impact of dumped chemical warfare agents in the Bornholm basin from 1947-2008 NERI report.

SINTEF. 2008. Overtrawlability test on Nord Stream Pipeline in the Baltic Sea.

Skaret, G., Axelsen, B. E., Nottestad, L., Ferno, A. and Johanssen, A. 2005. The behaviour of spawning herring in relation to a survey vessel. ICES Journal of Marine Science.

Skov, H., Durinck, J., Leopold, M.F. & Tasker, M.L. 2007. A quantitative method for evaluating the importance of marine areas for conservation of birds. Biology Conservation 36(3).

Smit, C.J. & Visser, G.J.M. 1993. Effects of Disturbance on Shorebirds: A Summary of Existing Knowledge from the Dutch Wadden Sea and Delta Area. WSG Special Report.

Snamprogetti. 2008.Offshore CP System Sizing.

Snamprogetti. 2008. Effects of Underwater Explosions.

Snamprogetti. 2008. Impact on the Environmental Temperature at German Landfall.

Snamprogetti. 2008. Pipe/Trawl Gear Interaction Study.

Snamprogetti. 2008. Risk assessment report for Finnish area- Operational phase.

Snamprogetti. 2008. Risk assessment report for Denmark area (south of Bornholm) - Operational phase.

Snamprogetti. 2008. Risk assessment report for Sweden area- Operational phase.

Statoil. 1998. Tråltest over steinfyllinger på Sleipner kondensatrørledning 06.-14. juli 1998. (In Norwegian only).

Stock,T. Sea dumped chemical weapons under the CWC- more questions than answers. DYNAsafe Germany GmbH. http://www.pugwash.org/reports/cbw/52nd-workshop-2007/9-Stock.pdf (accessed October 7, 2008).

Stoecker, D.K., Sunda, W.G. and Davis, L.H. 1986. Effects of copper and zinc on two planktonic ciliates. Marine Biology.

Swedish Armed Forces Headquarters. 2007. Environmental effects of underwater explosions.

Swedish Environmental Research Institute (IVL). 2008. Complementary IVL background report - Consequences of nutrients released from seabed intervention works.

Swedish Environmental Research Institute (IVL). 2008. Complementary IVL background report: Environmental aspects of dumped ammunition and remaining sea mines in the Baltic Sea.

Swedish Meteorological and Hydrological Institute. 2007. Possible effects upon inflowing deep water of a pipeline crossing the flow route in the Arkona and Bornholm Basins. (This study is currently undergoing limited improvements.)

Tait, R.V. & Dipper, F. R. V. 1998. Elements of Marine Ecology: An Introductory Course. Butterworth-Heinemann.

Thomsen, F., Lüdemann, K., Kafemann, R. & Piper, W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg on behalf of Cowrie.

Netherlands Organisation for Applied Scientific Research (TNO). 2004. Update of an evaluation of PNEC values for water produced water according to the revised marine EU-TGD. The NEtherlands.

United States Environmental Protection Agency. ECOTOX Database. http://cfpub.epa.gov/ecotox/ (accessed September 20, 2007).

US National Oceanic and Atmospheric Administration (NOAA). National Ocean Service, Office of Response and Restoration. http://response.restoration.noaa.gov (accessed October 5, 2007).

US National Oceanic and Atmospheric Administration (NOAA). Small Diesel Spills (500-5000 Gallons). http://response.restoration.noaa.gov/book_shelf/974_diesel.pdf (accessed September 28, 2008).

United States Geological Survey (USGC). 1981. Water quality - New tables of dissolved oxygen saturation values. http://water.usgs.gov/admin/memo/QW/qw81.11.html (accessed October 15, 2008).

Valdemarsen, J.W. 1993.Tråling over 40” rørledning – virkninger på trålredskap. Trawling across 40” pipeline – effects on trawl gear. Havforskningsinstituttet. Fisken og Havet.

van Bernem, C. and Lübbe,T. 1997. Ól im Meer (Oil in the Sea). Wissenschaftliche, Buchgesellschaft, Darmstadt.

Vanninen, P., Söderström, M., Björk, H., Kostiainen, O., and Kuitunen, M. 2008. Chemical Analysis of Sea-dumped Chemical Warfare Agents in Sediment and Pore Water Samples. VERIFIN report.

Westerberg, H., Lagenfelt, I., and Svedang, H. 2007. Silver eel migration behaviour in the Baltic. ICES Journal of Marine Science.

Witt, G. and Siegel, H. 2000. The consequences of the Oder flood in 1997 on the distribution of Polycyclic Aromatic Hydrocarbons (PAHs) in the Oder river estuary. Marine Pollution Bulletin 40.

Wright, D.G, Hopky, G.E. 1998. Guidelines for the use of explosives in Canadian fisheries waters. Canadian Technical Report of Fisheries and Aquatic Sciences.

Wulff, F.V., Rahm, L.A. & Larsson, P. (eds.). 2001. A Systems Analysis of the, Baltic Sea. Ecological Studies 148. Springer. Heidelberg.

Yelverton, J.T., Richmond, D.R., Hicks, W., Saunders, K. and Fletcher, E.R. 1975. The relationship between fish size and their response to underwater blast. Topical Report DNA 3677T. Department of Defence, Washington, D.C.

Yrkesfiskeren. December 2006. Resultat av ålmärkning i Östersjön. no. 23/24. (In Swedish only).

Zijlstra, J. J. 1969. On the racial structure of North Sea Autumn spawning herring. Conseil International pour l'Exploration de la Mer.