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NORD STREAM 2

A NATURAL GAS PIPELINE THROUGH THE BALTIC SEA

ENVIRONMENTAL IMPACT ASSESSMENT REPORT, FINLAND

RAMBOLL

NORD STREAM 2

Environmental Impact Assessment Report, Finland

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General references on all maps:
- Limits of Exclusive Economic Zones and Territorial Waters: IBRU May 2010
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ABBREVIATIONS

3LPE	three-layer polyethylene
AHT	Anchor-handling tug
AIS	Automatic Identification System
ALARP	as low as reasonably practicable
ALT E1	the northen sub-alternative from KP 232 to KP 253
ALT E2	the southern sub-alternative from KP 232 to KP 253
ALT W1	the northen sub-alternative from KP 398 to KP 457–458
ALT W2	the southern sub-alternative from KP 398 to KP 457–458
As	arsenic
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
BIAS	Baltic Sea Information on the Acoustic Soundscape
BCM	billion cubic metres
BEAT	The HELCOM biodiversity assessment tool
BSAP	The Baltic Sea Action Plan
BWMC	IMO International Convention for the Control and Management of Ships' Ballast Water and sediments
BUCC	back-up control centre
approximately	circa
CAPEX	capital expenditure
Cd	cadmium
CEGH	Central European Gas Hub
cf.	confer
CH	methylidyne
CH_4	methane
cm	centimetre(s)
CO	carbon monoxide
Co	cobalt
COLREG	Convention on the International Regulations for Preventing Collisions at Sea
CO_2	carbon dioxide
Cr	chromium
CR	Critcally endangered
Cu	copper
CWC	concrete-weight-coated / concrete-weight-coating
d	days
dB	decibel(s)
DCE	Danish Centre for Environment and Energy
DDT	dichlorodiphenyltrichloroethane
DGPS	Differential Global Positioning System
DN	Nominal pipe diameter (in mm)
DNV	Det Norske Veritas
DNV GL	Det Norske Veritas and Germanischer Lloyd (International Certification Body and Classification Society)
DP	dynamically positioned
DW	dry weight
EEZ	exclusive economic zone
EHS	environmental, health, and safety
EIA	environmental impact assessment
ENTSOG	European Network of Transmission System Operators for Gas
ESMS	Environmental and Social Management System
EQS	Environmental Quality Standards
EU	European Union
EUGAL	the new European gas pipeline (485 km, from the Baltic Sea to the Germany and from there to the Czech), the project is in its early stages.
Fe	iron

FMI	Finnish Meteorological Institute
FNBA	Finnish National Board of Antiquities
FTA	Finnish Transport Agency
GES	good environmental status
GOFREP	Gulf Of Finland Reporting System
GT	gross tonnage
GTK	Geological Survey of Finland
g/m^2	grams per square metre
h	hours
HAZID	hazard identification
HC	hydrocarbon
HD	hydrodynamic
HELCOM	Helsinki Commission, the Baltic Marine Environment Protection Commission
HFO	heavy fuel oil
Hg	mercury
HSE	United Kingdom Health and Safety Executive
HSES	health, safety, environmental and social
HTWI	Hyperbaric Weld Tie-In (dry welding subsea via a specially designed habitat)
Hz	hertz
IBA	Important Bird and Biodiversity Area
ICES	the International Council for the Exploration of the Sea
IEA	International Energy Agency
IFC	International Finance Corporation
IFO	intermediate fuel oil
IMO	International Maritime Organization
In	indium
Ind/m^2	individuals per square metre
ISO 14001	International Standard on Environmental Management
IUCN	International Union for Conservation of Nature and Natural Resources
kg	kilogram(s)
km	kilometre(s)
km^2	square kilometre(s)
KP	kilometre point
kHz	kilohertz
LAeq	A-weighted Equivalent Sound Level
LC	least concern
LFL	lower flammable limit
LNG	liquefied natural gas
LTE	land termination end
m	metre(s)
m^3	cubic metre(s)
MARPOL	the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the protocol of 1978
max.	maximum
MBES	multibeam echosounder
MBT	2-mercaptobenzothiazole
MCC	Main Control Centre
MDO	marine diesel oil
MFO	medium fuel oil
MGO	marine gas oil
mg/l	milligrams per litre
mg/m^3	milligrams per cubic metre
$mg\ ww/m^2$	milligrams wet weight per square metre
mio. t.	million tonnes
ml/l	millilitres per litre
mm	millimetre(s)

MMF	Military Museum Finland
MMT	Marine Mätteknik Ab
Mn	manganese
mo	months
MPA	Marine Protected Area
MS	management system
MSFD	Marine Strategy Framework Directive
MSP	Maritime spatial planning
Mt	million tonnes
m/h	metres per hour
N	nitrogen
n	number
NA	not applicable
NavTex	Navigational Telex
NCG	NetConnect Germany, a joint venture between the gas network companies, handling the operational management of the gas market area cooperation
NGO	Non-governmental organisation
NE	north-east
NEL	the Northern European natural gas pipeline (440 km, in Germany), started operation in 2012.
ng/kg	nanograms per kilogram
Ni	nickel
NIS	non-indigenous species
nm	nautical mile
NO_X	nitrogen oxide
NO_2	nitrogen dioxide
NSP	Nord Stream pipeline system
NSP2	Nord Stream 2 pipeline system
NT	Near threatened
NTU	nephelometric turbidity units
N_2O	nitrous oxide
OPAL	Ostsee-Pipeline-Anbindungsleitung (470 km), started operation in 2009.
OSPAR	Oslo-Paris Convention, the current legal instrument guiding international cooperation on the protection of the marine environment of the North-East Atlantic
P	phosphorus
Pa	Pascal
PAH	polyaromatic hydrocarbon
PARLOC	pipeline and riser loss of containment
Pb	lead
PCB	polychlorinated biphenyls
PEC	predicted environmental concentration
PEAK	Peak Pressure Level
PCDD/F	polychlorinated dibenzo-p-dioxins (PCDD) and dibenzofurans (PCDF). Toxic organic compounds
PID	Project Information Document
Pig	Pipeline inspection gauge
PM	particulate matter
PNEC	predicted no-effect concentration
POP	persistent organic pollutant
PSU	practical salinity unit
PTA	pig trap area
PTAG	Pig Trap Area Germany
PTS	permanent threshold shift
QA/QC	quality assurance/quality control
RE	Regionally extinct
ROV	remotely operated vehicle

SAC	Special Area of Conservation
SAMBAH	static acoustic monitoring of the baltic sea harbour porpoise
SCI	Site of Community Importance
SEA Directive	strategic environmental assessment directive
SECA	sulphur emission control area
SEL	sound exposure level
SMT	Subsea Mechanical Tie-in
SOPEP	Shipboard Oil Pollution Emergency Plan
SO_X	sulphur oxides
SO_2	sulphur dioxide
SPA	Special Protection Area
SPL	sound pressure level
SRR	Search and Rescue Regions
SSS	side-scan sonar
SWF	Surface Welded Flange (dry welding)
SYKE	Finnish Environment Institute
t	tonne(s)
TBT	tributyltin
TEQ	toxic equivalent value, used to report the toxicity-weighted masses of mixtures of dioxins and furans
TPhT	triphenyltin
Territorial sea/waters	Defined by the 1982 United Nations Convention on the Law of the Sea, is a belt of coastal waters extending at most 12 nautical miles (22.2 km) from the baseline (usually the mean low-water mark) of a coastal state
TRS	total reduced sulphurs
TSS	Traffic Separation Scheme
TTF	The Title Transfer Facility, a virtual trading point for natural gas in the Netherlands
TTS	temporary threshold shift
Twh	terawatt hours
UCH	underwater cultural heritage
UNCLOS	United Nations Convention on the Law of the Sea
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
UV	ultraviolet
UXO	unexploded ordnance
VMS	vessel monitoring system
VTS	Vessel Traffic Service
VU	vulnerable
WFD	The Water Framework Directive
WHO	World Health Organization
WWII	World War II
Zn	zinc
°C	degrees celsius
µg/l	micrograms per litre
$µg/m^3$	micrograms per cubic meter

DEFINITIONS

Affected Communities	Groups of people that may be directly or indirectly impacted (both negatively and positively) by the Project.
Affected Party	The contracting parties (countries) to the Espoo Convention likely to be affected by the transboundary impact of a proposed activity.
Anchor corridor	Offshore corridor within which pipelay vessels would be deploying anchors.
Anchor corridor survey	Survey for sections where the pipeline may be installed by anchor lay vessel, to ensure that there is a free corridor for anchoring the lay vessel. The survey corridor is between 800 m and 1 km depending on water depth and the selected anchor lay vessel.
Ancillary activity	Ancillary activity is an activity that supports construction of the NSP2 system. In Finland ancillary activities are operation of a concrete weight coating plant, storage yards for weight-coated pipes, shipments from the coating plant to storage yards, rock quarrying and rock transport and storage yard of rock.
Anoxia	Condition of oxygen depletion in the sea.
As-Built Survey	As-built surveys are conducted as a final record of pipeline installation after all pipeline construction activities are completed and confirm that the pipelines have been installed correctly as designed, including trench depths, the extent of backfill and rock placement.
As-Laid Survey	As-laid surveys utilising bathymetry and side scan sonar measurements and visual inspection by ROV will be performed once the pipelines have been laid on the seabed to establish the as-laid position and condition of the pipelines.
Cathodic protection (sacrificial anodes)	Anti-corrosion protection provided by sacrificial anodes of a galvanic material installed along the pipelines to ensure the integrity of the pipelines over their operational lifetime.
Chance find	Potential cultural heritage, biodiversity component, munition object encountered unexpectedly during project implementation.
Commissioning	The filling of the pipelines with natural gas.
Construction support survey	A full survey spread equipped with multibeam sounders, side-scan sonar, sub-bottom profilers, pipe tracker, magnetometers and ROVs will be on standby during construction to perform touch down monitoring and ad hoc survey activities as required.
Contractor	Any company providing services to Nord Stream 2 AG.
Consultation zone	A corridor around the pipeline, where consultations with Nord Stream 2 should be carried out, if new infrastructure or nature exploration projects are planned to implement.
Cultural heritage	A unique and non-renewable resource that possesses cultural, scientific, spiritual or religious value and includes moveable or immoveable objects, sites structures, groups of structures, natural features, or landscapes that have archaeological, paleontological, historical, cultural, artistic, and religious values, as well as unique natural environmental features that embody cultural values.
Decommissioning	Activities carried out when the pipeline is no longer in operation. The activities take into account long term safety aspects and aim at minimizing the environmental impacts.
Descriptor	A high level parameter characterizing the state of the marine environment
Detailed geophysical survey	Survey of a 130 m wide corridor along each pipeline route utilising side-scan sonar, sub-bottom profilers, swathe bathymetry and magnetometer.
EU Habitats Directive	Ensures the conservation of a wide range of rare, threatened or endemic animal and plant species.
Exclusion zone	Area surrounding a cultural heritage, biodiversity component, munition object within which no activities shall be performed and no equipment shall be deployed.
Exclusive economic zone	An exclusive economic zone (EEZ) is a sea zone prescribed by the United Nations Convention on the Law of the Sea over which a state has special rights regarding the exploration and use of marine resources, including energy

	production from water and wind.
Footprint area	The area occupied by the pipeline system including support structures.
Freespan	A section of the pipeline raised above the seabed due to an uneven seabed or the pipeline span between rock berms made by rock dumping.
Geotechnical survey	Cone penometer and Vibrocorer methods that provide a detailed understanding of the geological conditions and engineering soil strengths along the planned route. The geotechnical survey assists in optimising the pipeline route and detailed design including the required seabed intervention works to ensure long-term integrity of the pipeline system.
Good environmental status	The environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive (Marine Strategy Framework Directive, Article 3).
Halocline	Level of maximum vertical salinity gradient.
HELCOM Marine Protected Area	Valuable marine and coastal habitat in the Baltic Sea that has been designated as protected.
HSES	Health, Safety, Environmental and Social. "Safety" incudes security aspects for personnel, assets and project affected communities.
HSES Plan	A written description of the system of HSES management for the contracted work describing how the significant HSES risks associated with that work will be controlled to an acceptable level and how, where appropriate, interface topics shall be managed.
Hydrotesting	Filling of as pipeline with water that is pressurized to control pipeline integrity.
Impact area	Area were impacts on the surrounding environment are assessed to appear.
LIFE+	EU funding instrument for environmental and climate related actions.
Management standard	A short statement defining the key principles of the HSES MS, followed by a number of expectations. There are 10 key principles.
Mattress	Concrete blocks / beams tied together by a steel grid laid on the seabed to raise the pipeline above the seabed. Typically used at crossings of cables and other pipelines.
Micro-tunnel	Tunnels with small cross section constructed at the landfall areas. The pipelines are installed in the tunnels.
Mitigation measure	Measures implemented to minimize environmental impacts.
Munitions clearance	Removal of unexploded munitions that pose a risk to pipeline construction, e.g. by relocation or by in situ detonation.
Munitions screening survey	Detailed gradiometer survey carried out to identify unexploded ordnance (UXO) or chemical warfare munitions that could endanger the pipeline or personnel during the installation and operating life of the pipeline system.
Natura 2000	EU-wide network of nature protection areas established under the 1992 Habitats Directive.
Nord Stream 2 AG	Project company established for the planning, construction and subsequent operation of the Nord Stream 2 Pipeline.
Party of Origin	The Contracting Party (country) or Parties (countries) to the Espoo Convention under whose jurisdiction a proposed activity is envisaged to take place.
PIG	Equipment to be sent through the pipeline to clean the pipeline and/or to investigate the condition of the pipeline.
Pig Trap Area (PTA)	Pig trap areas are used during the life of the pipeline to perform intelligent pigging operations and certain maintenance operations.
Pigging	The operation sending PIG's through the pipeline.
Pipe-lay	The activities associated with the installation of a pipeline on the seabed.
Pipe-lay survey	Survey to be performed just prior to the commencement of construction to confirm the previous geophysical survey and to ensure that no new obstacles are found on the seabed. ROV bathymetric and visual inspection survey will be undertaken for theoretical pipeline touchdown points on the seabed.
Post-lay trenching	The burying of a pipeline in a trench o the seabed after the pipeline has been laid on th e seabed.
Pre-commisioning	Activities carried out b efore gas filling of the pipeline to confirm the pipeline integrity.
Pre-trenching	The burying of a pipeline in a trench dug before the pipeline is installed.

Project	All activities associated with the planning, construction, operation and decommissioning of the Nord Stream 2 pipeline system.
Project area	The area of physical activity or disturbance related to the project. The broadest physical extent of the project's influence on the environment.
Project activity	Project activity is an activity that is related to the construction of the NSP2 system. The main project activities in the Finnish EEZ are surveys, munition clearance, rock placement, Crossing installations, pipelay, transportation of materials and equipment and pre-commissioning.
Pycnocline	A level of maximum vertical density gradient, caused by vertical salinity (halocline) and/or temperature (thermocline) gradients.
Reconnaissance survey	Survey providing information on the preliminary pipeline route, including geological and anthropogenic features, the surveys cover a 1.5 km wide corridor and used various techniques including side-scan sonar, sub-bottom profilers, swathe bathymetry and magnetometers.
Rock placement	Use of unconsolidated rock fragments graded in size to locally reshape the seabed, thereby providing support and cover for sections of the pipeline to ensure its long-term integrity. The rock material is placed on the seabed by a fall-pipe.
ROV	Remotely operated underwater vehicle which is tethered and operated by a crew aboard a vessel.
Safety zone	An area surrounding a cultural heritage, biodiversity component, munition object within which no activities shall be performed and no equipment shall be deployed.
Seabed preparation	Preparatory works on the seabed before pipelay
Stakeholders	Stakeholders are defined as persons, groups or communities external to the core operations of the Project who may be affected by the Project or have interest in it. This may include individuals, businesses, communities, local government authorities, local nongovernmental and other institutions, and other interested or affected parties.
Supplier	Any company supplying goods or materials to Nord Stream 2 AG.
Survey area	Area where baseline environmental, geotechnical and geophysical surveys were carried out.
Territorial waters	Territorial waters or a territorial sea as defined by the 1982 United Nations Convention on the Law of the Sea, is a belt of coastal waters extending at most 12 nautical miles (22.2 km; 13.8 mi) from the baseline (usually the mean low-water mark) of a coastal state.
Thermocline	An abrupt vertical temperature and density gradient in a water body, marked by a layer above and below which the water is at different temperatures. Thermocline prevents mixing between the surface waters and those beneath it.
Tie-ins	The connection of two pipeline sections. Tie in can be made on the seabed or by lifting the pipeline sections to be connected above water.
Trenching	Burial of the pipeline in the seabed
Weight-coated pipes	Pipe joints coated with concrete to increase weight

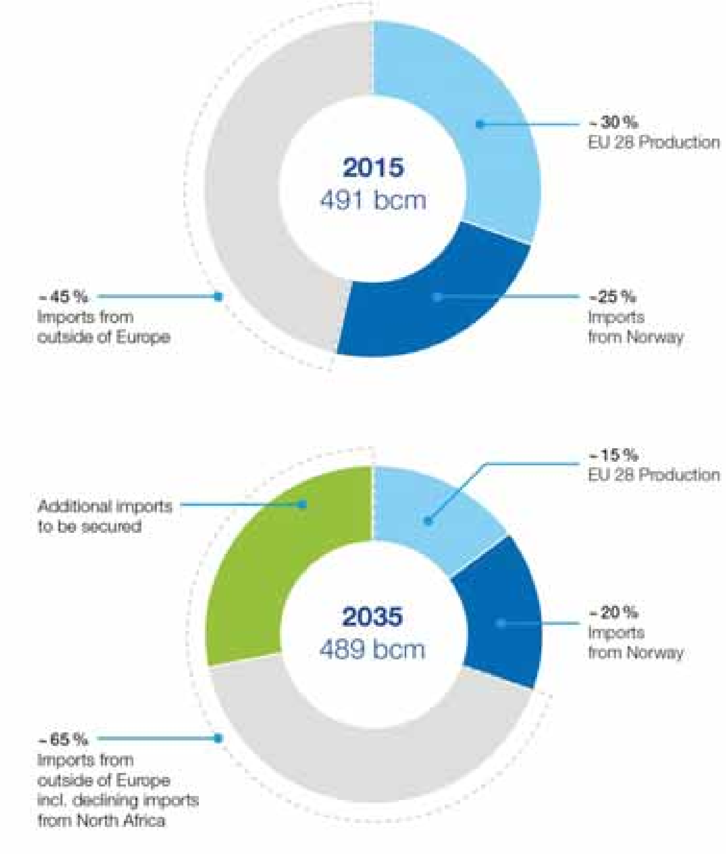
0. SUMMARY

0.1 Background and project justification

Access to natural gas is becoming increasingly critical for the EU as global demand rises and its own gas resources deplete. With Nord Stream 2, the EU can secure additional gas resources in the long term in order to ensure global industrial competitiveness and meet domestic demand.

Natural gas offers a cost-effective and sustainable way to achieve emissions reduction targets. It makes a good partner to a further build-out of renewables. Due to its role as an efficient, abundant and clean pathway to a low-carbon future, the demand for natural gas in Europe is projected to remain mostly stable over the coming 20 years.

EU's domestic natural gas production is in decline, especially in Norway, the Netherlands and the UK. At the same time, gas exports from Northern Africa will be increasingly constrained by own local consumption, while new gas from the Caspian region is projected to deliver only small amounts to the EU.



Source: based on Prognos 2017
Total demand includes all gas sourced from European market, EU countries plus Switzerland and western imports by Ukraine.

Figure 0-1. EU faces an import gap as demand outstrips supply.

This leaves an import gap of 120 bcm of European gas supply to be compensated over the next two decades – by either gas from the global LNG market or Russian gas. The share between them will be set by the market. Nord Stream 2 can cover up to 55 bcm of this gap – enough for 26.5 million households for one year.

However, the LNG market is typically subject to cycle shifts, as its global market is clearly focused on Asia, where very little pipeline capacity exists. The global demand for gas is projected to increase +25 % in the coming two decades (equal to about 1,000 bcm), therefore LNG availability and price for Europe will be under pressure – a risk to the European industry and consumers that cannot be resolved without sufficient available pipeline capacity. Nord Stream 2 helps mitigate these risks in Europe by providing capacities connecting to secure gas reserves readily available in Northern Russia. The new gas supply will drive the development of new interconnectors between member states to ensure that gas can flow freely across Europe to meet market needs.

Russia has been a reliable partner in supplying gas to Europe for 5 decades. The strategic expansion of the connection from Russia to the European market is therefore important to secure the supply of natural gas to the EU over the long term. Together with other suppliers and transport options, such as LNG, gas from Nord Stream 2 will ensure a competitive supply. The project aligns with the goals the EU has for its energy system – to provide secure, affordable and sustainable energy supply to Europeans. EU industry in particular needs reasonably priced energy if it is not to relocate production to other regions.

The Nord Stream 2 is a project for up to two offshore natural gas transmission pipelines from Russia to Germany through the Baltic Sea. The NSP2 pipeline system will have the capacity to supply 55 bcm (billion cubic metres) per annum of natural gas. The NSP2 pipelines are designed for operational life of 50 years. The pipeline route covers a distance of approximately 1,200 km. Pipelines are scheduled to be laid during 2018 and 2019, and to be operational at the beginning of 2020. Besides pipelay, the construction activities include e.g. munitions clearance, rock placement and crossing installations.

0.1.1 Route and pipeline design

The design of the NSP2 pipelines largely benefits from previous experience from the design and construction of the existing Nord Stream pipelines. During the concept development of the Nord Stream 2 project, a number of feasible routes were identified and this work was the basis for further planning and the starting point for the routing of the NSP2 pipelines. The main constraints taken into account in the route development were Engineering and Environmental.

Several offshore environmental and technical surveys have been conducted in connection with the planned NSP2 pipelines to gather specific knowledge on seabed conditions, topography, bathymetry and artefacts such as wrecks, munitions, etc. These surveys support engineering and construction of the pipelines.

Within the Finnish Exclusive Economic Zone (EEZ), the route follows the existing Nord Stream Pipelines 1 and 2. The pipeline route is located entirely in the Finnish EEZ and does not enter Finnish territorial waters. The length of the route in the Finnish sector is approximately 378 km (Figure 0-2). NSP2 consist of two pipelines A and B.

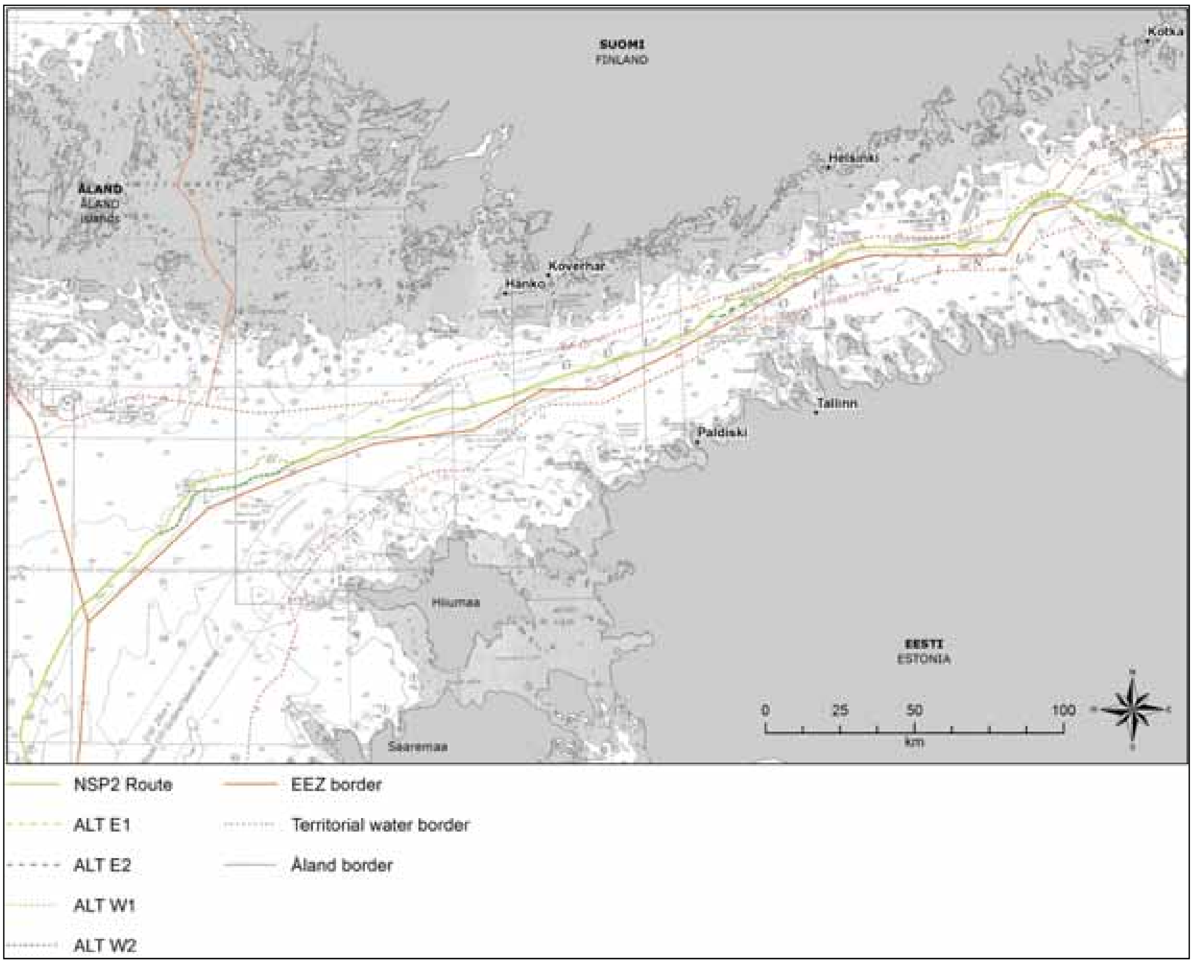


Figure 0-2. The Nord Stream 2 pipeline route in the Finnish EEZ.

0.1.2 Offshore project activities

In order to install the pipelines on the seabed, a number of activities for the construction of the project are necessary. Hereunder, a brief description of the offshore project activities that will take place in Finland, is presented.

Rock placement
Rock will be placed locally at designated locations, thereby providing support and covering for sections of the pipeline in order to ensure its long-term integrity. Rock placement is required for freespan correction, gravel basement at the potential hyperbaric tie-in location and for crossings with other pipelines. Rock material will potentially be supplied from the Kotka region and will be transported by ship to designated locations along the pipeline. Rock material will be placed precisely on the seabed using a fall pipe. Rock placement activities will be carried out prior to and after pipelay.

Munitions clearance
The Nord Stream 2 pipeline installation and the security corridors on both sides of the pipelines will be surveyed for munitions. Where munitions are found, these will be identified. The pipeline route has been optimized to avoid munitions to the extent possible. However, some of the munitions will have to be cleared to ensure the safe installation and operation of the pipeline. The most common way to clear munitions is to detonate them in-situ utilizing a donor charge. Nord Stream 2 will perform a study on alternative methods and mitigation techniques to reduce the impacts from munitions clearance.

Crossing installations
The Nord Stream 2 pipeline will cross telecommunications and power cables as well as gas pipelines. Cables will be protected by concrete support mattresses prior to pipelay. Rock placement will be used to prevent interaction between pipelines. Nord Stream 2 will be in contact with cable and pipeline owners to agree on the detailed crossing method.

Pipelay
In the pipelay process of the two pipelines, individual pipe sections (pipe joints) will be transported from Mussalo, Kotka, and Koverhar, Hanko, by pipe supply vessels to the lay barge, welded together on-board and lowered as a continuous string onto the seabed from the lay barge. The average speed of the pipelay vessel is 2–3 kilometres per day. A dynamically positioned (DP) lay barge is planned to be used in the Finnish EEZ from the Russian border at pipeline kilometre point (KP) 114 to south of Hanko (approximately KP 350). Either an anchored or a DP lay barge is intended to be used in the Finnish EEZ from south of Hanko to the Swedish EEZ. A DP lay barge uses thrusters for positioning, whereas an anchored lay barge is positioned by anchors which are moved by anchor handling tugs according to planned anchor patterns. As the basis of this assessment, an anchored lay barge is assumed to be used in the western section of the Finnish EEZ. A remotely operated vehicle (ROV) will be used for continuous touchdown monitoring at critical points such as pipelay start-up and laydown, during the crossing of rock supports and at pipeline and cable crossings. Approximately 300 days (150 days per pipeline) of pipelay operations will be carried out in the Finnish EEZ. However, pipelay is estimated to take place over a total of approximately 9 months.

Transport of pipe joints, rock and other material
The project includes the following offshore transport activities:

- Transport of concrete weight-coated pipes to the lay vessels from Mussalo, Kotka, and Koverhar, Hanko, by pipe supply vessels
- Transport of rock material for rock placement from Mussalo, Kotka to designated rock placement locations along the pipeline route
- Transport of fuel and other materials to lay barge(s) and support vessels

Pre-commissioning
After installation, the Nord Stream 2 pipeline will undergo a series of activities which prepares the pipeline system for use. These activities include cleaning, gauging and testing/leak detection. Two options are under investigation. These are:

- Option 1: “Dry” pre-commissioning without pressure testing using alternative testing methods and without hyperbaric (underwater) tie-ins. Under this option, the pipeline will not be water-filled, and there will be neither water intake from the Finnish EEZ nor water discharges to the Finnish EEZ. The estimated amount of rock to be used decrease from 110,000 to 80,000 to m^3, constituting approximately 5 % of the total rock volume in the Finnish EEZ.

- Option 2: Standard “Wet” pre-commissioning operations as implemented for Nord Stream, including a hyperbaric tie-in in the Finnish EEZ at KP 300. Each of the two pipelines will be filled with approximately 1,300,000 m^3 of seawater to be taken from the hyperbaric tie-in locations. Pressure test water will be discharged in Russia.

Commissioning
Commissioning comprises all activities that take place after pre-commissioning and until the pipelines commence natural gas transport, including filling the pipelines with natural gas. Prior to the activity of gas-in, all pre-commissioning activities must be completed successfully and the pipeline filled with dry air that is close to pressure. After pre-commissioning, the pipelines will contain dry air. Nitrogen gas, as an inert buffer, is then inserted into the pipelines immediately prior to natural gas-filling. This ensures that the inflowing natural gas will not be able to react

with the atmospheric air and create unwanted mixtures inside the pipeline as the nitrogen gas will act as a buffer between the atmospheric air and the natural gas. Commissioning will then proceed by filling the pipelines with natural gas from the connected landfall facilities.

Operation of the pipeline system

Nord Stream 2 AG is the owner and operator of the pipeline system. The system is designed to have an operating life of at least 50 years. An operations concept and security systems will be developed to ensure the safe operation of the pipelines, including avoiding over-pressurisation, managing and monitoring potential gas leaks and ensuring material protection.

The protection, control and monitoring strategy for the Nord Stream 2 pipeline system will be based on manned landfall facilities in Russia and Germany. These will be supervised by the Main Control Centre (MCC) in Switzerland and a back-up facility, the Back-Up Control Centre (BUCC), also located in Switzerland.

Decommissioning

NSP2 is designed for operational life of approximately 50 years. In case reuse of the pipelines will not be a viable option, a decommissioning programme will be developed during the latter years of the operational phase of NSP2. Consideration will be given to any new or updated legislation and guidance available at the time, as well as to good international industry practise and technical knowledge gained over the lifetime of NSP2.

Two decommissioning scenarios (a base case and theoretical alternative) for NSP2 have been considered during the EIA phase. Based on precedent and industry best practice guidelines for large diameter pipelines, the base case is to leave the pipeline on the seabed (in situ). Based on a review of other potential options, the theoretical alternative is pipeline removal by reverse lay recovery or by sectional recovery, followed by waste management.

0.1.3 Ancillary activities

Nord Stream 2's ancillary activities include both onshore and offshore activities as follows:

Concrete weight coating plant in Kotka

The pipe joints, which are manufactured in Russia and pre-coated with polyethylene plastic, will be coated with a concrete and iron ore mix in Wasco Coating Finland Oy's Kotka plant in order to double their weight to increase stability of pipelines on the seabed. Kotka will receive approximately 110,000 pipes form Russia starting from Q3/2016. The plant will be operational until Q3/2019.

Storage yards for weight-coated pipes

Wasco will store the concrete weight-coated pipes in interim storage yards in Mussalo, Kotka and Koverhar, Hanko. It will transport pipes by pipe transhipment vessels from Mussalo to Koverhar.

Extraction, transport and storage of rock material

The rock material is assumed to be extracted from existing Finnish quarries in the Kotka region. The rock will be transported by trucks from the quarries to the interim storage in Mussalo, Kotka. Rock transport is assessed to take place for approximately 18 months.

0.2 Assessed alternatives in the national EIA

Nord Stream 2 route

The pipeline route (Nord Stream 2 route) in the Finnish section is located entirely in the Finnish EEZ, which is considered international waters, and does not enter territorial waters. To the east, the route enters from Russian territorial waters and, to the west, continues into the Swedish EEZ. The closest distance from the route to Finnish territorial waters is 0.6 kilometres and the closest distance to the Estonian EEZ is 1.8 kilometres. Within the Finnish section, the pipeline route is located north of the Nord Stream pipelines for the most part. The total length of the pipeline route within the Finnish EEZ is approximately 378 kilometres.

Sub-alternatives
In the Finnish EEZ there are two sections where two alternative routes were considered for the pipeline route:

- The eastern section is located south of Porkkala in the Gulf of Finland (sub-alternatives ALT E1 and ALT E2). ALT E2, the southern sub-alternative, is about 700 m shorter than ALT E1. The seabed profile along ALT E2 is more irregular and, therefore, the rock volume required for intervention works as well as the estimated number of long freespans is greater than for ALT E1. ALT E2 is located closer to Nord Stream pipelines than ALT E1. When considering the future use of the EEZ, the cumulative impact with Nord Stream pipeline may be slightly lower in Sub-alternative ALT E2.

- Another section where the route divides into two alternative routes is located in the northern Baltic Proper in the western part of the Finnish EEZ (sub-alternatives ALT W1 and ALT W2). ALT W2, the southern sub-alternative, is about 2.8–3.1 kilometres shorter than ALT W1. The rock volume required for ALT W1 intervention works as well as the number of long freespans is greater than for ALT W2, due to the uneven seabed. ALT W2 is located closer to Nord Stream pipelines than ALT W1. When considering the future use of the EEZ, the cumulative impact with Nord Stream pipeline may be slightly lower in Sub-alternative ALT W2.

Construction alternatives
The two pre-commissioning alternatives, without or with hydrotest ("Dry" and "Wet") have been assessed. See the description of these alternative methods in Subchapter 0.1.2 Offshore project activities.

Non-implementation
An EIA must also include a non-implementation (or zero-) alternative describing a situation in which the planned project is not implemented in the Finnish EEZ. Non-implementation would lead to no environmental or social impacts from the project, neither adverse nor beneficial.

0.3 Environmental impact assessment procedure

National procedure
The environmental impact assessment procedure aims to increase and enhance environmental information for decision-making and planning. For this purpose, the project's environmental impacts are assessed and possible different project alternatives compared. The procedure also aims to promote the participation of the public in the planning phase and to provide information to the public. Consequently, the purpose of the EIA procedure is to prevent the occurrence of harmful environmental impacts and to reconcile opposing views and goals.

The Uusimaa Centre for Economic Development, Transport and the Environment (ELY Centre Uusimaa) is the coordinating authority for the Finnish EIA procedure for Nord Stream 2. The EIA procedure was officially initiated when the EIA Programme was submitted on 25 March 2013 to the coordinating authority. The Uusimaa ELY Centre issued its statement on the EIA Programme on 4 July 2013. On the assignment of the Developer (Nord Stream 2 AG), Ramboll has prepared the EIA Report, based on the EIA Programme and the statement from the Uusimaa ELY Centre.

The EIA procedure must be conducted before any decisions are made to officially approve a proposed project. Hence, the EIA procedure is not a decision-making process, and permits for a project are granted separately in accordance with the relevant legislation.

The EIA procedure provides authorities, other stakeholders and the public various ways to participate in the procedure. Information on the NSP2 project has been shared during several meetings and is publicly available on the project’s website, *www.nord-stream2.com*. The EIA procedure is conducted in an interactive manner to provide the authorities, other stakeholders and the public an opportunity to discuss and express their views on the project and its impacts.

International procedure
Finland is a signatory to the Convention on EIA in a Transboundary Context (“Espoo Convention”), which promotes international cooperation and public engagement when the environmental impact of a planned activity is expected to cross a border. The Espoo Convention lays down the general obligation of countries (“Parties of Origin”) to notify and consult one another (“Affected Parties”) on all major projects that are likely to have a significant adverse environmental impact across state boundaries.

For the Nord Stream 2 Project, the parties of origin are Russia, Finland, Sweden, Denmark and Germany, and the affected parties are Russia, Finland, Estonia, Sweden, Latvia, Lithuania, Poland, Denmark and Germany. Russia has signed but not ratified the agreement. To comply with the Espoo Convention, Nord Stream 2 AG will issue a description of the project and its potential transboundary effects (so called “Espoo Report”) to all potentially affected countries. International consultation will take place at the same time as national EIA consultation.

Yet it should be noted, that impacts of the NSP2 project in the Finnish EEZ have been assessed in this EIA Report, and impacts of the whole project expected to cross a border have been assessed in the Espoo Report.

0.4 Assessment scope, methodology and baseline

The Finnish study area comprises the Finnish EEZ and territorial waters and is geographically located both in the Gulf of Finland and in the Northern Baltic Proper. In addition, ancillary activities will affect specific onshore areas in Mussalo, Kotka (harbour, industrial site and interim storage) and in Koverhar, Hanko (harbour and interim storage). Also, quarrying as an ancillary activity has been assessed in the EIA.

The environmental baseline has been prepared on the basis of peer-reviewed scientific literature, other EIAs, technical reports and data as well as the knowledge and experience gained from Nord Stream, for example, from long-term environmental monitoring of the construction and operation of the pipelines. Nord Stream 2 has conducted several offshore environmental and technical surveys to collect information on the marine baseline along the pipeline route. Mathematical modelling has been applied to predict sediment dispersion and underwater noise propagation caused by the offshore construction activities. Citizen surveys in Finland and public opinion survey in Estonia have been carried out in order to gather information on people's opinions of the project.

The main objective of the baseline description is to establish a foundation of information for the impact assessment by describing and evaluating the present state of the environment along the pipeline route and ancillary activity areas, revealing sources of environmental contaminants, providing additional data for the mathematical modelling and identifying the potential receptors and areas that may be sensitive to disturbance. The following environmental aspects have been examined:

- Physical and chemical environment
  - Climate and air quality
  - Underwater noise
  - Bathymetry
  - Seabed morphology and sediments
  - Ice conditions
  - Hydrography and water quality

- Biotic environment
  - Benthic flora and fauna
  - Pelagic environment (plankton)
  - Fish
  - Marine mammals
  - Birds
  - Protected areas
  - Non-indigenous species
  - Biodiversity
- Socio-economic environment
  - Ship traffic
  - Commercial fishery
  - Military areas
  - Munitions
  - Barrels
  - Existing and planned infrastructure
  - Scientific heritage
  - People and society
- Transboundary baseline
- Baseline Kotka region and Hanko region
  - Land use
  - Physical and chemical environment
  - Biotic environment and protected areas
  - Socio-economic environment

0.5 Impact assessment

The results of the environmental impact assessment indicate that the impacts caused by the Nord Stream 2 pipeline will be mostly negligible or minor within the Finnish EEZ. Most of the potential impacts will be local and short-termed, occurring solely during the construction period. The pipeline project was assessed to be environmentally viable; however, special attention must be paid to planning and implementing adequate mitigation measures during construction activities.

0.5.1 Climate and air quality

The total carbon dioxide (CO_2) and nitrogen oxides (NO_X) emissions of the Nord Stream 2 Project during construction and operation of the pipeline in Finland are assessed to be approximately 3 %, sulphur dioxide (SO_2) emissions under 1 % and particulates emissions 2 % of the total emissions occurring annually from the vessel traffic in the Baltic Sea. Offshore activities are assessed to cause approximately 97–99 % of the project emissions and only a small percentage of the emissions would derive from onshore activities. Of the offshore activities, pipe laying is assessed to be the most significant contributor, comprising 28–34 % of offshore total emissions.

0.5.2 Seabed sediments and water quality

Mathematical modelling has been carried out to assess the extent of sediment spreading and sedimentation caused by the construction activities. The total amount of suspended sediments due to offshore construction works is assessed to be relatively small. Re-sedimentation of suspended sediments is assessed to be at most a few millimetres and will occur only near the construction site. Seabed sediment spreading during construction is assessed to be comparable to the natural processes that occur over the seabed during storms. Suspended sediments also alter water quality. These changes are assessed to be temporary and occur in the water layer closest to the seabed and relatively near to the activity. A slight increase in the concentration of suspended solids during munition clearance will be detected beyond the project area. The concentration level of dissolved contaminants mobilised to the seawater due to construction activities is assessed to be low if detectable at all. Suspended phosphorus is assessed to not have any effects on the eutrophication status of the Gulf of Finland.

0.5.3 Benthic environment

The presence of benthos in the offshore areas of the Gulf of Finland is mostly dependent on the oxygen concentration near the seabed. As a result of permanent anoxic conditions, there is virtually no life on the seabed in the western parts of the pipeline route. Consequently, construction activities (mainly rock placement, munitions clearance and to a lesser extent anchor-handling) is assessed to lead to defaunation or interference with benthic communities only in a small portion of the pipeline route (in the shallower areas). Benthic communities underneath the pipelines and support structures will be permanently lost but only a very minor part of the benthic life will be affected. Any other adverse impacts on benthos are assessed to be local and of short duration because the communities are able to recover.

0.5.4 Marine mammals

There are three resident marine mammal species in the Gulf of Finland: grey seals, ringed seals and harbour porpoises. The population of grey seals is abundant and has been increasing over the last decades. The population of ringed seals in the Gulf of Finland has been declining over the last decades and at the moment it is considered to be in a poor state. The harbour porpoise is a very occasional visitor in Finnish waters. Munitions clearance by detonation produces high underwater noise peaks that are uncommon in the normal sea environment. Noise levels can be far-reaching and cause adverse impacts on marine mammals. Other project activities (e.g. rock placement and pipelay) generate much less underwater noise. The use of mitigation measures will warrant that the occurrence of blast injuries and hearing losses will be reduced in the proximity of munitions clearances. The most important are the deterring measures used prior to detonation to scare animals away from the detonation zone. For this purpose, NSP2 will deploy acoustic deterrent devices (ADDs), which are activated prior to detonation, and will increase the area avoided by marine mammals. In addition to those munitions clearance methods and mitigation techniques successfully implemented for the Nord Stream Project, Nord Stream 2 will perform a study of alternative clearance methods and mitigation techniques that would allow limiting or removing the potential adverse impacts caused by munitions detonation.

0.5.5 Fish

Avoidance reactions of fish in relation to construction activities are assessed to be temporary and not to have an impact on fish communities. Munitions clearance by detonation may kill some individual fish close to the clearance site; however, this is not assessed to have an impact on fish stocks. Suspended sediments and released contaminants are not likely to affect sprat eggs and larvae survival (due to the low value of individual sprat eggs in the context of overall sprat stock).

0.5.6 Birds

According to available data, no significant feeding or resting areas have been identified in the vicinity of the planned Nord Stream 2 pipeline in the Finnish EEZ. Areas of shallow water are located more than 5 kilometres from the planned pipeline route, and all internationally Important Bird Areas (IBAs) are located more than 8 kilometres away from the pipeline route. Therefore, no impacts are foreseen on birds.

0.5.7 Protected areas

Most of the protected areas are located at a distance of 8 kilometres or more from the Nord Stream 2 pipeline. Only one protected area, a Natura 2000 site called the “Sea Area South of Sandkallan”, is located closer than 2 kilometres from the pipeline route. According to the Natura assessment screening and the results of the sediment spreading modelling, the Nord Stream 2 project will not have adverse impacts on the protection objective (habitat type “reefs”) of the site in question. Munitions clearance by in-situ detonation may have negative impacts on the nearest protected sites with seal species as a conservation objective (“Kallbådan Islets and Waters”). Therefore, a detailed Natura assessment will be carried out for the project’s permit application. This assessment will be based on the latest munitions survey data and on the study of mitigation measures applicable to clearance activities. Additionally, a Natura assessment screening will be carried out for three other sites as a precautionary measure.

0.5.8 Non-indigenous species

The spreading of non-indigenous species (NIS) due to construction or operation of the planned pipeline within the Finnish EEZ is assessed to be *negligible*. The reason for this is that according to General Guidance on the Voluntary Interim Application of the Ballast Water Exchange Standard in the north-east Atlantic and the Baltic Sea, vessels entering the Baltic Sea must exchange their ballast water at least 200 nautical miles (ca. 370 km) from the nearest land in water at least 200 metres deep within North-East Atlantic, which reduce the risk of unintentional introduction of NIS.

0.5.9 Biodiversity

The biodiversity status in the Baltic Sea and in the Gulf of Finland has been assessed to be "unacceptable level" (HELCOM 2010a). The Nord Stream 2 Project will not affect the majority of the biodiversity components (e.g. species, habitats and ecosystem). Direct mechanical disturbance on the seabed and impacts caused by sediment dispersion have very limited impacts on any life form in the Gulf of Finland. The same applies to the amount of space occupied by the pipelines in shallow waters (which can be seen as a measure of potential impacts on biodiversity). Underwater noise from detonations may have negative populaton level impacts on seals (Gulf of Finland ringed seal population). Only one link (Gulf of Finland ringed seal) in the chain of biodiversity is assessed to be affected, while the other links remain unaffected. Therefore, the system as a whole is likely to withstand minor or even moderate changes.

0.5.10 Ship traffic

Potential impacts on ship traffic during the construction phase are mitigated with *Notices to Mariners* and safety zones around project vessels. However, there are two locations where special mitigation measures are planned to ensure the smooth running of third party ship traffic: 1) Traffic Separation Scheme (TSS) Off Kalbådagrund – an assisting tug will be stationed at the shoal nearby TSS, 2) TSS Off Porkkala Lighthouse – further discussion and planning with the Finnish Transport Agency will be carried out.

0.5.11 Commercial fishery

Only a fraction of the fishing area is impacted by construction vessels for short periods of time and, as the pipelay vessel moves about 2.5 kilometres per day, it does not pose a hindrance to fishing at any location for more than a day. During the operation phase, there will be freespanning pipeline sections which may cause some hindrance to trawling. However, the pipelines do not make the project area untrawlable as the prevailing trawling method in the area is mid-water trawling.

0.5.12 Military areas

Because of the distance, neither the construction activities nor the operation of the pipelines is assessed to cause any impacts to the use of the restricted areas by the Finnish Navy, restricted areas for aviation (R areas) or airspace danger areas (D areas). During the EIA process, this has been confirmed by the Finnish Defence Forces.

0.5.13 Existing and planned infrastructure and future use of the Finnish EEZ

Two existing Nord Stream pipelines and twenty-four existing cables cross the Nord Stream 2 pipeline route. Planned infrastructure that would cross the Nord Stream 2 pipeline route are one gas pipeline (Balticconnector) and two telecommunications cables. All other existing or planned infrastructure is located at least 10 kilometres from the Nord Stream 2 pipelines. By adopting mitigation measures for impacts on pipelines and cables, there are no impacts assessed from construction activities. If new infrastructure is planned in the future in the nearby areas of the pipeline, consultations with Nord Stream 2 will be necessary.

0.5.14 Scientific heritage

Sedimentation caused by construction activities is assessed to be so low that negative effects on benthos monitoring stations are unlikely. Similarly, turbidity changes are so short-lived that the representativeness of the water sampling stations would not be compromised. Therefore, no impacts are envisaged to occur to scientific heritage.

0.5.15 Cultural heritage

Due to the mitigation measures applied, there are no impacts assessed to occur on submerged historical wrecks during the construction and operational life of the pipelines. World War II historical sites are assessed to be partially affected because some relatively small parts of the antisubmarine-net (barrage) might fall under the pipeline.

0.5.16 Social impacts

The assessed social impacts include possible impacts on tourism and living conditions as well as people's fears and aspirations. Social impacts that orginate from offshore activities are assessed to be very limited, except for a certain degree of concerns that exist among the resident of the coastal area, for example the environmental status of the Baltic Sea and possible political dimensions of the project. It is assessed that the impacts will begin to diminish during the construction phase and towards the operation phase in the event that no uninented impacts occur. No social impacts from offshore operations on recreation, tourism, and the living environment are otherwise assessed to occur.

0.5.17 Effects on qualitative environmental targets

According to Finland's Marine Strategy (2012–2021), the initial status of the marine environment has been assessed and general environmental objectives and environmental descriptors of Good Environmental Status (GES) have been outlined. Some of the environmental descriptors of GES are relevant when considering the impacts associated with the Nord Stream 2 Project. Since the majority of the impacts are limited in time and intensity, it is assessed that the project will have no impacts on the capability of Finland to reach GES for the long-terms goals of the Marine Strategy Framework Directive (MSFD). However, noise from different sources has been identified to be among the newly identified pressures affecting the good status of the sea. In this EIA, it is assessed that underwater noise originated by munitions clearance, although it considerably exceed ambient noise levels, are short-term (peaks) and limited to construction phase. Considering that underwater noise is taking place over a short period of time and that no long-term detrimental effects to the ecosystem are predicted to occur, the achievement of the GES in terms of introduction of underwater energy and underwater noise would not be prevented.

0.5.18 Impacts on the Kotka region

The project activities are estimated to have a slightly positive impact on land use in Kotka, since existing infrastructure in Mussalo Harbour and industrial area will be used. A slight increase in emissions to air is not expected to deteriorate general air quality in the Kotka region or cause exceedances of guideline limit values. Overall noise levels due to onshore activities in Mussalo, Kotka are estimated to be below the noise guideline values. Quarrying activities have been assessed on the basis of the assumption that the same quarries used during the Nord Stream project in the Kotka area would also be used for Nord Stream 2. Rock transport from quarries to Mussalo Harbour will increase heavy traffic, especially on Road 355, Merituulentie. It is assessed that the Kotka region will benefit economically from the project activities since a large number of new jobs and additional business will be generated by project related activities for the duration of the project in an area of high unemployment. Some impacts are assessed to relate to residential amenity and traffic safety due to noise, heavy traffic and dust.

0.5.19 Impacts on the Hanko region

Wasco will utilise existing harbour and infrastructure in Koverhar, Hanko, for storage yard. In Hanko, economic development has been slow in recent years. Construction activities are not assessed to affect much the Hanko region. However, they will induce a small increase in business and job opportunities.

0.5.20 Transboundary impacts

The majority of the impacts from the Nord Stream 2 construction or operation phase will remain within the borders of the Finnish EEZ. The focus in the transboundary impact assessment was on the potential impacts on water quality and from underwater noise during construction phase, and concerns for example about the possible negative impacts on environment and marine life that have been expressed in Estonia. Sediment spreading and related contaminant dispersion was found not to have any impact on neighbouring countries due to their short duration and low concentrations. Underwater noise from munitions clearance is assessed to have impacts on the Gulf of Finland ringed seal population (with the impact extending into Estonia and Russia). Fisheries in neighbouring countries are assessed to gain minor impacts by the project activities.

0.5.21 Cumulative impacts

Potential cumulative impacts with the planned Balticconnector pipeline and existing Nord Stream pipeline have been assessed in the EIA. The Nord Stream 2 and Balticconnector pipelines are planned to be constructed approximately during the same time period. If the construction periods overlap, increased ship traffic in the same area would also increase the associated risks. The existence of both the Nord Stream 2 and Nord Stream pipelines is assessed to cause additional hindrance to commercial fishery, due to the freespans of four pipelines in the Finnish EEZ. However, mid-water trawling is the prevailing trawling method in these waters, not bottom-trawling. When considering the potential future use of the Finnish EEZ, the existence of both the Nord Stream 2 and Nord Stream pipelines means that it is probable that consultations with Nord Stream 2 or Nord Stream will be necessary. However, it is assessed that the existence of both pipelines will not prevent future projects, but may have an impact on the planning and technical design of such projects.

0.5.22 Impacts from unplanned events

Construction and operation of NSP2 give rise to a number of hazards which may present risks to the environment and the public/third parties. The identified risks assessed relate to the following unplanned events:

- Vessel collisions during construction and subsequent oil spill
- Pipeline failures (e.g. a hole or a rupture) during operation and subsequent gas release
- Unplanned repair works

It is assessed that Nord Stream 2, as a consequence of increased traffic, will cause a negligible increase in the risk of an accidental oil spill. In case of an accidental oil spill, there is a risk of coastal impacts and impacts to Natura 2000 sites or other protected areas. However, the spill scenarios are similar to those which would be generated even without the project as a result of the existing ship traffic in the area.

The probability of a pipeline failure is low and, therefore, there is only a minor increase in the risk of an accidental gas release. If released into water, natural gas will rise to the surface and be transferred into the atmosphere, thereby having little effect on water quality. In the unlikely event of a gas release, it is estimated that fish, marine mammals and birds within the gas plume or the subsequent gas cloud would either perish or flee the area. The impact would be restricted to the area immediately surrounding the rupture.

Nord Stream AG has prepared a document to describe and assess the environmental impacts in the event of an unplanned intervention (emergency repair) on the Nord Stream Pipeline System within the Finnish EEZ. In NSP the overall significance of the effects from emergency repair works on the environmental and socioeconomic parameters has been assessed to result in "No impact – Minor impact". The assessments are considered to be similar for for NSP2.

0.6 Key mitigation measures

Nord Stream 2 AG is committed to designing, planning and implementing the pipeline project with the least impact on the environment as is reasonably practicable. One of the most important factors during optimisation of the pipeline route has been avoidance of uneven seabed, thereby reducing the number of locations where seabed intervention works are necessary.

The key mitigation measures to minimise the environmental impacts on those areas that are assessed to have most significant impacts are:

Technical solutions:
- Use of a dynamically positioned lay barge in the heavily mined areas of the Gulf of Finland to minimise impacts from munitions clearance.
- Controlled rock placement utilising a fall pipe and instrumented discharge head located near the seabed to ensure precise placement of rock material.

Marine fauna:
- Deployment of acoustic deterrent devices for marine mammals prior to munitions clearance detonation to drive animals away from the detonation zone.
- Stationing of marine mammal and bird observers on munition clearance vessels.
- In addition to the munitions clearance methods and mitigation techniques successfully implemented for the Nord Stream Project, Nord Stream 2 will perform a study of alternative clearance methods and mitigation techniques to reduce the impact associated with underwater noise from in-situ detonation.
- Construction activities, such as pipelay and rock placement, are not planned in winter ice conditions to prevent impacts on seals during the breeding season.

Ship traffic:
- Information on project vessels' plans and schedules will be provided to the Finnish Transport Agency for Notices to Mariners.
- Specific consultation will be held and procedures will be agreed with the pipelay contractor and relevant authorities at TSS Off Kallbådagrund and TSS Off Porkkala Lighthouse.
- The Finnish authorities will be notified of unplanned events during pipeline operation.

Underwater cultural heritage:
- The Nord Stream 2 Project is committed to implementing stringent measures to ensure that no adverse impacts on cultural heritage occur from project activities. In general, a 50 m minimum safety distance will be assigned to each cultural heritage site.
- In those areas where an anchored lay barge is planned to be used, an anchor corridor survey will be completed to identify, verify and catalogue potential cultural heritage objects. Anchor patterns will be designed and approved prior to construction in consultation with the National Board of Antiquities.

Contractor audits:
- Nord Stream 2 will periodically audit its contractors (including ancillary activities) to ensure that they operate in accordance with their environmental permits.
- A waste management strategy and plan will be developed and implemented for waste generated offshore. Contractor waste management plans and supporting procedures will be developed and implemented for each vessel.

0.7 Health, safety, environmental and social management system

Nord Stream 2 AG has adopted a Health, Safety, Environmental and Social (HSES) Policy, which outlines the general principles of HSES management. Furthermore, it sets the objectives as to the level of health, safety, environmental and social responsibility performance required by Nord Stream 2 AG staff and contractors. The Policy is implemented through a HSES Management System (HSES MS) aligned to international standards.

0.8 Proposed monitoring programme

The purpose of environmental monitoring during the construction and operation of the pipelines is to verify the assessments presented in this EIA Report and in the water permit application. Environmental monitoring will be directed to those areas of environmental sensitivity that are predicted to experience significant impacts from the project. Monitoring results will also identify whether further mitigation measures may be required. Subjects proposed to be monitored during the construction and operation of the Nord Stream 2 pipelines are summarised in the Table 0-1.

Table 0-1. Proposed subjects to be included into the environmental monitoring programme for the construction and operation of NSP2 pipelines.

Subject	Construction phase			Operation phase
	Prior to	During	After	
Underwater noise	x	x		
Commercial fishery				x**
Cultural heritage (wrecks)	x		x*	

* After the activity has ceased

** According to schedule to be decided later

A detailed plan for the monitoring programme will be prepared for the permitting phase of the project.

0.9 Further schedule and permitting

As stated earlier in Subchapter 0.4, the ELY Centre will organise the consultation for the EIA Report. After that, the coordinating authority will give its statement on the EIA Report within two months. The issuance of the statement concludes the national EIA procedure. The Espoo Report is submitted together with the national EIA and the associated consultation arranged in parallel with the national EIA procedure.

The EIA Report consultation and statement phase will take place during April – August 2017. A statement from the coordinating authority is expected August 2017. An application for the consent according to the EEZ Act as well as the permit application according to the Water Act will be submitted to the Finnish authorities in August 2017. Permit decisions are expected in Q1/2018.

Detailed surveys along the Nord Stream 2 pipeline route will continue during 2017. Engineering will also continue during 2017 and offshore construction works are planned to commence in 2018 once permit approvals have been issued.

1. INTRODUCTION

1.1 Project background

Nord Stream 2 is a pipeline system through the Baltic Sea planned to deliver natural gas from vast reserves in Russia directly to the European Union (EU) gas market. The pipeline system will contribute to the EU's security of supply by filling the growing gas import gap and by covering demand and supply risks expected by 2020.

The twin 1,200-kilometre subsea pipelines will have the capacity to supply about 55 billion cubic metres of gas per year in an economic, environmentally safe and reliable way. The privately funded €8 billion infrastructure project will enhance the ability of the EU to acquire gas, a clean and low carbon fuel necessary to meet its ambitious environmental and decarbonisation objectives.

Nord Stream 2 builds on the successful construction and operation of the existing Nord Stream Pipeline, which has been recognised for its high environmental and safety standards, green logistics as well as its transparent public consultation process. The Nord Stream 2 Pipeline is developed by a dedicated project company: Nord Steam 2 AG.

The Nord Stream 2 Pipeline Project envisages construction and subsequent operation of twin subsea natural gas pipelines with an internal diameter of 1,153 millimetres (48 inches). Each pipeline will require approximately 100,000 24-tonne concrete-weight-coated (CWC) steel pipes laid on the seabed. Pipe-laying will be done by specialised vessels handling the entire welding, quality control and pipe-laying process. Both pipelines are scheduled to be laid during 2018 and 2019, in order to facilitate testing and commissioning of the system at the end of 2019.

The route will stretch from Russia's Baltic coast near Ust-Luga, west of St Petersburg to the landfall in Germany, near Greifswald. The Nord Stream 2 routing is largely parallel to Nord Stream. Landfall facilities in both Russia and Germany will be separate from Nord Stream.

Nord Stream 2 – like Nord Stream – transports gas supplied via the new northern gas corridor in Russia from the fields on the Yamal peninsula, in particular the supergiant field of Bovanenkovo. The production capacity of the Yamal peninsula fields are in the build-up phase, while producing fields from the previously developed Urengoy area that feed into the central gas corridor have reached or passed their plateau production. The northern corridor and Nord Stream 2 are efficient, modern state-of-the-art systems, with an operating pressure of 120 bar onshore and an inlet pressure of 220 bar to the offshore system.

The Nord Stream 2 Pipeline will be designed, constructed and operated according to the internationally recognised certification DNV-OS-F101 which sets the standards for offshore pipelines. Nord Stream 2 AG has engaged DNV GL, the world's leading ship and offshore classification company and a world-leader in independent assurance and expert advisory services, as its main verification and certification contractor. DNV GL will verify all phases of the project.

The downstream transport of gas supplied by Nord Stream 2 to the European gas hubs will be secured by upgraded capacity (NEL pipeline) and newly planned capacity (EUGAL pipeline), developed simultaneously by separate transmission system operators (TSO). Thus, the new downstream infrastructure will be delivering gas to Germany and north-western Europe as well as to central and south-eastern Europe via the gas hub in Baumgarten, Austria, complementing the southern corridor. This will strengthen the EU's gas infrastructure, hubs and markets and will complement the existing infrastructure.

The new state-of-the-art gas supply infrastructure will be privately funded. The project budget (CAPEX) is around 8 billion euros, with 30 % shareholder funded and 70 % from external financing sources.

Implementation of the Nord Stream 2 Pipeline Project is carried out recording the follow schedule.

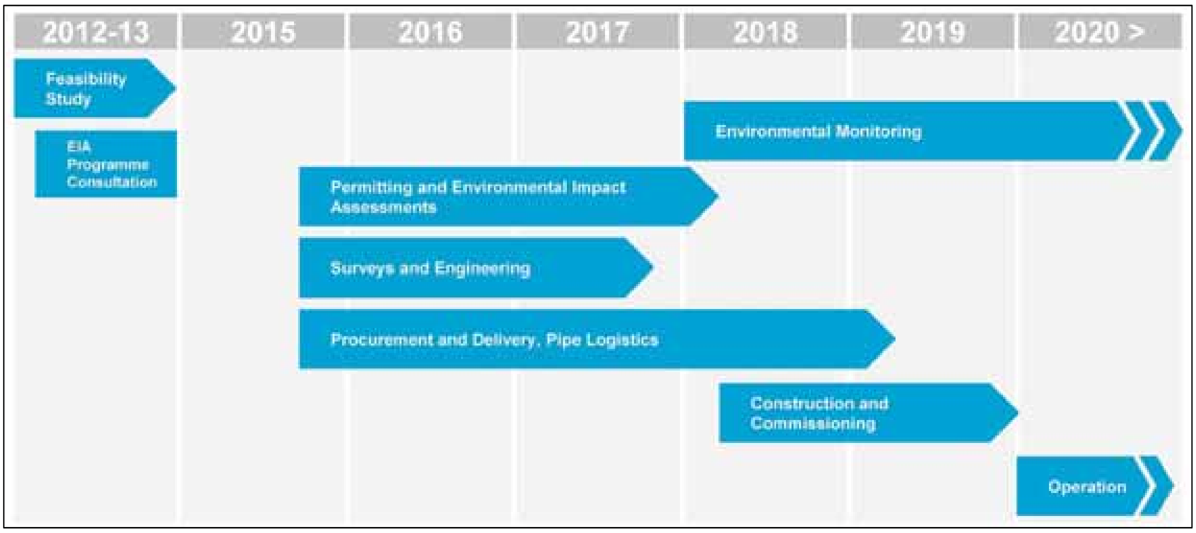


Figure 1-1. Overall schedule of Nord Stream 2 Pipeline Project.

1.2 Project history

The Nord Stream 2 Pipeline will be implemented based on the positive experience of construction and operation of the existing Nord Stream Pipeline.

The Nord Stream Pipeline project, upon its completion, was hailed as a milestone in the long-standing energy partnership between Russia and the EU, contributing to the achievement of a common goal – a secure, reliable and sustainable reinforcement of Europe's energy security.

Nord Stream's first line was put into operation in 2011 and the second line came on stream in 2012. The entire project was completed on schedule and on budget, and received many accolades for high environmental and HSE standards, green logistics, open dialogue and public consultation.

In May 2012, at the request of its shareholders, Nord Stream AG conducted a feasibility study of two potential additional pipelines. The study included technical solutions, route alternatives, environmental impact assessments and financing options.

The feasibility study confirmed that extending Nord Stream with one or two additional lines was possible.

In its feasibility study, Nord Stream AG developed three main route corridor options to be investigated further based on reconnaissance level surveys, environmental impact assessments and stakeholder feedback, in order to come to an optimized route proposal.

In 2012, Nord Stream AG submitted requests for survey permits in the relevant countries. The aim was to further research the route corridor options and to find the optimal routing for the pipelines with minimum length and environmental impact.

In April 2013, Nord Stream AG published the Project Information Document (PID) on the potential extension project, a key milestone in enabling planning for future environmental impact assessments. The PID highlighted the proposed project in the context of the international consultation process according to the Espoo Convention, enabling potentially affected parties to determine their role in the future environmental and social impact assessments and associated permitting processes, in accordance with their country-specific laws and regulations.

In preparation for further development of an extension project, Nord Stream discussed the programme proposals for the national environmental impact studies in the five countries (Russia, Finland, Sweden, Denmark, and German) whose Exclusive Economic Zones (EEZ) or territorial waters the proposed route would cross. Initial consultations were also conducted with the authorities and stakeholders in other Baltic Sea countries.

The permitting, survey and engineering work initiated by Nord Stream AG was taken over by a dedicated project company, Nord Stream 2 AG, which was established in July 2015.

1.3 Developer

Nord Stream 2 AG is a project company established for planning, construction and subsequent operation of the Nord Stream 2 Pipeline. The company is based in Zug, Switzerland and is currently owned by Public Joint Stock Company (PJSC) Gazprom. Gazprom is the largest supplier of natural gas in the world, accounting for approximately 15 percent of world gas production.

At its headquarters Nord Stream 2 AG has a strong team of over 200 professionals of over 20 nationalities, covering survey, environment, HSE, engineering, construction, quality control, procurement, project management and administrative roles.

Based on its stringent procurement policy and international tenders, Nord Stream 2 contracts leading companies to supply materials and services. Europipe GmbH, Mülheim / Germany, United Metallurgical Company JSC (OMK), Moscow / Russia and Chelyabinsk Pipe-Rolling Plant JSC (Chelpipe) and Chelyabinsk / Russia were chosen to deliver approximately 2,500 km of large-diameter pipes with a total weight of roughly 2.2 million tons. The first pipe deliveries started at the end of September 2016. Wasco Coatings Europe BV was contracted for concrete weight coating, pipe storage and logistics and will operate an existing weight coating plant in Kotka, Finland, a second plant in Mukran Germany, as well as storage yards located around the Baltic Sea for storing the pipes, including Hanko, Finland and Karlshamn, Sweden. The pipelay contract has been awarded to Allseas, who will undertake offshore pipelay works for both lines in 2018 and 2019.

As with Nord Stream AG, Nord Stream 2 AG adheres to high standards, with regard to technology, environment, labour conditions, safety, corporate governance and public consultation.

Nord Stream AG, the operator of the existing Nord Stream Pipeline, has been absolutely committed to safety and environmentally-friendly solutions from the very start of the project – through the planning, construction and now the operational phases. In addition to a state-of-art technical design, Nord Stream demonstrated in a very transparent way its competence in the sustainable management of the environmental and social aspects associated with the implementation of a pipeline project. The implementation of an Environmental and Social Management System enabled Nord Stream to monitor its contractors and closely follow up on all commitments and obligations. This ensures good management of construction and operational activities in an environmentally and socially responsible manner, as well as transparent and comprehensive reporting to authorities and stakeholders.

Following this approach, quality assurance by suppliers, contractors of Nord Stream 2 AG and the company itself will exceed the standards normally applied to other offshore pipelines and will guarantee the highest possible standard of operational safety. Nord Stream 2 AG is also committed to complying with the Environmental and Social standards of the International Finance Corporation.

Following completion of the project phase, the results from Nord Stream's Environmental and Social Monitoring Programmes demonstrate that pipeline construction did not cause any unforeseen environmental impact in the Baltic Sea and confirms the positive trend in environmental recovery after construction. So far, all monitoring results have confirmed that construction-related impacts were minor, local and predominantly short-term. Also transboundary effects have been verified as being insignificant. The data in the environmental surveys and monitoring programmes has been transferred to the 'Data and Information Fund' and can be reviewed and used for scientific purposes.

The results of previous surveys and the experience gained during the construction and operation will help to ensure that the Nord Stream 2 Pipeline will meet the same stringent environmental standards and can be built without any lasting adverse effects on the environment.

In line with the company's commitment to transparency and open dialogue, Nord Stream 2 has a dedicated website where extensive project related information can be reviewed and inquiries can be addressed.

1.4 Purpose of the EIA Report and Procedure

This environmental impact assessment (EIA) Report for the Nord Stream 2 project in the Finnish EEZ has been conducted in compliance with Finnish EIA Act (468/1994) and EIA Decree (713/2006). The EIA procedure is applied to gas pipelines with a diameter of more than DN 800 mm and a length of more than 40 km.

The EIA procedure aims to increase and enhance environmental information for decision-making and planning. For this purpose, the project's environmental impacts have been assessed and project alternatives compared. The procedure also aims to promote the participation of the public in the planning phase and to improve the availability of information to the public.

The EIA procedure has two phases. In the first phase, scoping phase, the EIA Programme has been prepared to define how the EIA procedure will be organised. During public display of the EIA Programme, ELY Centre received 18 statements from authorities, 12 statements from municipalities and 5 opinions from private persons and associations. These were taking into account in the ELY Centre's coordinating authority statement and further in the preparation of the EIA Report. In the second phase the EIA Report has been prepared. The EIA Report contains details of the project and alternatives, as well as assessments of the potential environmental impacts.

On the assignment of Nord Stream 2 AG, Ramboll has been prepared this EIA Report in hand. A list of external contractors responsible for various studies, surveys, modelling and assessments for this EIA is presented in Appendix 2. The national EIA Report is an essential document for further project planning and permitting procedures. The EIA procedure must be completed before any decisions are made to officially approve a proposed project.

Due to the international extent of the project, the EIA procedure has also been carried out in compliance with the UNECE Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) and the bilateral Agreement between Finland and Estonia on Environmental Impact Assessment in a Transboundary Context. This so-called "Espoo Report" is attached to the Finnish EIA Report.

This EIA Report is intended for all of those who are interested in project and its' environmental impacts.

1.5 Report structure

The EIA Report for Finland begins with an Introduction (Chapter 1) that includes information on the background, history and developer of the Nord Stream 2 project. The purpose and structure of the report are also described. Next follows the project justification (Chapter 2) which describes the developer's view on the importance of the Project to the EU energy market.

The project description (Chapter 4) presents the general features of the Nord Stream 2 twin gas pipeline system from Russia to Germany. Project activities in the Finnish EEZ and supporting ancillary onshore activities have been presented with additional information on the relevant activities. Route sub-alternatives and construction alternatives are introduced in Chapter 5 Alternatives.

The Report includes a Baseline description of the project and impact areas, occurring offshore, onshore and of a transboundary nature (Chapters 7–9). Project area is the area of physical activity or disturbance related to the project. Impact area is the area were impacts on the surrounding environment are assessed to appear. The assessment scope and methodology have been discussed in Chapter 10.

The main results of the assessments are presented in Chapters 11–13 (both offshore, onshore and transboundary impacts). Cumulative impacts have been addressed in a separate Chapter 14 as well as environmental considerations for decommissioning (Chapter 15). Unplanned events and their possible consequences have been dealt with in Chapter 16 Risk assessment. A summary of mitigation measures is presented in Chapter 17.

Additionally, the EIA report contains chapters regarding proposed environmental monitoring (Chapter 18) and the health, safety, environmental and social management system (Chapter 19). The final chapters of the report include en evaluation of gaps and uncertainties (Chapter 20), presentation of overall conclusions (Chapter 21), and description of further planning and permitting (Chapter 22).

2. PROJECT JUSTIFICATION

This section describes the occasion and reasons for the Nord Stream 2 project and proves why this project is required to secure the supply of gas to the European Union and its Member States. Nord Stream 2 AG has commissioned Prognos AG to prepare a study on the European gas balance, forecasting future gas demand and possible sources for demand coverage. In view of the above, Prognos AG, which advises decision-makers from politics, business and society in Europe providing objective analyses and forecasts, completed the study "Current Status and Perspectives of the European Gas Balance" in January 2017 *(Prognos AG 2017)*.

The study area of this chapter is thus the European Union, consisting of 28 Member States (*EU 28*) – consistently including the United Kingdom (UK). A possible withdrawal of UK from *EU 28* ("Brexit") would have no significant impact on the natural gas flows between UK and other *EU 28* Member States as well as Norway, as UK's natural gas import requirements, and the *EU 28* total imports, would not change *(Prognos AG 2017)*. The geographic area will be extended within the following analysis, when required from an *EU 28* perspective i.e. non *EU 28* Member States are able to or have decided to cover their gas import requirements exclusively from the *EU 28* *(Prognos AG 2017)*. In the following this is discussed in detail.

It would not be appropriate to focus solely on those areas which are directly supplied by pipeline. The EU internal gas market is significantly influenced by the global LNG market.

Thus, an overall European gas balance has to be analysed in order to assess the extent of supply security. Ignoring the interdependencies with supply and the available sources, the complexity of the markets would not be treated appropriately and thus the requirements of a sound forecast would not be met. It is particularly important to consider the relevant geographic area when comparing the results presented below with other studies, as some studies focus on OECD Europe instead of *EU 28*. The main difference between OECD Europe and *EU 28* is that OECD Europe considers Norway (a large net exporter of natural gas) and Turkey (a large importer of natural gas). Further, the *EU 28* Member States Romania, Bulgaria, Croatia, Latvia and Lithuania are not part of OECD Europe. This leads to considerable differences in the respective quantitative balances.

The time horizon for projections in this document, is usually 2020 until 2050 (depending on specific analyses). In view of the long forecasting period and the complexity of the subject – which is characterised by significant uncertainties – Prognos has analysed in detail numerous studies on future gas demand in its study *(Prognos AG 2017)*.

Figures in this document are rounded to the first or no decimal, potentially leading to slight deviations in shown totals.

The Nord Stream 2 pipeline project is essential for the secure, cost-effective and sustainable supply of natural gas to the general public for the following reasons.

Prognos differentiates between so-called target and reference scenarios. Target scenarios generally aim at an all-electric world fuelled by solar and wind-based power generation and show strongly declining fossil fuel demand trajectories to achieve politically set climate protection targets detached from the likelihood of achieving them (Figure 2-1). Given their methodological approach they are not suitable for setting a reliable basis in order to forecast future supply needs. Reference scenarios, on the other hand, take into account the risk of not complying with ambitious targets.

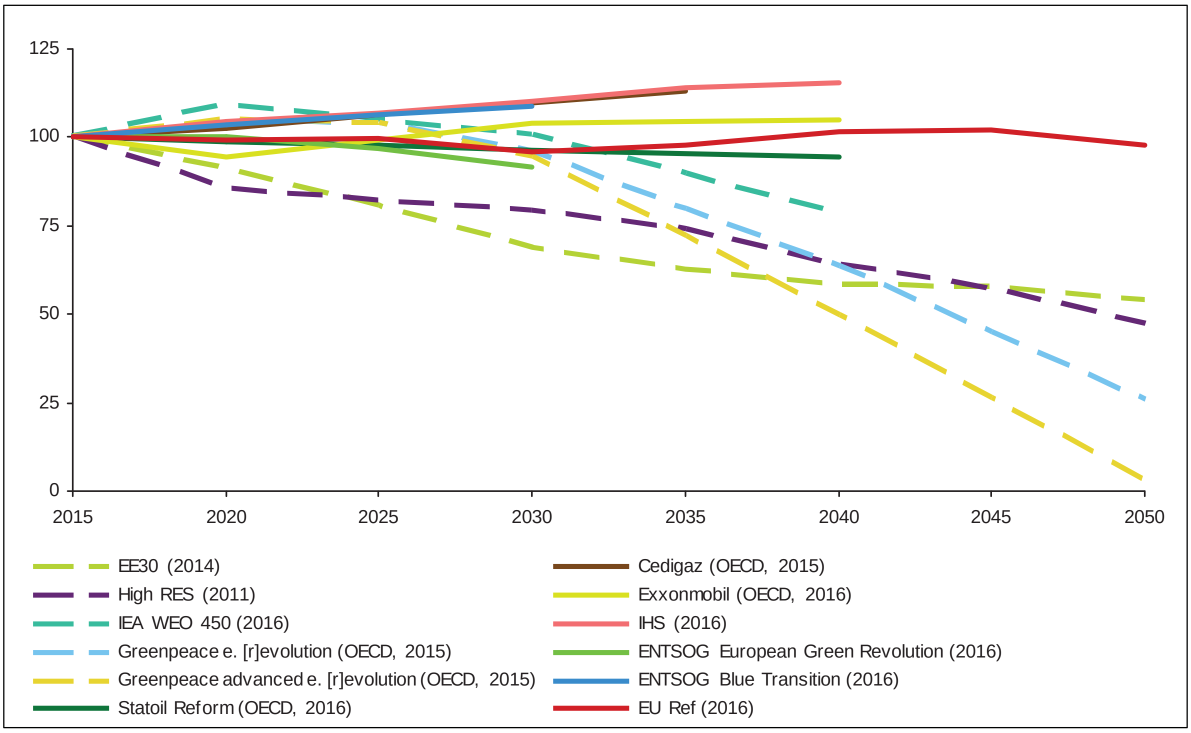


Figure 2-1. Natural gas demand scenarios for EU 28 and OECD Europe [indexed with 2015 = 100].

In order to ensure the security of energy supply of the *EU 28* with natural gas, particularly in the event of not fulfilling such objectives, it is necessary to base the medium- to long-term planning on reference scenarios. Prognos therefore bases its analysis on the *EU Reference Scenario* (2016), also taking into account recent developments. Prognos, as subject matter experts, consider the *EU Reference Scenario* as a good starting point to analyse *EU 28* energy demand and production, as its projections are based on present best practices (from a technological and legal perspective) and it is highly transparent. However, Prognos concluded that the *EU Reference Scenario* needs to be adjusted where more up-to-date official production outlooks are available and extended to include projections for imports from the EU internal gas market by Switzerland and Ukraine to *EU 28* figures, in order to get a complete picture of future gas import requirements.

Considering Switzerland and Ukraine, which are expected to import approximately 20 bcm/a of natural gas from the EU internal gas market as of 2020, demand of *EU 28* is projected to show an almost stable development from 494 bcm in 2020 to 477 bcm in 2030 and 487 bcm in 2050. At the same time however, *EU 28* domestic production is projected to decline by 55 % between 2015 and 2050 (Figure 2-2).

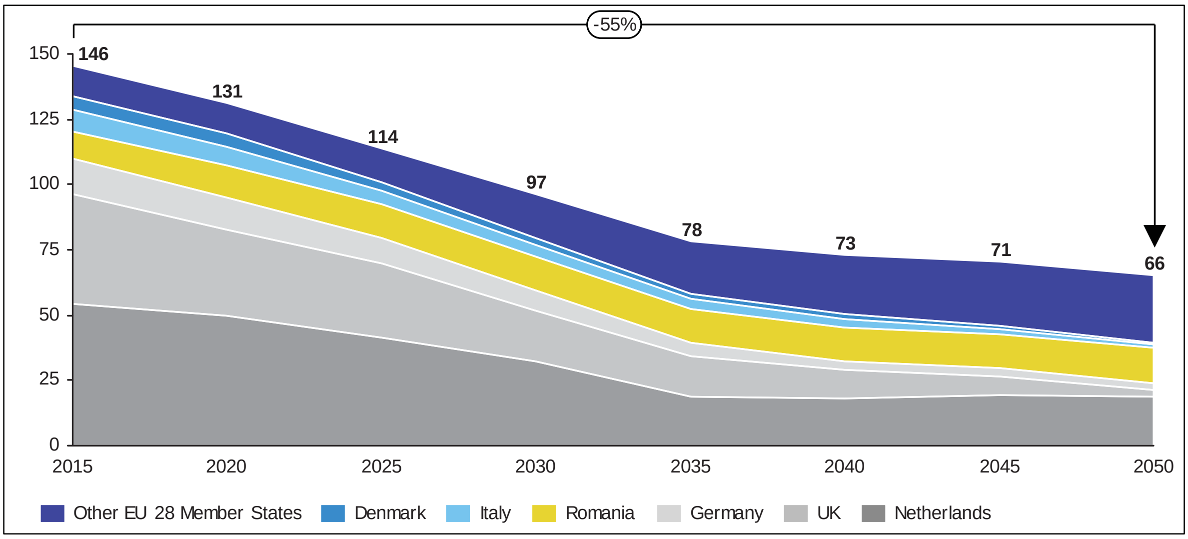


Figure 2-2. **EU 28 natural gas production projections according to Prognos based on EU Reference Scenario 2016 [bcm].**

According to Prognos, natural gas production is expected to decrease even further than projected due to recent decisions by the Dutch government to reinforce limitations on the natural gas production from the Groningen field, as well as lower projections for natural gas production in Germany and the UK.

After adjustments, *EU 28* domestic production is projected to decline from 118 bcm in 2020 to 83 bcm in 2030 and 61 bcm in 2050 (Figure 2-3).

In combination, the stable development of demand and the strong decline in production results in a constantly increasing natural gas import requirement of *EU 28*, developing from 376 bcm in 2020 to 394 bcm in 2030 and 427 bcm in 2050 (Figure 2-3), with the result that additional gas supplies will be necessary to ensure the sustainable supply security of *EU 28*.

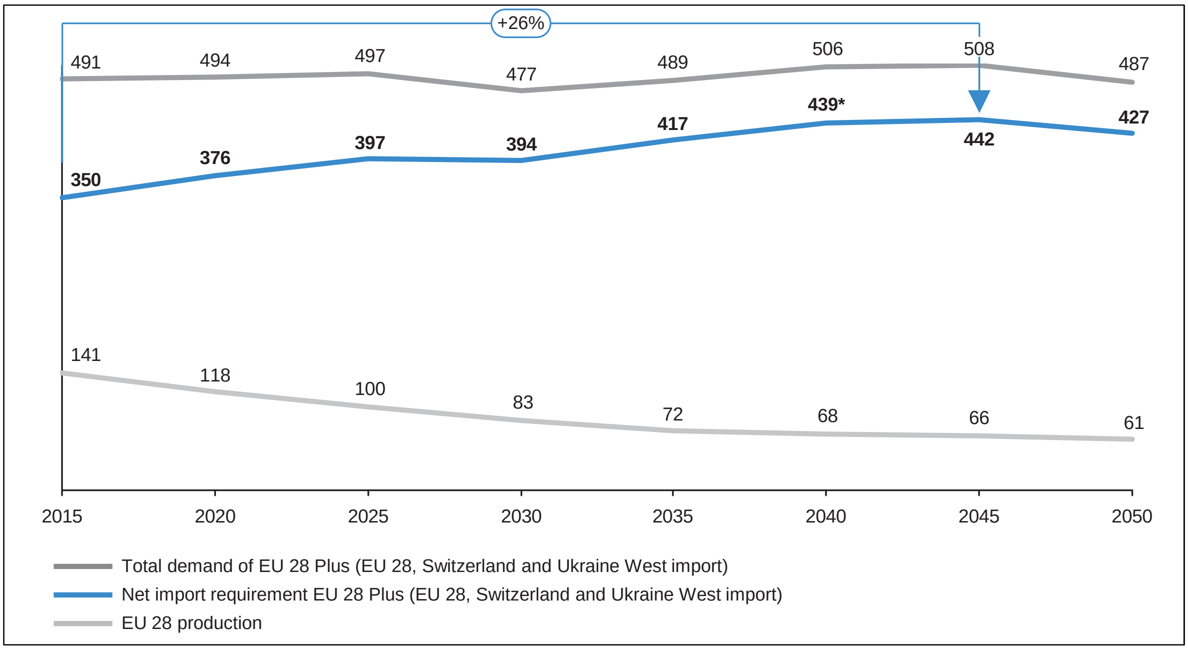


Figure 2-3. **Natural gas demand, production and import requirement of EU 28 [bcm].**

According to Prognos, without Nord Stream 2, it cannot be ensured that this natural gas import requirement will be covered (securing energy supply) if these gaps cannot be filled with pipeline gas. The global LNG market is subject to drastic fluctuations, so that LNG cannot be assumed reliably cover any potential demand gaps. Therefore, the realization of the project is necessary in order to eliminate uncertainties of supply and to facilitate a competitive situation with the aim of providing gas at low costs.

Pipeline gas: To cover the import requirement, pipeline gas and natural gas imported as LNG are available to *EU 28*. With regard to pipeline gas, however, all existing suppliers to the EU internal gas market with the exception of Russia (Norway, Algeria and Libya) are projected to supply decreasing volumes due to restrictions in future production and/or increases in domestic consumption (Figure 2-4 and Figure 2-5).

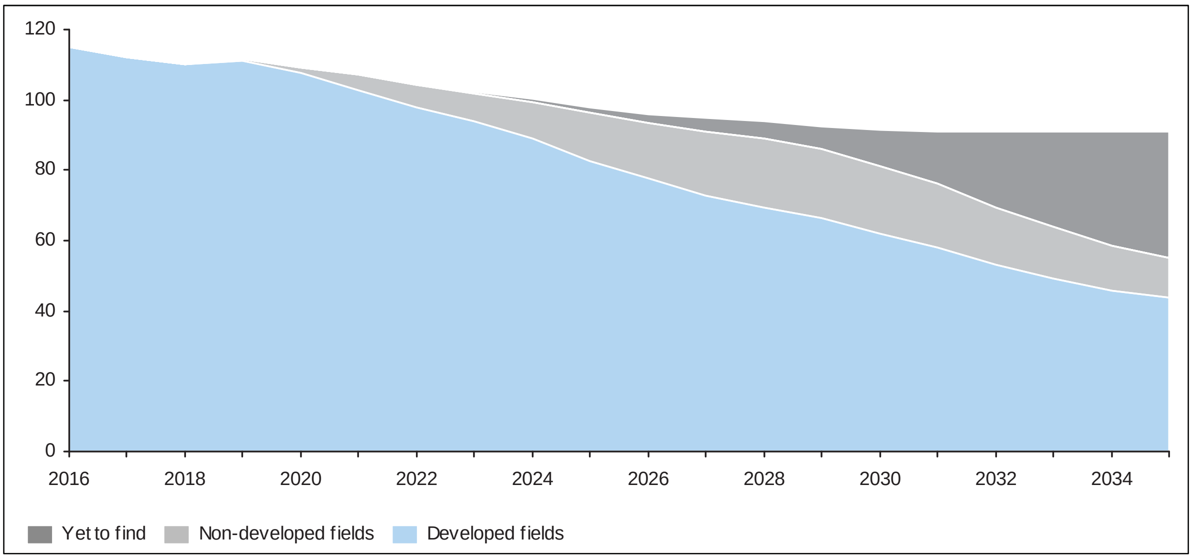


Figure 2-4. Natural gas production forecast for Norway [bcm].

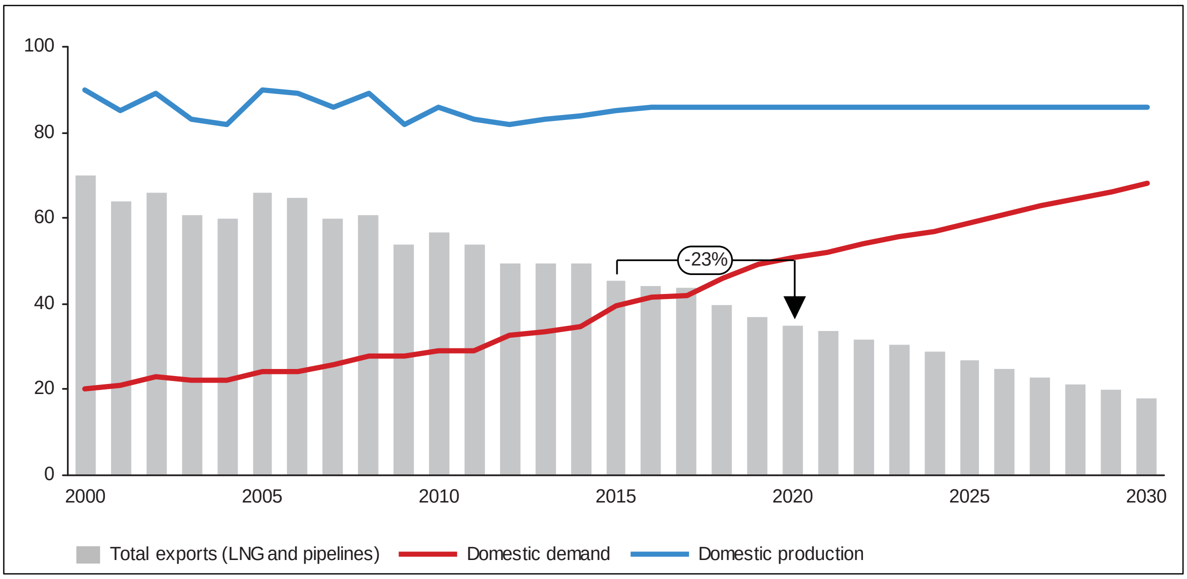


Figure 2-5. Natural gas balance forecast for Algeria [bcm].

Russia, in contrast, holds the largest proven natural gas reserves worldwide and has extensive production capacity to satisfy both domestic demand and export demands of *EU 28* and other countries (Figure 2-6).

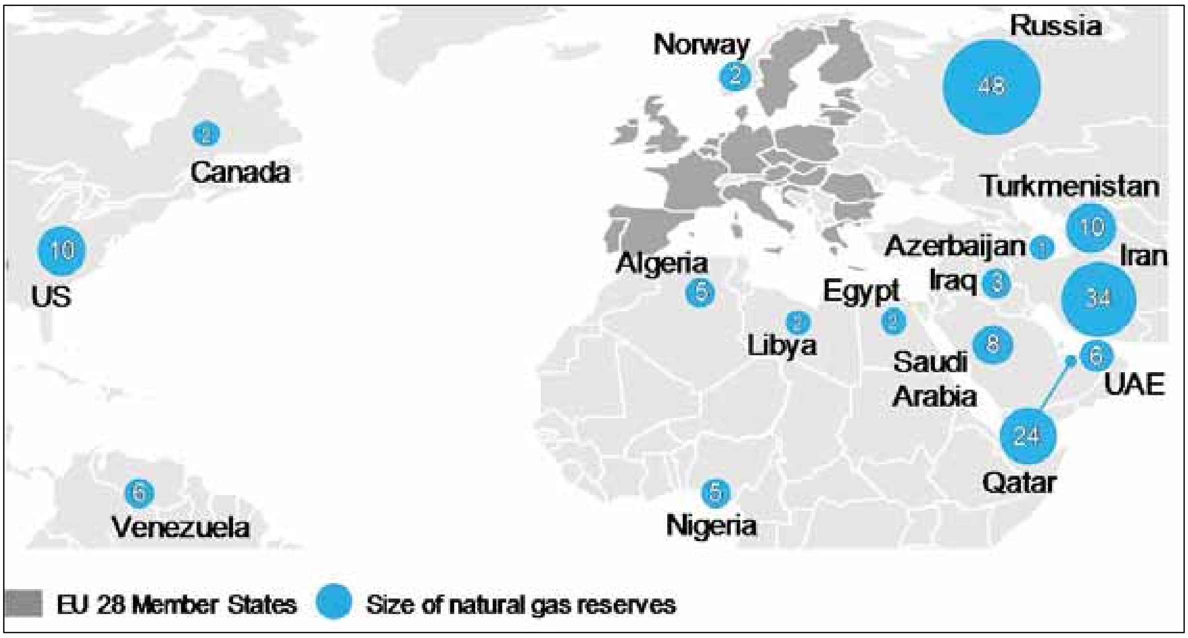


Figure 2-6. Distribution of global natural gas reserves [tcm].

With regard to the transportation of produced gas to the EU internal gas market, Nord Stream (1) and Yamal-Europe as well as Russian gas transports to the Baltic States (Estonia, Latvia, Lithuania) and Finland are reliably available. However, for the Central corridor through the Ukraine, further transport capacity of only 30 bcm/a can be considered as sustainably available. This transport capacity is only available if the required refurbishment, which is funded by EBRD (Europäische Bank für Wiederaufbau) / EIB (Europäische Investitionsbank) emergency loans, is actually pursued. However, in order to ensure this transport capacity in the long term, substantial maintenance and refurbishment measures are required in the future, which has not been the case at least in recent years. In fact, the planned investment programme has been consistently under-fulfilled by the operator.

The inadequate condition of the system has resulted in an incident rate about 10-times higher than the European average. A situation likely to exacerbate, as pipelines enter the fourth and sometimes fifth decade of operation in 2020. Furthermore, the depleting Nadym Pur Taz region is substituted by gas production from the more north-western located Yamal region. The Nord Stream corridor running from the Yamal region to the EU internal gas market is not only technically more advanced, but also about one-third shorter than the Central corridor. This leads to a significantly lower gas consumption of the compressors for the transport and thus to a higher efficiency and profitability of the transport system. As a result, the respective demand gaps cannot be reliably covered by pipeline gas ensuring future gas supply.

With regard to pipeline gas potentially supplied from new source countries (Azerbaijan, Turkmenistan, Israel, Iraq and Iran) to the EU internal gas market, is clearly limited. Apart from additional volumes from Azerbaijan transported via the new TAP /TANAP pipeline project – currently under construction with a maximum capacity of 10 bcm/a – no additional pipeline gas coming to the EU internal gas market is conceivable. As a result, no additional import volumes are expected from these suppliers in the foreseeable future.

LNG: The global LNG market generally represents a possible supply source to import considerable additional volumes of natural gas to cover the future *EU 28* import requirement. However, due to its nature as a cyclical industry (Figure 2-7) LNG cannot ensure to cover natural gas demand. Therefore, reliable medium and long term forecasts of the LNG market are hardly feasible.

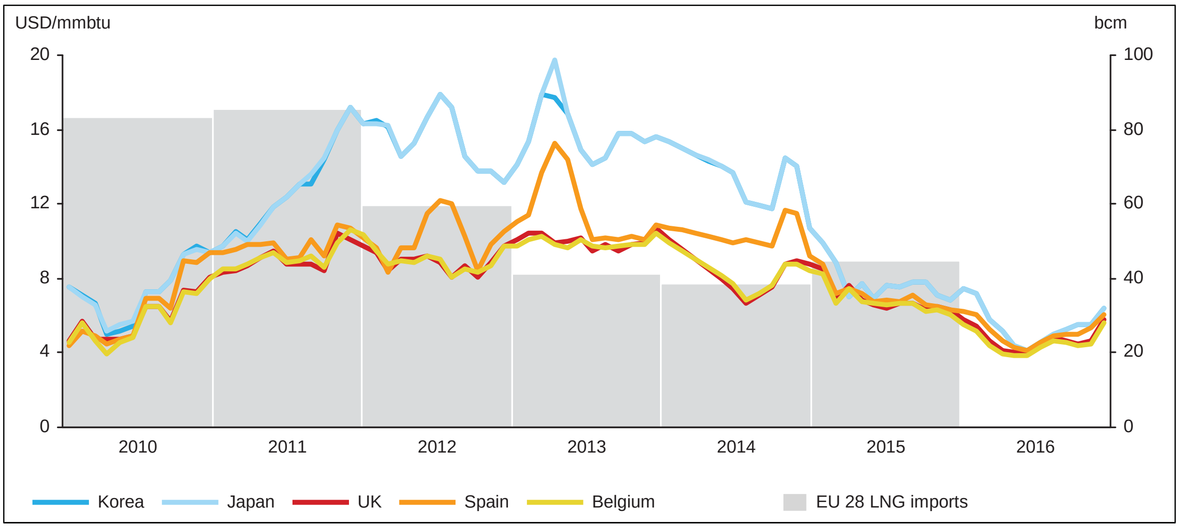


Figure 2-7. Development of regional landed LNG prices [USD/mmbtu] and EU 28 LNG imports [bcm].

In addition, Prognos and various other available studies are assuming that the LNG demand will exceed the supply in the early 2020s, so that sufficient quantities for Europe are not guaranteed, resulting in an increased price competition *(e.g. Prognos AG 2017, Royal Dutch Shell plc. 2017, The Boston Consulting Group 2016)*. Natural gas imported as LNG into the EU internal gas market therefore is not a reliable supply option. Based on available LNG scenarios, LNG imports with an average of 67 bcm in 2020 and up to 95 bcm in 2030 are expected and considered in the following.

As a result, there would be an import gap without the implementation of the Nord Stream 2 project. This import gap will increase from 30 bcm in 2020 to 59 bcm in 2030 and 110 bcm in 2050 (Figure 2-8). The construction of the Nord Stream 2 pipeline can close this import gap from 2020 onwards. This will increase Russia's sustainable transport capacity towards the EU internal gas market and thus avoid the additional reliance on volatile LNG. With its designed annual capacity of 55 bcm per year[1], the Nord Stream 2 pipeline will contribute to the closure of the import gap from 2020 onwards, thus guaranteeing the security of supply with natural gas.

[1] In Figure 2-8 a typical utilisation rate of 90 % is applied to the designed annual capacity of Nord Stream 2 (55 bcm/a), which leads to average annual volumes of 50 bcm.

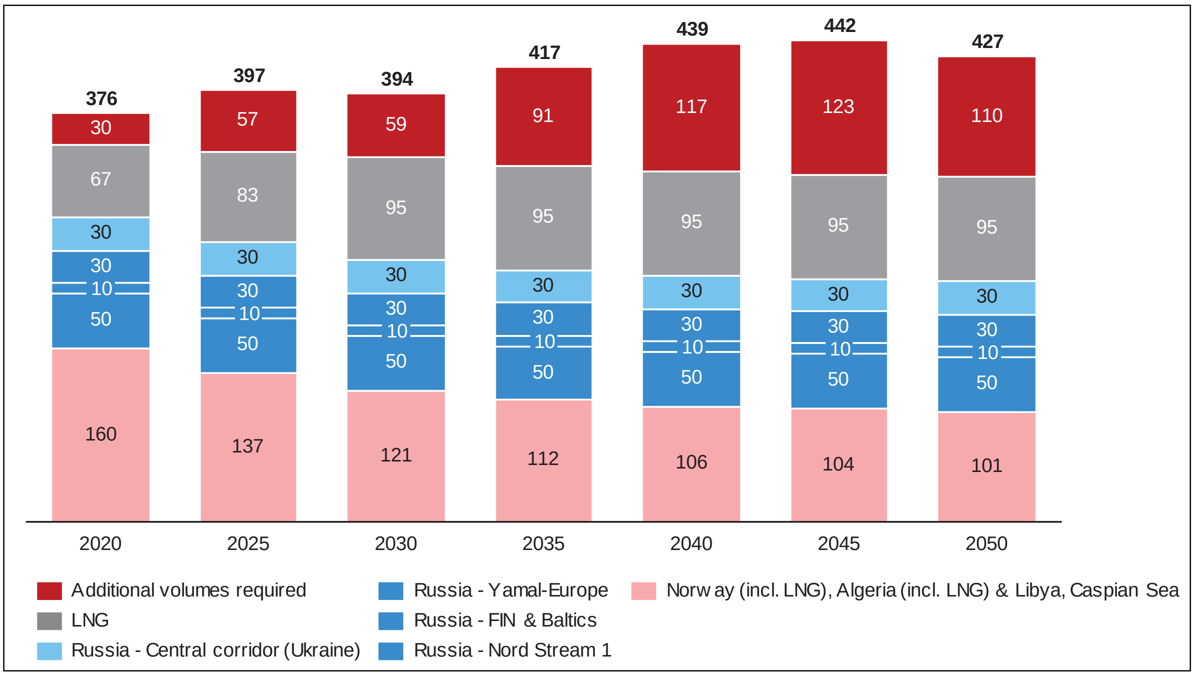


Figure 2-8. **EU 28 import gap forecast with average LNG and 30 bcm/a Ukraine transit (Reference Case) [bcm], figures for Russian supplies in the bar chart are arranged in the same order as used in the legend**

In view of the broad range and the complexity of possible forecasts, it cannot be excluded that other studies generate different results. However, these won't be able to prove that the EU's security of supply can be guaranteed in the future without the implementation of Nord Stream 2. On the contrary, there are additional risk factors which can currently lead to an increased threat to the security of supply. The Nord Stream 2 pipeline can help to ensure security of supply, particularly in terms of potential transit, supply and demand risks.

The most prominent risk factors are a complete halt of transit through Ukraine on commercial or legal grounds (Figure 2-9) or low levels of LNG supply due to a tightening global LNG market (Figure 2-10) Furthermore, demand or supply-side risks could be higher than assumed by Prognos, such as a complete stop of production from the Groningen field or a halt of exports from North Africa, which would endanger the security of gas supply of *EU 28* (Figure 2-11).

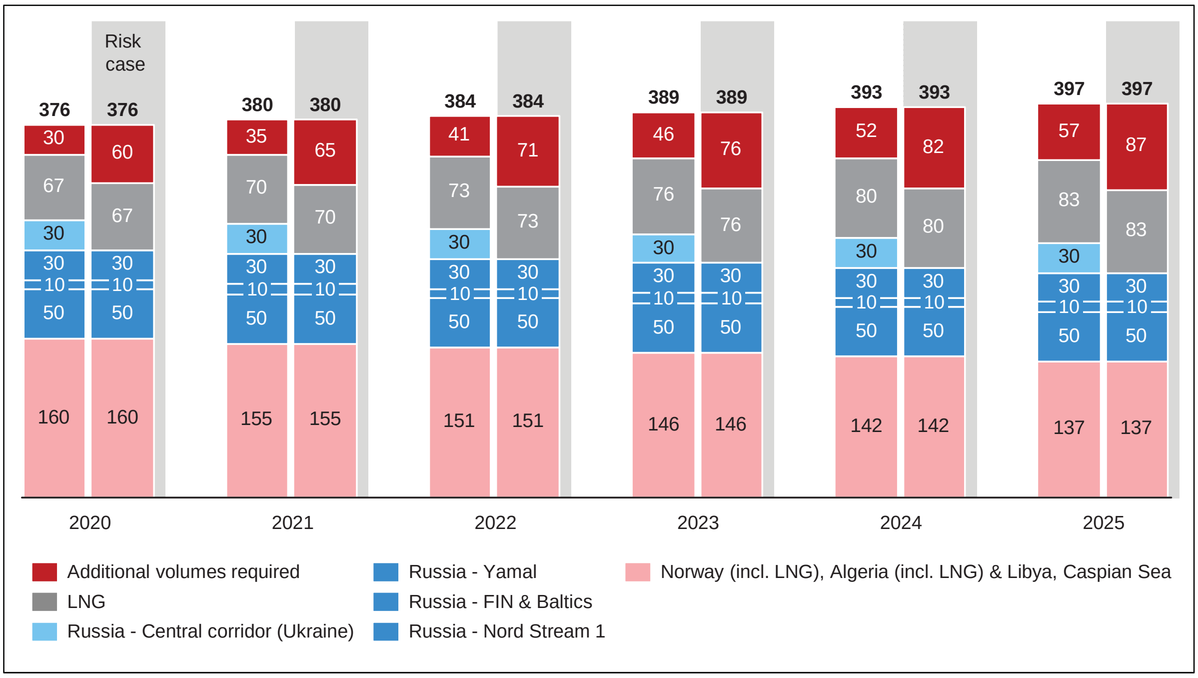


Figure 2-9. Risk case 1 for EU 28: 0 bcm/a Ukraine transit [bcm].

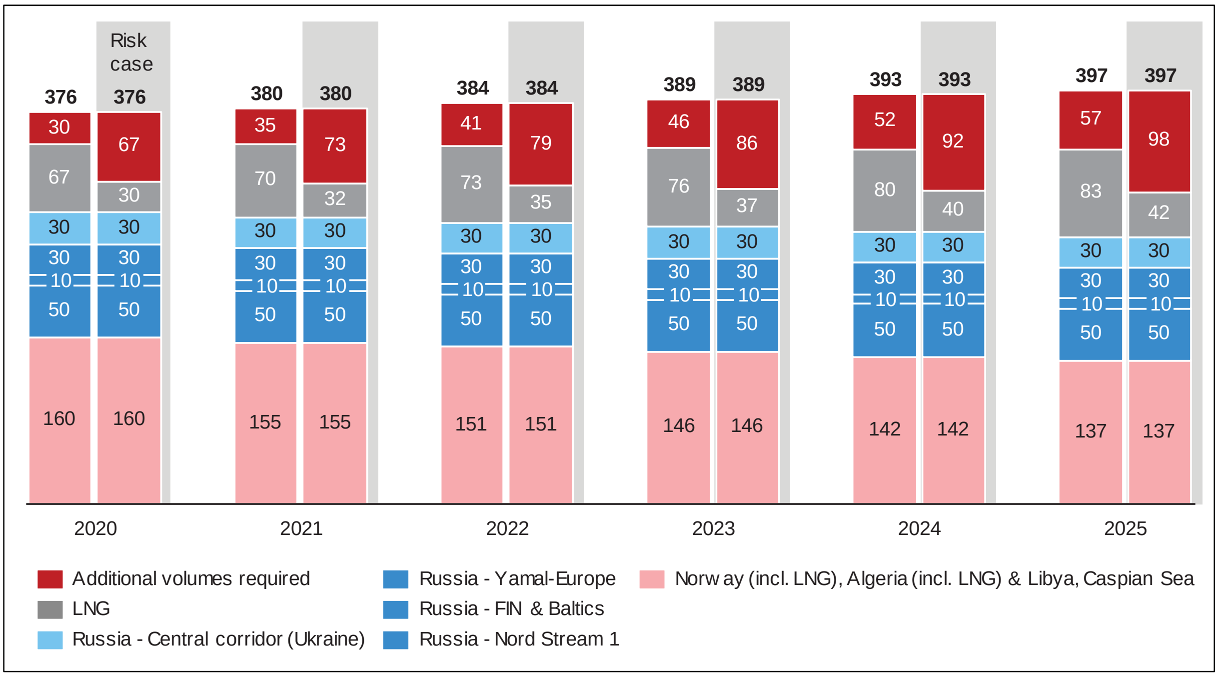


Figure 2-10. Risk case 2 for EU 28: Minimum LNG import by EU 28 [bcm].

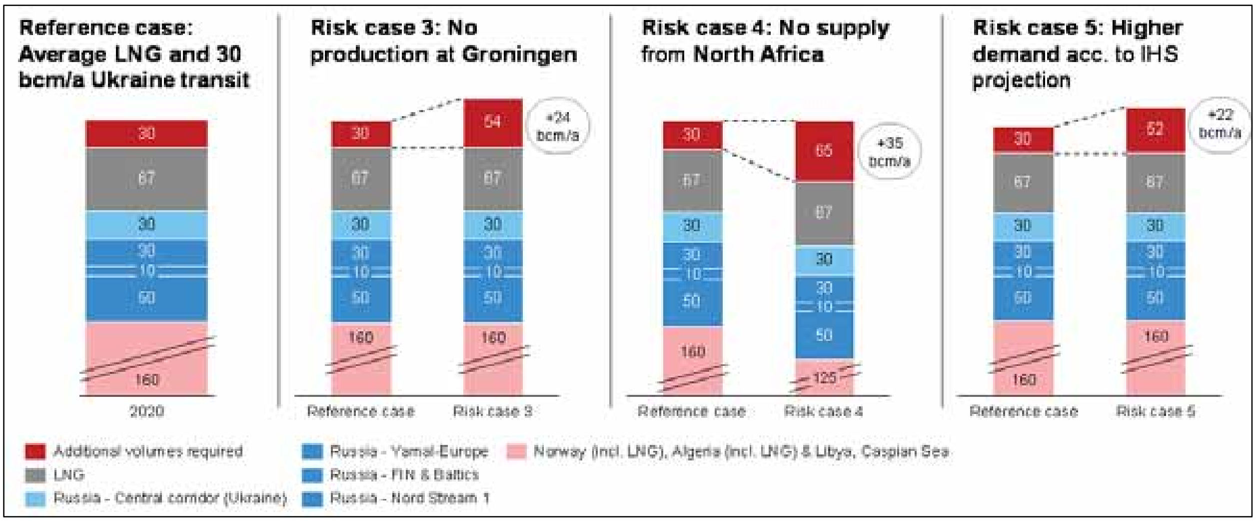


Figure 2-11. Other relevant risk cases for EU 28: No supply from Groningen (NL), North Africa or higher demand for natural gas [bcm]

In addition, Nord Stream 2 will increase competitive pressure on natural gas supplied to the EU internal gas market from different countries, resulting in lower gas market prices for end consumers and therefore contributing to the affordability of energy supply. Furthermore, Nord Stream 2 will trigger further integration of the EU internal gas market through additional downstream pipeline infrastructure.

Finally, the proposed project contributes to an environmental friendly supply of energy. This applies to natural gas as a fossil fuel and its general importance in the energy mix, but also to the project itself.

Natural gas, is a fuel with various applications in the heating, power generation, industry and transport sector of the *EU 28* (Figure 2-12). Being the fossil fuel with the least greenhouse gas (GHG) and other emissions resulting from combustion (e.g. particulate matter) – especially in comparison with coal and oil – natural gas can serve as both a transitional energy source, enabling a build-out of renewables as well as a back-up energy source guaranteeing overall security of energy supply. Thus, natural gas as an intermediary has the potential to accompany and promote the transition to a low-carbon economy and will continue to play an important role in the *EU 28* energy supply in coming decades. Through the continued use of natural gas, ambitious targets set by the *Paris Agreement* of 2016 on climate change can be reached without jeopardizing the overall security of energy supply.

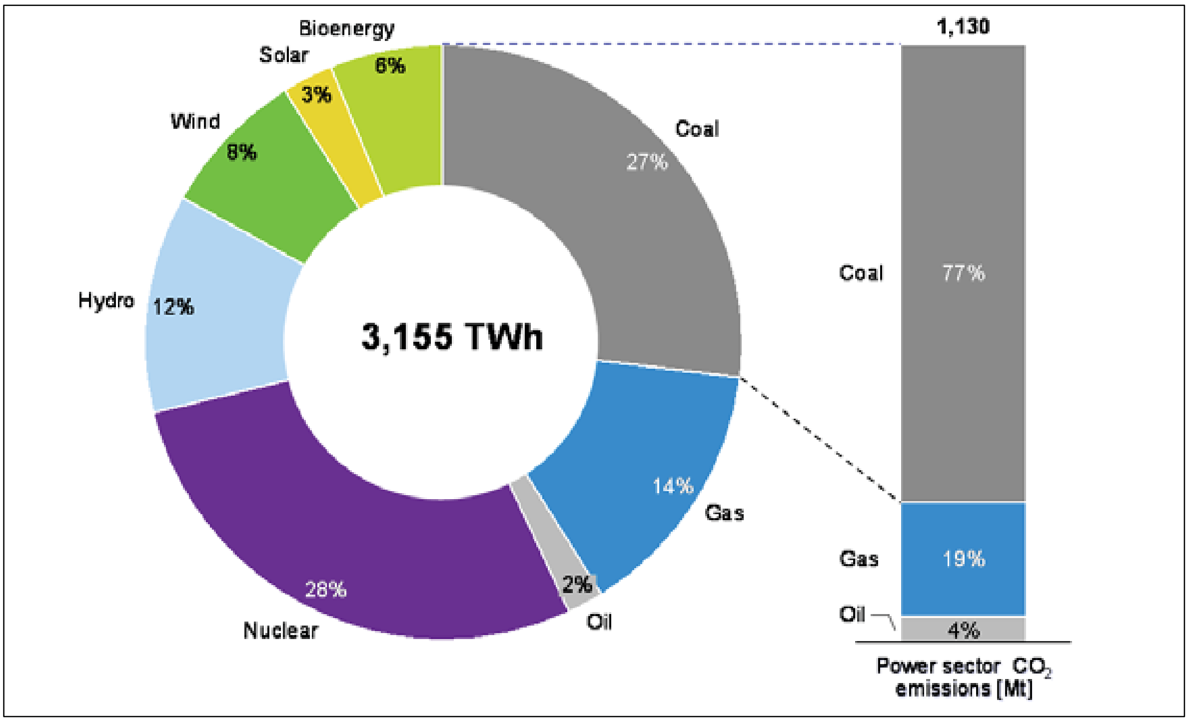


Figure 2-12. Electricity mix 2014 in EU 28 by energy source [TWh, %] and corresponding CO_2 emissions [Mt, %].

Also, from an environmental perspective Nord Stream 2 – combining state-of-the-art technical design with a much shorter route from the relevant production fields in Russia to the EU internal gas market (Figure 2-13) – has significant advantages in terms of environmental and climate impacts.

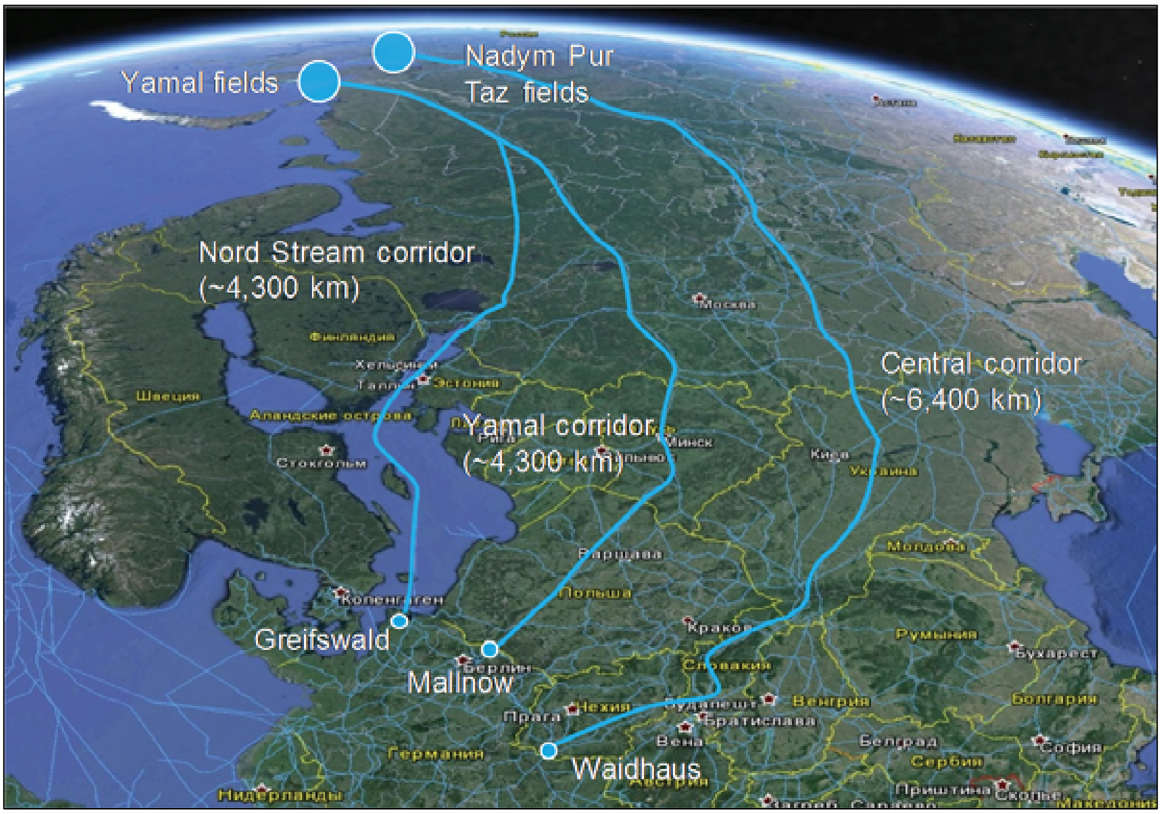


Figure 2-13. Overview of Russian gas fields and pipelines to the EU [schematic], (Background chart: Google Earth)

This applies to both Russian gas supplied to *EU 28* via Yamal-Europe and the Central corridor as well as compared to important LNG supply options (Algeria, Australia, Qatar and US). Among the potential sources of gas supply able to significantly contribute to closing the *EU 28* import gap, Russian gas supplied via the Nord Stream corridor has the lowest carbon footprint. Compared to natural gas reaching the EU gas market via the Nord Stream corridor, the CO_2 footprint of alternative Russian pipeline gas routes is at least 46 %, and that of LNG alternatives at least 131 % greater (Figure 2-14).

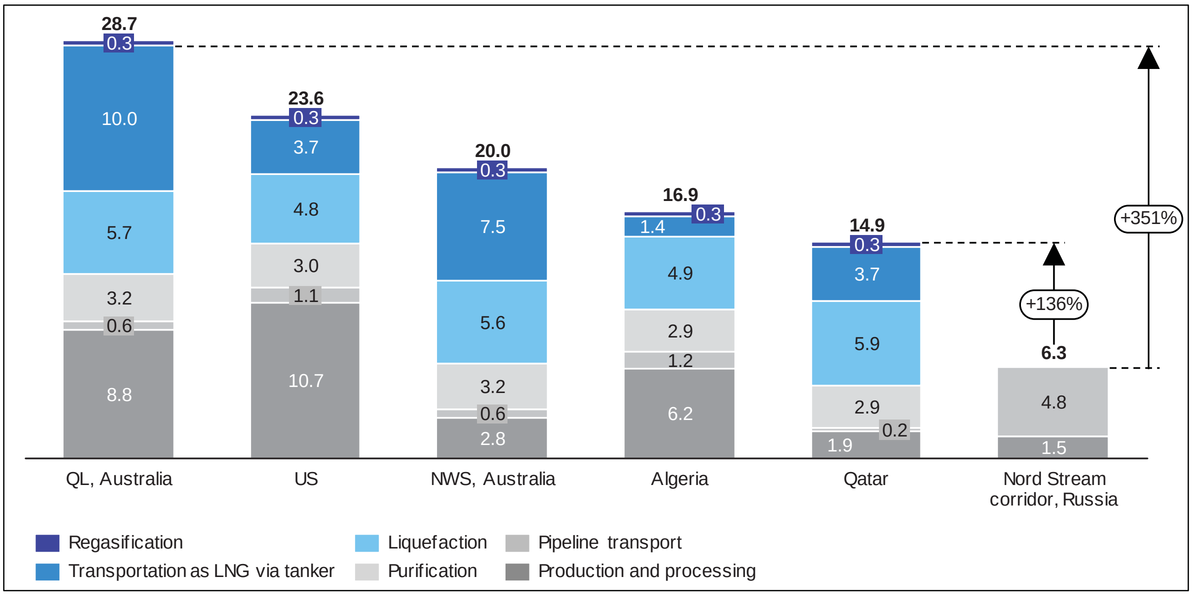


Figure 2-14. Carbon footprint of Russian pipeline gas coming to EU 28 via the Nord Stream corridor and from different sources via LNG [gCO_2e/MJ].

Natural gas is poised to remain a backbone of *EU 28* energy supply, outpacing coal and oil and leading to lower GHG emissions. With a mostly stable natural gas demand, but rapidly decreasing gas production in *EU 28*, alternative gas supply is needed to cover the upcoming natural gas import gap starting already in 2020. The state-of-the-art transport system Nord Stream 2 can contribute to covering the upcoming import gap of *EU 28* as of 2020, while making the EU's gas supply more robust, more economically beneficial, more sustainable, more efficient – and more consumer-friendly.

3. ENVIRONMENTAL IMPACT ASSESSMENT PROCEDURE

3.1 EIA procedure and participation in Finland

3.1.1 Applying the EIA procedure

The environmental impact assessment procedure aims to increase and enhance environmental information for decision-making and planning. For this purpose, the project's environmental impacts are assessed and possible project alternatives compared. The procedure also aims to promote the participation of the public in the planning phase and to improve the availability of information to the public. Consequently, the purpose of the EIA procedure is to prevent the occurrence of harmful environmental impacts and to reconcile opposing views and goals.

The EIA procedure and the preconditions for applying the procedure have been laid down in Finland in the Act on the Environmental Impact Assessment Procedure (468/1994, as amended, hereinafter the "EIA Act") and the Government's Decree on the Environmental Impact Assessment Procedure (713/2006, as amended, hereinafter the "EIA Decree"). The EIA procedure is applied to projects which may cause significant adverse environmental impacts and to projects specifically defined by decree.

With respect to transmission of energy, the EIA procedure is applied to gas pipelines with a diameter of more than DN 800 mm and a length of more than 40 km (Chapter 2, Section 6 of the EIA Decree). The applicable projects located in the Finnish EEZ are also subject to the EIA procedure (Chapter 2, Section 4a of the EIA Act). Since the diameter of the Nord Stream 2 pipeline and the length of the pipeline route exceed the set limit values, the project is subject to the EIA procedure.

The EIA procedure has two phases. The EIA procedure is officially initiated when the developer submits the assessment programme (EIA Programme) to the coordinating authority. The project developer defines in the EIA Programme how the EIA procedure will be organised. According the EIA Decree, the assessment programme must contain, on a sufficient scale e.g.

- information on the project, its purpose, planning stage and location;
- alternatives of the project, one of which is the non-implementation alternative;
- plans, permits and decisions required;
- baseline of the environment, already carried out or planned studies, methods to be used and assumptions;
- proposal for study area;
- plan for arranging the EIA procedure and participation; and
- schedule.

The coordinating authority notifies other authorities and municipalities about the availability of the EIA Programme. A public announcement is published in the project's impact area. After the hearing, the coordinating authority issues a statement regarding the Programme, which ends the first phase of the EIA.

After the coordinating authority has issued its statement, an EIA Report is prepared by the developer. The EIA Report contains details of the project and the various project alternatives, as well as assessments of the expected environmental impacts of each alternative. The EIA report must contain, on a sufficient scale:

- information in EIA Programme as revised;
- account of how the project and its alternatives relate to land use plans and such plans and programmes for the use of natural resources and environmental protection which are relevant in regard to the project;
- main characteristics and technical solutions of the project, description of construction and operation phases, including decommissioning;
- main information used in the assessment;
- baseline of the environment and assessment of the environmental impacts of the project and its alternatives, main uncertainty factors, and assessment of the possibility of environmental accidents and their consequences;
- account of the feasibility of the project and the alternatives;
- mitigation measures;
- comparison of the alternatives;
- proposal for a monitoring programme;
- description of the assessment procedure, including the participation;
- account of how the coordinating authority's statement on the assessment programme has been taken into account; and
- non-technical summary.

As in EIA Programme phase, the coordinating authority notifies about the availability of the EIA Report and a public announcement is published in the project's impact area. The coordinating authority must also issue a statement with respect to the EIA Report. Figure 3-1 gives an overview of the EIA procedure in Finland.

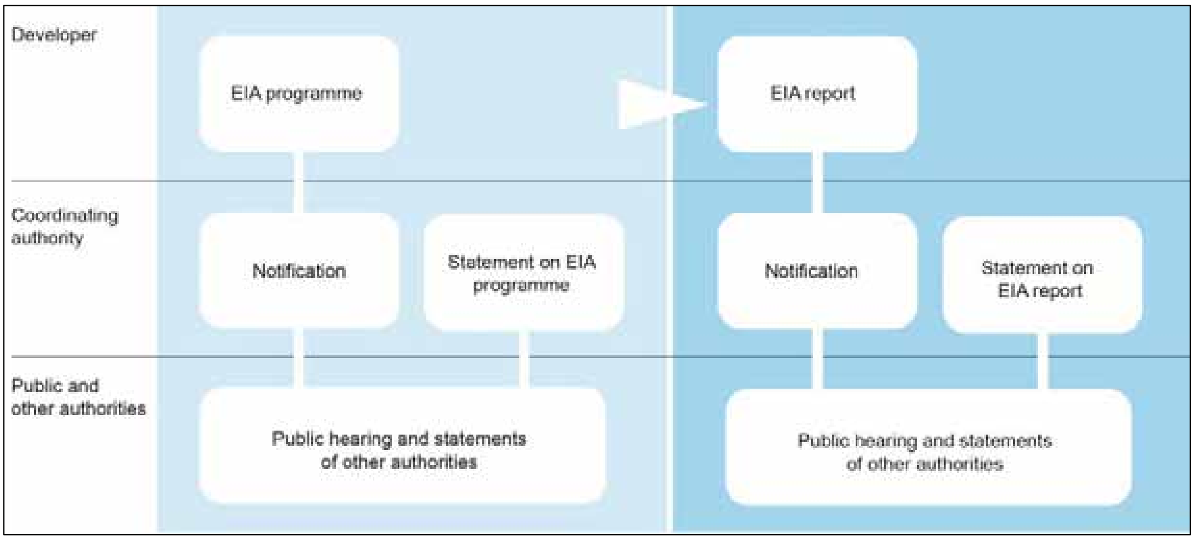


Figure 3-1. EIA procedure in Finland.

Nord Stream Extension EIA Programme, the scoping document, was submitted to the coordinating authority, The Uusimaa Centre for Economic Development, Transport and the Environment (ELY Centre), on 25 March 2013 (the Nord Stream 2 Project was called the Nord Stream Extension at that time). Public hearings took place from 8 April to 6 June 2013. The coordinating authority issued a statement on the EIA Programme on 4 July 2013 (Figure 3-2).

This EIA Report on hand was prepared based on the EIA Programme and the statement from the coordinating authority. The EIA Report was submitted to the coordinating authority early April 2017. After the notification, a two-month public hearing phase will take place from mid April to mid June. After the public hearing, the coordinating authority has two months to prepare a statement. The coordinating authority will provide its statement within 2 months in mid August 2017.

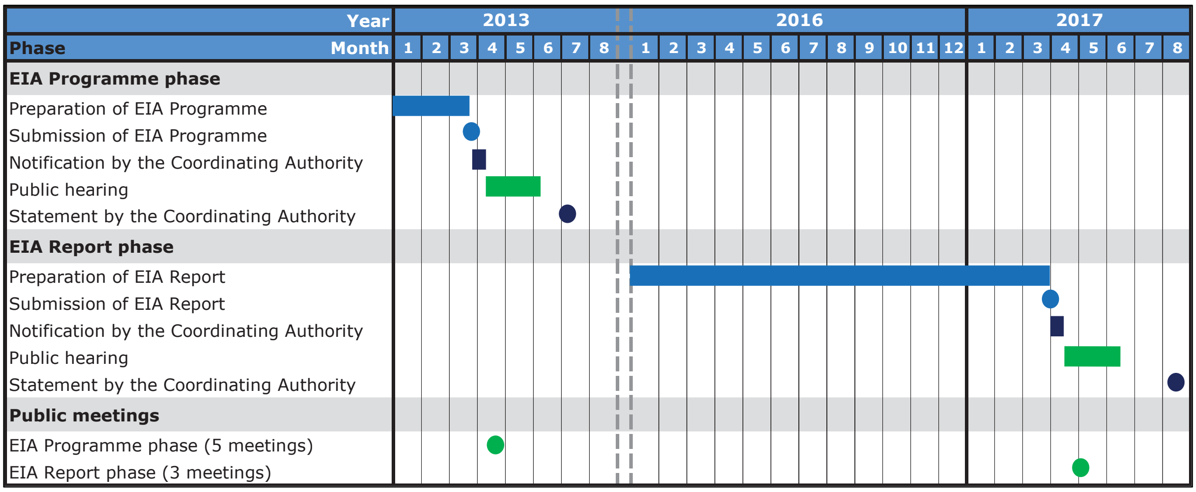


Figure 3-2. Time schedule for the Nord Stream 2 EIA procedure in Finland.

The EIA Report and the respective statement form the basis for the subsequent permitting procedure. The EIA procedure must be conducted before any decisions are made to officially approve a proposed project. Hence, the EIA procedure is not a decision-making process, and permits for the project are granted separately in accordance with the relevant legislation. See Chapter 22 'Further schedule and permitting' for permits requiredfor this project.

3.1.2 Parties in the EIA procedure

The project developer, Nord Stream 2 AG, as the party responsible for the preparation and implementation of the project, is responsible for the preparation of the necessary environmental surveys and assessments required for the completion of the EIA.

The Uusimaa Centre for Economic Development, Transport and the Environment (ELY Centre), as the coordinating authority of the Finnish EIA procedure, carries out the statutory hearings and issues statements on the EIA documents (Programme and Report).

Other authorities and parties whose circumstances or interests the project may affect, including the general public, are parties to the EIA procedure (see Subchapter 3.1.4 Communications and public participation).

3.1.3 The statement of the coordinating authority on the EIA Programme

The Uusimaa ELY Centre issued its statement regarding the EIA Programme for the proposed project on 4 July 2013 (Appendix 1). According to the statement, the EIA Programme covers the content requirements set in section 9 of the EIA Decree, and the assessment programme has been conducted in the manner required by Finnish EIA legislation.

Table 3-1 below presents the key issues to be taken into account in the impact assessment work and the related reports as well as the EIA Report. The right-hand column of the table presents how the statement of the coordinating authority was taken into consideration in the assessment work.

Table 3-1. Key topics and requirements included in the statement of the coordinating authority and a description of how those requirements were taken into account in the assessment work.

Key topics and requirements included in the statement of the coordinating authority	Description of how those requirements have been addressed in the EIA Report
Project description	
The land use requirement of the project must be presented in the EIA Report. The activities related to the construction phase of the project must be described in detail. The extent, size and placement on the seabed of the dumping areas and structures must be stated. The type of rock material used must also be described.	The general land use requirements of the project are presented in Chapters 4 and 10. The project's construction activities, phases and methods are described in Chapter 4. Information about seabed intervention works in critical sections (rock placement on the sea bottom) was obtained from the basic engineering. Numbers are approximate and subject to final optimisation. The preliminary assessments are conservative and the impacts are likely to be reduced in the later route optimisation phase. The size and quality requirements of rock material are specified in Chapter 4.
The Finnish Exclusive Economic Zone as the planning area	
The EIA Report must describe the starting points, the legislation concerning the Finnish EEZ, as well as the international agreements and the competent authorities for the planning and implementation of the project.	The starting point and the legislation concerning the use of the Finnish EEZ, as well as the international agreements are described in Chapter 6. The competent permit authorities are described in Chapter 22.
Permits and approvals needed by the project	
The EIA Report must state the issues the permit applications must contain. A possible connection of a Natura assessment with the permitting process in accordance with section 65 of the Nature Conservation Act must also be stated. Other existing projects and their rights must be taken into account.	The content requirements of the permit applications are described in Chapter 22. Natura assessment screening is implemented in Chapter 11. Considerations related to other projects and their rights (e.g. cables and pipelines) are described in Chapter 4.
Strategies, programmes and plans that relate to the project and the project area	
All laws, decrees, agreements, strategies and policies that concern the project or the project area must be taken into account.	All legislation relevant to the project is taken into account in the assessment. How existing strategies, policies, plans and international agreements concerning the use of natural resources and environmental protection relate to the project and the project area is described in Chapter 6, Subchapter 7.2 and Subchapter 11.20.
How the project relates to other projects	
Other existing and planned projects in the Finnish EEZ and their rights must be taken into account in all activities. These include e.g. scientific heritage (monitoring points) and the crossings of other pipelines and cables.	A description of how other existing and planned projects relate to the proposed project and the project area is stated in Chapter 4. The baseline description of existing infrastructure and its use of the sea area are presented in Subchapter 7.21.
Ship traffic in the Gulf of Finland	
Particular attention must be paid to the impact on ship traffic and on safety during the construction and use of the pipeline. The assessment must be based on risk mapping and experiences gained from the two previous pipelines.	The impact of the project on traffic safety is discussed in Subchapters 11.12 (ship traffic), and 12.1.2 (onshore traffic). A risk assessment of the construction and use of the pipeline was conducted and described in Chapter 16.
Assessment of alternatives	
Justifications must be included for the selection of alternatives, what other route alternatives may have been studied already and why the other alternatives were discarded. All project alternatives must be compared in the EIA Report.	Justifications for the selection of alternatives and sub-alternatives are discussed in Subchapter 4.1.1. The comparison of alternatives is presented in Chapter 21.

Key topics and requirements included in the statement of the coordinating authority	Description of how those requirements have been addressed in the EIA Report
Fish and fishery	
Co-operation with commercial fishermen and organisations representing them is recommended. The possible impacts of Nord Stream pipelines 1 and 2 on the dioxin levels in fish can be identified by measuring the current dioxin levels in fish.	Co-operation with fishermen and their organisation have been carried out during the EIA process. Possible impacts of the project on the dioxin levels in fish have been assessed based on experience gained from the environmental monitoring of the construction of the Nord Stream pipelines and on the most recently available literature on the issue in the Baltic Sea. Measuring contaminant levels in fish with respect to a specific project is considered very challenging and would include a wide range of uncertainties. As presented in Subchapter 7.10, atmospheric deposition is the main source of dioxins currently found in the fatty tissue of fish species such as the pelagic Baltic herring.
Seabed	
It is important to investigate the current status of the seabed and the impacts of the construction phase by way of sediment sampling in a sufficiently comprehensive manner. Particular attention should be paid to the concentrations of contaminants and the possible spreading of contaminants.	A programme for the environmental baseline surveys for the EIA was compiled. The purpose of the investigations that commenced in December 2015 and continued until spring 2016 was to provide data for the EIA. Special attention was paid to the sampling procedure because of the long and small-scale, heterogenic nature of the survey area. Sediment samples were taken in order to study physical and chemical characteristics of the surface sediments, contaminants and benthos. Current measurements were also conducted. New data was used to validate the sediment spreading model. These issues are discussed in Subchapters 7.4 (baseline) and 11.2 (impact assessments).
Hydrology and water quality	
The impact on the ecological state of the sea must also be assessed. Regarding the mathematical model, attention must be paid to gaining sufficiently accurate results. The results of the water samples must be compared to the EQS or PNEC values.	Ecological impacts are identified and assessed in Subchapter 11.3. Besides that, a qualitative assessment of the compliance of the Nord Stream 2 Project in the context of the relevant directives (MSFD and WFD) and HELCOM Baltic Sea Action Plan is in Subchapter 11.20. Mathematical modelling was applied with the revised sediment spreading model and underwater noise model. Impacts on water quality are assessed in Subchapter 11.3.
Heating effect of the gas pipeline	
Investigating the heating effect of the gas pipelines and measuring the heating effect of the existing pipelines is recommended.	The heating effect was assessed based on a desk study (modelling) prepared during the Nord Stream EIA. According to the conservative modelling results (Subchapter 11.3.3.2), impacts were small even near the Russian landfall site. Therefore no measurements were considered to be necessary. Cumulative impacts are discussed in Subchapter 14.2.
Underwater noise	
Underwater noise measurement and assessment methods must be specified. Underwater noise must be assessed in accordance with mentioned decisions and limit values. Special attention must be paid to underwater noise in the vicinity of Natura 2000 areas and seal reserves.	Underwater noise baseline measurements were carried out in 2016 (Subchapter 7.7). A separate study was conducted for underwater noise modelling (Subchapter 10.4). The results and conclusions of the modelling were utilised in the marine ecological assessments (Subchapter 11.4 and Appendix 8B).

Key topics and requirements included in the statement of the coordinating authority	Description of how those requirements have been addressed in the EIA Report
Munitions	
The possibilities to drive away aquatic birds and seals in the area to be cleared should be investigated.	The impacts of munitions clearance are discussed in Subchapter 10.3 and for each relevant impact target in Chapter 11. Mitigation measures (seal scarers etc.) are part of the project implementation. NSP2 is also performing a atudy of alternative clearance methods and mitigation techniques to reduce the impact associated with underwater noise from in situ detonation.
Biodiversity	
The impact of the project on the biodiversity of the marine ecosystem must be assessed.	The impact assessment on the biotic environment (including marine biodiversity) is presented in Subchapters 11.5–11.11.
Nature Conservation Areas	
The impact of the pipeline construction on the Natura 2000 area of Sandkallan must be assessed.	A Natura assessment screening for Sandkallan Natura 2000 area was conducted and submitted to the ELY Centre Uusimaa (Appendix 9). The conclusions of the study are presented in Subchapter 11.9.
Marine mammals	
The impact on Sandkallan–Stora Kölhällen seal reserve during construction and use of the pipeline must be investigated. The impacts of constructing the pipelines on the population of Baltic ringed seals in the Gulf of Finland must be investigated.	The impacts on marine mammals are assessed in Subchapter 11.7 and Appendix 8B.
Underwater cultural heritage	
Underwater cultural heritage is recommended to be taken into account in the planning and construction of the pipelines.	The preservation of underwater cultural heritage has been one of the criteria in the route selection and design. The baseline is presented in Subchapter 7.23 and assessment in Subchapter 11.18. Mitigation measures are set out in Chapter 17.
Littering	
Activities occurring on land and in particular at sea must be planned so that littering is avoided. The amount of by-products and waste produced during the construction and use of the pipeline must be estimated and recycling and disposal arrangements planned.	Offshore waste generation is described in Subchapter 4.1.8 and offshore waste management principles are covered in Subchapter 17.15. Waste management of ancillary activities is described in Subchapter 4.3.
Decommissioning of the gas pipelines	
The alternatives for the decommissioning of pipelines (leaving on the bottom of the sea or raising out of the sea) and the impacts of these alternatives should be presented on a general level in the EIA Report.	Decommissioning and alternatives for it are described in Subchapter 4.4. The potential related impacts are generally assessed in Chapter 15.
Transport of rock material	
An estimate of the amount of rock material, the most likely transport routes, amounts transported and the duration of the transport must be presented in the EIA Report as accurately as possible at this stage of the project. The impacts of traffic must be assessed through noise modelling. The assessment must take into account all other targets of the disturbance in addition to residential areas, such as day care centres, schools and hospitals. It is recommended that the possibility of the transport of rock material to the port of Kotka by rail should be assessed.	The transport routes, the quantities of rock and the duration of rock transport have been based on the information available and are presented in Chapter 4. It has been assumed that rock from same quarries as in NSP will be used for NSP2. Traffic noise has been modelled and impacts assessed in Subchapter 12.1.4. Baseline of the land use in Kotka has been addressed in Subchapter 8.1. The possibility of rail transport has been addressed in Subchapter 4.3.2.

Key topics and requirements included in the statement of the coordinating authority	Description of how those requirements have been addressed in the EIA Report
Concrete coating plant	
The impact of the concrete coating plant and its storage areas should be viewed as part of the EIA procedure for the project. The impacts can be assessed on a general level using, as an example, the plant and its storage areas that operated in Kotka for Nord Stream pipelines.	The impacts of the concrete coating plant and its storage areas are assessed in Chapter 12.
Monitoring	
The monitoring plan must be attached to the EIA Report.	A proposal for the monitoring programme is presented in Chapter 18. The programme will be further developed and submitted as part of the water permit application.
Participation	
As the project is likely to have an impact on the fishing trade, arranging co-operation and discussion events with organisations representing commercial fishermen is recommended in addition to conducting the survey.	Participation efforts, meetings, events and other co-operation with non-governmental organisations as well as with authorities have been described in Subchapter 3.1 and Appendix 3. During the EIA four extensive resident and fishermen questionnaires were conducted (Subchapter 11.19 and Appendix 11).
International EIA procedure	
The agreements on the EIA procedure made under the Espoo Convention and the bilateral agreement between Finland and Estonia must be taken into account.	Relevant international agreements have been described in Chapter 6 and taken into account in the assessment.

3.1.4 Communications and public participation

The EIA procedure provides authorities, other stakeholders and the public with various ways to participate. Information on the project has been shared in several meetings and on the project website. The EIA procedure is conducted in an interactive manner to give the authorities, other stakeholders and the public an opportunity to discuss and express their views on the project and its impacts.

The feedback received has been taken into account during the impact assessment process. Feedback has been processed by experts and considered if it causes changes to the assessment frame presented in the EIA Programme. Based on the feedback some further studies have been launched and the accuracy of baseline information as well impact assessment has been improved to face the needs of different parties.

3.1.4.1 Public hearing

During public hearing periods in the EIA Programme phase and EIA Report phase. the EIA documents are publicly displayed in the website of the coordinating authority.

Finnish national EIA documents are available at the Uusimaa ELY Centre's webpage:
http://www.ymparisto.fi/fi-FI/Asiointi_luvat_ja_ymparistovaikutusten_arviointi/Ymparistovaikutusten_arviointi/YVAhankkeet/Nord_Stream_Ag_Nord_Stream_2_Uusimaa/Nord_Stream_Ag_Nord_Stream_2_Uusimaa(17072)

International assessment documents (e.g. Espoo Report) are available at the Ministry of the Environment's webpage:
http://www.ym.fi/fi-FI/Kansainvalinen_yhteistyo/Ymparistovaikutusten_arviointi/Venajan_ja_Saksan_valisen_merenalaisen_m(4669)

3.1.4.2 Meetings

During the public hearing period of the EIA Programme, five public meetings were held to present the project and the programme (table of meetings is shown in Appendix 3). Public meetings during the EIA Report public hearing phase will be held in Kotka, Helsinki and Hanko. These meetings will be chaired by the EIA coordinating authority.

During the EIA Programme phase, an authority expert meeting was held to discuss and gain feedback on the draft EIA Programme. During the preparation of the EIA Report, similar meetings have been organised to support the assessments and provide information on the project. An EIA Expert Group consisting of several authorities was established in the early stages of the EIA Report phase. The EIA Expert Group convened three times and has commented on draft versions of the EIA Report (Appendix 3).

Meetings with the coordinating authority (ELY Centre Uusimaa), have been organized in a regular manner to discuss the project and the EIA Report (Appendix 3).

Meetings with other authorities, research institutes, non-governmental organisations and other stakeholders have also been organised by the developer. Meetings with various authorities on specifical topics during the EIA process are presented in in Appendix 3.

3.1.4.3 Citizen and fishermen surveys

During the EIA Report phase in the spring of 2016, three questionnaire surveys were performed in Finland. Surveys were directed at:

1) fishermen trawling in the Gulf of Finland, Based on information from the Nord Stream Project, fishermen were recognised as an important stakeholder group. The survey aimed to gather information of possible impacts of the Nord Stream 2 Project, update information of commercial fishing in the Gulf of Finland and at the same time share information of the planned Nord Stream 2 project.
2) residents living in southern coastal municipalities; Survey was conducted to gather general information of how people receive the project and its possible impacts. Information was used as one information source for social impact assessment.
3) residents living near the Kotka onshore ancillary activities; To gather information of the possible (social) impacts of the project’s ancillary activities onshore, a citizen survey for the citizens of the possible impact area was conducted.

A citizen interview survey was additionally conducted in Estonia to get an overview of how the project is received in Estonia to map the potential transboundary (social) impacts.

For more information on citizen surveys, see Appendix 11.

3.1.4.4 Website and map portal

Nord Stream 2 AG will provide up-to-date project and EIA information on its website *http://www.nord-stream2.com/*. It will also be possible for users to provide feedback or ask questions about the Nord Stream 2 project.

A map portal presenting the NSP2 pipeline route and information from the Finnish EEZ will be available during the public hearing phase of the EIA Report. The map portal includes a possibility to give unofficial feedback or official opinions to the EIA Report. Access to the map portal is available on the Nord Stream 2 website *https://www.nord-stream2.com/fi/permitting-finland/*.

3.2 International EIA procedure

3.2.1 Espoo Convention

The principles of international cooperation in the assessment of environmental impacts are laid down in the Espoo Convention (Convention on Environmental Impact Assessment in a Trans-boundary Context, SopS 67/1997). The convention is complemented by the Protocol on Strategic Environmental Assessment *(Kyiv, 2003).*

The Espoo Convention lays down the general obligation of countries (“Party of Origin”) to notify and consult one another (“Affected Parties”) on all major projects that are likely to have a significant adverse environmental impact across state boundaries. For the Nord Stream 2 pipeline project, the parties of origin are Russia, Finland, Sweden, Denmark and Germany. Russia has signed but not ratified the agreement. However, for the Nord Stream 2 Project, Russia will act as a Party of Origin as far as it considers it possible according to its legislation. Parties of Origin and Affected Parties in Nord Stream 2 Project are listed in Table 3-2.

Table 3-2. Parties of origin and Affected parties in the Nord Stream 2 Project.

Country	Parties of Origin	Affected Parties
Russia	O	A
Finland	O	A
Sweden	O	A
Denmark	O	A
Germany	O	A
Estonia		A
Latvia		A
Lithuania		A
Poland		A

In each of the five *Parties of Origin*, Nord Stream 2 is subject to a national permitting process. Nord Stream 2 is preparing permit applications and EIA documentation for each of these countries. Due to different laws, guidelines and practices on assessing impacts, the national EIA documentation can vary and can have different nuances.

In November 2012, Nord Stream AG issued a *Project Information Document* (PID) covering the Nord Stream Extension, now called Nord Stream 2, for review and reference. In February 2013, a meeting between the Parties of Origin was held to discuss the content of the PID and the procedures for the project according to the Espoo Convention.

Following this meeting and taking comments received into account, Nord Stream AG submitted the final PID to the Parties of Origin in March 2013. In April 2013, the Parties of Origin submitted the PID to the Affected Parties as prescribed by Article 3 ("Notification") of the Espoo Convention. In Finland the Ministry of the Environment coordinates the Espoo procedure with a support of the Finnish Environmental Centre. The public consultation phase on the PID subsequently took place in all countries in parallel with the issuance of the national EIA programmes as required by each country's national legislation. All Affected Parties expressed their interest in participating in the Espoo procedure for the Nord Stream Extension and submitted comments on the PID resulting from the public consultation phase. Comments from the notified parties (authorities, organi-sations and individuals) have been evaluated and taken into account by the developer to ensure that issues raised are addressed in the Espoo Report.

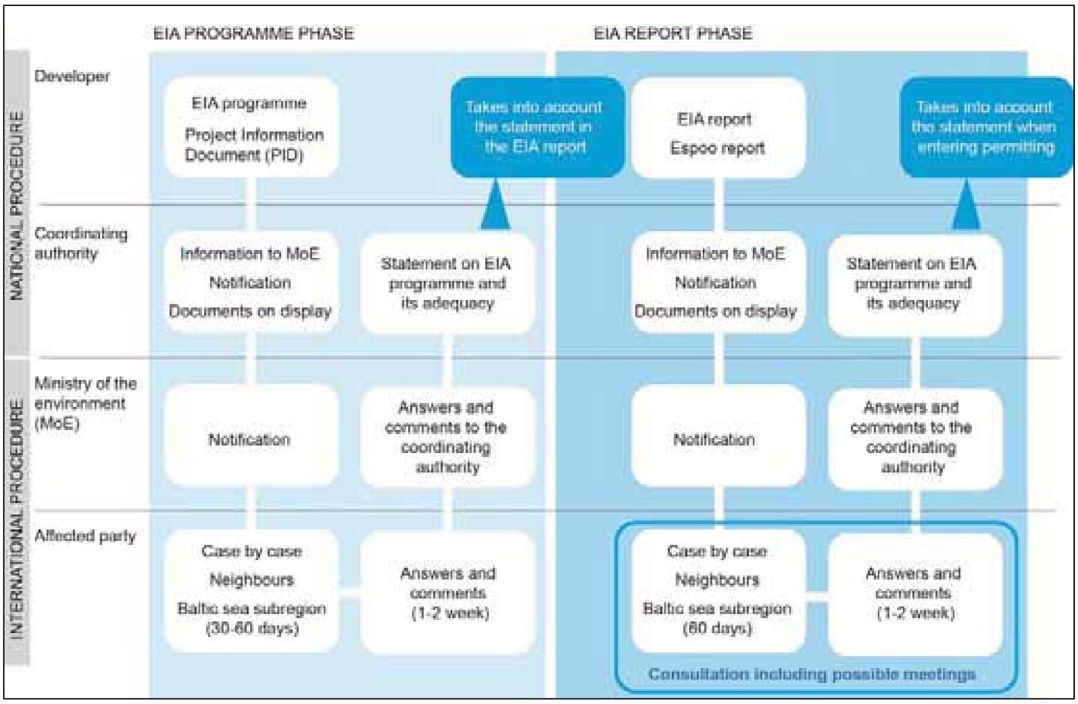


Figure 3-3. International EIA procedure (based on Koivurova et al. 2012).

The Nord Stream 2 Espoo Report and Atlas (Appendices 13 and 14) supplement the EIA documentation which is prepared for each of the five countries. As the focus of the Espoo Report is on the overall impacts of the entire project on the Baltic Sea environment and on potential transboundary impacts, the conclusions have different nuances compared to the national EIA documentation. The Espoo Report is written in English and translated into the nine languages of all Affected Parties. The Espoo Report is also part of the EIA documentation in Finland.

3.2.2 Estonia

Finland and Estonia have signed a bilateral agreement on transboundary EIA (*Agreement between the Government of the Republic of Estonia and the Government of the Republic of Finland on Environmental Impact Assessment in a Transboundary Context, SopS 51/2002*), which promotes and develops further the co-operation laid down in the Espoo Convention. Hence, when it comes to the cooperation in assessment of environmental impacts between Finland and Estonia, the provisions of the bilateral agreement are applied together with provisions of the Espoo Convention.

The bilateral agreement is applicable to large-diameter oil and gas pipelines and underwater pipelines in the Baltic Sea and hence Nord Stream 2 Pipeline Project.

The provisions of the agreement are to a large extent equivalent to the provisions of the Espoo Convention. The provisions provide that Finland must inform Estonia of the preparation of environmental impact assessments in Finland. There is a joint commission on EIA in a transboundary context for the implementation of the provisions of this bilateral agreement. The commission convenes at least once a year and as necessary. The role of the commission is advisory in nature and the commission convenes mainly for communication purposes.

The developer has organized meetings with Estonian authorities and scientific institutes (Appendix 3). A public meeting was organized in Tallinn during the Finnish EIA Programme public hearing phase. During the Finnish EIA Report phase, a similar public meeting is proposed to be organized in Estonia.

A citizen survey was carried out in Estonia in spring 2016. More information on the survey can be found in Chapter 13.

4. PROJECT DESCRIPTION

The purpose of this chapter is to describe the overall technical concept for the Project and to describe the technical components and activities assessed within the national EIA. The intention is to provide an overview of the key technical elements of the Project to orientate the reader and to provide more detail on aspects that will be addressed in the assessment of environmental impacts in later chapters of this EIA Report for Finland.

Description of the overall project activities (4.1)
The overall project description is based on the Project Technical Description (Nord Stream 2 AG 2016b) and includes descriptions of (resp. chapter):

- Pipeline route (4.1.1)
- Pipeline design (4.1.2)
- Surveys activities (4.1.3)
- Munitions clearance (4.1.4)
- Seabed intervention works (4.1.5)
- Crossing installations (4.1.6)
- Pipelay (4.1.7)
- Transportation of materials and equipment (4.1.8)
- Landfalls (4.1.9)
- Pre-commissioning (4.1.10) including hyperbaric tie-in
- Commissioning (4.1.11)
- Operation and maintenance (4.1.12)
- Overall construction schedule (4.1.13)

Also Decommissioning of the pipelines is described and is presented in Subchapter 4.4.

Description of the Project activities in the Finnish EEZ (4.2)
Additional information of the project in the Finnish EEZ is given in Subchapter 4.2 and includes the following:

- Pipeline route
- Pipeline design
- Surveys
- Munitions clearance
- Rock placement
- Crossing installations
- Pipelay
- Transportation of materials and equipment
- Pre-commissioning, including hyberbaric tie-in

Operation and maintenance is presented in the overall description in Subchapter 4.1.12 and is applicable also in the Finnish EEZ.

Description of the Ancillary activities in Finland (4.3)
Ancillary activities in Finland are described in Subchapter 4.3, and include the following:

- Operation of a concrete weight coating plant at Mussalo Harbour, Kotka
- Storage yards for weight-coated pipes at Mussalo Harbour and Hanko Koverhar Harbour
- Shipments from the coating plant to storage yards
- Rock quarrying and rock transport from quarries to Mussalo Harbour
- Storage yard of rock at Mussalo Harbour

4.1 Overall project description

The overall project description is intended to give information of all phases and activities of the NSP2 Project.

4.1.1 Pipeline route

4.1.1.1 Route development and optimisation

During the concept development of the NSP2 Project, a number of feasible routes were identified (Figure 4-1) and this concept development was the basis for further planning and the starting point for the routing of the NSP2 pipelines.

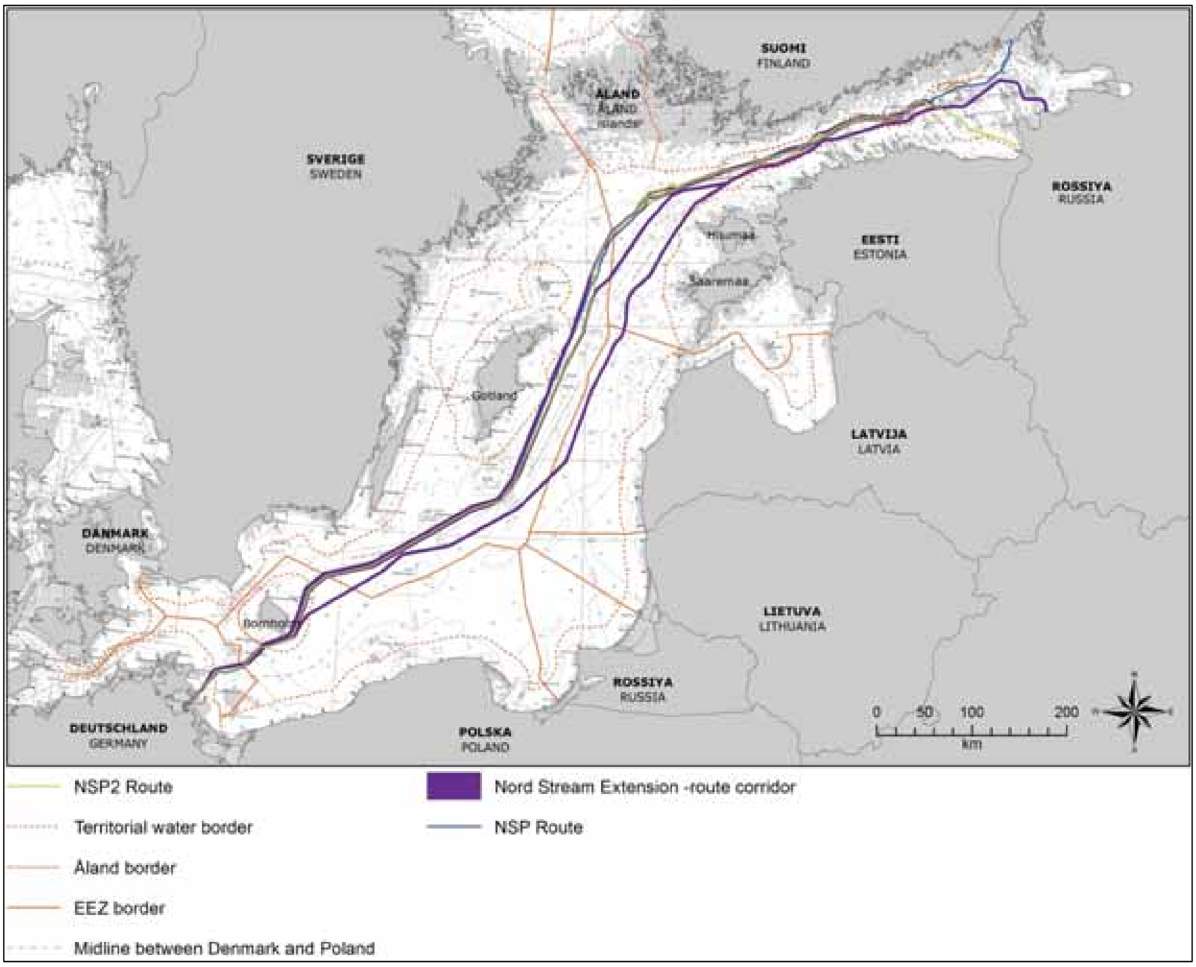


Figure 4-1. Identified feasible routes during the concept development.

In order to plan a route corridor for the NSP2 pipelines, it was first necessary to identify potential constraints to the route to allow for a consistent approach and reasoning as far as possible throughout the entire route. The constraints fall into the two broad categories of Engineering and Environmental.

Engineering criteria applied to route development included, water depth for installation, repair, pipeline stability and operation, minimum pipeline bend radii, separation requirements (between the two pipelines as well as from the NSP pipeline system – see Subchapter 4.1.1.3), criteria for cable and pipeline crossings, distance to and crossing of shipping lanes and seabed roughness among other criteria.

Environmental criteria considered during route development related to, for example, relevant distances to designated and/or important environmental protection areas, third party infra-structure, military hazards, shipping, fishery, cultural heritage, environmental monitoring stations and designated areas for mineral and hydrocarbon extraction.

Major influence on routing was the Estonian government decision in 2012 to not grant a survey permit to perform a reconnaissance survey in the Estonian EEZ. Before that several main route options were studied in the feasibility study including a routing through the Estonian and Latvian EEZ. Thus, due to the negative survey permit decision in Estonia, the originally identified route option through the Estonian and Latvian EEZ could not be considered further, and route development was continued through the Finnish and Swedish EEZ.

The possible route corridors identified during the Feasibility Study have formed the basis for further assessments and surveys. This work has resulted in the proposed route corridor crossing the waters of the countries Russia, Finland, Sweden, Denmark and Germany. The route stays close to the existing Nord Stream pipelines for a large part, because one of the targets is the minimisation of the cumulative footprint of the two pipeline systems.

4.1.1.2 Selected pipeline route

The Nord Stream 2 pipeline system (NSP2) comprises two 48” diameter subsea pipelines including onshore facilities in Russia and Germany. The proposed lines extend through the Baltic Sea from the southern Russian coast (Narva Bay) in the Gulf of Finland to the German coast, in the Lubmin area. The NSP2 system will have the capacity to supply 55 bcm (billion cubic metres) per annum of natural gas. The NSP2 pipelines are designed to operate for 50 years.

The pipeline route covers a distance of approximately 1,200 km. The pipeline route crosses the territorial waters of Russia, Denmark and Germany and runs within the Exclusive Economic Zones (EEZ) of Finland, Sweden, Denmark and Germany. Figure 4-2 provides an overview of the routing considered (Appendix 12, Map PR-01-F).

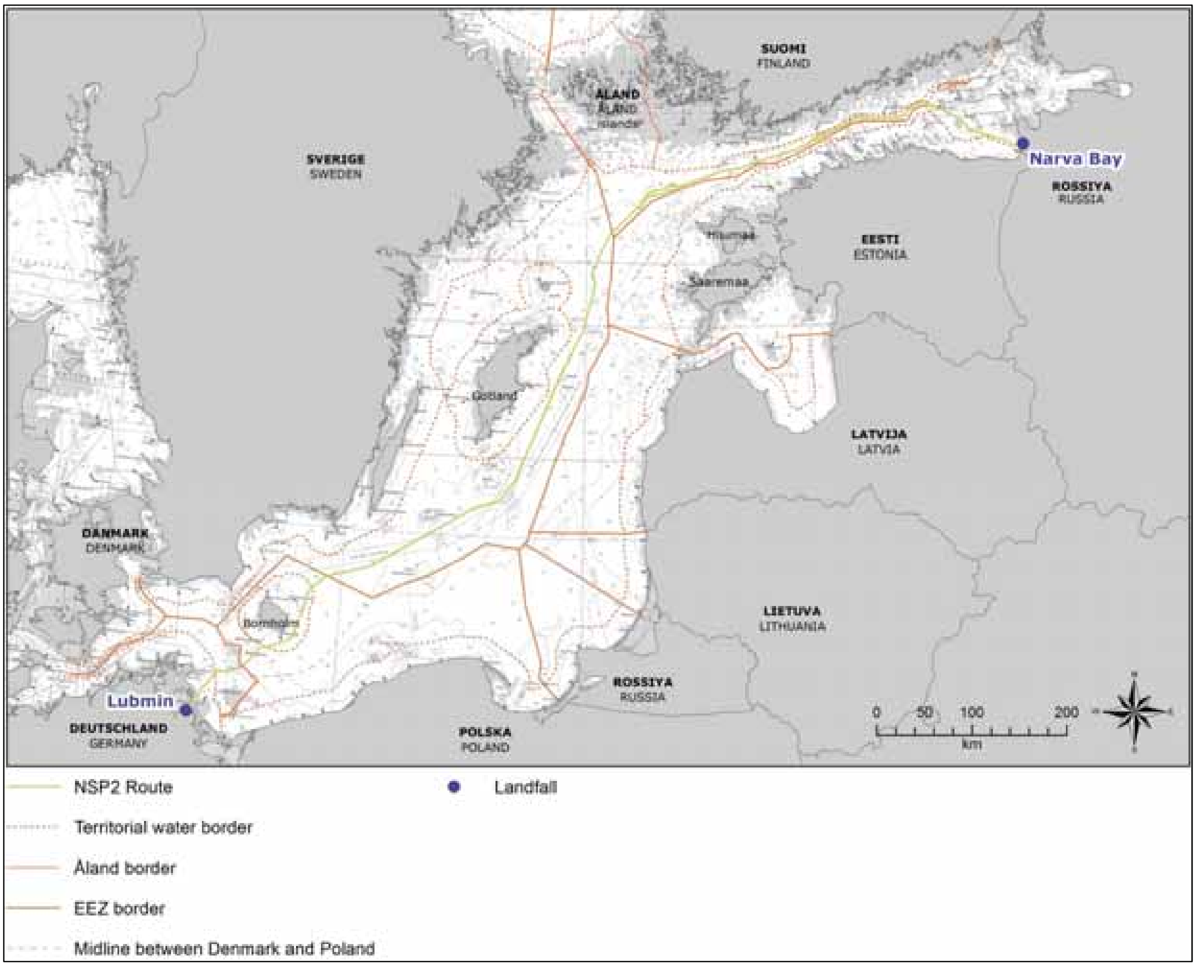


Figure 4-2. NSP2 routing in the Baltic Sea.

4.1.1.3 Pipeline separation

The NSP2 pipeline system is independent from the existing NSP system, but the route runs in parallel for a substantial length. Therefore criteria for the minimum separation of the two pipeline systems has been developed, as well as separation criteria between the NSP2 pipelines.

These criteria are based on the detailed assessments of the risks associated with construction and operation of the NSP2 pipeline system. The basic criteria is presented below. Deviations from basic separations are evaluated case by case, and separation may be less for short sections of the pipelines. *(Saipem 2016c)*.

Separation criteria between NSP2 and NSP pipeline systems

The constraints which have an influence on the selection of the pipeline systems minimum separation during the construction phase of the NSP2 Project are:

- Pipelay vessel positioning system: anchored or dynamically positioned.
- Dropped objects from construction vessels.
- Flexibility to temporarily laying down the pipeline anywhere along the route (e.g. due to adverse weather conditions or vessels mechanical breakdown).
- Interaction between adjacent intervention works.
- Safety distance to allow munitions clearance.

Scenarios which have an influence on the definition of the pipeline system minimum separation during the operational phase are those related to marine traffic:

- Dragged anchors
- Sinking ships

In conclusion, the general principles used in the design for the NSP / NSP2 minimum separation distances are summarized in Table 4-1.

Table 4-1. NSP/ NSP2 minimum separation distances.

Water Depth [m]	NSP / NSP2 Minimum Separation [m]	
	Anchored Lay Vessel	DP Vessel
30–100	1,200	500
100–200	1,400	500

The separation could be reduced on a case by case basis, in the event that other seabed constraints dictate a closer separation.

Separation criteria between the NSP2 pipelines A and B

The hazardous scenarios which have an influence on the selection of the pipelines minimum separation during the construction phase of the NSP2 Project are mainly related to:

- Dropped objects from construction vessels
- Interaction between the existing/installed pipeline and the lay vessel anchor wires when installing the second pipeline

Other constraints which have an influence on the selection of the pipelines minimum separation during the construction phase of the NSP2 Project are the:

- Interaction between the existing/installed pipeline and the DP vessel clump weight when installing the second pipeline
- Interaction between adjacent intervention works
- Clearance at hyperbaric tie-in locations
- Clearance at cable/pipeline crossing locations

In conclusion, the general principles used in the design for the NSP2 pipelines minimum separationdistances between pipelines A and B are summarized in Table 4-2.

Table 4-2. NSP2 pipelines minimum separation distances.

Water Depth [m]	NSP2 (A & B) Minimum Separation [m]	
	Anchored Lay Vessel	DP Vessel
< 100	55	75
> 100	55	105

4.1.2 Pipeline design

The design of the NSP2 pipelines largely benefits from previous experience from the design and construction of the existing Nord Stream pipelines. NSP2 has drawn heavily on previous experience as a means to maximise synergies while allowing for efficient planning and use of gained knowledge and implementation of lessons learned.

The development of the technical design is an on-going process in which input from investigations of the route corridors, basic engineering, stakeholder consultation, environmental and social impact assessments and regulatory review are continuously used to optimise the design and reduce the associated environmental impact. Therefore, minor changes to the description below may be made during the detailed design period. The design development, however, will not change the project significantly, i.e. result in new environmental impacts or impacts that are worse than those set out in this document.

4.1.2.1 Standards, verification and certification

The pipelines will be designed, constructed and operated in accordance and in compliance with the international offshore standard DNV OS-F101, Submarine Pipeline Systems, along with its associated recommended practices, issued by Det Norske Veritas (DNV).

NSP2 has appointed DNV GL as independent third-party expert to confirm that the pipeline system, from pig trap to pig trap, has been designed, fabricated, installed and pre-commissioned in accordance with the applicable technical, quality and safety requirements. When DNV GL has completed third-party verification of all project phases and the pipeline has been successfully pre-commissioned, a DNV GL certificate of conformity will be issued for each of the Nord Stream 2 pipelines.

4.1.2.2 Pipeline dimensions and materials

The NSP2 pipelines will be constructed from individual steel pipe joints each with a length of 12.2 m that are welded together in a continuous laying process. The steel pipe has a nominal diameter of 48” (1,219 mm) and a constant internal diameter of 1,153 mm. Approximate maximum external diameter of the pipeline is 1.4 m.

The design pressures for the pipelines are similar to Nord Stream i.e. in the range of 220 barg / 200 barg / 177.5 barg in three pipeline sections. The wall thickness of the steel pipe is based on design (internal) pressure during operation, prevention of external collapse and resistance to external impacts and therefore varies in four thicknesses between 26.8 and 41.0 mm.

The pipe joint will be internally coated with an epoxy-based material. The purpose of the coating is to reduce hydraulic friction, thereby improving the flow conditions. An external three-layer polyethylene coating will be applied over the pipe to prevent corrosion (Figure 4-3).

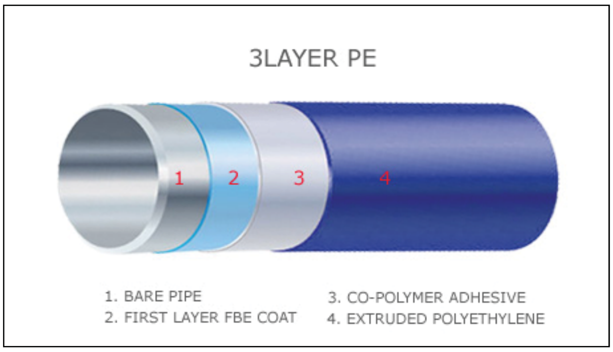


Figure 4-3. The three-layer anticorrosion coating.

A concrete weight coating containing iron ore will be applied over the pipe joint external anti-corrosion coating (Figure 4-4). The thickness of the coating is between 60 and 110 mm. While the primary purpose of the concrete coating will be to provide on-bottom stability, the coating will also provide additional external protection against foreign objects, such as impact by fishing gear.

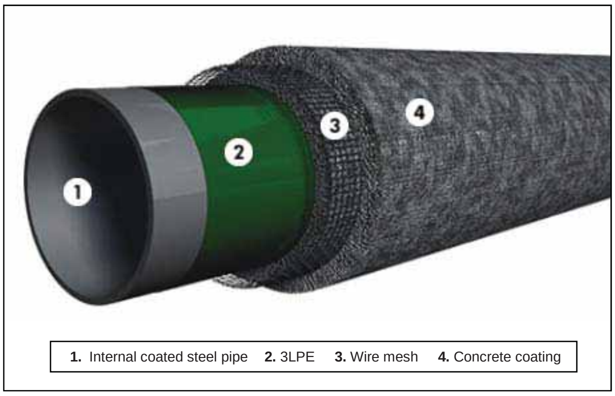


Figure 4-4. The concrete weight coating.

To ensure the integrity of the pipelines over their design life, secondary anti-corrosion protection is provided by sacrificial galvanic anodes. This secondary protection is an independent system that will protect the pipeline in case of damage to the external anti-corrosion coating. The design of anodes will ensure an exposed surface area able to provide the required protection current, and sufficient anode mass for an estimated life of 50 years.

Color rings are applied on the coated pipes to identify the type of pipe (wall thickness, concrete thickness etc.).

4.1.3 Survey activities

Several offshore surveys are conducted in connection with the planned NSP2 pipelines to gather specific knowledge on seabed conditions, topography, bathymetry and artefacts such as wrecks, boulders, munitions, etc. Surveys support engineering and construction of the pipelines. A short overview is provided in the following subchapters.

4.1.3.1 Surveys supporting engineering

Reconnaissance survey

The purpose of the reconnaissance survey was to identify the best possible route for the pipelines based on information on geological and anthropogenic features. The seafloor is not a flat, featureless plain; it has a varying morphology with rocky outcrops, cliffs, trenches, etc. The two gas pipelines are relatively inflexible and cannot twist and turn to avoid such obstacles. Careful mapping of the seafloor helps identify the best possible route for the pipelines and reduces seabed intervention works to a minimum.

The survey covered a various-width corridor (from 1.5 km to 5 km in the Finnish EEZ) and comprised side-scan sonar, sub-bottom profiler, multibeam echosounder and magnetometer.

Figure 4-5. Side scan sonar (SSS) used in geophysical surveys. Photo by Nord Stream AG.

Geotechnical Survey

Geotechnical surveys were performed to optimise the pipeline route and detail design including the required seabed interventions to ensure the long-term integrity of the pipeline system.

Cone penetrometer (CPT's) and Vibrocorer (VC) locations were selected to ensure detailed understanding of the geological and soil strengths for engineering purposes along the planned routes.

Detailed Geophysical Survey

A detailed geophysical survey was performed along the proposed pipeline routes. These routes are more accurately defined based on the results of the reconnaissance survey. This enables all significant objects to be detected and the acquisition of detailed profiles along each planned pipeline centreline.

The survey width was approximately 130 m along each design route and comprised side-scan sonar, sub-bottom profiler, multi-beam echosounder and magnetometer.

Visual surveys of cultural heritage and munitions

Visual surveys were performed to identify different kinds of objects on the seabed, e.g. ship wrecks and munitions. Remotely operated vehicles (ROVs) are used in these surveys. Devices such as video camera or multibeam echo sounder (MBES) are mounted on ROVs. More information about surveying underwater cultural heritage (e.g. ship wrecks) and munitions, which were visually surveyed, are in following paragraphs.

Figure 4-6. Remotely operated vehicle (ROV) equipped with a gradiometer. Photo by Nord Stream 2 AG.

Side-scan sonar (SSS) data from reconnaissance survey was reviewed to assess the potential underwater cultural heritage (UCH) sites (e.g. ship wrecks) in relation to the proposed pipeline routing. UCH sites of historical and archaeological importance are hence taken into account in NSP2 pipeline routing optimisation as part of the national EIA procedure.

A munition screening survey is used to identify any potential unexploded munitions that could constitute a danger to the pipeline or the environment during the installation and/or the operatinal life of the pipeline system.

The survey is conducted along a 15 m wide installation corridor centred on each pipeline design route and wider where intervention works such as rock placement may be required. In addition a security corridor outside the installation corridor is surveyed for location of potential munitions and cultural heritage.

Width and timing of surveys supporting engineering

Figure 4-7 next page shows different survey corridor widths on either side of the planned pipeline routes. Note that the geophysical reconnaissance survey corridor varies in width depending on the location and planned construction activities at the location.

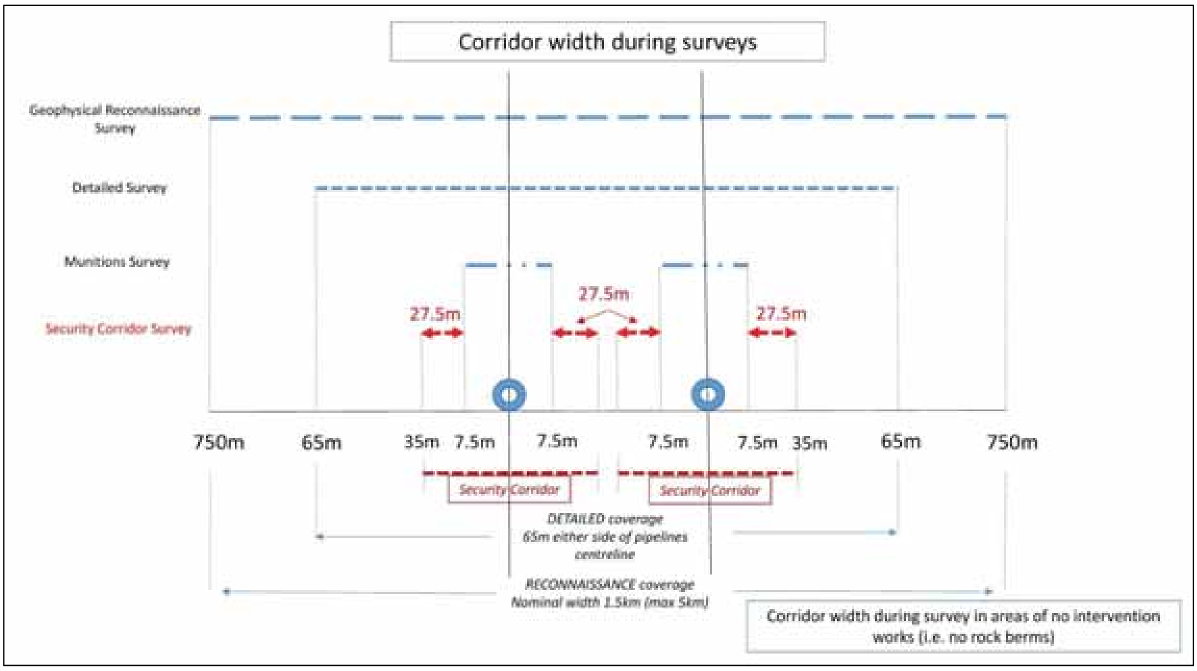


Figure 4-7. Schematic picture on different survey corridor widths around the planned pipeline routes.

4.1.3.2 Surveys prior, during and after construction

Anchor Corridor Survey

Prior to the installation of the pipelines, an anchor corridor survey will be undertaken on sections of the route where pipeline is to be installed by anchored lay vessel to ensure that there is a free corridor for anchors and anchor wires. The anchor corridor survey will identify and catalogue all obstructions in the corridor to be avoided during pipelay and anchoring operations.

The anchor corrodor survey will be conducted in a corridor to each side of the route alignment. The width of the survey corridor will depend on the selected pipelay vessel and water depth, and generally is in the order of 1 km.

Pre-lay Survey

A pre-lay survey will be performed just prior to commencement of pipelay. The scope of the pre-lay survey is to confirm the previous bathymetric survey and to ensure that no new obstacles are found on the seabed. ROV bathymetric and visual inspection surveys will be undertaken for theoretical touchdown monitoring and ad hoc survey activities as required.

Construction Support Survey

A full survey capability will be available to perform touch down monitoring where required and any adhoc survey activities that may arise during pipeline construction.

As-Laid Survey

To document the pipe-laying, an as-laid survey will be performed once the pipelines have been laid on the seabed by the pipe-laying vessel. The survey will establish the as-laid position and condition of the pipelines.

As-Built Survey

As a final record of the pipeline installation, an as-built survey will be conducted as afinal record as a of pipeline installation when all construction activities have been completed. The survey will demonstrate that the pipelines have been installed correctly. The as-built survey, in combination with the as-laid survey, will be used to establish that the required depth of burial has been achieved, the extent of backfill and rock placement is as designed, and that the integrity of the pipelines is maintained.

4.1.4 Munitions clearance

To ensure safe installation and operation of the pipeline, munitions within the pipeline installation corridor and security corridor (defined in Subchapter 4.7) are surveyed (Subchapter 4.1.3). Based on the experience from Nord Stream, the NSP2 Project will encounter conventional munitions in Russia and Finland. The pipeline route will be optimized to avoid munitions to the extent possible based on the survey results.

The conventional and most common way to clear munitions offshore is by in situ detonation. During NSP, the clearance works were carried out by a disposal vessel with the munitions disposal team onboard. In addition, a work boat supported the operations and a ROV was used for several tasks:

- Survey of the munition and seabed at the detonation site prior to detonation
- Placement of the donor charge near the munition into the position for demolition
- Confirmation of the demolition as well as scrap and equipment recovery after the detonation
- Survey of any sensitive receptors near the munition prior to and after the detonation

The donor charge installed by ROV was fired after it was confirmed that no third party shipping was in the exclusion zone area. Other mitigation techniques successfully implemented during NSP are described in more detail in Subchapter 4.2.5. These techniques are also planned to be implemented in NSP2.

4.1.5 Seabed intervention works

Seabed intervention works are carried to ensure that the as-laid P/L profile does not exceed the allowable stress/strain criteria and to protect existing infrastructure at crossing locations. Intervention works are traditionally carried out by trenching (and dredging) or by rock placement.

4.1.5.1 Rock placement

Rock placement is the use of crushed rock graded in size to locally re-shape the seabed, thereby providing support and cover for sections of the pipeline to ensure its long-term integrity.

Rock placement is primarily required for the following:

- Supports for free span correction (pre- and post-lay)
- Gravel cover (post-lay) for additional stabilisation of the pipeline after pipelay, where required
- Gravel basement at the hyperbaric tie-in locations
- Pre- and post-lay support/stabilisation at the pipeline crossings

Crushed rock is transported by ship to each location where rock placement is required. The rock material is loaded into the fallpipe by conveyors on the ship and then falls through the water column within the fallpipe, as shown in the Figure 4-8. The rock placement vessels are able to place the rock in a controlled and accurate manner.

Technical requirements for the rock are:

- Chemically and mechanically stable for the entire lifetime of the pipeline
- Unweathered basalt, gabbro or granite
- Average size is 50 mm (range from 20 to 100 mm)
- The material used must not contain any contaminants, such as heavy metals, that can be dissolved in the water environment

In addition, rock material must be clean, i.e. not containing any clay, silt, lime, vegetation or other scattering constituents.

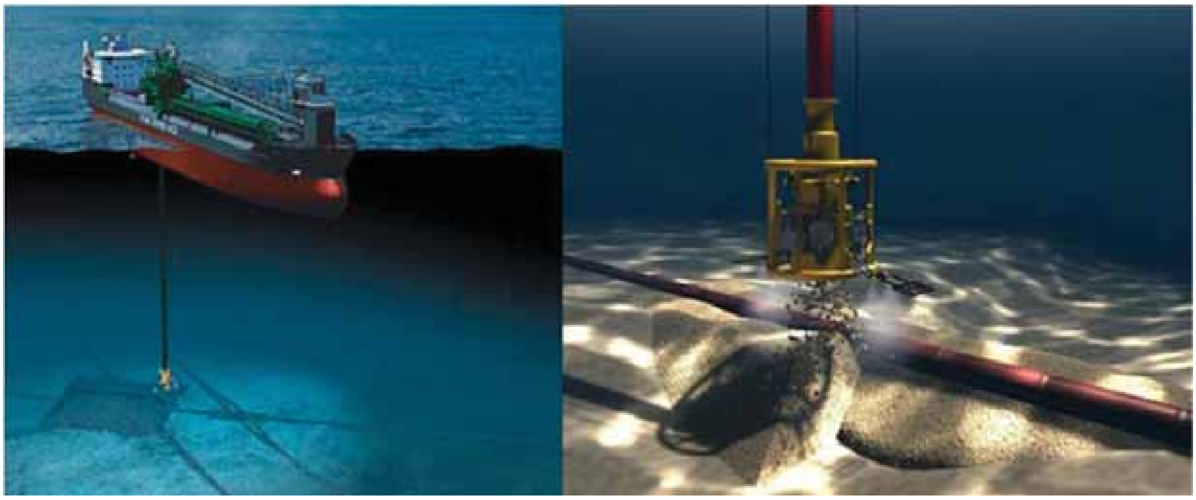


Figure 4-8. Rock placement on the seabed through a fallpipe. (Drawing by Nord Stream AG)

4.1.5.2 Trenching

The offshore installation of the pipelines in some areas (especially in shallow waters) requires additional stabilisation and/or protection against hydrodynamic loading (e.g. waves, currents), which can be secured by trenching the pipeline into the seabed.

Trenching is not planned to be carried out in Finland.

4.1.6 Crossing installations

The pipeline route will cross existing cables (active and inactive) and pipelines.

The following methods can be considered for the crossings:

Table 4-3. Potential crossing methods.

Type	Crossing Method
Pipeline	Rock berm, protected by rock and mattresses
Telecom cables	Protected by rock and mattresses (Figure 4-9)
Abandoned cables	Cut and removed
Power cables	Protected by rock and mattresses

Nord Stream 2 AG intends to contact all cable and pipeline owners prior to commencement of pipelay to agree on the crossing method, as well as to discuss the commercial and liability aspects of the crossing.

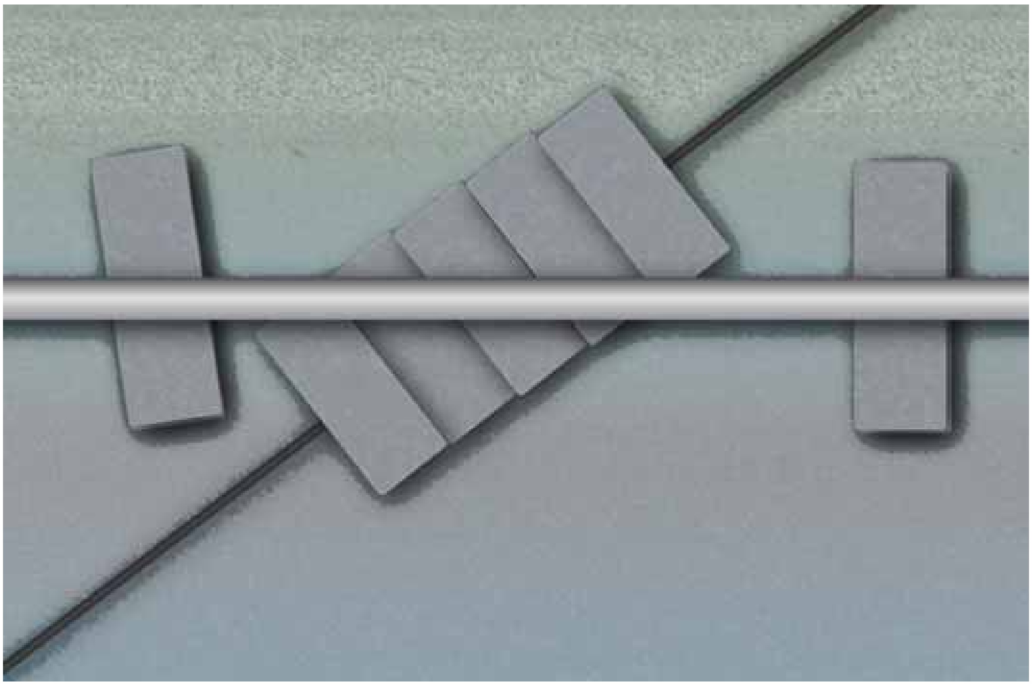


Figure 4-9. Typical cable crossing layout. The cable (black line) is under the mattresses.

4.1.7 Pipelay

In the pipelay process individual pipe sections (pipe joints) are transported by pipe supply vessels to the lay barge, welded together onboard and lowered as a continuous string onto the seabed from the lay barge. The average speed of the pipelay vessel is 2–3 km per day.

Pipelay will be carried out within the following corridors:

- The pipelay corridor (pipeline installation corridor) is a width made up of the pipelay tolerance centred on the design route centreline within which the pipeline will be laid. The pipelay tolerance will be +/-7.5 m of the design route centreline in general, +/-2.5 m at restricted areas such as crossings and pre-lay rock berms.

- The security corridor is a width centred on the design route centreline within which all UXOs will be identified and assessed, and if deemed to be a risk to the pipeline, disposed of. The security corridor width is based on the minimum distance required for the pipeline to safely withstand the effects of an underwater explosion of UXO charge weight long the route, and includes the pipelay tolerance. The security corridor will be locally widened to encompass pre-lay and post-lay rock placement.

Construction methods and the construction philosophy is generally similar to that of the Nord Stream pipelines; however, the NSP2 pipelines are planned to be laid simultaneously. It is currently planned that one pipeline will start pipelay at Russia and the second in Germany.

Pipelay, either by anchored lay barge or DP (dynamically positioned) vessel, will be performed using the conventional S-lay process. A typical S-lay system is comprised of three main components:

- The stinger, an extension of the firing line that reduces the length of the overbend. The overbend is a hog bend that usually originates behind the tensioners, and describes the upper curvature of the pipe string entering the water via the stinger;
- The tensioners, which reduce the stresses in the overbend and the sag bend. The sag bend describes the bending under which the pipe string is laid onto the seabed;

- The positioning system, which controls the vessel's position. The vessel position must be maintained under the specified tension needed to keep the sag bend within the bending limitations of the pipe. The positioning system also ensures that the pipeline is laid within its approved corridor on the seabed.

The process onboard the pipelay vessel comprises the following general steps, which take place in a continuous cycle and are illustrated below.

- Welding of pipe on the firing line (and simultaneously in the multi-joint station(s), if available);
- Non-destructive examination (NDE) of welds;
- Field joint coating;
- Laying on the seabed.

As the lay vessel moves forward, the pipe string exits the stinger of the vessel into the water. The stinger extends some distance behind and below the vessel and has the function of controlling and supporting the pipe configuration. The pipe string running from the stinger to the touchdown location on the seabed is kept under tension at all times, thereby avoiding the risk of buckling and damage to the pipe. The average lay rate will depend on the welding system used and weather conditions.

An ROV deployed from a survey vessel will be used for continuous touchdown monitoring through critical areas such as pipelay start-up and laydown, during the crossing of rock supports, at pipeline and cable crossings, through other constrained sections.

The transport of pipe to the pipelay vessel is carried out by dedicated pipe carriers which maintain their position alongside the pipelay vessel on DP while pipes are offloaded. A more or less continual process is required to maintain pipe stock on the pipelay vessel.

A typical S-lay pipelay vessel with survey support vessels is shown in the schematic below (Figure 4-10).

Figure 4-10. The S-lay pipe-lay vessel and survey support vessels.

4.1.7.1 Anchored pipelay vessel

An anchored pipelay vessel is positioned by a number of anchors which are moved by anchor handling tugs according to planned anchor patterns, as shown in Figure 4-11.

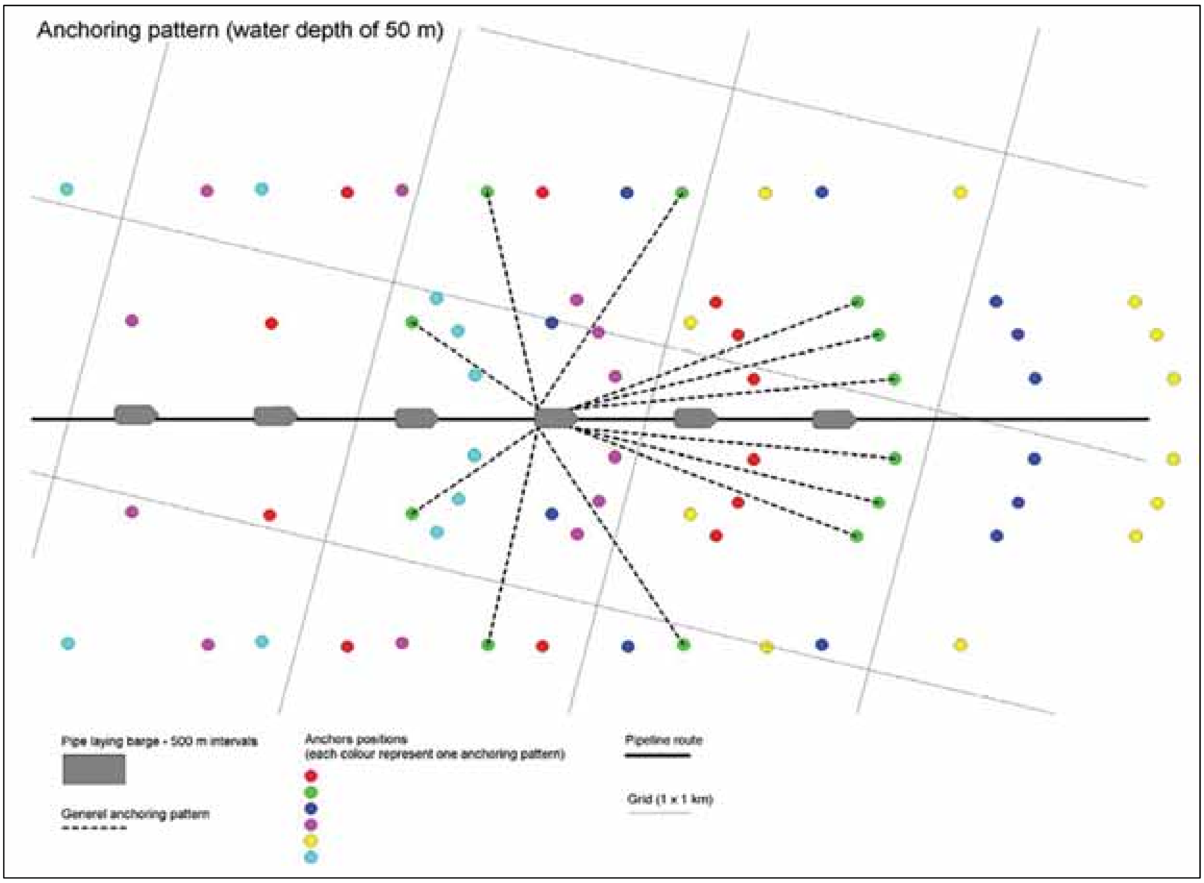


Figure 4-11. Typical anchor pattern.

The anchors are placed on the seabed by anchor handling tugs (AHT) which are equipped with winches and specialised equipment for this operation. The AHTs are also fitted with a DGPS-based navigation system, known as a tug management system (TMS), which enables the anchors to be accurately installed in accordance with the pre-defined anchor pattern.

A typical anchored lay barge is the Castoro Sei (C6). The vessel has a twelve point mooring system to facilitate accurate positioning and movement. The total weight of an anchor is approx. 25 tonnes. Based on a typical anchor pattern from NSP, with the C6 using 12 anchors, there were approximately 20 anchor drops per km (i.e. roughly 10 per side). Anchoring patterns are planned to avoid sensitive objects during pipelay.

Figure 4-12. An anchored lay vessel – Castoro Sei. Photo by Nord Stream AG.

4.1.7.2 Dynamically positioned (DP) pipelay vessel

A dynamically positioned (DP) pipelay vessel has a number of thrusters. These thrusters are located at the fore and aft, as well as the port and starboard sides of the vessel, in order to maintain position from every direction.

A typical DP vessel is the Allseas Solitaire, below, which was used to install the first 350 km of the Nord Stream pipelines in Russian and Finnish waters. The Solitaire has 10 thrusters.

Figure 4-13. Typical DP Vessel – Allseas Solitaire.

A computerised positioning system automatically employs the thrusters when it is necessary. Information about the position of the vessel is communicated from special sensors on the ocean floor, or via the use of a taut wire system. The taut wire system operates by lowering a clump weight by wire to the seabed. The wire is held in constant tension to remove vessel motion from the system. The angle of the wire is measured and the position of the weight with respect to the vessel can be calculated.

Additionally, satellite communications and weather and wind information is transmitted to the computer system, further helping it control the movements of the vessel. Using the information provided to it, the positioning computer automatically engages the thrusters to overcome any changes in the location of the vessel.

4.1.8 Transportation of materials and equipment

Large-scale offshore pipeline construction work requires support from onshore support facilities, such as weight-coating plants and storage yards. In addition to weight-coating and storage of pipe joints, the support facilities will provide general storage for the supply of consumables to the offshore fleet and managerial support for Nord Stream 2 AG and its contractors. Additionally, ship-generated waste will be transported to onshore recycling and treatment facilities.

A key feature of the impact-minimised logistics concept of Nord Stream was the creation and use of a network of strategically located logistics sites in Germany, Sweden and Finland. In order to achieve a safe and smooth supply chain for the project, two concrete weight coating (CWC) plants and four storage yards will be used. The locations of the CWC plants will be Kotka in Finland and Mukran in Germany. The planned locations of the storage yards will be Kotka and Koverhar, Hanko, in Finland, Karlshamn in Sweden and Mukran in Germany.

The project includes the following offshore transport activities:

- Transport of weight-coated pipes to the storage yards
- Transport of weight-coated pipes to the lay vessels from the weight-coating plants and storage yards
- Transport of material for rock placement from intermediate onshore storages areas to the rock placement locations
- Transport of fuel and other materials to lay vessels and support vessels

The logistics concept has been designed to reduce onshore and offshore transportation. The use of existing facilities has been favoured in order to avoid new construction wherever feasible. A primary focus in the development of the logistics concept, therefore, has been on minimising environmental impacts and reducing costs.

4.1.8.1 Pipe joint logistics

The pipe joint logistics will be based on utilisation of existing ports within the Baltic Sea area. The Port of HaminaKotka (Mussalo) in Finland is serving as a weight-coating location and a storage yard for the eastern pipeline route.

The port of Mukran in Germany is the favoured location to serve as a weight-coating location and a storage yard for the western part of the route. It is planned that two additional ports will serve as storage yards along the route as shown in Figure 4-14.

Figure 4-14. Pipe joint logistics Nord Stream 2.

After weight-coating, the pipe joints will be stored close to the weight-coating plant. From Kotka, they will be transported directly to the lay vessel or to the storage yard in Koverhar, Hanko. From Mukran, pipes are planned to be transported to Karlshamn, which is closer to the middle section of the pipeline route to minimise sailing distances to the pipe-laying vessels.

The distance from the weight-coating plants and storage yards to the pipe-laying vessel is targeted to be as short as possible. This minimizes the distance that one pipe-supply vessel will travel from the stockyard to the lay vessel and back.

NSP2 has currently made agreements with four ports, however, further improvement to shorten the sailing distances in the middle sector of the pipeline route is still under investigation. One possibility is to use the Freeport of Ventspils in Latvia as an additional pipe storage yard.

In case that Ventspils would be used as an additional pipe storage yard, it would receive weight-coated pipes by rail from Russia (approx. 20,000 pipes) and by coaster vessels from Kotka (approx. 12,800 pipes). From Ventspils the pipes would be transported with pipe supply vessels to the lay vessels when in Swedish and Finnish waters. This would consequently mean that corresponding fewer pipes would be transported from Hanko and Kotka to the pipe-laying vessels.

Figure 4-15. Loading coated pipe joints onto the pipe-supply vessel. (Photos by Nord Stream AG)

4.1.8.2 Offshore rock transport

Rock placement material will be extracted from sources on land. Crushed rock will be stored in the selected harbours and transported to a number of rock placement locations mainly in the Gulf of Finland.

4.1.8.3 Offshore waste management

Ship-generated waste will be routed to appropriate recycling and treatment through a selected port or ports in the Baltic Sea area. During the NSP project most of the offshore waste was delivered to the Port of Norrköping.

Nord Stream 2 AG will take care to ensure that its contractors are managing wastes to applicable international standards. The waste management strategy and planning are presented in Subchapter 19.3.7. This chapter also includes a short description of the management of offshore wastes generated during construction activities *(Nord Stream AG 2012)*.

The majority of wastes generated during the offshore works of the Project will come from the pipelay vessels. Based on experience from the NSP project most of the waste (>90 %) is comprised of the following waste fractions:

- Concrete waste – this includes waste welding flux, which is inert.
- Metal waste – comprises mainly metal turnings from the pipe bevelling stations.
- General and domestic waste – relating to general office and non-hazardous waste including personal protective equipment, domestic waste from living quarters and food waste that was not segregated at source.

Other waste fractions are typically: wood waste, hazardous waste, plastic waste, food waste, paper/cardboard waste and glass waste. The total amount of offshore wastes is expected to be approximately 7,000 tons. Figure 4-16 shows the percentages of wastes generated during the NSP offshore operations.

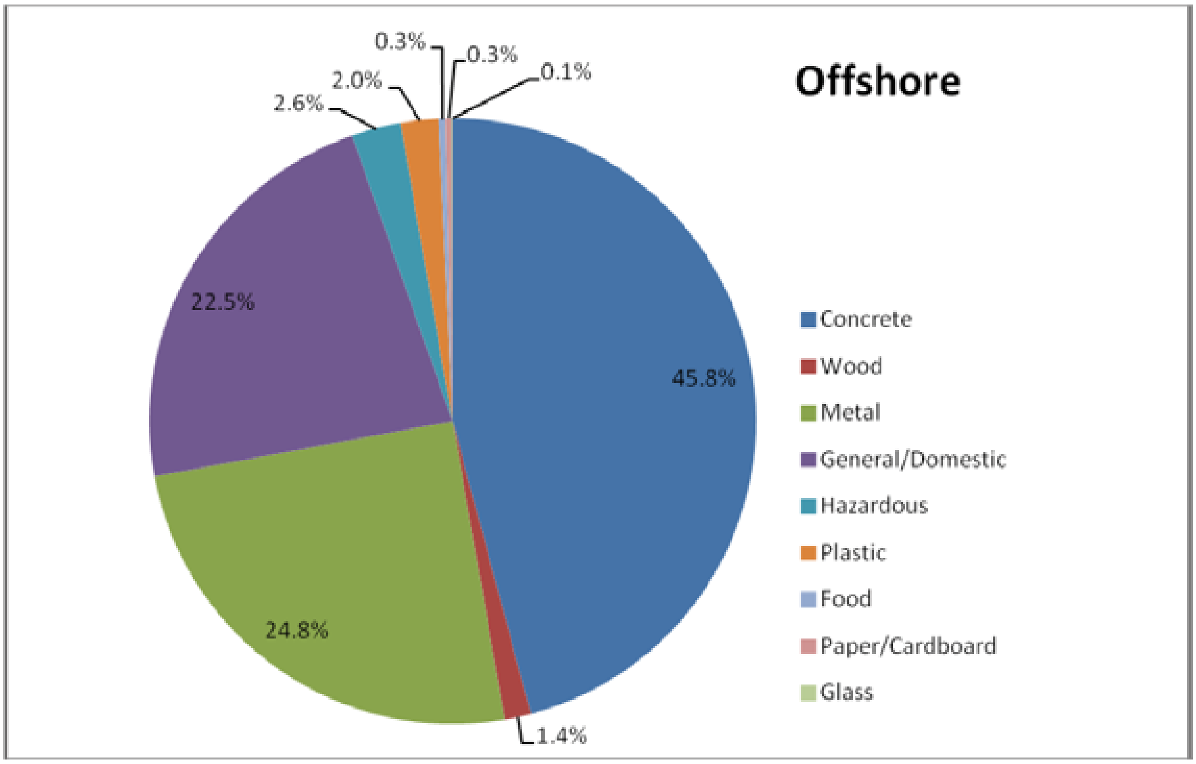


Figure 4-16. The percentages of wastes generated during the NSP offshore operations.

Principles of offshore waste management planning are presented in Subchapter 17.15.

4.1.8.4 Other offshore transport activities

Other transport activities include supply of fuel and other materials to the lay vessel and support vessels.

4.1.9 Landfalls

Landfall facilities of the NSP2 system in Russia and Germany will connect the two pipelines to the Russian and Euro-pean gas networks, which are located beyond the Pig Trap Areas (PTAs) at each end.

The Narva Bay area has been selected for the landfall in Russia. The PTA in Narva Bay is located approximately 4 km inland from the Land Termination End (LTE). The Lubmin area has been se-lected for the landfall in Germany. The PTA in Lubmin is located approximately 0.36 km from LTE.

The main function of the Russian and German PTAs is to provide the pig launching and receiving facilities, the isolation, blow-down and shut-down valves and the instrumentation required for the control and safeguarding of the NSP2 system.

4.1.10 Pre-commissioning

After installation, the NSP2 pipelines undergo a series of activities which prepare the pipeline system for use. These activities include cleaning, gauging and testing / leak detection.

The offshore pipeline pre-commissioning concept for NSP2 will be completed after receipt of the pipe-lay bids and finalisation of the lay scenario. In principle, two options are under investigation. These are:

- "Dry" pre-commissioning without pressure testing using alternative testing methods and without hyperbaric tie-ins (option 1)
- Standard "Wet" pre-commissioning operations as done for NSP (option 2)

4.1.10.1 Option 1

The offshore pipeline will not be pressure-tested with water. The pipelines will be cleaned and gauged with dry air as a pigging medium. The pipelines will not be water-filled and, consequently, no dewatering and drying is required. Leak detection will be carried out using an inspection pig or alternatively by an external ROV survey in conjunction with the cleaning and gauging of the pigging operation. As no water is used, there will be no additives and no such discharges at the Russian landfall.

According to this philosophy, hyperbaric tie-in operations will not be needed since laying activities from Russia to Germany will be performed by means of shallow and deep-water barges, which will operate through multiple pipeline abandonments and recoveries. If this option is chosen, no rock berms for hyperbaric tie-ins will be required.

At least one above-water tie-in (AWT) is required on each pipeline, but not within the Finnish sector. The above-water tie-in technique is used to connect two pipe sections that have previously been laid down during various phases of the construction works. Above-water tie-ins will be carried out by a specific lay-barge positioned over the tie-in location. Each pipe section is lifted sufficiently clear of the water and suspended alongside the barge and welded together. Once tested, the pipe is then lowered to the seabed. The locations of the AWTs will be confirmed following the selection of the pre-commissioning option.

4.1.10.2 Option 2

"Wet" pre-commissioning includes pressure-testing with water. The offshore pipeline design is divided into three segments as listed below and tested at three different test pressure values:

- First offshore segment from the pull head in Russia to approximately KP300 (in Finland)
- Second offshore segment from approximately KP300 to approximately KP675 (in Sweden)
- Third offshore segment from approximately KP675 to the pull head in Germany.

The following "Wet" pre-commissioning activities are to be performed:

- Flooding, cleaning and gauging
- Pressure-testing

After the performance of the pressure test, the segments are connected by means of two hyperbaric tie-ins. Once all hyperbaric tie-in operations are complete, the following operations can take place in the completed offshore pipeline:

- Dewatering
- Drying

The "Wet" pre-commissioning concept for the offshore pipelines is to supply seawater from a section break offshore and discharge seawater at the Russian landfall. Approximately 1,300,000 m^3 of sea water will be required to fill each of the two pipelines. All water will be taken from the hyperbaric tie-in locations at a water depth of 5 to 15 m.

In order to prevent corrosion of the pipeline due to the presence of dissolved oxygen, all water will be treated with an oxygen scavenger. The active substance in the oxygen scavenger will be sodium bisulphite ($NaHSO_3$). The concentration of the oxygen scavenger is up to 85 ppm. Additionally, ultraviolet (UV) treatment may be required to reduce the number of bacteria present in the seawater.

During pre-commissioning operations, a limited discharge from the pipeline(s) is expected at the hyperbaric tie-in locations. This water will not be treated with any additives. Discharge locations and amounts of water will depend on actual sequence of operations.

During dewatering, a pig train will be launched from Germany towards Russia. The medium used to propel the pig train will be dried compressed air. As it travels through the pipeline, the pig train will push all 1,300,000 m^3 of treated water out of the pipeline. At the Russian end, discharged water will be routed via a temporary pipeline back into the sea.

Hyperbaric tie-in

Each of the project pipelines will be built in three sections with different wall thickness. The sections can be connected under water, using so-called hyperbaric tie-ins (Figure 4-17) to form the complete app. 1,200 km pipeline.

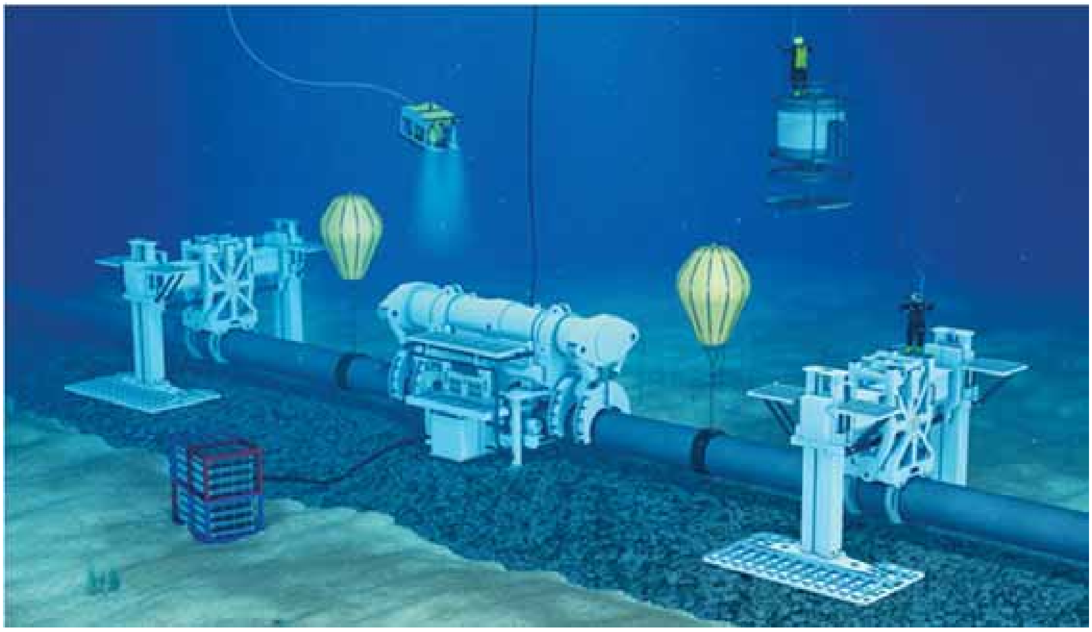


Figure 4-17. Hyperbaric tie-in setup. (Drawing by Nord Stream AG)

Hyperbaric tie-ins will consequently be conducted on the seabed at the two locations where the pipeline wall thickness changes. At both locations, gravel berms will be installed on the seabed to provide stability for the tie-in operations. Once a section of the pipeline is installed, a lay down head is welded to the end of the pipeline before the pipe-lay vessel lays it down. This head provides an air- and water-tight seal.

At the tie-in locations, the ends of the two respective pipeline sections overlap. Then, for hyperbaric welding, they are aligned using large H-frames and cut back. An underwater habitat or "hyperbaric chamber" will be placed over the connection and the pipelines welded together inside that habitat. The entire operation will be remotely controlled from a support vessel and assisted by divers. Once the tie-ins are finished, the habitat will be removed and a survey will confirm the correct position of the pipeline.

4.1.11 Commissioning

Commissioning comprises all activities that take place after pre-commissioning and until the pipelines commence natural gas transport, including filling the pipelines with natural gas. Prior to the activity of gas-in, all pre-commissioning activities must be completed successfully and the pipeline filled with dry air that is close to atmospheric pressure.

After pre-commissioning the pipelines contain dry air. Nitrogen gas is then inserted into the pipelines as an inert buffer immediately prior to natural gas-filling. This ensures that the inflowing natural gas will not be able to react with the atmospheric air and create unwanted mixtures inside the pipeline since the nitrogen gas acts as a buffer between the atmospheric air and the natural gas. Commissioning will then proceed by filling the pipelines with natural gas from the connected facilities.

At this stage of the project three different commissioning options are under study:

1) The compression station is in operation (dehydrated gas is available) and it is used to

properly regulate gas pressure and temperature.

2) The compression station is in operation (dehydrated gas is available), but gas pressure and temperature are regulated in the temporary skid mounted HRE (heating and reducing equipment).
3) The compression station is not ready and it is by-passed. Gas is directly taken from the Russian domestic grid (upstream of the compression station) and a temporary drying unit is necessary to treat the gas as well as to regulate pressure and temperature. Note that this option does not require a dedicated HRE unit for NSP2.

For all options, a nitrogen batch will be used to separate pipeline air content from hydrocarbon gases injected. The nitrogen batch will be sized to ensure no intermixing is possible between air and hydrocarbons.

The gas filling operation is done in two stages. The first stage comprises replacement of air and nitrogen by hydrocarbon gases. During this phase, the pipeline blowdown system in PTAG is used to vent off the air as well as the nitrogen batch. During this phase the pipeline will not be pressurised.

The second stage comprises pipeline pressurisation. This will commence upon detection of on-spec hydrocarbon gas at the vent location in PTAG. At this point, the blowdown system will be closed and PTAG will be set into operational configuration up to the first block valve in the downstream system.

Gas injection will continue from the Russian side until the required pipeline pressure to start normal operation is achieved.

4.1.12 Operation and maintenance

Nord Stream 2 AG will be the owner and operator of the pipeline system. The system is designed for an operating life of at least 50 years. An operations concept and security system will be developed to ensure the safe operation of the pipelines, including avoiding over-pressurisation, managing and monitoring potential gas leaks and ensuring material protection. The operation system is currently planned to be set up in a very similar way as to that of NSP.

4.1.12.1 Main pipeline system facilities

The protection, control and monitoring strategy for the Nord Stream 2 pipeline system will be based on manned landfall facilities, namely the pig trap areas in Russia and in Germany. These will be supervised by the Main Control Centre (MCC) in Switzerland with a back-up facility, the Back-Up Control Centre (BUCC), also located in Switzerland.

The Pipeline Control and Communication System (PCCS) is an overall monitoring and safeguard system composed of a few different systems, e.g. Pipeline Control System, Pressure Safety System and Emergency Shutdown System. As in NSP, the PCCS will be used in NSP2 and during normal operating conditions of the PCCS the MCC is the central point of control and monitoring. Only in emergency cases will the BUCC be manned, which is if the MCC is not operational or during function tests.

Hence, redundant communication links will be provided between the pig trap areas in Russia and Germany and between both of the pig trap areas and the control centres (MCC and BUCC) as well as between the control centres themselves.

4.1.12.2 Normal pipeline operations

Normal operating conditions are those in which the pipeline system flow rate, pressures and temperatures are all within the pipeline design parameters and in which flow rate is regulated in accordance with the notification requirements of the gas transportation agreement. The pipeline inlet flow rate will be controlled by the number of compressors on line at the Russian Compressor Station while the pipeline outlet pressure will be controlled by the Gas Receiving Station control valves. These valves will also control line packing, which occurs when pipeline inlet flow is greater than pipeline outlet flow. The required pipeline inlet pressure will be determined by the sum of the pressure at the pipeline outlet plus the pressure drop along the pipeline. The compressor speed will adjust automatically to achieve the required compressor discharge pressure. To ensure that the outlet gas temperature does not fall below the specified minimum, the line heaters at the Gas Receiving Station will be used.

4.1.12.3 Maintenance operations

Maintenance operations comprise the planned maintenance and inspection of the Nord Stream 2 pipeline system in order to enable transport of natural gas through the pipelines in accordance with the uptime requirements of the gas transportation agreement.

Planned maintenance and scheduled inspections will be carried out as a minimum in accordance with DNV's requirements, statutory requirements as well as recognised good industry practice. Planned maintenance and inspections for the landfall facilities will be carried out throughout the year to ensure operation. Any large scale maintenance activities will be performed during a yearly shutdown in non-winter months. Service companies will perform standard maintenance activities of the pipeline, which comprises external inspection surveys and internal inspections.

A comprehensive repair strategy for the NSP2 pipeline system will be prepared on the basis of the experience gained from NSP. The strategy will be developed for both onshore facilities and offshore repairs. For both strategies, an analysis of possible repair scenarios will be performed including a probability assessment. In general, the strategy for each repair scenario will specify the tools and equipment required, a strategy to deal with the consequences of the damage scenario and the spare parts required to successfully repair the line within a limited time frame. Depending on the outcome of the probability assessment combined with the ecological and economic consequences, the repair strategies will be defined.

4.1.13 Overall construction schedule

The planned overall construction schedule is presented in Figure 4-18.

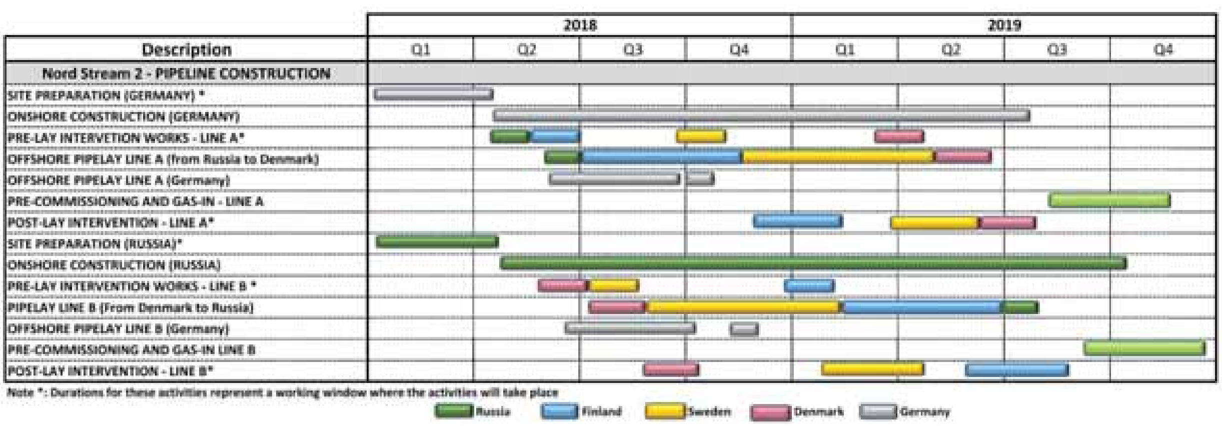


Figure 4-18. The planned overall construction schedule

4.2 Description of the project in Finland

4.2.1 General

This chapter provides a description of the project in Finland. The description covers the pipeline route (chapter 4.2.2), pipeline design (chaper 4.2.3) and the schedule (Subchapter 4.2.11), and in addition the main project activities in the Finnish EEZ, which are following:

- Surveys (Subchapter 4.2.4);
- Munition clearance (Subchapter 4.2.5);

- Rock placement (Subchapter 4.2.6);
- Crossing installations (Subchapter 4.2.7);
- Pipelay (Subchapter 4.2.8);
- Transportation of materials and equipment (Subchapter 4.2.9);
- Pre-commissioning (Subchapter 4.2.10).

Operation and maintenance is presented in the overall description in Subchapter 4.1.12 and is applicable also in the Finnish EEZ.

4.2.2 Pipeline route

In the Finnish EEZ, the NSP2 route crosses the existing NSP pipelines immediately after entering the Finnish sector and is routed north of the NSP pipelines. The NSP2 pipelines are identified as follows:

- Pipeline A, running on the northern side of the route corridor,
- Pipeline B, running on the southern side of the route corridor.

The length of the route in the Finnish sector is approximately 378 km, from KP 114 to KP 492. Figure 4-19 and Appendix 1 (Map PR-02-F) show the routing in the Finnish EEZ.

The Finnish sector of the NSP2 route is characterised by highly variable conditions: there are areas of very smooth seabed comprising very soft clay sediment, alternating with areas of rough seabed comprising coarse sediment, sand and outcropping bedrock. Water depth along the NSP2 route varies between 33 m and 184 m.

The pipeline route (NSP2 route) is located entirely in the Finnish EEZ and does not enter Finnish territorial waters. To the east the route continues into Russian territorial waters and to the west into the Swedish EEZ. The closest distance to Finnish territorial waters is 0.6 km and the closest distance to the Estonian EEZ 1.8 km. The minimum distance of the NSP2 pipelines from the Finnish coastline is 15 km and from the Estonian coastline is 25 km.

The pipeline route is located north of the Nord Stream pipelines for the most part of the Finnish sector. Only a short section, approximately 400 m, in the easternmost part of the pipeline route close to Russian waters is located south of the Nord Stream pipelines.

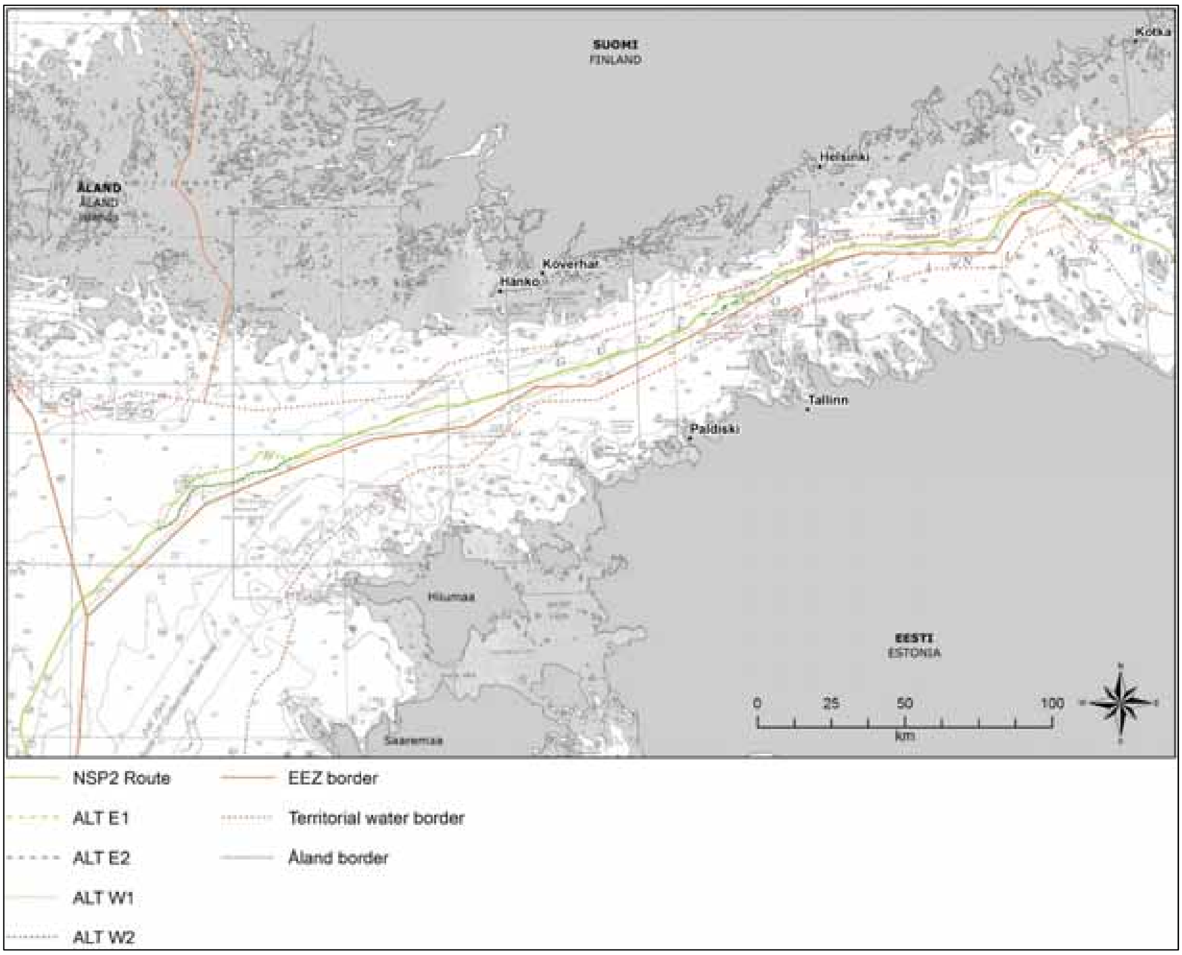


Figure 4-19. Routing in the Finnish EEZ.

General pipeline separation criteria are presented in Subchapter 4.1.1.3 (Table 4-1 and Table 4-2). However, deviations from the basic separations have been evaluated case by case. In the Finnish EEZ there are areas, where for feasibility reasons, the NSP2 lines cannot keep the minimum distance of 500 from the NSP lines. In these areas the possibility to go closer (min 350 m) is confirmed for a maximum length of approx. 5 km. A separation smaller than 350 m from the existing pipeline requires a formal Proximity Agreement with the third party (NSP) pipeline owner.

4.2.3 Pipeline design

Approximately 63,000 coated pipe joints will be installed in the Finnish EEZ. The number of anodes within the Finnish sector to be installed are as follows:

- Zinc 1,394 (line A) + 1,394 (line B)
- Aluminium 1,427 (line A) + 1,427 (line B)

The expected material consumption required for the pipeline sections in Finland is summarised in Table 4-4 below. Quantities are approximate and subject to final optimisation.

Table 4-4. Summary of material consumption in Finland.

Material	Finland
Total length of 2 pipelines (km)	756
Steel (t)	723,700
Concrete weight coating (t)	757,900
Anodes Zinc (t)	2,472
Anodes Aluminium (t)	885

Color rings are applied on the coated pipes to identify the types of pipe (wall thickness, concrete thickness etc.). The amount of paint is approximately 0.13 litres per pipe joint – approximately 8 m^3 for all pipes in the Finnish EEZ.

Pipelines that will be installed on the seabed are constituted for more than 99,8 % of materials that are insoluble or harmless to the marine environment (e.g. steel, concrete and dry film of paint). Due to their harmless properties, these materials is are not discussed in Chapter 11. However, zinc (comprising less than 0,2 % of the total pipe materials) is a potentially harmful substance and has been taken into account when assessing the impacts to the marine environment.

4.2.4 Surveys

Surveys in the Finnish EEZ cover the activities described in Subchapter 4.1.3. The schedule of performed and planned surveys in the Finnish EEZ are shown in Table 4-21.

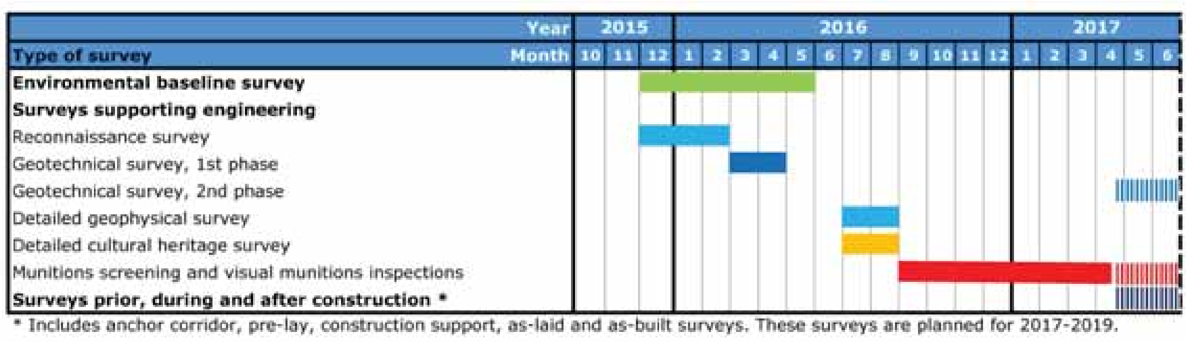


Figure 4-20 . Schedule of surveys carried out or planned in the Finnish EEZ. Survey schedule shown until mid-2017; however, surveys will continue until 2019.

Survey activities in the Finnish EEZ:

- The environmental baseline survey in the Finnish EEZ was performed between December 2015–May 2016. The surveys included e.g. the following measurements:
  - Water quality measurements during sediment/benthos sampling and in connection with current measurements
  - Survey of physical and chemical characteristics of surface sediments
  - Survey of macrozoobenthos (richness, frequency, biomass)
  - Current measurements
  - Underwater noise measurements

  More information about this survey and the results are presented in Appendix 4.

- The reconnaissance survey was carried out during December 2015–February 2016.
- The first phase of the geotechnical survey was performed during March–April 2016. The second phase of the geotechnical survey will begin in Q2/2017 after winter ice.
- The detailed geophysical survey was carried out during July-August 2016.
- Detailed surveys on selected potential underwater cultural heritage targets were carried out during July–August 2016.
- Munitions screening survey and visual inspections of potential munitions started in September 2016 and is continuing untill Q2/2017.
- The anchor corridor survey is estimated to be performed during 2017, if an anchored lay barge is used.
- Other surveys prior to, during and after construction will be carried out in 2018-2019.

Figure 4-21. Van Veen sampler used in benthos sampling. Photo by Nord Stream AG.

4.2.5 Munition clearance

During NSP approximately 300 munitions were identified within the Finnish EEZ. Due to the density of munitions within the Finnish EEZ, avoidance through localised re-routing will not be possible in all cases. Consequently, munitions relocation or clearance will be required prior to construction within the pipeline installation corridor and the wider security corridor as based on the risk assessments.

During NSP 55 munitions were cleared within the Finnish EEZ using the following clearance methods:

- Detonation in situ: 40 munitions including e.g. mines, depth charges and torpedo
- Relocation by air bag and detonation on the seabed: nine air dropped bombs
- Relocation by ROV out of the security corridor and leaving on the seabed: six projectiles

The number of munitions requiring clearance during NSP2 is expected to be of a similar order of magnitude as during NSP.

During NSP several measures were implemented to mitigate and monitor impacts on marine mammals, diving seabirds and fish. Visual observations were performed by marine mammal observers from one hour before the detonation to one hour after the detonation. A sonar survey to identify any fish shoals in the area was carried out by the work boat and a passive acoustic monitor was deployed to record any vocalisation by marine mammals prior to detonation. In addition to observations, acoustic deterrents (seal scrammers) were deployed and activated prior to detonation and a small fish scarer charge detonated was before firing the main donor charge to scare away any seals or fish from the area. Figure 4-22 shows an example of the mitigation array typically used during NSP.

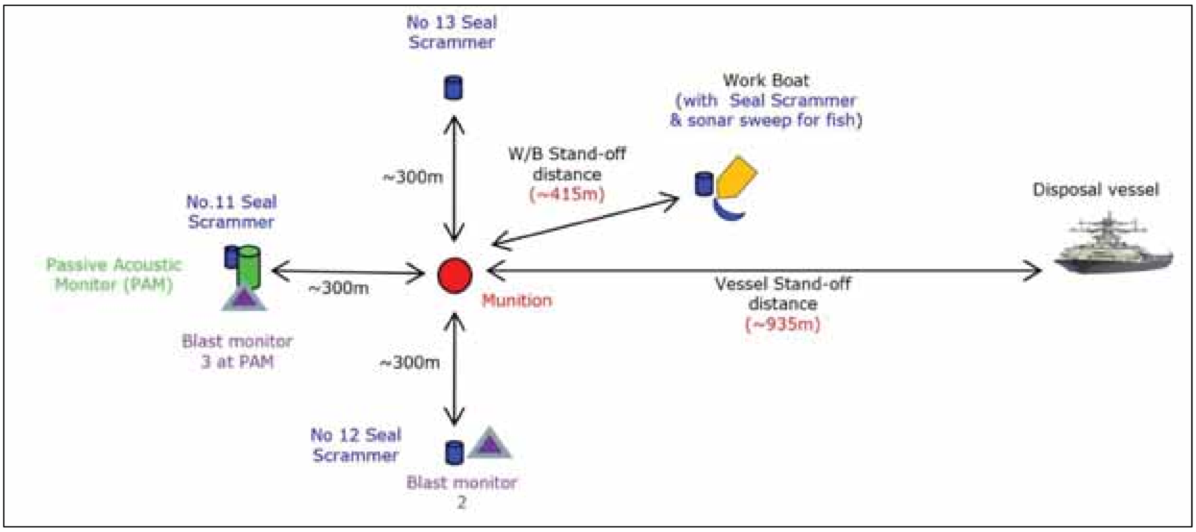


Figure 4-22. Layout of monitoring and mitigation equipment during munitions clearance (Witteveen+Bos 2011).

The above described mitigation measures will be implemented in the NSP2.

In addition to the munitions clearance methods and mitigation techniques successfully implemented for NSP, NSP2 is performing an assessment of alternative clearance methods and mitigation techniques to reduce the impact associated with underwater noise from in situ detonation. This study considers, as the munitions baseline, the munitions cleared during NSP. In general, the viability of alternative methods depends on the type and condition of a munition and associated risk assessments. Therefore, this initial study will be complemented with a detailed assessment based on the findings of the NSP2 munitions surveys during the permitting phase.

4.2.6 Rock placement

Rock placement is the only intervention work that is planned to be carried out n the Finnish EEZ and will be carried out in two phases:

- Phase 1 – Pre-lay rock placement, comprises intervention works to be carried out before pipe-laying.
- Phase 2 – Post-lay rock placement, comprises intervention works to be carried out after pipe-laying

An overview of the locations and types of rock placement works to be carried out in Finnish waters is presented in Appendix 12, Maps PR-03-Fand PR-04-F. Numbers are approximate and subject to final optimisation.

Table 4-5. Summary of the estimated rock volumes for rock placement in Finnish waters.

	Approximate total volume (m^3)*
Pipeline crossings (pre- and post-lay)	40,000
Stress/freespan correction, pre-lay	330,000
Stress/freespan correction, post-lay	1,080,000
In-service buckling mitigation (post-lay)	390,000
Seabed preparation for hyperbaric tie-in (pre- and post-lay), only "Wet" pre-commissioning	80,000 to 110,000
Total rock volume (including tie-in)	**1,950,000**

* Calculated for NSP2 route with sub-alternatives ALT E1 and ALT W1 (Chapter 5)

Total rock volume also depends on the pre-commissioning concept. Table 4-5 indicates the volumes for the "Wet" pre-commissioning concept. If the "Dry" pre-commissioning concept (no hyperbaric tie-ins) is selected, the amount of rock decreases by approximately 80,000 to 110,000 m^3.

Rock volumes presented above are based on the technical design in June 2016 *(Saipem 2016a)*, which is basis for the assessments in this EIA report. However, the latest technical note shows a rock volume decrease of approximately 25 % for the Finnish EEZ compared to volumes presented in Table 4-5.

4.2.7 Crossing installations

In the Finnish waters the Nord Stream 2 pipeline route will cross 24 existing and two planned cables (Table 7-26 and Appendix 12, Maps IN-01-F and IN-02-F). Six of the existing cables are unknown. Five of the 18 existing known cables are inactive. Cables will be protected by mattresses. Two types of mattresses will be used: flexible multi-block concrete mattresses with rounded edges (6 m x 2.5 m x 0.3 m) and rigid concrete beam mattresses (10 m x 3 m x 0.3 m).

In the Finnish EEZ the NSP2 route also crosses Nord Stream lines 1 and 2 at one location (i.e. a total of 4 crossings) close to the Russian boarder. The typical pipeline crossing is shown in Figure 4-23.

In addition, the route will cross the planned route of the Balticconnector pipeline in Finland; however, the installation schedule remains to be confirmed.

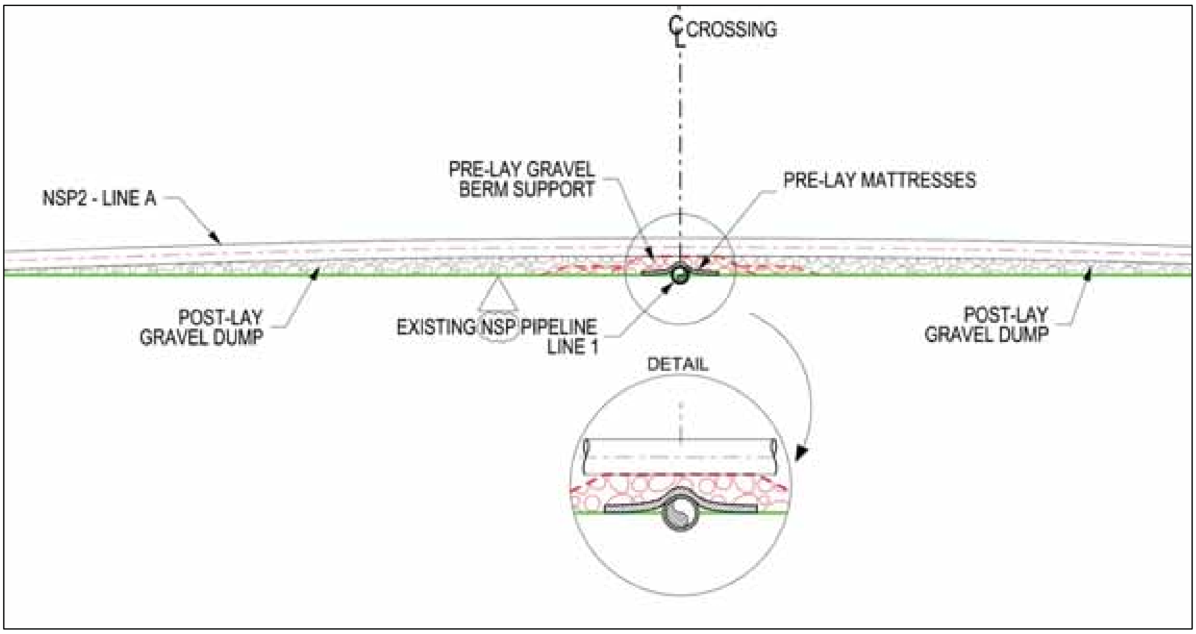


Figure 4-23. Typical pipeline crossing (preliminary drawing).

4.2.8 Pipelay

In the Finnish EEZ it is planned to use a DP lay barge from the Russian border (KP 114) to approx. KP 350. From approx. KP 350, South of Hanko, to the Swedish border/EEZ (KP 492) it is planned to use either an anchored lay barge or a DP lay barge.

Approximately 300 days of pipe-laying operations will be carried out in the Finnish EEZ assuming an average lay rate of 2.5 km per day. Pipelay is estimated to take approximately 5 months for each pipeline in the Finnish section (10 months in total). Pipelay is not foreseen in winter ice conditions.

4.2.9 Transportation of materials and equipment

Coated pipe joints

After coating, approximately 62,000 pipes will be shipped from the Mussalo, Kotka, site to the Koverhar, Hanko, storage yard. From the Koverhar, Hanko, storage yard, the coated pipes will be shipped to the NSP2 route. The remaining approximately 49,000 coated pipes will be shipped directly from the Mussalo, Kotka, storage yard to the NSP2 route (30,000 to the Finnish EEZ and 19,000 to Russian waters).

Estimated number of shipments from Mussalo is as follows:

- approximately 310 shipments over a period of 11 months to Koverhar, Hanko, 30 per month
- approximately 150 shipments over a period of 5 months to pipeline in the Finnish EEZ, 30 per month
- approximately 95 shipments over a period of 5 months to pipeline in Russian waters, 20 per month

Pipe supply vessels will transport coated pipe joints from the storage yards to lay vessels on the NSP2 route. Coated pipes (62,000) to be installed in the Finnish EEZ will come from Kotka Mussalo (30,000) and Hanko Koverhar (32,000). For more information see Subchapter 4.1.8.1.

Rock placement material

Rock placement material for the Finnish and Russian waters may be extracted from quarries on land in Finland (subject to international tender procedure), and transported from the intermediate storage at Mussalo, Kotka, to the construction sites. The amount of rock is estimated to be 2,660,000 m^3 (4,260,000 tons), of which 1,950,000 m^3 (3,120,000 tons) will be used in the Finnish EEZ and 710,000 m^3 (1,140,000 tons) will be used in Russian waters.

Rock material is transported by the rock placement vessel using established shipping routes where available to the placement location. Average capacity is 20,000 tonnes. Estimated number of shipments with 2-3 vessels in use during approximately 15 months is as follows:

- approximately 160 movements to pipeline in the Finnish EEZ, 10 to 11 per month
- approximately 60 movements to pipeline in Russian waters, 4 per month

Preliminary rock placement locations are presented in Appendix 12, Maps PR-03-F and PR-04-F.

Offshore waste

The amount of ship-generated waste in the Finnish EEZ is estimated to be 2,000 tons (total offshore waste appr. 7,000 tons, see Subchapter 4.1.8.4), as the length of the pipeline route in the Finnish EEZ is approximately 30 % of the total route. Wastes will be transported to a port to be selected in the later stages of the Project.

Offshore waste management will be carried out according to priciples presented in Subchapter 17.15. This will ensure that there are no emissions to sea or air. Therefore, waste materials are not further discussed in Chapter 11.

4.2.10 Pre-commissioning

During “Dry” pre-commissioning (Option1), the pipelines will not be water-filled, and there will be no water intake from the Finnish EEZ or discharges to the Finnish EEZ.

If the “Wet” pre-commissioning (Option 2) is selected, approximately 1,300,000 m^3 of sea water will be required to fill each of the two pipelines. All water will be taken from the hyperbaric tie-in locations at a water depth of 5 to 15 m. Some of this water will be taken from the Finnish EEZ, because hyperbaric tie-in will possibly be carried out at approximately KP 300.

During “Wet” pre-commissioning operations, a limited discharge from the pipeline(s) is expected at the hyperbaric tie-in locations – potentially also at KP 300 in the Finnish EEZ. This water will not be treated with any additives. The discharge locations and amounts of water will depend on actual sequence of operations.

The total rock volume also depends on the pre-commissioning concept. If the “Dry” pre-commissioning concept (no hyperbaric tie-ins) is selected, the amount of rock decreases by 80,000 to 110,000 m^3, approximately 5 % of the total rock volume.

4.2.11 Construction schedule in Finland

The planned schedule of the main construction activities in Finland is shown in table below:

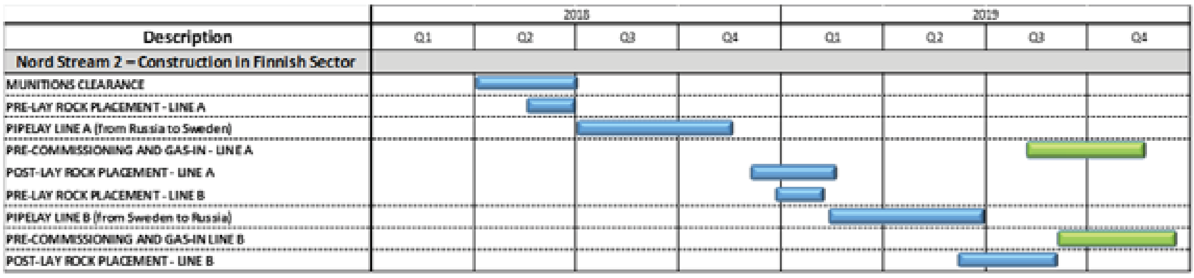


Figure 4-24. The planned schedule of the main project activities in Finland

4.3 Ancillary activities in Finland

4.3.1 General

The construction of the NSP2 system is supported by the following ancillary activities in Finland:

- Operation of the concrete weight coating plant at Mussalo Harbour, Kotka
- Storage yards for the weight-coated pipes at Mussalo Harbour and Hanko Koverhar Harbour
- Shipments from the coating plant to the storage yards
- Extractions of rock from the selected quarries
- Rock transport from the quarries to Mussalo Harbour
- Storage yard of rock at Mussalo Harbour

All major facilities used previously for the Nord Stream project are again available, such as the existing Concrete Weight Coating (CWC) plant, the storage areas and the berths. Mussalo, Kotka, is a part of the Kotka rail traffic operating point. The pipe storage and transport for the Nord Stream project was in and via the main port in Hanko. The NSP2 project is using instead Koverhar harbour on Hanko peninsula.

Ancillary activities are presented in the following subchapters as follows:

- Onshore activities in the Kotka region (Subchapter 4.3.2)
  - Operation of the weight coating plant and storage yard
  - Extraction, transport and storage of rock material
- Shipments from the coating plant to the storage yard in Koverhar, Hanko
- Onshore activities in Koverhar, Hanko (Subchapter 4.3.3)

4.3.2 Onshore activities in the Kotka region

The proposed activities in Kotka harbour area are shown in Figure 4-25.

Figure 4-25. Ancillary activities in Kotka.

4.3.2.1 Operation of the weight coating plant and storage yard

The Kotka coating plant will coat 110,000 pipe joints starting from Q1/2017 and the plant will be operational untill Q3/2019. The estimated use of materials at the Kotka coating plant is shown in Table 4-6.

Table 4-6. Material use at Kotka coating plant

Main components	Tonnes / item	No. of items	Total tonnes
Pipe	10.0	110,000	1,100,000
Iron ore	8.31	110,000	914,100
Cement	2.41	110,000	265,100
Aggregate	2.68	110,000	294,800
Overall	23.4		2,574,000

The pipes, which are manufactured in Russia and pre-coated with polyethylene plastic, are coated with a concrete and iron ore mix in Wasco's *(Wasco Coatings Europe BV)* Kotka plant in order to increase their weight, and are stored for later delivery to either pipe-laying vessels or to Hanko or Karlshamn for intermediate storage.

Pipes to be coated will be transported directly by train from the manufacturing sites to the weight-coating plant. Materials for concrete coating, such as cement and aggregate, will be supplied to the weight-coating plant mainly from local sources. Iron ore will be transported by ship from international suppliers; e.g. from South Africa to Kotka in cargo ships. NSP2 tracks the source of iron ore and, prior to approval of the supplier, ensures that the mining operations comply with the labour, safety and environmental standards to which NSP2 adheres.

A summary of the estimated material transport to the coating plant is presented in Table 4-7.

Table 4-7. Transport of materials to the Kotka coating plant.

Main components	Total tonnes	Transport method	Load/ transport unit	Number of transport units	Average frequency
Pipe	1,100,000	Rail	5 pipes/wagon 300 pipes/train	2,200 wagons 370 trains	1 train every 2nd day
Iron ore	914,100	Ship	50,000 t/vessel	19 vessels	1–2 vessels/month
Cement	265,100	Road, local (or rail)	20 t/truck	12,050 trucks	20 trucks/day
Aggregate	294,800	Ship, local	7,000 t/vessel	44 vessels	2 vessels/month

The pre-coated pipe joints will be transferred to the plant hall in the reception area with a bridge crane. The insides and outsides of the pipes are washed by spraying them with warm water in a washing cabin. No detergents are used. After washing the pipes are pre-heated, and then hot air is blown through the pipe in order to hasten the drying. After drying, the pipes will be transferred to the inspection station where the condition of the pipes is visually assessed to check for possible quality errors, etc. Approved pipes are numbered and transferred to either the installation area or the anode addition area.

A steel net is installed on the pipes in the net installation area. The size of the net is determined on the basis of the information received from the previous station. The half-nets for the anode pipes are transported to the anode installation area with a conveyor. On the conveyors, plastic fasteners holding the net are installed on the pipes. The anodes are pressed against the pipes with a pressure meter, after which they are welded and the fasteners are soldered. Polyurethane is added to the gaps.

The pipes equipped with nets will finally be installed in the coating wagons, in which the pipes go through the concreting unit (conveyor and drums). The pipe surfaces are moistened using spraying nozzles placed above the pipes. The concrete that does not adhere to the pipes will drop to the conveyors, which returns the concrete through the concrete mixing system back to the process.

The pipe unloading wagons transport the coated pipes to the exit platform for finishing and from there further to the hardening area and the loading station to be loaded onto trucks. The hardening areas are heated with steam in order to boost the drying of the coating.

The onshore traffic related to the weight-coating plant and stockyards will be limited. The aim is to store the pipes as close to the berth as possible to minimise transportation distances. Handling of pipes in the stockyards will be carried out by cranes, front loaders, reach stackers and trucks. Harbour cranes will reload the pipes from the stockyards to the pipe-carrier vessels.

The total area reserved for onshore activities (mainly for pipe storaging) at Mussalo logistics area is ca. 60 hectares.

The coating process generates eg. rejected concrete waste. This waste is inert, and if possible could be used as filling material in earthworks in the area. Wood waste, scrap steel, paper and cardboard will be delivered to recycling facilities. Hazardous wastes (e.g. lubricating oils) will be delivered to recycling facilities or disposed via licenced treatment companies. *(Wasco Coatings Finland Ltd 2016)*

Evaluated options for the Kotka coating plant

When developing the logistics concept for the project, options for Kotka were evaluated. The choice of locations for the weight-coating plants and storage yards are based on thorough analysis of a wide range of factors to minimise onshore and offshore transportation requirements, thereby minimising environmental impacts. The nearest options are Leith (Scotland) and Mo i Rana (Norway), Figure 4-26.

Kotka is an ideal location for logistics hub of the Project. It can supply coated pipes and rock material for the construction of the eastern section of the pipeline. The nearest rapidly-deployable, similar weight coating plants with sufficient capacity are located in Leith (Scotland) and Mo i Rana (Norway). However, the transport distances from Leith and Mo i Rana to the Baltic Sea and to the Gulf of Finland are much longer than from Kotka.

Leith. Bredero Shaw’s Leith facility is a full service facility that has large coating and storage capacities and is capable of applying anti-corrosion, internal coatings and concrete weight coatings. This allows for multiple projects to be completed simultaneously. The facility was established in 1972 and has coated over 15,000 km of pipe, which is the majority of UK North Sea concrete weight coated and insulated pipelines. Marine transshipments of coated pipes to location close to pipeline work are carried out through the Leith Docks.

Mo i Rana. Wasco’s concrete weight coating facility in Mo i Rana, Norway serves the European market, particularly the areas around the North Sea, Norwegian Sea and the Barents Sea. This high capacity impingement type concrete coating facility is designed to operate in the climatic conditions near the Arctic Circle. The plant and extensive storage areas are located at the Mo Industrial Park situated within the port area at Mo i Rana.

Distances (km) between the locations are:

	Hanko	Kotka	St. Petersburg
Kotka	260	-	-
Leith	2,080	2,270	2,430
Mo i Rana	2,590	2,800	3,000

CO_2-emissions for pipe transport in optional coating plants are:

	CO_2-emission tonnes
Kotka	46,400
Leith	524,200
Mo i Rana	650,300

Pipes to Kotka will be transported directly by train. After coating, they will be transported by vessels to the offshore construction site. Pipes to Leith and Mo i Rana need firstly a transport by vessels from St. Petersburg, and after coating, a transport back to Gulf of Finland by vessels. Comparison of the transshipment emissions reveal that Leith will cause 11 times higher CO_2 emissions than Kotka, and Mo i Rana respectively 14 times higher emissions, so they are not environmentally and economically realistic locations. Increasing ship traffic also increases the risk for possible collisions and spills.

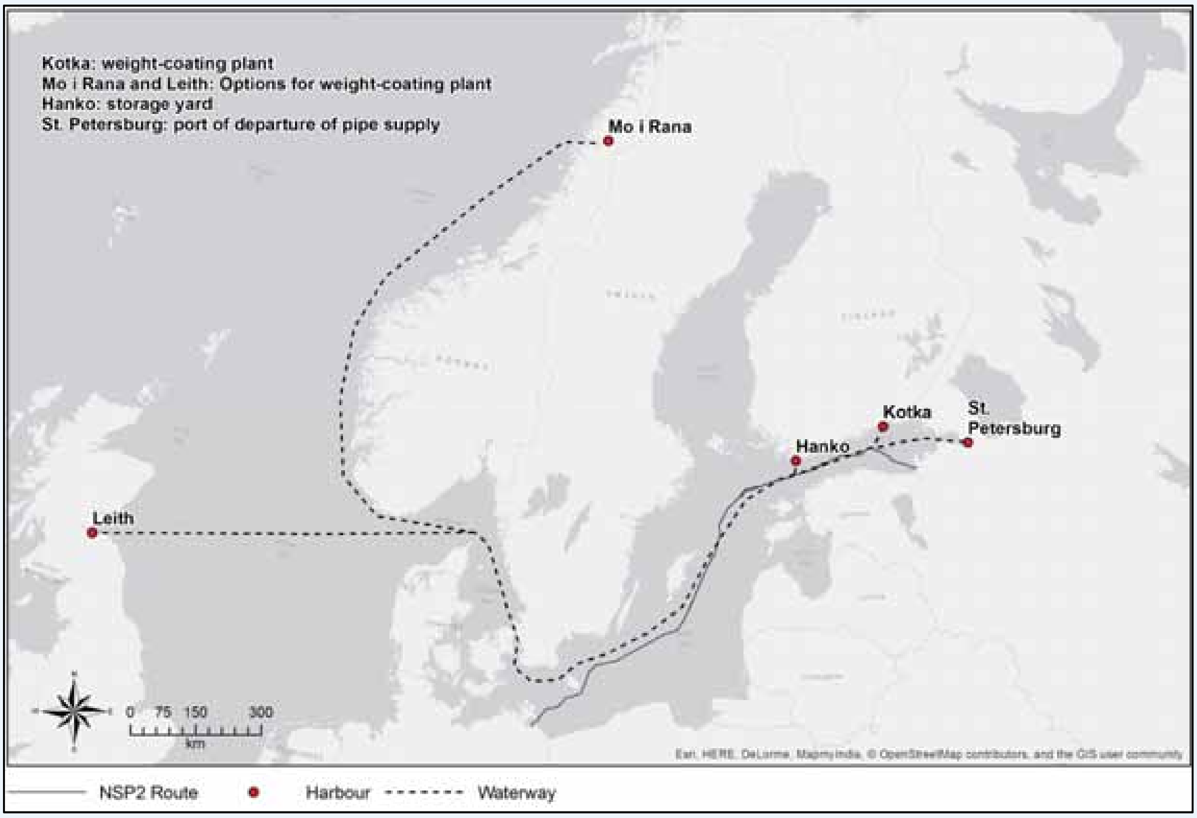


Figure 4-26. Locations of possible options for the Kotka weight-coating plant; Leith and Mo I Rana.

4.3.2.2 Extraction, transport and storage of rock material

As stated before, the rock placement material needed for the Finnish and Russian intervention works may come from Finland, subject to international tender procedure. The amount of rock is estimated to be 2,660,000 m^3 (4,260,000 tons).

During Nord Stream project, only virgin rock material was used, and this also an option during Nord Stream 2 Project. Nord Stream 2 has prepared a study on the potential rock quarries in the Kotka region. This information have been included in the tender documentation provided to the rock placement contractors. In addition, Nord Stream 2 has advised the rock placement contractor to evaluate the possibility of utilizing side-rock from other projects in Finland. The possibility of transforming the rock material in order to fulfil the material requirements (e.g. via crushing) should also be considered. Prior to the side-rock selection and utilisation, the side-rock material should undergo all the required tests in order to verify that the rock possesses the suitable properties for the project. Potential sources of side-rock material are large infrastructure projects in the southern Finland.

As the rock sources are not yet known, the impact assessment in the following chapters is based on the assumption that the sources of rock material are the same quarries used during NSP. These quarries are:

- Rudus Oy, Kotka (maximum extraction volumes: overall 11,000,000 m^3, annual 1,300,000 m^3/a)
- Destia Oy, Pyhtää (maximum extraction volumes: overall 480,000 m^3, annual not specified in the extraction permit)

The typical operation of rock quarry and rock aggregate production consists of the following activities:

- Removal of topsoil (often by banking up noise barriers around the quarry)
- Quarrying (drilling, blasting, breaking)
- Crushing and screening
- Mitigation measures
- Storage yard of aggregates
- Transport

The rock aggregates will be transported from the quarries or other sources of rock material to Mussalo Harbour. It is assumed that the transport will be done by trucks. The load capacity of the trucks is approximately 40 tonnes. Previous experience shows that 13–15 trucks may be used for transportation. Working hours are difficult to estimate, but could possibly be up to 16 hours per day, five to six days per week. Rock transport is assumed to take place in the time frame of 18 months.

Rock material is assumed to be transported from the quarries via Heinsuontie to Highway 7 (E18) and then via Road 15 (Hyväntuulentie) and Road 355 (Merituulentie) to Mussalo. The average daily traffic from truck transport is approx. 600 trips.

Coordinating authority recommended that the possibility of rail transport in rock material transport should be assessed. Although the harbour has a railway connection, none of quarries exist along the track. In addition, possible quarries are located quite near (ca. 15 km) from assumed harbour to be used (Mussalo, Kotka). Rail transport is therefore not a sensible logistics solution.

Upon arrival at Mussalo Harbour, the crushed rock will be stored on the quay. The amount of interim rock in storage can be up to 250,000 tonnes (160,000 m^3).

From the storage location, rock material will be transported by rock placement vessels to each location where rock placement is required. Loading will be done directly from the quay using one or more conveyors. The assumed loading speed will be between 1,000 and 2,000 tonnes per hour. The vessels will be moored for half a day to one day during loading.

4.3.3 Shipments from the coating plant to the storage yard in Koverhar, Hanko

Coated pipes are trans-shipped from Kotka by freighters using established shipping routes to storage yard in Hanko Koverhar. Approximately 62,000 pipes are trans-shipped to Koverhar, i.e. approximately 310 shipments over a period of 11 months.

4.3.4 Onshore activities in Koverhar, Hanko

Activities in Koverhar, Hanko include operation of the storage yard for coated pipe joints. In total approx. 62,000 pipes will be stored using existing Koverhar Harbour, which provides sufficient berths (1 in + 2 out) and storage area. The storage areas of up to 20 hectares are situated in Koverhar Harbour and industrial area (previously a steel factory area). The operations in Koverhar, Hanko, are planned to take place in Q2/2017–Q1/2018.

The weight-coated pipes will be loaded out from the vessels into the stockyard by mobile harbour cranes. Handling of pipes in the stockyards will be carried out by cranes, front loaders, reach stackers and trucks. Harbour cranes will reload the pipes from the stockyards to the pipe-carrier vessels.

4.4 Decommissioning

NSP2 is designed to operate for approximately 50 years. The proposed decommissioning programme will be developed during the operational phase of NSP2 to allow consideration to be given to any new or updated legislation and guidance available at the time, as well as to utilise good international industry practise (GIIP) and technical knowledge gained over the lifetime of NSP2. However, it is considered highly likely that statutory requirements, technical options, and preferred methods for decommissioning will have changed in 50 years' time.

The condition of NSP2 infrastructure (onshore and offshore) may also influence the preferred decommissioning method and relevant mitigation measures.

This chapter highlights the legislation and policy context related to decommissioning, the options for decommissioning NSP2 (offshore and onshore). Associated environmental considerations are described on a general level in Chapter 15.

The decommissioning process for offshore structures is regulated by a framework of international conventions which are designed to, in turn, influence national legislative requirements for offshore installations and removal. The legislation regulates both the removal of installations and disposal of materials (as appropriate). The primary international conventions specifically related to decommissioning are listed and defined in Table 6-1.

There is no Finnish legislation or guideline specific to the de-commissioning of offshore installations. However, Water Permit Decision no. 4/2010/4 by the Regional State Administrative Agency of Southern Finland issued for the NSP pipelines includes the following permit provision (provision 36):

A pipeline de-commissioning plan must be submitted to the permit authority well in advance; however, no later than one year before the de-commissioning. The plan must specify the measures required in order to eliminate the harms to the marine environment, and the marine area use restrictions caused by the pipeline. On the basis of the plan, the permit authority may issue required stipulations for carrying out the de-commissioning.

Given this limited legislative framework, a review of other guidance documents has been undertaken to provide additional context, see below.

4.4.1 Overview of decommissioning guidelines

Although there is no international guidance on the decommissioning of pipelines, nor specific guidance developed for the Baltic Sea, Norway and the UK have enforced guidelines within this field. Those of particular relevance to NSP2 include:

- DNV Recommended Practice document: Marine Operations during removal of offshore installations - provides guidance on technical feasibility and overcoming technical challenges related to removal of offshore installations *(Det Norske Veritas 2004)*.
- The Norwegian Parliament's white paper: Decommissioning of redundant pipelines and cables on the Norwegian Continental Shelf - briefly addresses the options for the decommissioning of pipelines and cables and highlights the need for decommissioning programmes to be developed with due consideration given to potential environmental, socio-economic and marine spatial planning impacts as well as the overall cost *(The Norwegian Parliament's white paper)*.

- UK Oil and Gas Guidance Note: Decommissioning of offshore installations and pipelines - provides a framework for decommissioning of both offshore installation and pipelines and provides guidance for the safe decommissioning of pipelines *(BEIS 2011)*.
- Oil & Gas UK: Decommissioning of pipelines in the North Sea region - provides an overview of pipeline infrastructure in the North Sea, and the industry's achievements in decommissioning parts of that infrastructure. It also highlights the technical capabilities and limitations that impact the decommissioning options available to owners of pipeline systems *(Oil & Gas UK 2013)*.

In the absence of specific guidance for the Baltic Sea, the general principles contained within these documents are considered broadly applicable to the development of the decommissioning programme for NSP2.

These general principles can be summarised as follows:

- The potential for reuse should be considered before decommissioning. If reuse is considered viable, suitable and sufficient maintenance of the pipeline should be detailed;
- All feasible decommissioning options should be considered and a comparative assessment undertaken in respect of technical, environmental and socio-economic criteria (including those relevant to marine spatial planning and other sea users). Assessment of decommissioning options should be based on scientific evidence, with consideration given to the following topic areas as a minimum:
  - Water Quality;
  - Geology;
  - Hydrography;
  - Biodiversity (including threatened species and habitats);
  - Commercial Fishery; and
  - Contamination and Pollution.
- The condition of the pipeline should be considered in respect to deterioration, exposure and/or burial (both in terms of potential implications for decommissioning method and possible future impacts on the environment); and
- The decision should be undertaken in light of individual circumstances.

According to UK Oil and Gas Guidance Note *(BEIS 2011)*, the following pipelines may be candidates for *in situ* decommissioning:

- Pipelines which are adequately buried or trenched and which are not subject to development of spans and are expected to remain so;
- Pipelines which were not buried or trenched at installation but which are expected to self-bury over a sufficient length within a reasonable time and remain so buried;
- Pipelines where burial or trenching of the exposed sections is undertaken to a sufficient depth and it is expected to be permanent;
- Pipelines which are not trenched or buried but which, nevertheless, are candidates for leaving in place if the comparative assessment shows that to be the preferred option (e.g. trunk lines);
- Pipelines where exceptional and unforeseen circumstances due to structural damage or deterioration or other causes mean they cannot be recovered safely and efficiently.

The guidance also states that where rock placement has been used to protect a pipeline, the removal of the pipeline (or pipeline section) is unlikely to be practicable. It is therefore assumed that rock placement will remain in place, unless there are special circumstances that would warrant consideration of removal. Should the rock be associated with a pipeline that is removed, a minimum disturbance of the rock dump to allow safe removal of the pipeline and any seabed obstructions would be expected.

Although the above guidelines serve as an illustration of the general principles to be applied in decision making processes concerning decommissioning, it is anticipated that additional international or national guidelines will be developed before the end of the life of the NSP2 pipelines. Should such documents become available, these will be taken into consideration when preparing the decommissioning programme for NSP2.

4.4.2 Decommissioning practices

The comparative assessments of the majority of decommissioning cases in the United Kingdom have demonstrated that the preferred decommissioning option for large diameter pipelines is to leave them in situ, either on the seabed or buried. This approach is often complemented by remedial actions to reduce risks to other sea users, for example the cutting and removal of exposed pipeline ends to minimise snagging risk *(Oil & Gas UK 2013)* and in accordance with the guidelines highlighted in Table 6-1.

4.4.3 Decommissioning options for NSP2

As noted above, at this point in time, there is no certainty as to which decommissioning method will be applied to NSP2. Therefore, a detailed impact assessment for the decommissioning phase has not been carried out within this report.

The decommissioning plan for the offshore structures of NSP2 will be developed during the latter years of the operation phase. The identification of the preferred option will likely be based on the following criteria:

- Technical feasibility;
- Health and safety;
- Environmental impacts;
- Socio-economic impacts.

Notwithstanding this, two decommissioning scenarios (a base case and theoretical alternative) for NSP2 have been considered during the EIA phase. The options considered (based on the guidelines outlined in Table 6-1) are as follows:

- Based on precedent and industry best practice guidelines for large diameter pipelines, the base case is to leave the pipeline on the seabed (*in situ*):
  - Following the gas inventory removal and pipe cleaning operations, the pipeline will then be flooded in a controlled manner with seawater. After the pipeline is filled with water, the ends would be capped and buried. The pipeline and rock berms will then remain *in situ*, until they slowly degrade according to natural processes in the marine environment.
- Based on a review of other potential options, the theoretical alternative is pipeline removal by reverse lay recovery or by sectional recovery, followed by waste management:
  - Reverse-lay recovery would be carried out by pulling the pipelines up using a pipe-laying barge. The pipeline, when recovered to the pipe-lay barge, would then be then cut into convenient sections (12-24 m) and taken by pipe-carrier vessels to the shore for disposal. Whilst technically feasible, such reverse lay would require a significant engineering assessment of the condition of the pipelines and of the pipeline seabed configuration.
  - Reverse lay for pipeline removal would be an extremely risky operation. Apart from the risks that the structural strength of the pipeline might be questionable, the pipeline might have self-buried in sections or, even when on seabed, the soils could have consolidated. Thus the resistance during reverse pipelay would be very unpredictable and vary suddenly during initial break-out of the soil consolidation. The reverse lay operation would be very difficult to control and could result in harm to the vessel, equipment and personnel.
  - Sectional recovery would comprise cutting the pipelines into sections (12-24 m) on the seabed and the recovery of the sections to a pipe-carrier piece-by-piece. This method can be perfomed with the use of a ROV and a diamond cutter or a high-powered water jetting system.

- When onshore the pipeline materials would either be further processed for material recovery or disposed of. Regardless, temporary storage areas (i.e. storage yards for removed pipe sections) and processing would be required. Permanent areas for disposal may also be necessary.

It should also be noted that hybrid options (comprising a combination of the above) may also be considered. However, given that the pipelines will, over their operational lifetime, become an integrated part of the seabed due to embedding, leaving the pipelines *in situ* (base case) is likely to remain the optimal solution.

4.5 Connections with other projects

According to the Finnish EIA Decree, sections 9 and 10, the assessment report shall contain, on a sufficient scale, information on the project, its purpose, planning stage, location, land use needs and *connections with other projects*, and information on the developer, among other information.

The NSP2 Project itself does not have any technical or commercial connections with other planned project in the Finnish EEZ or in Finland, e.g. the pipeline has no landfall in Finland and is not connected to the gas network in Finland.

Naturally *other projects in the Finnish EEZ* and their rights must be taken into account in all NSP2 activities. These are:

- Balticconnector, a planned gas pipeline between Finland and Estonia which may cross or be crossed by the NSP2 pipeline; however, the installation schedule remains to be defined;
- A planned branch to the C-Lion data cable from the Finnish EEZ to Hanko landfall which may cross or be crossed by the NSP2 pipeline; however the installation schedule remains to be defined.

Possible cumulative impacts from NSP2 and other projects are assessed in Chapter 14.

- Regarding *existing infrastructure* in the Finnish EEZ, the Nord Stream 2 Lines A & B pipeline route crosses 24 cables, nine of which are unknown. The pipeline route also crosses Nord Stream lines 1 and 2 at one location (i.e. a total of 4 crossings) and runs mostly north of the NSP pipeline. A description of how these infrastructure projects relate to the NSP2 Project and the project area is provided in Chapter 14. A baseline description of existing infrastructure and use of the sea area is presented in Subchapter 7.21.

Possible cumulative impacts from NSP2 and other existing infrastructure are assessed in Subchapter 11.15.

The relationship of the NSP2 Project to general level strategies, programs and plans is presented in Chapter 6.

5. ALTERNATIVES

The NSP2 routing (including sub-alternatives), technical alternatives and non-implementation (0-alternative) of the project are described in this chapter. Route development and route alternatives during previous phases of the NSP2 Project in the Finnish section have been described in Subchapter 4.1.1.

This EIA Report includes assessments of following alternatives:

- NSP2 route (Alternative NSP2)
- Sub-alternatives (sections along NSP2 route)
  - ALT E1
  - ALT E2
  - ALT W1
  - ALT W2
- Construction alternatives
  - Pre-commissioning with hydrotest ("Wet" pre-commissioning)
  - Pre-commissioning without hydrotest ("Dry" pre-commissioning)
- Non-implementation (zero-alternative)

5.1 Assessed route alternatives

5.1.1 NSP2 route

The pipeline route (NSP2 route) in the Finnish section is located entirely in the Finnish EEZ and does not enter territorial waters. From the east the route comes from Russian territorial waters and to the west it continues into the Swedish EEZ. The closest distance to Finnish territorial waters is 0.6 km (south of Loviisa, close to Russian territorial waters) and the closest distance to the Estonian EEZ 1.8 km (between Helsinki and Tallinn).

The pipeline route is located north of the Nord Stream pipelines for most of the Finnish section. Only a short section, approximately 400 m, in the easternmost part of the pipeline route close to Russian waters is located south of the Nord Stream pipelines. Apart from the pipeline crossing area, the minimum distance to the Nord Stream pipelines is 0.2 km in the western part of the Finnish section along the ALT W2 route. The maximum distance to the Nord Stream pipelines (6.6 km) is at about the same location, but from the ALT W1 route.

The total length of the pipeline route in the Finnish EEZ is approximately 378 km from KP 114 to KP 492. The total length varies slightly depending on the chosen route alternatives. Table 5-1 provides more detailed information on NSP2 route.

Table 5-1. Information on NSP2 route.

	Line A	Line B	Total (NSP2 route)
Length, km (min-max depending of sub-alternatives)	374.4-378.3	373.9-377.5	373.9-378.3
Distance to Finnish territorial waters, km (min-max)	0.6-62	1.2-62	0.6-62
Distance to the Estonian EEZ, km (min-max)	1.9-9.3	1.8-9.3	1.8-9.3
Distance to the Nord Stream pipeline, km *	0.6-6.6	0.2-6.6	0.2-6.6
Rock volume, mill. m^3 (min-max depending on sub-alternatives and construction alternatives) **	0.91-1.04	0.86-1.07	1.78-2.11
Freespans (min-max depending on sub-alternatives) ***			
Total length of freespans, km	51.1-55.1	46.2-51.3	97.3-106.4
Number of freespans	557-595	505-546	1,062-1,141
Number of pipeline crossings ******	2	2	4
Number of cable crossings (min-max depending on sub-alternatives) *********	31-37	31-38	62-75
Water depth, m (min-max)	33.2-183.6	35.3-183.3	33.2-183.6

* Distance excluding the pipeline crossing area.

** In maximum rock volume estimation the assumption for rock berm at the hyperbaric tie-in is 110,000 m^3 in total, and 55,000 m^3 for each pipeline.

*** Including freespans with length > 25 m and heigth > 0.5 m.

**** Crossings with Nord Stream pipelines 1 and 2

***** Existing cables, either active or inactive, included.

5.1.2 Sub-alternatives

In Finnish EEZ, there are two sections along the pipeline route where the route divides into two alternative routes (Figure 5-1). The eastern section is located south or southwest off Porkkala in the Gulf of Finland and the sub-alternatives are called **ALT E1** and **ALT E2** (Figure 5-2). Another section is located in the Northern Baltic Proper in the western part of the Finnish EEZ and the sub-alternatives are called **ALT W1** and **ALT W2** (Figure 5-3).

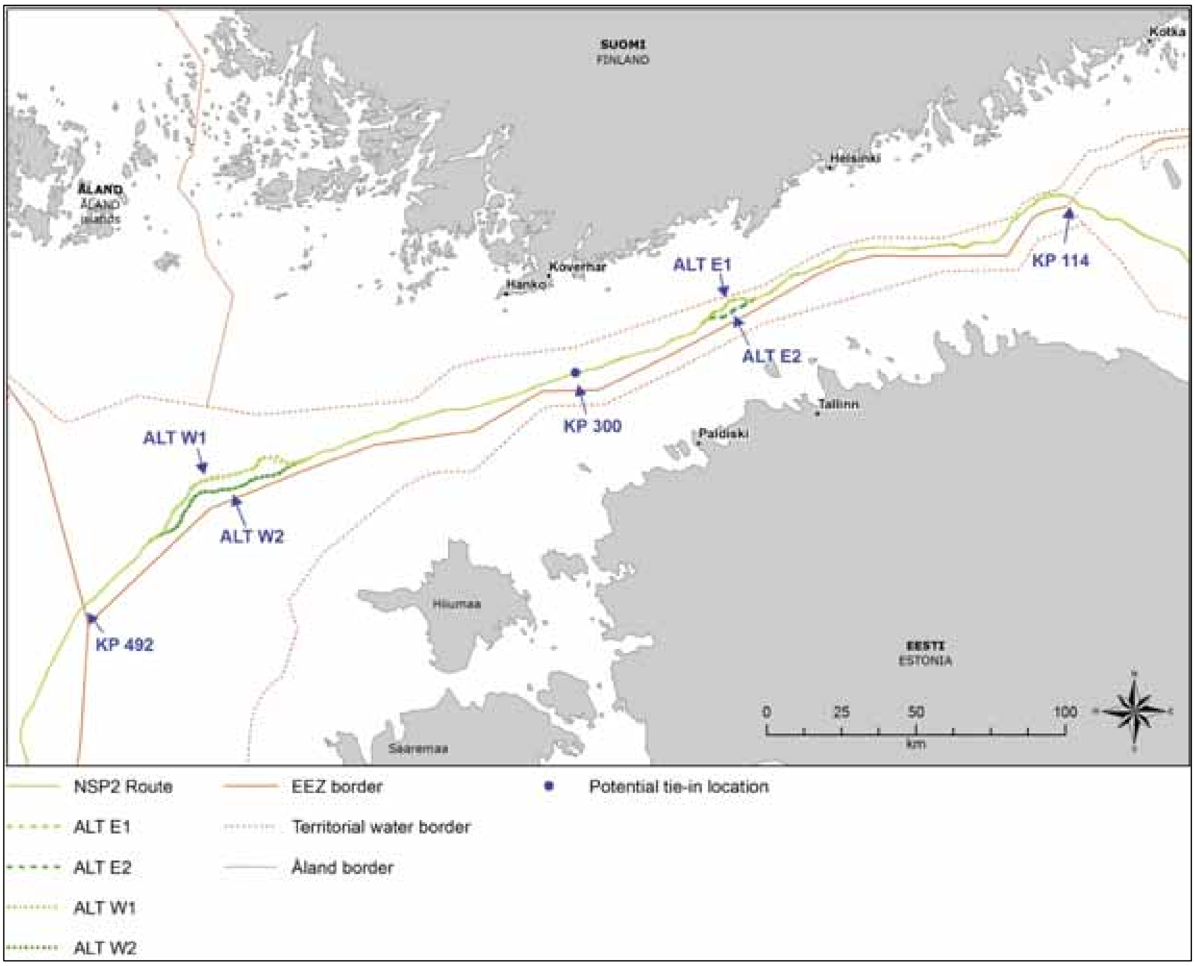


Figure 5-1. Pipeline route, route alternatives and approximate location for potential tie-in in the Finnish EEZ.

5.1.2.1 ALT E1/E2

The length of the section ALT E1/E2, depending on the pipeline (Line A or B) and sub-alternative, is 19.8-20.8 km from KP 232 to KP 253 (Figure 5-2 and). ALT E2, the southern sub-alternative, is approx. 700 m shorter than ALT E1. The seabed profile along ALT E2 is more irregular and therefore the rock volume required for intervention works (160,000 m^3 higher) as well as the estimated total length of freespans is higher than for ALT E1. Both sub-alternatives are mostly in the range of 50 to 70 m water depth, but ALT E1 runs through a short shallow water section where the minimum water depth is 33 m. There are more cable crossings with ALT E1 than with ALT E2. ALT E2 is located closer to the Nord Stream pipelines than ALT E1 (0.2 km at the closest point).

Table 5-2. Comparison of sub-alternatives ALT E1 and ALT E2.

	Line	ALT E1	ALT E2	Difference (ALT E1 – ALT E2)
Length, km	Line A	20.806	20.083	0.723
	Line B	20.533	19.806	0.727
Rock volume, m³	Line A	56,800	121,000	-64,300
	Line B	64,200	158,000	-93,800
	Total	*121,000*	*279,000*	*-158,100*
Total length of freespans, km *	Line A	4.0	6.7	-2.7
	Line B	4.0	5.6	-1.6
	Total	*8.0*	*12.3*	*-4.3*
Number of cable crossings	Line A	8	4	4
	Line B	8	4	4
	Total	*16*	*8*	*8*
Minimum water depth, m	Line A	33.2	48.5	-15.3
	Line B	35.4	45.9	-10.5

* including freespans with length > 25 m and heigth > 0.5 m

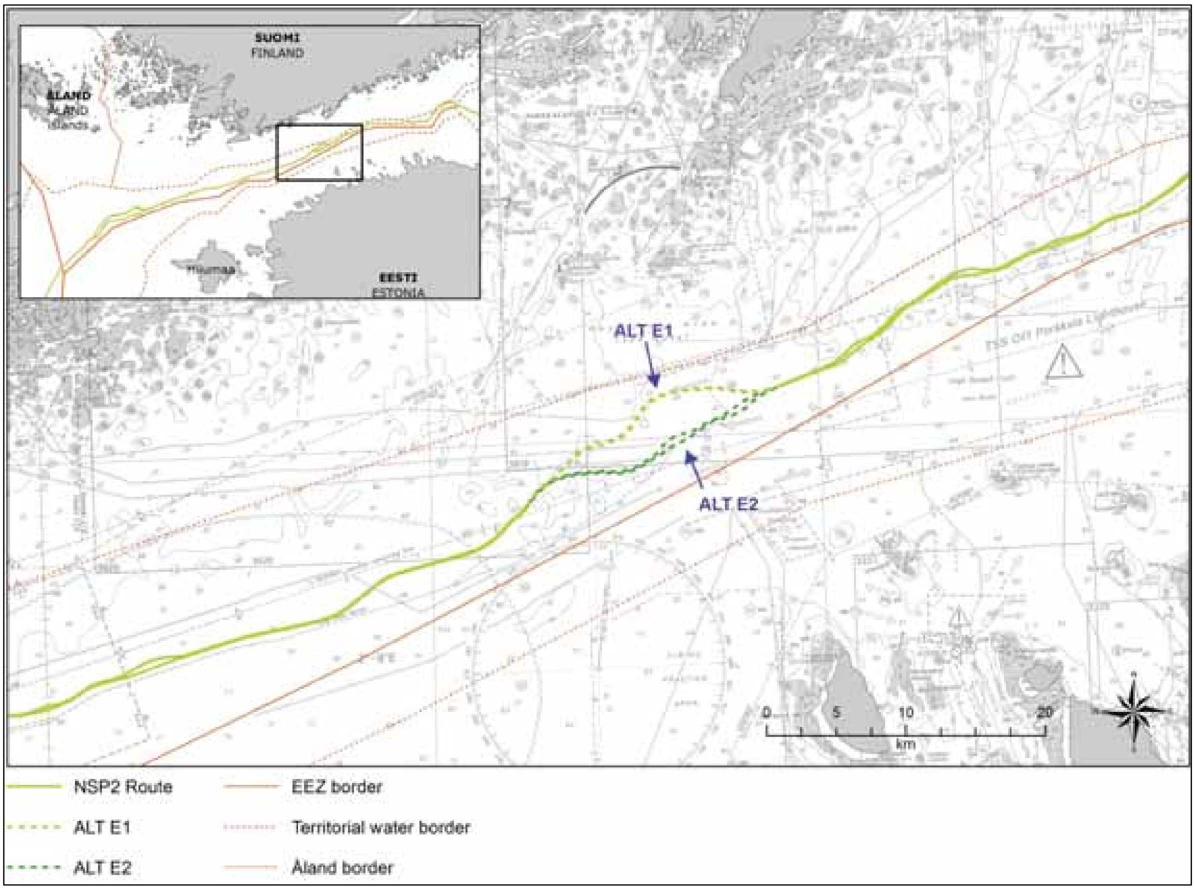


Figure 5-2. Sub-alternatives ALT E1 and ALT E2 south or southwest from Porkkala.

5.1.2.2 ALT W1/W2

The length of the section ALT W1/W2, depending on the pipeline and sub-alternative, is 56.3–60.1 km from KP 398 to KP 457–458 (Figure 5-3 and Table 5-3). ALT W2, the southern sub-alternative, is approx. 2.8-3.1 km shorter than ALT W1. The separation between the existing Nord Stream pipelines and the planned pipeline route is less than the minimum required separation (1,200 m if water depth is less than 100 m and 1,400 m if water depth is more than 100 m) for an approx. 8.6 km section in the case of ALT W2. ALT W1 keeps the minimum required separation for the whole length of the route. The seabed profile along ALT W1 is more irregular and therefore the rock volume required for intervention works (100,000 m^3 higher) as well as the estimated total length of freespans is higher than for ALT W2. Both sub-alternatives are mostly in the range of 80 to 160 m water depth, but ALT W1 runs through a short shallow water section where minimum water depth is 45 m. There are more cable crossings with ALT W1 than with ALT W2. ALT W2 is located closer to the Nord Stream pipelines than ALT W1 (0.2 km at the closest point).

Table 5-3. Comparison of sub-alternatives ALT W1 and ALT W2.

	Line	ALT W1	ALT W2	Difference (ALT W1 – ALT W2)
Length, km	Line A	60.132	56.984	3.148
	Line B	59.106	56.275	2.831
Rock volume, m^3	Line A	148,000	152,000	-4,200
	Line B	192,000	130,000	61,400
	Total	*340,000*	*282,000*	*57,200*
Total length of freespans, km *	Line A	18.6	17.3	1.3
	Line B	19.0	15.5	3.5
	Total	*37.6*	*32.8*	*4.8*
Number of cable crossings	Line A	4	2	2
	Line B	4	2	2
	Total	*8*	*4*	*4*
Minimum water depth, m	Line A	54.9	82.9	-28.0
	Line B	45.2	87.1	-41.9

* including freespans with length > 25 m and heigth > 0.5 m

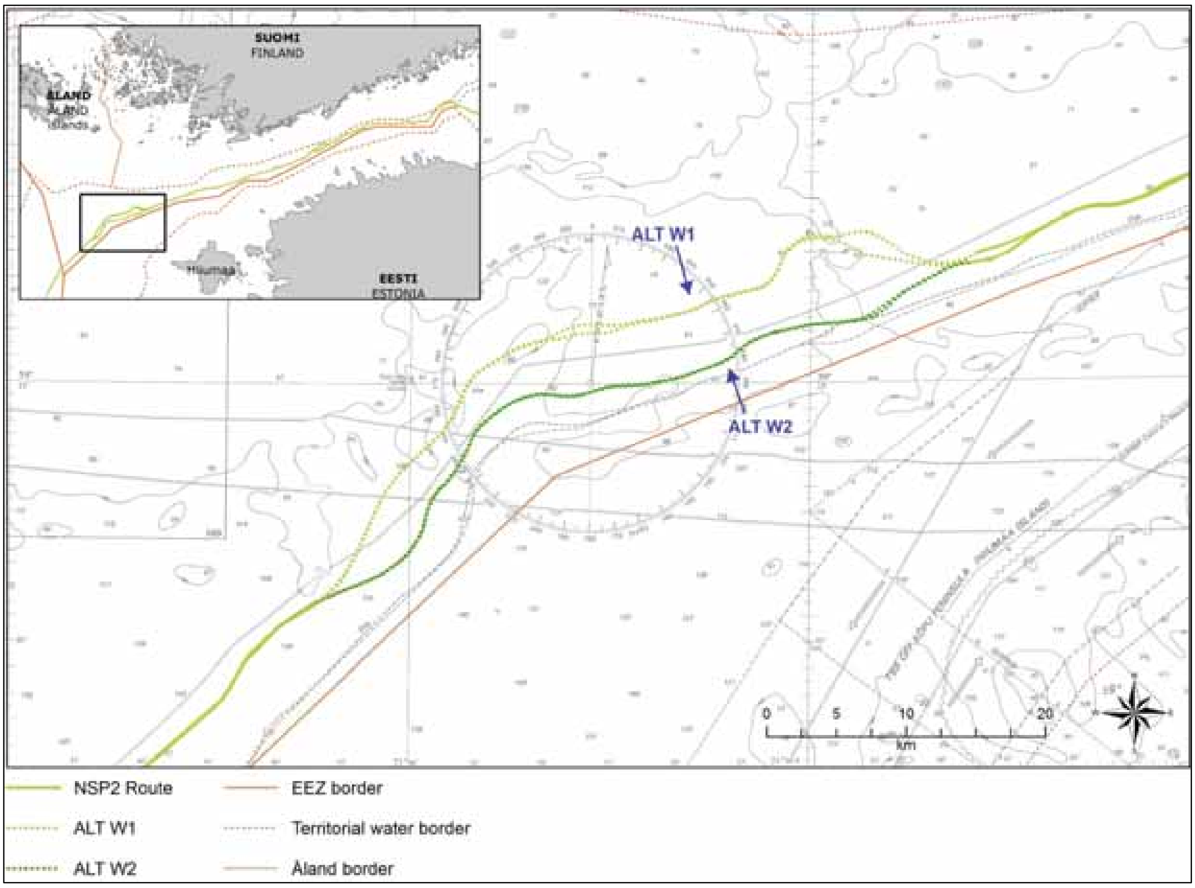


Figure 5-3. Sub-alternatives ALT W1 and ALT W2 in the western part of the Finnish EEZ.

5.2 Assessed construction alternatives

Two construction alternatives in the project are pre-commissioning with or without hydrotest ("Wet" and "Dry" pre-commissioning).

5.2.1 Pre-commissioning without hydrotest (Option 1, "Dry" pre-commissioning)

In this alternative the pipelines will not be pressure tested with seawater. Consequently, no seawater intake at the tie-in location at approximately KP 300 or seawater discharge are required.

Construction of a hyperbaric tie-in is not needed. This means a decrease in the rock volume of about 80,000 to 111,000 m^3, which is about 4 to 6 % of the estimated total rock volume in the Finnish section, and that the hyperbaric tie-in works will not take place in the Finnish EEZ at approximately KP 300.

5.2.2 Pre-commissioning with hydrotest (Option 2, "Wet" pre-commissioning)

In this alternative the pipelines will be pressure tested with seawater. Pressure test water will be taken from hyperbaric tie-in locations, including the tie-in at approximately KP 300 in the Finnish EEZ, at a water depth of 5 to 15 m. The seawater will be filtered and treated with an oxygen scavenger and potentially with UV treatment before filling the pipelines. Pressure test water will be discharged at the Russian landfall. A limited discharge from the pipeline(s) is expected potentially also at the tie-in at approximately KP 300 in the Finnish EEZ. This water will not be treated with any additives. The discharge locations and amounts of water will depend on the actual sequence of operations.

"Wet" pre-commissioning requires the construction of a hyperbaric tie-in at approximately KP 300. The rock volume used for the rock berm(s) at the tie-in location is estimated to be from 80,000 to 111,000 m^3. Hyperbaric tie-in works will be carried out as described in Subchapters 4.1.10 and 4.2.10.

5.3 Non-implementation

An environmental impact assessment should include a non-implementation (or zero-) alternative describing a situation in which the planned project is not carried out; in the present case that the Nord Stream 2 natural gas pipeline system is not constructed and operated in the Finnish EEZ. Non-implementation would mean that there will be no environmental or social impact from the project, neither adverse nor positive. The assessment of the non-implementation corresponds to the environmental baseline described in this EIA report (Chapters 7–9).

It should be emphasized that the Nord Stream 2 Pipeline has been designed in a way to avoid or minimise adverse environmental and socio-economic impacts. However, some environmental and socio-economic impacts can be expected based on the impact assessment carried out in this EIA. However, with several mitigation measures applied these impacts can be largely avoided. The experience from the former Nord Stream project and the extensive monitoring carried out in this project supports this assessment. The 0-alternative will, however, avoid all adverse impacts.

It should be noted that if the Nord Stream 2 Project is implemented, positive impacts will occur regarding certain socio-economic aspects. These positive socio-economic consequences, e.g. increase of employment and other revenues, will not occur if the project is not to be realized.

6. RELATIONS TO ENVIRONMENTAL POLICIES, PLANS AND PROGRAMMES

There are several international, EU and national policies, plans and programmes as well as other international commitments, concerning the use of natural resources and environmental protection which also cover the project area. The key plans and programmes and how they relate to the project are presented in Table 6-1.

Table 6-1. How environmental policies, plans and programmes concerning the use of natural resources and environmental protection relate to the project.

How environmental policies, plans and programmes concerning the use of natural resources and environmental protection relate to the project			
	Title	**Content**	**Relationship to the project**
CLIMATE AND ENERGY	**UN Framework Convention on Climate Change**	Under the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol has been adopted in 1997. The Kyoto Protocol legally binds developed countries to emissions reduction targets. The Protocol's first commitment period started in 2008 and ended in 2012. The second commitment period began on 1st of January, 2013 and will end in 2020. At the Paris Climate Conference (COP21) in December 2015, 195 countries adopted a universal, legally binding global climate deal. The agreement sets out a global action plan to limit global warming. Governments agreed on a long-term goal to keep the rise in global average temperature to below 2°C above pre-industrial levels. Additionally, the agreement aims to strengthen the ability to deal with the impacts of climate change. The agreement is due to enter into force in 2020.	Compared to other fossil fuels, natural gas produces less carbon dioxide emissions. Hence, the replacement of other fossil fuels with natural gas can reduce the average greenhouse gas emissions from energy production. Natural gas can provide low carbon energy for a long period of time by utilising already existing technologies. The use of natural gas is also more energy-efficient than the use of other fossil fuels in combined heat and power (CHP) production, in particular. Therefore, the overall efficiency of energy production can be increased by developing the use of natural gas. The climate change mitigation effects are discussed in more detail in Chapter 2 (Project justification). The project does not directly affect Finland, as the planned pipeline is not connected to the Finnish gas transmission network. However, the project is in line with the objectives of the National Energy and Climate Strategy of Finland, since the Strategy recognizes the role of gas in the transition towards a carbon neutral society.
	EU Energy Strategy	Some of the main objectives of EU energy policy are to lower greenhouse gas emissions, pollution and fossil fuel dependence. To pursue these goals, the EU has formulated targets for 2020, 2030, and 2050. The 2020 Climate and Energy Package defines the energy priorities between 2010 and 2020. It aims to reduce greenhouse gases by at least 20%, increase the share of renewable energy in the EU's energy mix to at least 20% of consumption and improve energy efficiency by at least 20%. The 2030 Framework for Climate and Energy Policy sets targets for the period between 2020 and 2030. Targets for 2030 are a 40% cut in greenhouse gas emissions compared to 1990 levels, at least a 27% share of renewable energy consumption and at least 27% energy savings compared with the business-as-usual scenario. The Commission's Energy Roadmap sets out four main routes to a more sustainable, competitive and secure energy system in 2050. The EU has set itself a long-term goal of reducing greenhouse gas emissions by 80–95% compared to 1990 levels by 2050.	

How environmental policies, plans and programmes concerning the use of natural resources and environmental protection relate to the project

	Title	Content	Relationship to the project
	Finland’s National Energy and Climate Strategy	Finland has adopted a national energy and climate strategy. The latest strategy update was adopted in 2013. The strategy defines the national energy and climate targets for 2020. The strategy also entails a programme to reduce oil dependence. Also, a Parliamentary Committee report, Energy and Climate Roadmap 2050, was published in 2014. The roadmap serves as a strategic-level guide on the way towards a carbon neutral society. The roadmap contains an analysis of the means for an 80–95% reduction in greenhouse gas emissions in Finland from 1990 levels by 2050. A new national strategy is also currently being prepared. The key objectives of the new strategy will be to increase the share of renewable energy, reduce greenhouse gases and observe the objectives of EU's energy and climate strategy.	
MARINE STRATEGIES AND PLANS	**EU Coastal and Marine Policy, Marine Directive**	The European Commission presented an Integrated Maritime Policy (IMP) in October 2007. It aims to achieve a good environmental status for EU marine waters by 2020 and to protect the resources upon which marine-related economic and social activities depend. The Marine Strategy Framework Directive 2008/56/EC (or Marine Directive) is the environmental pillar of the policy. The directive is aimed at the protection of the marine environment and natural resources and creating a framework for the sustainable use of marine waters. In order to achieve its goal, the directive establishes European marine regions, one of which is the Baltic Sea, and sub-regions on the basis of geographical and environmental criteria. In order to achieve strategy targets by 2020, each Member State is required to develop a strategy for its marine waters.	As stated in the first part of the Finnish Marine Strategy, the Strategy targets have not been achieved for any part of the Baltic Sea in Finnish territory. Consequently, the achievement of the strategy targets calls for measures in all of Finland’s marine areas. The recently adopted programme of measures sets obligations on authorities to promote the set goals. The programme includes measures concerning, for example, the sustainable use of natural resources within the marine environment, reduction in underwater noise (including underwater construction) and avoidance of damage and loss of seabed habitats. The implementation of the programme has commenced in 2016. In Estonia and Sweden a programme of measures has also been prepared. Both in Estonia and Sweden the programme was scheduled to commence in 2016. The compliance with the MSFD is discussed in more detail in Subchapter 7.2.1 and 11.20.1.
	Finland Marine Strategy	Finland's Marine Strategy implements EU maritime policy and the respective directive at national level. The Strategy consists of three parts. The first part, an initial assessment of the current status of the marine environment, was adopted in 2012. The second part, a monitoring programme for the marine strategy, was adopted in 2014.The third part of the marine strategy, the programme of measures for achieving a good environmental status in marine waters, was adopted by the Government in December 2015. The programme assesses the sufficiency of current measures to protect the marine environment and proposes new ones for achieving and maintaining a good environmental status.	

How environmental policies, plans and programmes concerning the use of natural resources and environmental protection relate to the project			
	Title	**Content**	**Relationship to the project**
	EU Strategy for the Baltic Sea Region	The EU Strategy for the Baltic Sea Region (EUSBSR) was approved by the European Council in 2009. The Strategy is a regional policy that includes a number of policy areas and horizontal actions to protect the sea, interconnect the region and increase prosperity in the Baltic Sea region. The various projects and processes implementing the strategy have been described in the Action Plan for the EU Strategy for the Baltic Sea Region.	The Action Plan is a framework that allows the European Union and Member States to identify needs and match them to the available resources by coordinating appropriate policies. Hence, the strategy as such does not impose any direct obligations on the operator.
MARITIME SPATIAL PLANNING	**EU Framework for Maritime Spatial Planning**	In July 2014, the European Parliament and the Council adopted legislation to create a common framework for maritime spatial planning in Europe (Maritime Spatial Planning Directive 2014/89/EU). The directive sets out the minimum common requirements for local, regional and national planning in sea areas. Pursuant to the directive, Member States are obliged to prepare their maritime spatial plan by 31th of March, 2021. The objectives of the legislation are to promote the sustainable growth of maritime economies, the sustainable development of marine areas and the sustainable use of marine resources.	The marine spatial planning has been implemented in national legislation in 2016 (Land use and Building Act, 482/2016) which came into force in October 2016. Detailed regulations regarding how to present spatial plans, the total number of plans etc. will be provided by Government decree. (Appendix 1, Map MP-01-F)
	Regional Baltic Maritime Spatial Planning Roadmap 2013–2020	The Regional Baltic Maritime Spatial Planning Roadmap 2013–2020 was prepared as part of the 2013 HELCOM Ministerial Declaration. The goal recognized in the road map is to draw up and apply maritime spatial plans (MSPs) throughout the Baltic Sea Region by 2020 which are coherent across borders and apply the ecosystem approach. The roadmap sets out the necessary steps to achieve the set goal. One of the steps is to have national frameworks for coherent MSPs in place in all Baltic Sea countries by 2017.	
RIVER BASIN MANAGEMENT	**River basin management plans and legislation**	In 2000, the EU Water Framework Directive 2000/60/EC (WFD) was adopted. The purpose of the directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwaters. Pursuant to the WFD, Member States must identify the individual river basins lying within their national territory and assign them to individual river basin districts. A river basin management plan must be prepared for each district. The plan contains a programme of measures that are set to meet the objectives of the directive. On a national level, the Act 1299/2004 on Water Resources Management, the Decree 1303/2004 on River Basin Districts, the Decree 1040/2006 on Water Resources Management and the Decree 980/2011 on Seawater Resources Management and the Decree 1022/2006 on Hazardous and Harmful Substances for the Aquatic Environment implement the EU Water Framework Directive. River basin management plans have been drafted for all of Finland's river basins.	The river basin district of Kymijoki–Suomenlahti covers the coastal areas of the Gulf of Finland. The river basin district of Kokemäenjoki-Saaristomeri – Selkämeri covers mainly the Finnish Archipelago Sea and the coastal areas of southwest Finland. The plans for 2015–2021 were approved in December 2015. In the Kymijoki-Suomenlahti plan the "Nord Stream extension project" has been recognised as a project that could have an impact on the status of the waters. The plan states that the impacts are mainly local impacts related to the construction of the pipeline and occur only for a limited period of time.

How environmental policies, plans and programmes concerning the use of natural resources and environmental protection relate to the project

	Title	Content	Relationship to the project
	River basin management plans and legislation		In the Kokemäenjoki-Saaristo-meri –Selkämeri plan, the Nord Stream extension project has not been recognised as a project that could have an impact on the water areas. The compliance with the WFD is discussed in more detail in Subchapter 7.2.2 and 11.20.2.
BALTIC SEA PROTECTION	**Convention on the Protection of the Marine Environment of the Baltic Sea Area (HELCOM)**	The 1992 Helsinki Convention entered into force in 2000. The Convention covers the whole of the Baltic Sea area, including inland waters as well as the water of the sea itself and the seabed. The Convention sets the contracting parties an obligation to take all appropriate measures to prevent and eliminate pollution in order to promote the ecological restoration of the Baltic Sea area and the preservation of its ecological balance. The Baltic Marine Environment Protection Commission (Helsinki Commission, HELCOM) is an environmental policy maker for the Baltic Sea area and the governing body of the Convention. HELCOM makes recommendations of its own and recommendations supplementary to measures imposed by other international organisations.	The convention and the related action plan contain measures, for example, on exploration and exploitation of the seabed and its subsoil as well as prevention of pollution from offshore activities. The convention sets the govern-ments an obligation to implement the provisions within their territorial sea and internal waters.
	Baltic Sea Action Plan (HELCOM)	The Baltic Sea Action Plan (BSAP) is a programme established to restore the good ecological status of the Baltic marine environment by 2021. The BSAP is regularly updated in ministerial meetings. National action plans have been formulated on the basis of the BSAP. In 2005, the Ministry of the Environment approved the Action Plan for the Protection of the Baltic Sea and Inland Watercourses, as a means of implementing the programme in Finland.	
	National Plans and Program-mes for the Protection of the Baltic Sea	Finland's Programme for the Protection of the Baltic Sea was introduced in 2002. The Programme objectives are to reduce the eutrophication of the Baltic Sea, to improve the ecological state of the nature and water areas of the Baltic Sea, to reduce the risks and potential damage from the transportation of hazardous substances and to preserve the biodiversity of the sea and coastal habitats. The National Action Plan for the Protection of the Baltic Sea was adopted in 2005.	The Action Plan requires envi-ronmental impacts of offshore construction works to be assessed and foresees measures to be taken to reduce harmful impacts.

How environmental policies, plans and programmes concerning the use of natural resources and environmental protection relate to the project			
	Title	**Content**	**Relationship to the project**
NATURE CONSERVATION PROGRAMMES	**The Natura 2000 Programme**	Natura 2000 is an EU-wide area network of core breeding and resting sites for rare and threatened species and some rare natural habitat types which are protected in their own right. The aim of the network is to ensure the long-term survival of Europe's most valuable and threatened species and habitats. The network includes Special Areas of Conservation (SAC) based on the Habitats Directive (1992) and Special Protection Areas (SPA) under the Birds Directive (1979). Sites of Community Importance (SCI) are areas proposed by a Member State to the European Commission to be included in the Natura 2000 network. In Finland, the Natura 2000 Programme has been implemented by Nature Conservation Act 1096/1996. Most of the protection areas have been established in the late 1990s, and the latest update of the network was undertaken in 2015.	There are numerous Natura 2000 areas in Finnish waters in the Gulf of Finland and Archipelago Sea. The project area is located in the deep sea areas in the middle of the Gulf of Finland. The route alternatives in the Finnish EEZ do not cross any Natura 2000 areas. However, at one location, a the NSP2 route comes close to the protected Sandkallan Natura 2000 area. Regarding the onshore sites, the main thoroughfare from Kotka–Mussalo harbour passes through a Natura 2000 area (FI0480001 "Itäisen Suomenlahden saaristo ja vedet"). There are also two, small, nature conservation sites: "Lehmänsaari" (YSA200556) and "Sarvenniemenkari" (YSA051521). The Natura 2000 area of Tam-misaari and Hanko Archipelago and Pohjanpitäjänlahti (FI010005) is located in the immediate vicinity of the Hanko–Koverhar onshore site. The effects of the project on the Natura 2000 protection network and Sandkallan area are described in more detail in Subchapter 11.7.
	National Conservation Programme for Bird Water Areas	The National Conservation Programme for Bird Water Areas has been established to preserve certain water areas in their natural state. The protected areas include the so-called Ramsar are-as that are defined in the international Ramsar Convention on Wetlands. All Ramsar areas are also part of the Natura 2000 network.	The Baltic Sea and the sea front are types of wetland recognised in the Ramsar Convention. Seve-ral Ramsar areas are located in the Gulf of Finland, such as Sö-derskär and Långören Archipela-go. However, such areas are not in the proximity of the project.
	National Shore Conservation Programme	The National Shore Conservation Programme aims to preserve the valuable freshwater shores and sea shores. The protected areas are unbuilt shores, the protection of which is mainly ensured by the Land Use and Building Act 132/1999. On the basis of the programme, 4% of sea shores and 5% of freshwater shores have been protected.	The measures of the programme do not cover the project area as such. However, onshore operations in areas around Kotka and Hanko should be organised in a way that the protected sea shores and freshwater shores are not affected. Such effects are not anticipated as onshore operations are not in the vicinity of any protected areas.
	National Strategy for the Protection	The main objective of the strategy adopted in 2012 is to half biodiversity loss in Finland by 2020. The national action plan, which is based on	The Baltic Sea and shore areas are also subject to the action plan. Direct obligations with

How environmental policies, plans and programmes concerning the use of natural resources and environmental protection relate to the project			
	Title	**Content**	**Relationship to the project**
	of Biodiversity and Sustainable Land Use	and implements the above strategy, includes 105 measures contributing to halving the loss of biodiversity and the degradation of ecosystem services.	respect to improving the state of the Baltic Sea and protecting the biodiversity are set by the respective authorities. Nord Stream 2 actions are not directly connected to the strategy and, therefore, no obligations are imposed on the operator.
	Action Plan for Improving the State of Endangered Habitats	The action plan, adopted in 2008, aims to stop the degradation of natural habitats by 2020 and to improve the state of already endangered habitats. According to the action plan, half of the underwater habitats of the Baltic Sea are estimated to be endangered. Red algae communities, eelgrass communities, charophyta fields and kelp communities have a reduced habitat area or the habitat has significantly declined in quality.	According to the action plan, the main reason for the deterioration is eutrophication, but the state of the underwater habitats could also be improved by taking deteriorated habitats into consideration in construction carried out in water areas. However, no direct obligations are imposed on operators.
	Agreement on the Conserva-tion of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas, ASCO-BANS	The ASCOBAN Agreement, adopted in Finland in 1999, contains a conservation and management plan that sets out measures for the conservation, research and management of the small cetaceans of the Baltic. The parties to the agreement have committed to apply within the limits of its juris-diction and in accordance with its international obligations the measures in question. The agreement also obliges to identify present and potential threats to the different species.	The harbour porpoise (cetacean), that is native to the Baltic Sea, is discussed in detail in the environmental baseline Subchapter 7.11.
CIRCULAR ECONOMY STRATEGIES	**EU Circular Economy Package**	In December 2015, the European Commission adopted a new Circular Economy Package to pro-mote European businesses and consumers to make the transition to a more circular economy where resources are used in a more sustainable way. The revised legislative proposals on waste set targets for reduction of waste and for establishing a long-term path for waste management and recycling. Key elements of the revised waste proposal include, among others, a common EU target for recycling 65 % of municipal waste by 2030 and a common EU target for recycling 75% of packaging waste by 2030.	The package consists of an EU action plan for the circular eco-nomy, which comprises of the adoption of a number of legislative proposals on waste. The Circular Economy Package does not impose any direct obligations on the operator. The NSP2 waste management plan is discussed in Subchapter 17.15
LANDSCAPES	**Landscapes of national interest**	There are 156 areas in Finland that have been classified as landscapes of national interest. The areas have been selected by a decision-in-principle by the Government in 1995. A new inventory of such areas was made in 2010-2014 and but no decision on new areas has been yet made. In accordance with the Land Use and Building Act 132/1999, landscapes of national interest must be taken into consideration in land use.	In the coastal areas of southern Finland, there are several areas classified as landscapes of national interest, such as Porkkala Archipelago and the Eastern Gulf of Finland Archipelago. Areas classified as landscapes of national interest do not have any direct impact on the operator.

How environmental policies, plans and programmes concerning the use of natural resources and environmental protection relate to the project

	Title	Content	Relationship to the project
SHIP TRAFFIC	**International Convention for the Prevention of Pollution from Ships (MARPOL)**	The MARPOL Convention is aimed at preventing and minimising pollution from ships. The Convention has six technical Annexes which set out direct obligations regarding the prevention of pollution from ships. National legislation implementing the MARPOL Convention has been adopted in Finland.	The MARPOL Convention and the respective national legislation set direct obligations regarding the prevention of pollution from ships. The obligetions concern, for instance, the prohibition to discharge at sea waste and sewage from ships. The mitigation measures on management of waste are discussed in Subchapter 17.15
	Maritime Transport Strategy for Finland 2014–2022	Finland has adopted a Maritime Transport Strategy for 2014–2022. The key aim of the Strategy is to ensure that Finland´s maritime transport and maritime industries can operate effectively and that the competitiveness of the national economy and environmental and safety issues are taken into account.	
DECOMMISSIONING	**United Nations Convention on the Law of the Sea, 1982 (UNCLOS)**	The process of decommissioning is in general regulated by international conventions in terms of the removal of installations and disposal of materials. The existing regulations aim at improving safety of navigation and other users of the sea as well as preventing pollution. There is no national legislation in Finland concerning the decommissioning of underwater structures. However some international conventions contain measures which may affect pipeline decommissioning to some extent. Article 60 (3) of the UNCLOS convention permits the partial removal of structures provided that International Maritime Organisation (IMO) criteria are met. The relevant IMO guidelines are described below.	The convention allows partial removal of underwater structures, in case other IMO guidelines are being followed.
	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972	The London Dumping Convention of 1972 and a later protocol of 1996 contain generic guidance for any wastes that can be dumped at sea. New guidelines of 1996, which specified different classes of waste, including platforms and other manmade structures, are based on the precautionary principle and mean that leaving the listed wastes in sea require a permit.	Controlled sea disposal, i.e. leaving the pipeline structures in sea bottom after the lifespan of the pipeline are allowed according to the 1996 protocol, but disposal requires a permit.
	International Maritime Organisation (IMO) 1998 guidelines	The 1989 IMO Guidelines require the complete removal of all structures in water depths less than 100 m and weighing less than 4,000 tonnes. Those structures in deeper waters can be partially removed, leaving a minimum 55 m of unobstructed water column above the partially removed installation for the safety of navigation. The guideline applies to abandoned or disused offshore installation or structures on any continental shelf or in any EEZ, hence, also on disused gas pipe installations. All structures installed after 1 January 1998 must be designed so that complete removal is feasible.	The decommissioning of NSP2 installations will be conducted in accordance with the regulation in force at the time of the decommissioning. Also, the best practices on decommissioning shall be taken into consideration.

How environmental policies, plans and programmes concerning the use of natural resources and environmental protection relate to the project			
	Title	**Content**	**Relationship to the project**
	EU offshore safety directive	The European Commission has issued Directive 2013/30/EU on the Safety of Offshore Oil and Gas Operations in June 2013. The Directive establishes minimum requirements for preventing major accidents in offshore oil and gas operations and limiting the consequences of such accidents. Offshore oil and gas operations mean all activities relating to exploration and production of oil and gas, but excluding conveyance of oil and gas from one coast to another.	The Directive requires operators that fall within the scope of the Directive to reduce risk of a major environmental accidents to a level *As Low As Reasonably Practicable*. Specific obligations on operators have been laid down in the Directive in this respect. However, the obligations do not apply to conveyance of oil and gas from one coast to another.

7. BASELINE OFFSHORE

This chapter presents the baseline information for the environmental impact assessment (EIA) of the planned Nord Stream 2 offshore gas pipeline project in the Finnish project area. The Finnish project area comprises the Finnish EEZ and territorial waters and is geographically located both in the Gulf of Finland and the Northern Baltic Proper.

On the whole, the description is primarily focused on providing adequate baseline information from the survey area (see definitions of areas in Subchapter 10.1.3) in the Finnish EEZ, where environmental impacts may potentially occur.

The baseline description includes information on:

- Physical and chemical environment (Subchapters 7.3–7.7), e.g. bathymetry, sediments, currents and water quality
- Biotic environment (Subchapters 7.8–7.15), geographical location and distribution of, e.g. fish, birds, marine mammals and also includes information on protected areas (e.g., existing Natura 2000 areas and national parks)
- Socio-economic environment (Subchapters 7.16–7.24), e.g. ship traffic, existing and planned infrastructure, commercial fishery, military areas, scientific and cultural heritage
- Environmental baseline status of the Finnish marine waters (Finnish Marine Strategy and the expected impacts of the project on that (Subchapter 7.2)

The main objectives of the baseline description are to describe and evaluate the present state of the environment along the pipeline route, to reveal sources of environmental contaminants, to provide additional data for the mathematical modelling (Subchapter 10.3) of possible impacts induced by the Nord Stream 2 Project and to identify the potential targets and areas that may be sensitive to disturbance.

7.1 Methods used to describe the environmental baseline

A large quantity of basic data of the current state of the abiotic and biotic environment of the planned project area in the Finnish EEZ has been obtained during the Nord Stream Project in 2008–2015. Ramboll Finland Oy prepared the national EIA and also the environmental monitoring reports during the construction and operation of the Nord Stream pipelines. Versatile information from different sources was collected also in 2012–2013 during the feasibility study and the EIA Programme Phase of the Nord Stream 2 Project *(Ramboll 2013a)*. Moreover, results from the environmental baseline studies conducted between December 2015 and May 2016 have been used to describe the physical, chemical and biological environment of the survey corridor in Finnish waters *(Luode Consulting Ltd 2016a)*. Sampling parameters and procedures were based on the survey programme *(Ramboll 2015a)*.

Available information on the environmental status and conditions in the open, deep sea waters and on the locations of the protected areas in the Gulf of Finland was acquired from different sources of which the main ones were the Finnish Environment Institute *(SYKE)* and HELCOM *(Baltic Marine Environment Protection Commission – Helsinki Commission).* The report on the evaluation of the cultural heritage objects (wrecks) inside the survey corridor was performed in 2016 by ARK-Sukellus on the assignment of Nord Stream 2 AG.

References used in describing the current state of the environment are presented in Chapter 23 References.

7.2 Marine strategic planning

7.2.1 Marine Strategy Framework directive

Finland's Marine Strategy implements EU marine environmental policy and the respective directive (Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy) at national level. The directive has been implamented in Finland by the Act on Water Resources and Marine Resources Management (1299/2004, as amended) and Government Decree on Marine Resources Management (980/2011).

The Strategy has three parts. The first part was adopted in 2012 and includes an initial assessment of the status of the marine environment and outlines the general environmental objectives and environmental descriptors of good environmental status (GES) *(Government Decision 13.12.2012)*. In marine strategic planning GES is described with 11 qualitative descriptors and with several indicators that are connected to these descriptors.

The second part was adopted in 2014 and includes a monitoring programme for the marine strategy.

The programme of measures for achieving a good environmental status in marine waters (GES), which is the third part, was adopted by the Government in December 2015 *(Laamanen 2016)*. The programme summarises the status (environmental descriptors of GES) of the marine environment and the human-based environmental pressures as well as presents the actions that will be adopted to improve environmental health. General environmental targets and their interactions with the qualitative descriptors are presented in Figure 7-1.

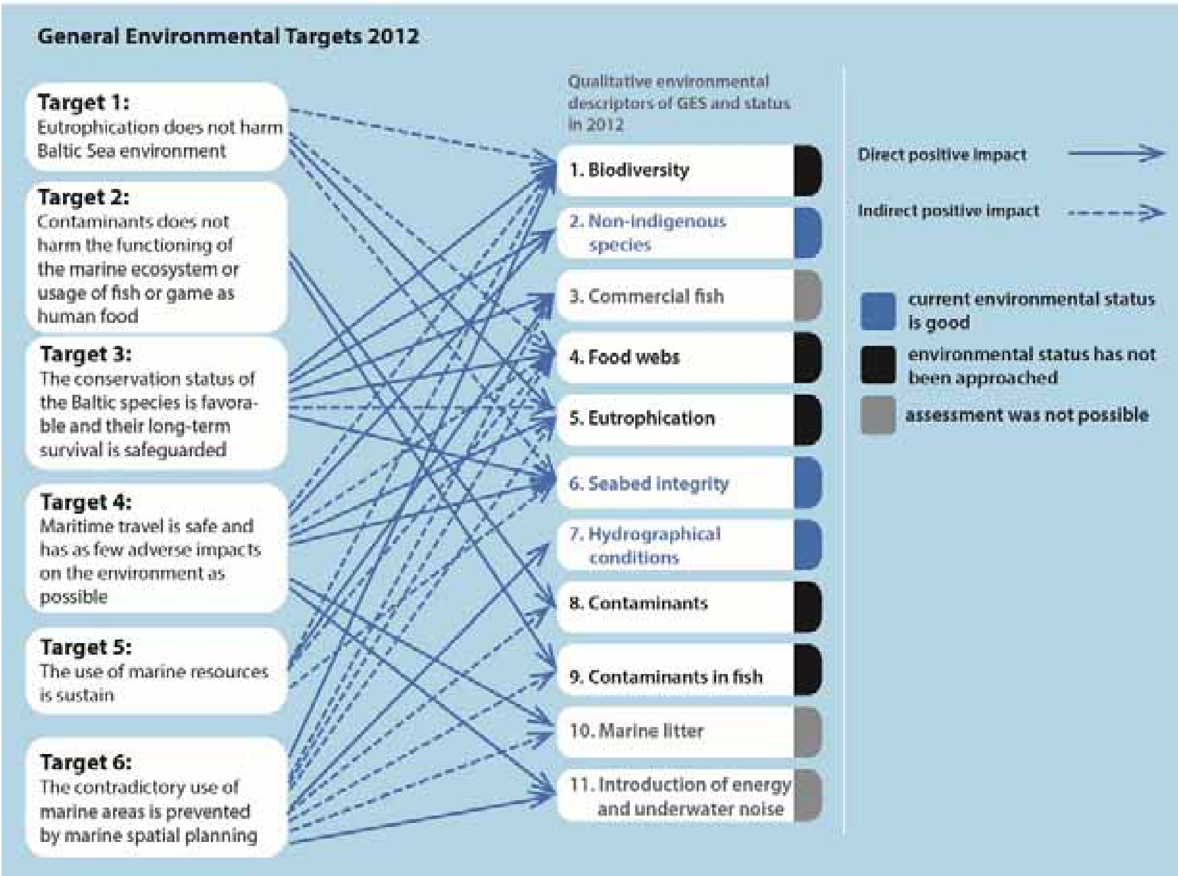


Figure 7-1. Links between general environmental targets and descriptors of good environmental status (GES). Achievement of general targets will cause either direct or indirect positive effects on descriptors of GES. (After Laamanen 2016)

Some of the environmental descriptors of GES are relevant when considering the impacts associated with the NSP2 Project. Environmental descriptors, the environmental status and the

Chapter on the baseline information are summarised in Table 7-1. The criterias for descriptors and associated relevant indicators and pressures are presented in Table 7-2.

Table 7-1. The current environmental status (2012) of environmental descriptors with respect to the set targets and the relevant human-induced pressures (Government Decision 13.12.2012, Laamanen 2016) and references to further information on the topics in the EIA.

Descriptor	Refers to:	Environmental Status, GES (2012)	Baseline information in the EIA
D1 Biodiversity	Biological diversity is maintained. The quality and occurrence of habitats and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.	Not approached	7.8 7.9 7.10 7.11 7.12 7.13 7.15
D2 Non-indige-nous species	The number of non-indigenous species present are at a level where no detrimental changes to existing ecosystems occurs.	Good	7.14
D3 Commercial fish	Populations of commercially exploited fish, shellfish and molluscs being within safe biological boundaries with respect to age and size distributions of populations i.e. reflecting good stocks (commercial fish).	Not assessed	7.10 7.17
D4 Food webs	To all elements of marine food webs occurring in normal abundance and diversity and at a level that ensures the long-term abundance of species and the complete preservation of their reproductive capacity.	Not approached	7.8 7.9 7.10 7.11 7.12
D5 Eutrophication	To the minimisation of harmful effects, such as deterioration of biological diversity and ecosystems; harmful algal blooms and oxygen deficiency of the seabed.	Not approached	7.6 7.8 7.9
D6 Seabed integrity	Conditions where the composition and functioning of the marine ecosystems are safeguarded and there are no harmful impacts to habitats associated with the seabed.	Good	7.9 7.21
D7 Hydrographi-cal conditions	Conditions where no harmful permanent impacts on marine ecosystems occurs.	Good	7.5
D8 Contaminants	Contaminants are at levels that do not lead to pollution impacts (especially mercury and organic pollutants).	Not approached	7.4 7.6
D9 Contaminants in fish	To the levels of contaminants in fish and other seafood used for human consumption that does not exceed levels set in legislation and relevant standards.	Not approached	7.10
D10 Marine litter	To the quantity or characteristics of litter that does not lead to harmful effects on coastal- or marine environments.	Not assessed	4.8.3
D11 Introduction of energy and underwater noise	To the levels that do not have adverse impacts to marine environment.	Not assessed	7.7

Table 7-2. Relevant criteria, indicators and pressures of qualitative descriptors of GES (Government Decision 13.12.2012, Milieu Ltd 2014).

Descriptor	Relevant criteria	Relevant indicators	Relevant pressures
D1 Biodiversity	• The species distribution corresponds to their natural distribution ranges and the populations are viable and the use of maritime space do not endanger the long-term survival of species, populations and communities • The populations are healthy and the state and use of marine waters do not endanger the preservation of populations and communities in the long run • The distribution, extent and condition of habitats correspond to their natural features • The structure of the ecosystem enables occurrence of all habitats and their functional groups and the diversity of those groups is guaranteed	• Seal distribution • The number of endangered marine species and populations • The diversity index of soft-bottom macrozoobenthos in offshore areas • The status of species/ communities typical for natural habitats	P1 P2 P3 P5 P6 P7
D2 Non-indigenous species	• NIS do not deleteriously affect native species and functional groups, the function of the trophic levels and ecosystem or habitats	• Appearance of new NIS • Trends of established NIS	P7
D3 Commercial fish	• Natural reproduction capacity of a fish stock is at a good level and the number of a broodfish can secure normal reproduction of the stock. The number of reproduction areas is sufficient to secure biodiversity and maintains migrating fish stocks and the ability of stocks to withstand fishing pressure without fish planting.	• Area based spawning stock size of Baltic herring and sprat	P2 P6
D4 Food webs	• The populations of top-predators are healthy • Fish populations are healthy and productive and species occur in natural abundance in the prevailing temperature and salinity conditions • The composition of phyto- and zooplankton communities are stable and enssure the transport of energy to the upper levels of the food web • The composition of benthos communities are stable and enssure the transport of energy to the upper levels of the food web	• The population size and changes in abundance of seals (grey seal and ringed seal) in long term • Fish indicators, see D3 • No indicators for plankton / benthos available	P5 P6 P7
D5 Eutrophication	• The amount and concentration of human-induced nutrients and organic matter in water are at a level that does not directly or indirectly have negative effects on the marine environment • Water is clear and planktonic algae or mass occurrences of algae do not have negative effects on water quality or other indirect negative effects	• Concentration of N, P and Si • Yearly nutrient load • Chlorophyll-a • sécchi depth • Concentration of fykosyanin	P6
D6 Seabed integrity	• Direct and indirect impacts on the seabed caused by human activities are at a level that enssures the structure and functioning of the ecosystems and particularily that no harmful impacts are caused to benthic ecosystems • The functioning of the benthic community and the species richness and diversity are not endangered and they can provide the required ecosystem services (circulation of nutrients and carbon) and functioning	• No indicator available	P1 P2
D7 Hydrographical conditions	• Alterations by human activities of the dominating hydrographical conditions (e.g. salinity, temperature, pH, hydrodynamic) do not harm functioning of the species, populations or ecosystem	• No relevant indicators	–
D8 Contaminants	• The concentrations of contaminants in organisms or in the water are at levels that do not not cause direct /indirect negative impacts on sensitive marine organisms or to species at the top of the food web • The concentrations of contaminants are at a level that do not cause negative biological impacts at the individual level nor at any level in the food web and the health of the marine organisms is not endangered	• Heavy metals in water • Organic tin compounds in fish and water • Number of oil spills • The population size of seals	P5
D9 Contaminants in fish	• See Table 7-1, no separate criteria	• Heavy metals in fish • Polychlorinated biphenyls and dioxins/furans in fish	P5

Descriptor	Relevant criteria	Relevant indicators	Rele-vant pres-sures
D10 Marine litter	• Litter in the sea or litter that will end up in the sea or the amount of degraded litter is at a level that does not cause significant chemical or physical harm to ecosystems and to the recreational use of the marine environment and it does not lead to negative economic impacts on the marine industry	• No indicators available	P3
D11 Introduction of energy and under-water noise	• The degree of impulsive and continuing noise generated by human activities is not increasing and is at a level that does not exceed natural noise levels or cause harmful effects on the ecosystem and does not cause economic harm to coastal and marine industry	• No indicators available •	P3

Pressures	**Impacts (Underlined = relevant for NSP2 impacts)**
P1 Physical loss	Smothering, sealing, occupation of seabed
P2 Physical damage	Siltation, abrasion, extraction
P3 Other physical disturbance	Underwater noise, litter
P4 Interference with hydrological processes	Significant changes to thermal or salinity regimes
P5 Contamination by hazardous substances	Synthetic compounds, Non-synthetic compounds, radionuclides and other hazardous substances
P6 Nutrient and organic matter enrichment	Fertilisers, N- or P rich substances, Organic matter
P7 Biological disturbance	Introduction of NIS, microbial pathogens

7.2.2 The Water Framework Directive

The Water Framework Directive *(Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, WFD)* is an initiative aimed at improving water quality throughout the EU in order to achieve a good status of both surface waters and groundwateri. In this regard, the WFD has a number of objectives, such as preventing and reducing pollution, promoting sustainable water usage, environmental protection and improving aquatic ecosystems.In practice, the WFD in marine areas cover coastal zone up to 1 nm beyond straight territorial sea baseline (Appendix 12, Map MP-01-F).

Additionally, a general minimum chemical standard (chemical status) has been established. A good surface water chemical status meana, by definition, that the chemical status meets the objectives established in Article 4(1)(a), i.e. a body of water has achieved a chemical status in which concentrations of pollutants do not exceed the environmental quality standards established in Annex IX, under Article 16(7) and under other relevant Community legislation.

The objective is to achieve a good ecological status and a good chemical status for all EU waters by 2015. The objective can be postponed to 2021.

The directive has been implemented in Finland by the Act on Water Resources and Marine Resources Management (1299/2004, as amended) and a number of associated Acts. The latest river basin management plans for the period 2016-2021 were approved by the Finnish Council of state on December 3, 2015.

The management plans, in general, include information on the environmental status of the waters, the pressures on good environmental status, how the environmental status is monitored and the measures taken to achieve the objectives for the status of surface waters. For the coastal waters of the Gulf of Finland, the Kymijoki-Suomenlahti River Basin Management Plan is relevant *(Karonen et al. 2015).* In this plan, eutrophication and harmful substances have been identified as pressures that have connections to MSFD.

Nord Strean 2 Project is mentioned in the Kymijoki-Suomenlahti River Basin Management Plan as a project that potentially has impacts on the outer archipelago zone in the Gulf of Finland. *(Karonen et al. 2015)*. It is assumed that the Nord Stream 2 Project has minor relevance regarding for coastal zones of the Gulf of Finland.

The classification of coastal waters in Finland is based on phytoplankton, water macrophytes (where appropriate), benthos, water quality and hydrographical-morphological conditions.

The overall ecological status of the Finnish coastal waters in the Gulf of Finland is assessed to be poor around Kotka area in the eastern part of the Gulf, moderate along the majority of the coastline of the Gulf and poor in the inner archipelago zone around Raasepori–Inkoo in the western part of the Gulf. The main pressure on the coastal areas is eutrophication, which is related to nutrient load mainly from non-point sources and internal loading due to poor oxygen conditions near the seabed *(Karonen et al. 2015)*.

According to Karonen et al. (2015), the good ecological status will not be met by 2021 in the coastal areas of the Gulf of Finland. The objective is expected to be met by 2027.

7.2.3 HELCOM Baltic Sea Action Plan

The HELCOM Baltic Sea Action Plan is an ambitious programme to restore the good ecological status of the Baltic marine environment by 2021 *(http://helcom.fi/baltic-sea-action-plan)*. The plan was adopted by all the coastal states and the EU in 2007 and it provides a concrete basis for HELCOM work.

The goals and objectives of the plan are:

- The Baltic Sea is unaffected by eutrophication
- The Baltic Sea is undisturbed by hazardous substances
- The status of the Baltic Sea biodiversity is favourable
- Maritime activities are environmentally friendly

The Action Plan has been implemented in Finland by a number of national programmes and legislation (Chapter 6).

7.2.4 Maritime spatial planning (MSP)

The EU MSP came into force in July 2014. It provides a common framework for maritime spatial planning in Europe. MSP is a process that brings together various users of the marine areas – including energy, industry, governments, conservation and recreation – to make informed and consistent decisions with the aim to use marine recources sustainably. MSP generally uses maps to create a more comprehensive view of a marine area. In other words, the process is similar to land-use planning, but for marine areas. This procedure helps planners to consider the cumulative impacts of maritime industries on marine areas and the intended result of MSP is a more coordinated and sustainable approach to how marine areas are used.

Marine spatial planning has been implemented in national legislation in 2016 *(Land use and Building Act, amendment 482/2016)* and entered into force on October 1, 2016. Detailed regulations regarding how to present spatial plans, the total number of plans etc. will be provided by Government decree.

7.3 Climate and air quality

7.3.1 Baltic Sea climate

The Baltic Sea Basin is embedded in the general atmospheric circulation system of the Northern Hemisphere. Climatologically the region is controlled by two large-scale pressure systems over the Northeast Atlantic: the Icelandic Low and the Azores High, and a thermally driven pressure system over Eurasia (high pressure in winter, low pressure in summer). The climate of the Baltic Sea area is controlled to a large extent by the prevailing air masses and atmospheric parameters are controlled by the global climate as well as by regional circulation patterns. During the past century, the increased frequency of both anticyclonic circulation (clockwise circulation around a high pressure in the Northern Hemisphere) and westerly wind types has resulted in a warmer climate with reduced sea-ice cover and decreased seasonal amplitude of temperature, indicating that multidecadal climate change in the Baltic Sea region is at least partly related to changes in the atmospheric circulation *(Omstedt et al. 2004)*.

The near-surface wind climate exerts a strong impact on the ecosystem of the Baltic Sea. Storms are essential for the ventilation and mixing of the strongly stratified Baltic Sea and inflow events importing salt and oxygen from the North Sea are very dependent on the wind climate and pressure differences between these two seas. *(HELCOM 2013a)*

Surface air temperatures have overall shown a significant increase in the Baltic Sea region over the past 140 years. Since 1871, the annual mean temperature trends show an increase of 0.11 °C per decade north of 60°N and 0.08 °C south of 60°N, while the trend of the global mean temperature was about 0.05 °C per decade for the period 1861 to 2000. The daily temperature cycle is also changing and there has been an increase in temperature extremes. These changes are resulting in changes in the seasons: the length of the growing season has increased, whereas the length of the cold season has decreased. *(HELCOM 2013a)*

The amount of precipitation in the Baltic Sea area during the past century has varied between regions and seasons, with both increasing and decreasing precipitation. A tendency of increasing precipitation in winter and spring has been detected during the second half of the 20th century. *(HELCOM 2013a)*

Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased globally. Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. In the Northern Hemisphere, 1983–2012 was likely the warmest 30-year period of the last 1,400 years (medium confidence). *(IPCC 2013)*

The atmospheric concentrations of the greenhouse gases carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) have all increased since 1750 due to human activity. Total radiative forcing is positive, and has led to an uptake of energy by the climate system. The largest contribution to total radiative forcing is caused by the increase in the atmospheric concentration of CO_2 since 1750. Carbon dioxide concentrations have increased by 40% since pre-industrial times, primarily from fossil fuel emissions and, secondarily, from net land use change emissions. *(IPCC 2013)*

7.3.2 Baltic Sea air emissions and air quality

The Baltic Sea is one of the world's most densely used sea routes with an estimated 2,000 vessels in traffic at any given time. Burning of fuel oil and LNG causes emissions to air. The most significant ship emissions are nitrogen and sulphur oxides (NO_x and SO_x), particulate matter (PM), and greenhouse gases, mostly carbon dioxide (CO_2). Nitrogen oxides cause eutrophication of the Baltic Sea, sulphur oxides, in turn, cause acidification of water bodies. Sulphur is bound to fine particles with a diameter of less than 2.5 micrometres ($PM_{2.5}$), which are particularly harmful to human health.

Total emissions from all vessels in the Baltic Sea in 2014 were 320 kt of NOx, 81 kt of SOx, 16 kt of particulate matter (PM) and 15.0 Mt of CO_2. Emissions of these pollutants have decreased by 2.2 %–2.8 % compared to 2013. The emissions of particulate matter and sulphur from Baltic Sea shipping have decreased gradually since 2006 because of the tightening SO_x emissions regulations of the MARPOL Convention in the Baltic Sea SECA area. *(Johansson and Jalkanen 2015)*.

A summary of the 2014 results are shown in Table 7-3, where the estimated annual total emissions are shown for different parts of the Baltic Sea. Most of the emissions are produced in the main body of the Baltic Sea, although the much smaller areas of Kattegat and the Gulf of Finland constitute a fair share of the total emissions. *(Johansson and Jalkanen 2015)*.

Table 7-3. Air emissions in the Baltic Sea in 2014.

	NO_X [tonnes]	SO_X [tonnes]	$PM_{2.5}$ [tonnes]	CO [tonnes]	CO_2 [kilotonnes]
Kattegat	60,230	13,949	2,861	6,372	2,705
Gulf of Finland	47,544	10,902	2,295	5,191	2,206
Gulf of Bothnia	22,440	6,910	1,343	2,563	1,267
Gulf of Riga	4,613	975	212	550	218
Other areas in Baltic Sea	187,703	49,108	9,498	19,417	8,691
Total	322,530	81,844	16,209	34,093	15,087

In 2010, the total waterborne and airborne input of nitrogen to the Baltic Sea was 977,000 tonnes. Atmospheric nitrogen deposition amounted to 218,600 tonnes (22 %) of the total nitrogen input. However, Baltic Sea shipping accounted for 13,840 tonnes of airborne nitrogen input, amounting to 6 % of total atmospheric and 1% of total nitrogen input (Figure 7-2). *(HELCOM 2015a)*

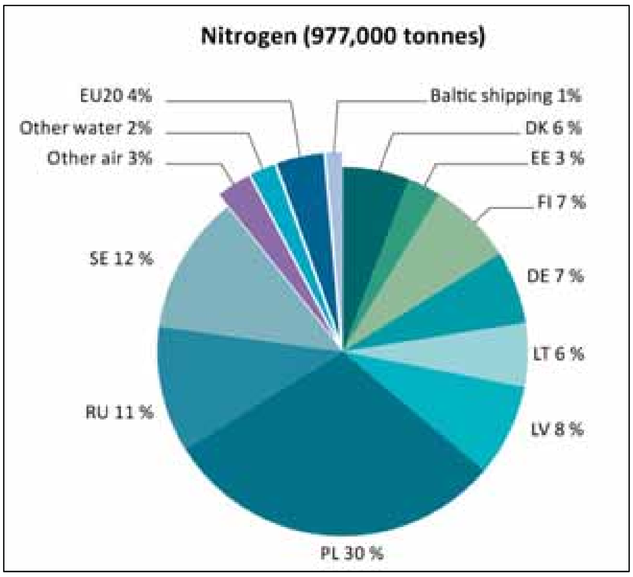


Figure 7-2. Total actual waterborne and airborne inputs of nitrogen to the Baltic Sea in 2010 by HELCOM Contracting Parties and other sources (HELCOM 2015a).

7.4 Seabed morphology and sediments

The seabed along the survey corridor consists of sedimentation areas, erosion areas and a mixture of these (Figure 7-3). The properties of the surface sediments vary from very soft silt or clay to bedrock. Numerous outcrops of hardground occur within the Finnish sector. The size and frequency of outcrops of hardground is highest in the east and decreases towards the west (Figure 7-4; *Fugro Survey Limited 2016*).

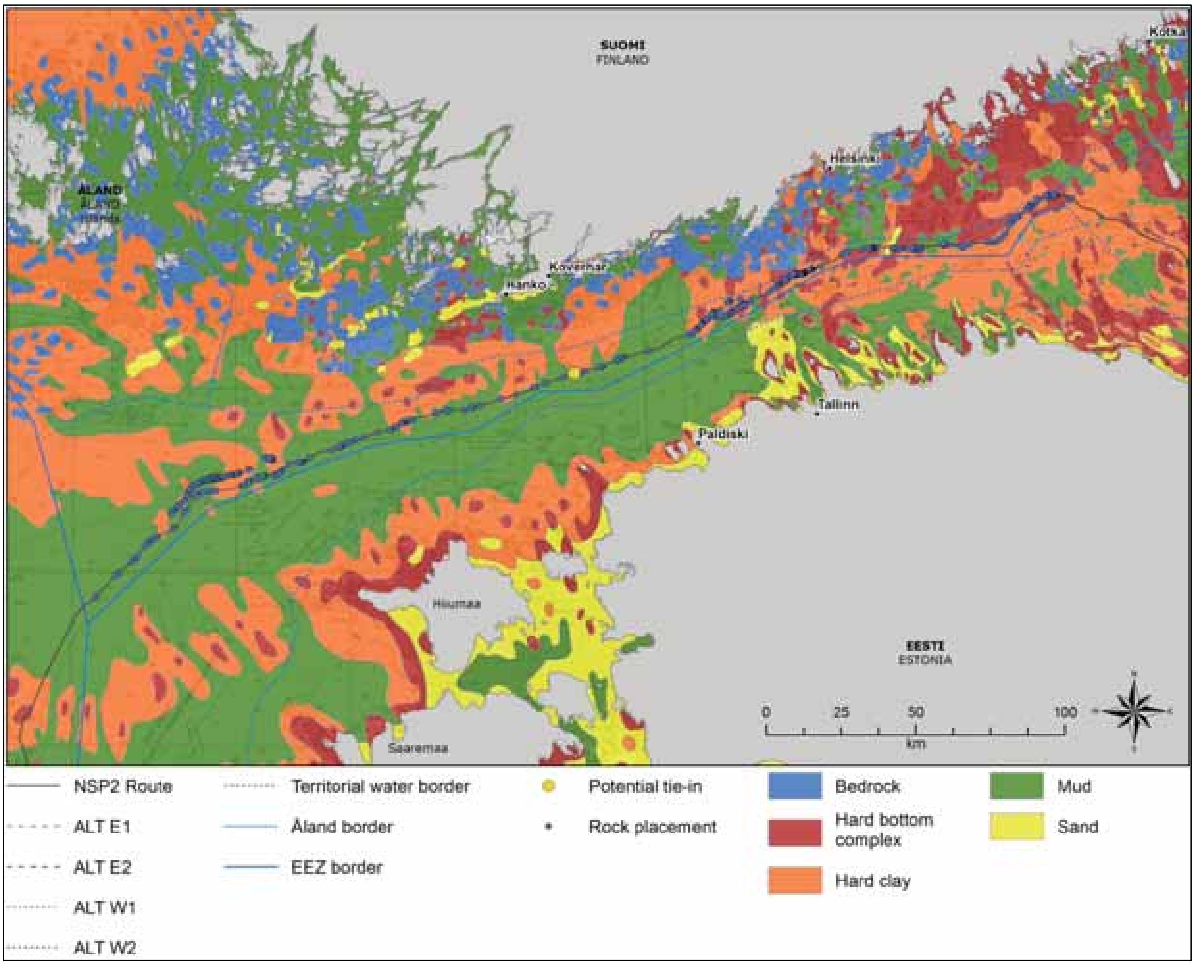


Figure 7-3. **Schematic seabed structure of the pipeline route, the Gulf of Finland and the Northern Baltic Proper [Source: Geological Survey of Finland (GTK)].**

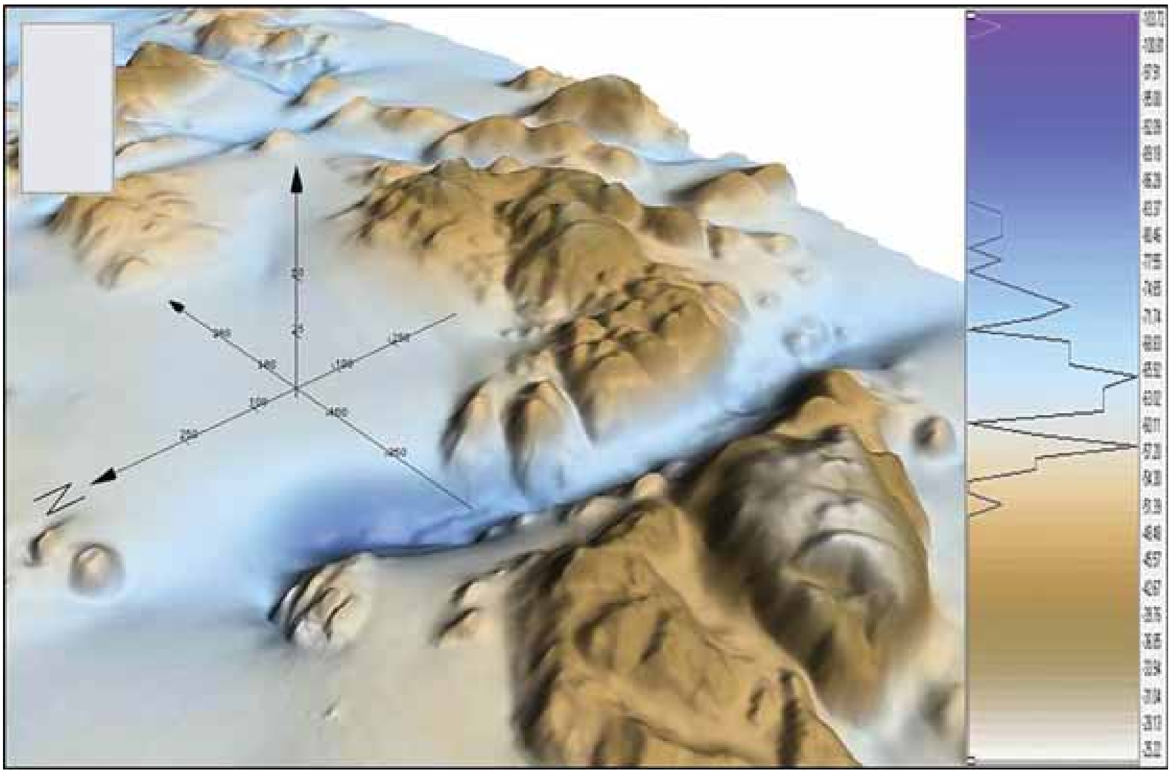


Figure 7-4. **Seabed morphology inside the survey corridor. 3D illustration of bathymetry showing an elongated bathymetric low from approximately KP 119 to KP 122.5. (Fugro Survey Limited 2016).**

7.4.1 Grain size classification and sediment properties

Grain size is one of the most important physical properties, because it is an index of specific surface area and can, thus, give information of its ability to adsorb harmful substances. The smaller the particle is, the larger specific surface area it has.

Sediment particles are normally classified according to size as follows:

particle	limit (mm)
- Clay	<0.002
- Silt	0.005 (0.075)
- Sand	2
- Gravel	75

Mud is a mixture of water and some combination of soil, silt and clay.

The natural, small-scale variation in the physical composition of the seabed is typical for the open, deep sea waters of the Gulf of Finland. The eastern part of the Finnish EEZ is located mainly on hard seabed consisting of hard clay, while the middle and western parts consist mainly of soft clay/mud sediments. Soft seabed areas form about 59 % of the total project area.

Surface sediment properties along the survey corridor were described in December 2015 during the environmental baseline survey. In the eastern stations, the seabed consisted of substances like rock, gravel, concretions[2], sand, silt, clay, mud and sulphide mud.

An odour of hydrogen sulphide was detected in places, along the survey corridor, where soft sediment type was present, indicating poor oxygen conditions in the sediment-water interface.

[2] Concretions, also called nodules, are mineral deposits that are found in oceans, lakes and soils. Iron manganese (Fe Mn) concretions cover vast seabed areas in the Gulf of Finland. Bacterial community structures in these concretions are different from surrounding sediments.

The oxidised surface layer was very thin, if any, approximately one centimetre thick (Figure 7-5). As can be seen from Figure 7-5, conditions may vary relatively significantly even on a soft seabed type within an areal station.

Figure 7-5. Sediment profiles at areal station FIN_EBS_LUO_2 (Figure 7-7). The smell of hydrogen sulphide was present in the profile shown on the right hand image. Water depth was 69 m (left image) and 74 m (right image).

In the western Gulf of Finland and in the Northern Baltic Proper, soil type changed into clay and soft mud. Also, these areas were noted to have only a very thin (≈1 cm) oxidised surface layer, if any, (Figure 7-5, left image). Below the oxidised surface layer, a layer of black sulphide mud was present with a thickness varying from a few centimetres to about 20 cm. In the deepest waters, sulphide mud was observed to be the first layer in the sediment profile right from the uppermost seabed surface (Figure 7-6, right image). Odour emanating from hydrogen sulphide was very common (17/24) at these stations *(Luode Consulting Ltd 2016a)*.

The median content of organic matter (loss on ignition) in the surface sediments was 7.2 % (6.8 %–10.4 %), being on average lowest in the eastern stations and increasing towards the west. Also, the proportion of clay (grain size fraction <2 μm) in the sediments was on average lowest in the easternmost stations (40 %) compared to the westernmost stations (52 %). All the surface sediments were rich in nutrients (median concentration of total phosphorus was 710 mg/kg and total nitrogen was 3,000 mg/kg; *(Luode Consulting Ltd 2016a)*.

Figure 7-6. **Sediment profiles at areal stations FIN_EBS_LUO_5 and 7 (Figure 7-7). Water depth was 71 m (left image) and 111 m (right image).**

7.4.2 Metals and organic substances

The analysed concentrations of heavy metals and dioxins/furans during the baseline survey in 2009 (related to the construction of the Nord Stream pipelines in the Finnish EEZ) were generally low in the surface sediment. However, metals like copper and cadmium were observed to be randomly high *(Ramboll 2011a, Ramboll 2013b).* The main source of tributyltin (TBT) is antifouling paints previously applied to the hulls of vessels. TBT can be expected to occur in the surface sediments near the shipping lanes.

7.4.2.1 Environmental baseline survey

In December 2015, baseline surveys were carried out for the Nord Stream 2 Project. Sediment samples were taken from seven areal stations to analyse the presence of contaminants in the surface sediments along the survey corridor. Within a single station, samples were taken randomly from eight locations. In total, 56 sediment samples or profiles were taken. Each sediment profile was photographed and the sample described. Analysis depths were 0–2 cm, 2–10 cm and 10–30 cm. Samples were analysed for heavy metals, polycyclic aromatic hydrocarbons (PAHs), organotin compounds (TBT, TPhT), polychlorinated biphenyls (PCBs) and dioxins and furans (PCDD/F; *Luode Consulting Ltd 2016a*).

Metals

Because of natural, small-scale variations on the seabed, the quality of surface sediments may vary significantly even within short distances. In 2015, the normalised median concentrations of metals, calculated from the whole data, were lower than the lowest guideline value 1 of the dredging guidelines (Environmental Administration Guidelines 1/2015; see footnote for Table 7-4). However, normalised concentrations of some metals (As, Cr, Cu, Cd and Zn) in single samples exceeded this level but were still within an acceptable level 1A (Table 7-4). This was found at all stations. The higher guideline value 2 (Environmental Administration Guidelines 1/2015) in single samples was exceeded by nickel (4 samples) and copper (1 sample, *Luode Consulting Ltd 2016a*).

Table 7-4. Analysed and normalised median heavy metal concentrations (mg/kg dry matter) in the surface sediments of seven areal stations. Environmental baseline study, December 2015.

Sediment profile 30 cm/Metal	Analysed median concentration, 0–30 cm (min–max)	Normalised median concentration, 0–30 cm (min–max)	MoE 1/2015[3]			
			Lower guideline value (concentration level 1) normalised			Higher guideline value (concentration level 2) normalised
			1*	1A**	1B***	
Arsenic	9.5 (1.2–63)	7.3 (1–48)	<15	15-50	50-70	>70
Mercury	<0.07	<0.1	<0.1	0.1-0.6	0.6-0.8	>1
Cadmium	0.5 (0.2–2.3)	0.4 (0.2–2)	<0.5	0.5-2.5		>2.5
Chromium	52.0 (3–110)	34.8 (2–74)	<65	65-270		>270
Copper	33.0 (1–58)	24.2 (1–42)	<35	35-50	50-70	>90
Lead	21.0 (2–50)	16.7 (2–40)	<40	40-80	80-100	>200
Nickel	38.0 (3–79)	22.3 (2–46)	<45	45-50	50-60	>60
Zinc	140.0 (6–270)	93.4 (4–180)	<170	170-360	360-500	>500

*Concentration level represents naturally occurring background level.

**No harm is expected to be caused to aquatic organisms even during long-term exposure. Concentration level is below the PNEC level.

*** No harm is expected to be caused to aquatic organisms during short-term exposure

Vertical distribution of heavy metals in the surface seabed sediments between the areal stations was relatively constant in different sediment layers (Figure 7-7).

[3] Environmental Administration Guidelines 1/2015. Guidelines for dredging and depositing dredged materials. Ministry of the Environment.

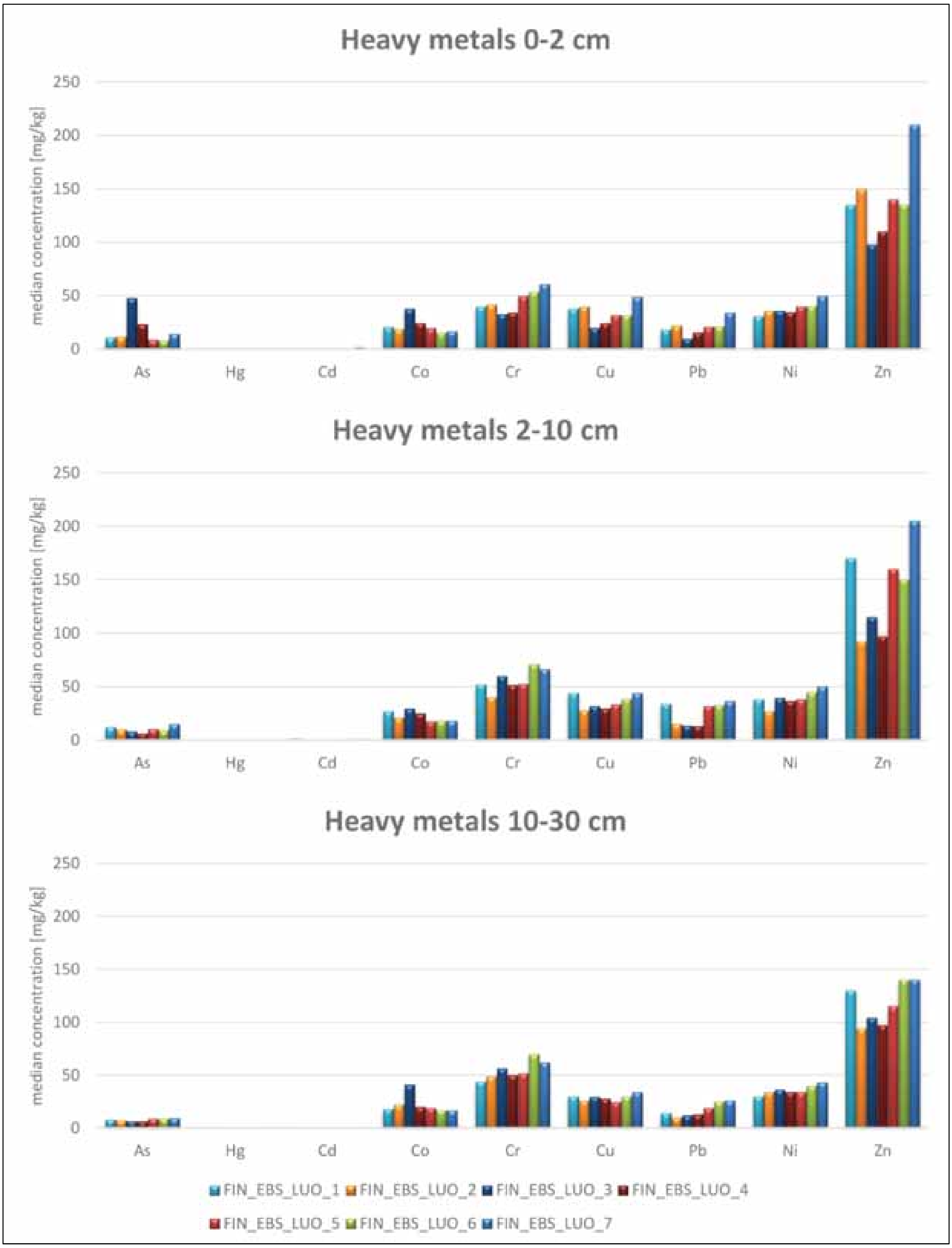


Figure 7-7. **Median heavy metal concentrations in the three surface sediment layers (0–2 cm, 2–10 cm and 10–30 cm) at areal stations FIN_EBS_LUO_1_SED – FIN_EBS_LUO_7 SED (Luode Consulting Ltd 2016a).**

In the data, the median concentration of cadmium exceeded slightly the lowest guideline level 1 at three stations (*Environmental Administration Guidelines 1/2015*, Table 7-7). The median concentrations of metals at the stations were all within the range of the lowest guideline levels 1, 1A and 1B that are presented in Table 7-4 (*Environmental Administration Guidelines 1/2015*, Table 7-5 and Table 7-6).

Highest median concentrations were measured for zinc. Although no major differences were detected in the contamination level between the stations, concentrations were generally highest in the westernmost areal stations where the surface sediment properties are favourable to the attachment of chemical compounds (Table 7-5 and Table 7-6).

Table 7-5. Analysed median heavy metal concentrations (mg/kg dry matter) in the surface sediments (0-30 cm) of seven areal stations. Environmental baseline study, December 2015.

Metal	Areal station (Figure 7-13)						
	1	2	3	4	5	6	7
	Analysed median values (mg/kg) ± standard deviation						
Arsenic	11±8.9	10±2.7	8±24.9	8±19.1	9±2.7	8±2.1	13±4.7
Mercury	<0.07±0.0	<0.07±0.0	<0.07±0.0	<0.07±0.0	<0.07±0.0	<0.07±0.0	<0.07±0.0
Cadmium	0.9±0.6	0.6±0.6	0.3±0.4	0.2±0.2	0.6±0.3	0.5±0.2	1.1±0.8
Chromium	44±20.5	42±14.2	52±17.9	50±12.5	52±11.4	58±11.6	62±12.5
Copper	37±14.2	28±12.8	26±9.4	28±7.9	32±8.1	32±4.9	42±8.0
Lead	19±12.3	15±12.3	12±3.5	14±5.0	21±9.6	23±7.8	30±10.9
Nickel	31±12.3	34±8.9	37±21.3	36±13.8	35±8.1	40±6.0	50±5.6
Zinc	140±53.6	96±56.2	110±37.4	99±25.7	140±38.8	140±22.7	190±52.6

Table 7-6. Normalised median heavy metal concentrations (mg/kg dry matter) in the surface sediments (0-30 cm) of seven areal stations. Environmental baseline study, December 2015.

Metal	Areal station (Figure 7-13)						
	1	2	3	4	5	6	7
	Normalised median values (mg/kg) ± standard deviation						
Arsenic	8±5.5	9.0±4.5	7±26.4	6±18.6	7±2.4	7±1.8	7±3.8
Mercury	<0.07±0.0	<0.07±0.0	<0.07±0.0	<0.07±0.0	<0.07±0.0	<0.07±0.0	<0.07±0.0
Cadmium	0.9±0.5*	0.7±0.5*	0.6±0.5	<0.2±<0.2	<0.6±<0.2*	<0.4±<0.2	<0.4±<0.6
Chromium	32±32	42±14.2	33±5.0	31±4.3	34±9.3	41±6.6	40±9.5
Copper	26±19.2	22±8.6	23±5.3	21±17.0	<20±<6.7	24±2.7	29±4.6
Lead	15±10.3	14±11.2	10±2.6	11±4.6	<22±<9.1	22±6.7	23±9.7
Nickel	22±32.0	24±20.4	21±19.7	20±10.0	20±5.3	23±3.0	25±3.7
Zinc	97±71.8	85±36.3	110±37.4	68±45.6	90±30.6	91±15.6	91±39.8

*value exceeding the lowest guideline level 1

Organic substances

Median normalised concentration of *dioxins/furans* (PCDD/F) at the areal stations slightly exceeded the lower guideline value (Table 7-7). This happened generally at all stations. Highest normalised concentration (143 ng/kg) was measured in the uppermost surface layer (0–2 cm) at areal station FIN_EBS_LUO_1 nearest to the Finnish/Russian border (Figure 7-8). Within the station, also another concentration (65 ng/kg – sediment layer 10–30 cm) exceeded the higher guideline value. The PCDD/F concentration was on the same level in one sample (70 ng/kg – sediment layer 2–10 cm) at areal station FIN_EBS_LUO_5.

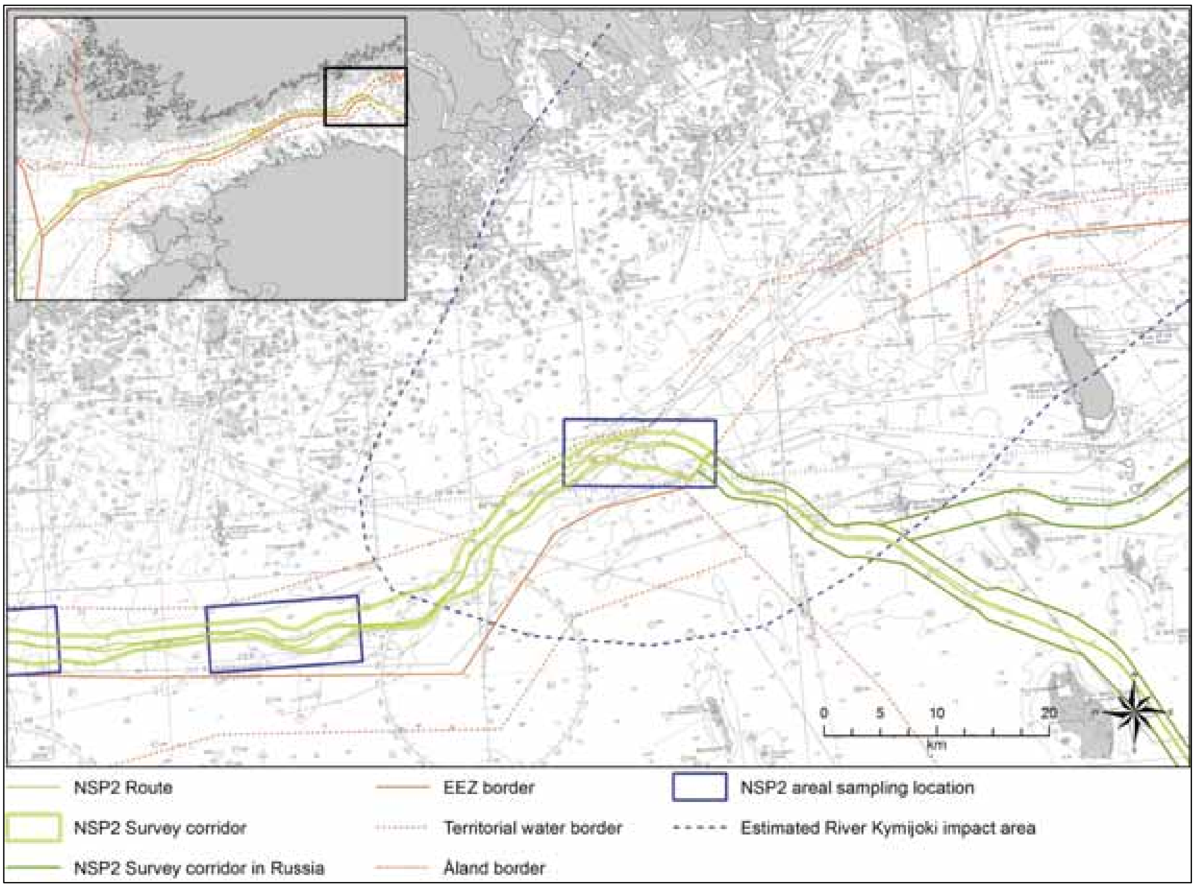


Figure 7-8. **Survey corridor and easternmost areal stations together with assessed impact area of River Kymijoki.**

The distance from the pollution source is the determining factor for certain substances to be found in the surface sediments. The easternmost part of the route, near the Russian border, has empirically been shown to be within the impacted area of the polluted sediments from River Kymijoki. The assessed impact area of dioxins, originating from the river, extends to a distance greater than 50 km from the estuary. However, based on survey results, the dioxin concentrations *(Isosaari et al. 2002, Ramboll 2009a)* have declined to about one-seventh of the initial levels in the delta area of the river *(Ramboll 2012a)*. In general, dioxins that are strictly bound to particles can be found only in soft seabed sediments where circumstances for sedimentation of drifting particles are appropriate (sedimentation basins).

A clearly elevated sum concentration of *polychlorinated biphenyl (PCB)* congeners was detected only at one sampling location in one surface (0–2 cm) sediment sample at areal station FIN_EBS_LUO_5. Otherwise, values were under the detection limit. In the eastern part of the survey corridor, *polycyclic aromatic hydrocarbons (PAHs)* were present only sporadically at some sampling points, whereas in the western stations these compounds were found more commonly.

Organotin compounds, mainly tributyltin (TBT) were present at all stations normally in the uppermost 10 cm sediment layer. The highest normalised concentration (192 µg/kg) in a single sample (sediment layer 2-10 cm) was measured at areal station FIN_EBS_LUO_5. Variation was typically high in the concentration levels between the sampling locations within an areal station. Normalised median concentration (<14 µg/kg) was within the range of one of the lowest guideline levels, 1A. Normalised median concentration of triphenyltin (TPhT) in the data was low (Table 7-7).

Table 7-7. Analysed and normalised median concentrations of dioxins/furans and organotins in the surface sediments of seven areal stations. Environmental baseline study, December 2015.

Sediment profile 0-30 cm	Analysed	Normalised	Lower guideline value (concentration level 1) normalised			Higher guideline value (concentration level 2) normalised
			1	1A	1B	
Dioxins/furans WHO(2005)-PCDD/F TEQ upper ng/kg	5.0	8	<5	5-10	10-30	>60
Organotins µg/kg TBT TPhT	 7 (0.6–121) 2 (0.6–7)	 <14 <2	 <5 <2	 5-30 2-10	 30-100 10-20	 >150 >30

Highest median concentration of dioxins/furans was measured in the easternmost areal station. At the other stations the concentration level was the same. TBT concentrations varied randomly between the stations and TPhT concentrations very low at all stations (Table 7-8).

Table 7-8. Normalised median concentrations of dioxins/furans and organotins in the surface sediments of seven areal stations. Environmental baseline study, December 2015.

Sediment profile 0-30 cm	Areal station (Figure 7-13)						
	1	2	3	4	5	6	7
	Normalised median values						
Dioxins/furans WHO(2005)-PCDD/F TEQ upper ng/kg	18	9	8	7	7	6	8
Organotins µg/kg TBT TPhT	 <25 <1	 <29 <2	 <1 <1	 <9 <1	 <20 <2	 <14 <2	 <2 <2

Vertical distribution of the analysed values of dioxins/furans and organotin compounds in the surface sediment between the areal stations is presented in Figure 7-9 and Figure 7-10.

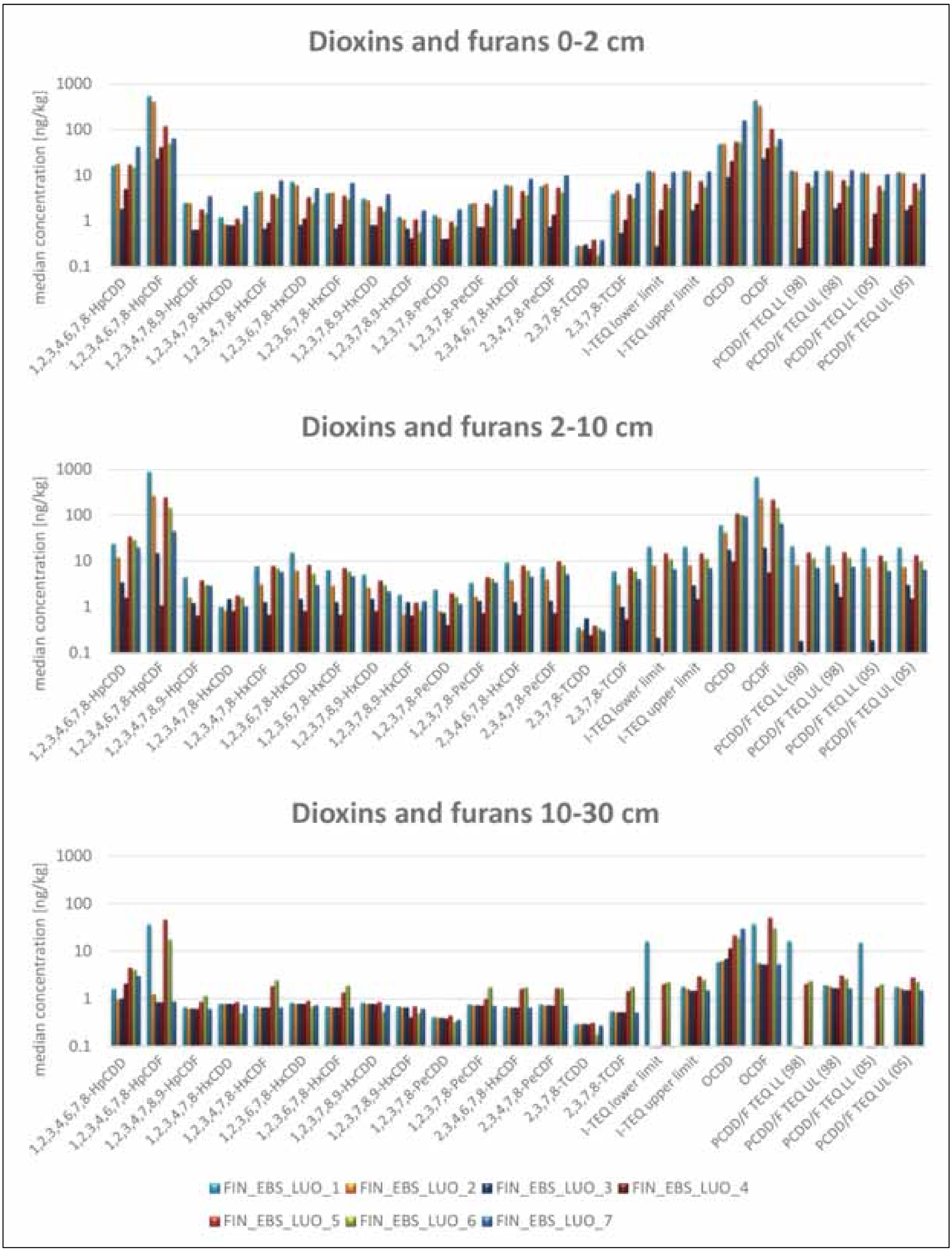


Figure 7-9. **Median dioxin/furan concentrations in the three surface sediment layers (0–2 cm, 2–10 cm and 10–30 cm) at areal stations FIN_EBS_LUO_1_SED – FIN_EBS_LUO_7 SED (Luode Consulting Ltd 2016a).**

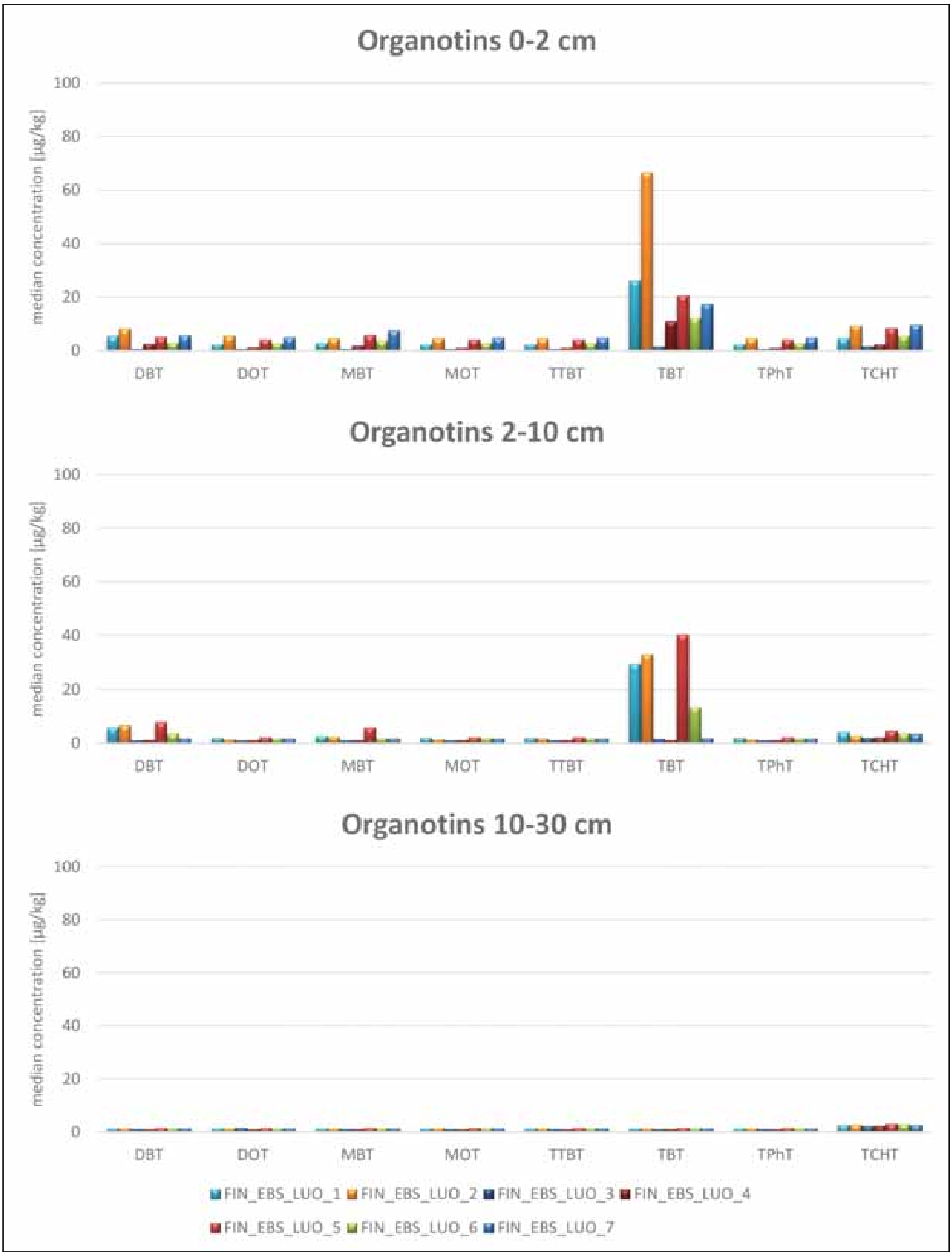


Figure 7-10. Median organotin concentrations in the three surface sediment layers (0–2 cm, 2–10 cm and 10–30 cm) at areal stations FIN_EBS_LUO_1_SED – FIN_EBS_LUO_7 SED (Luode Consulting Ltd 2016a).

7.4.3 Bathymetry

The average water depth in the Gulf of Finland is 37 m and the maximum depth is 123 m at Baldiski Deep *(Myrberg et al. 2006)*. The sea becomes shallower towards the east. Deepest areas (80 m →150 m) in the Finnish EEZ are located in the western and southern part of the Gulf. The prevailing water depth in these areas is greater than 70 m. The greatest depths are measured in the westernmost part that is classified as the Northern Baltic Proper (Figure 7-11).

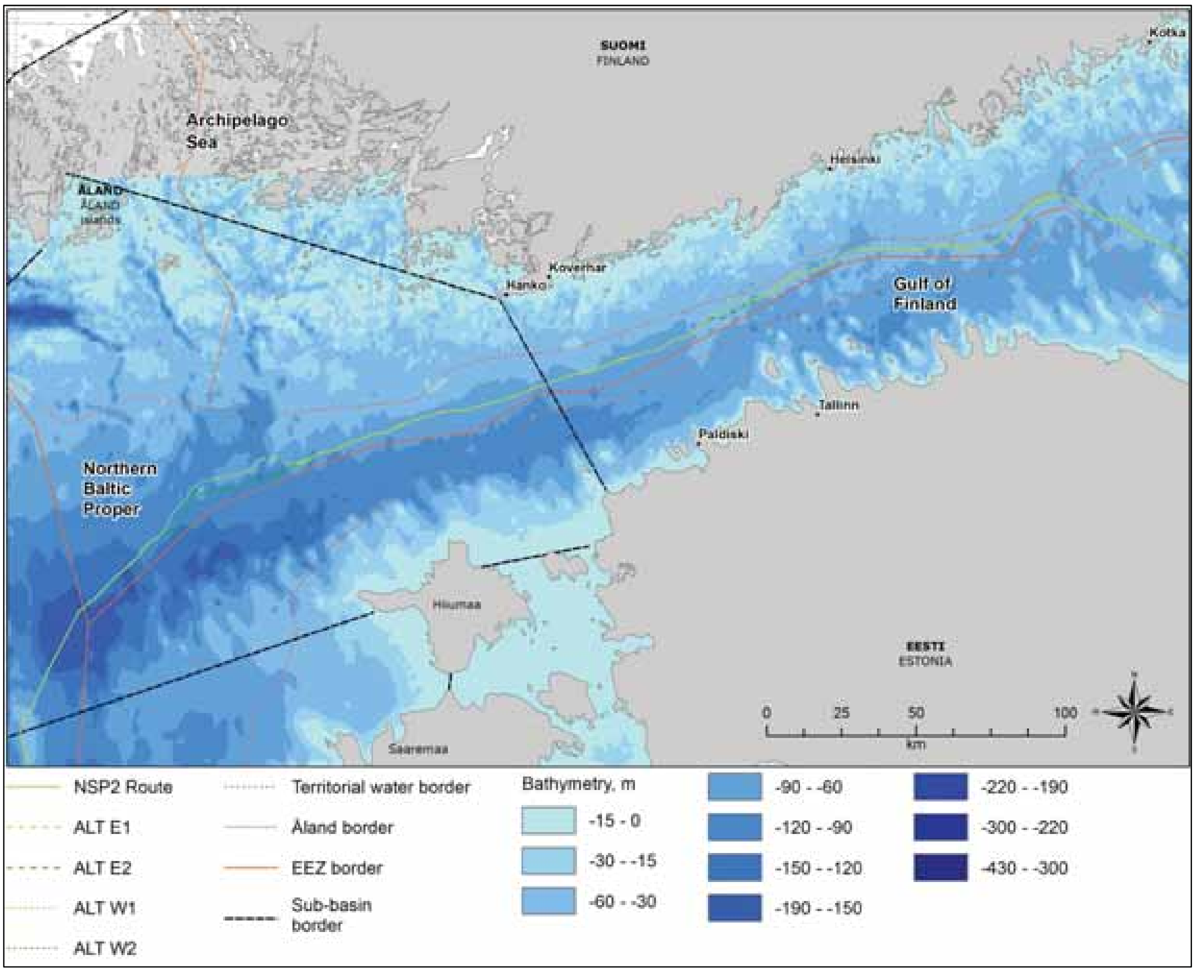


Figure 7-11. Seabed bathymetry in the Gulf of Finland and in the Finnish EEZ.

In the survey corridor of the Finnish EEZ, depth varies between 19 m and 196 m. *(Fugro Survey Limited 2016)*.

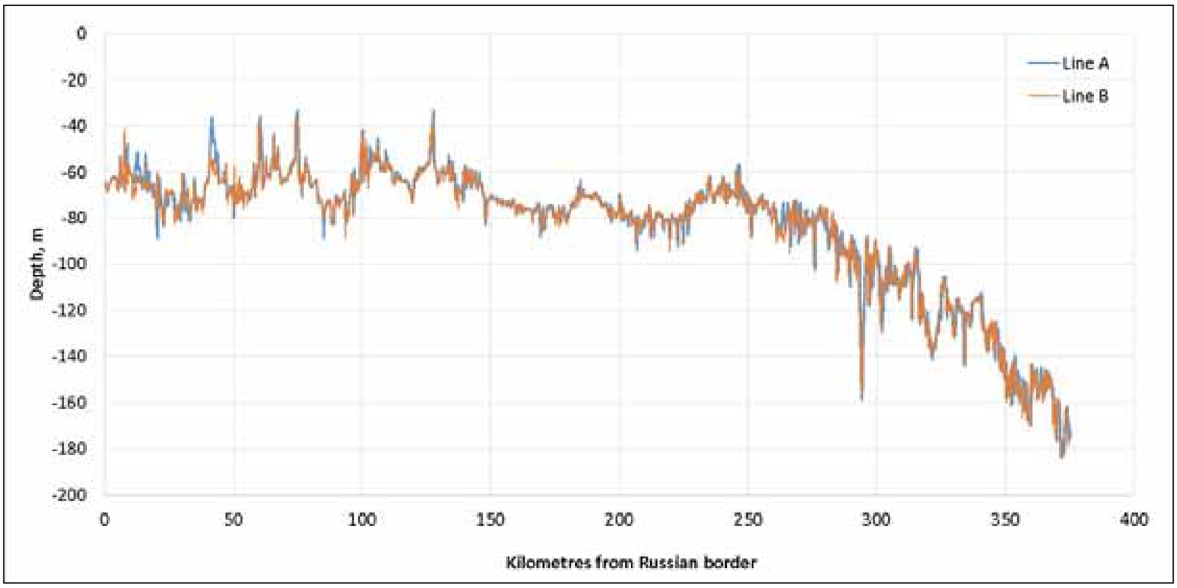


Figure 7-12 Vertical profile of the planned pipeline route E1+W2 in the Finnish EEZ.

According to the environmental baseline study carried out in December 2015, depth at the sampling locations at seven areal stations varied from east to west between 44 m to 114 m, respectively (Figure 7-13; *Luode Consulting Ltd 2016a*).

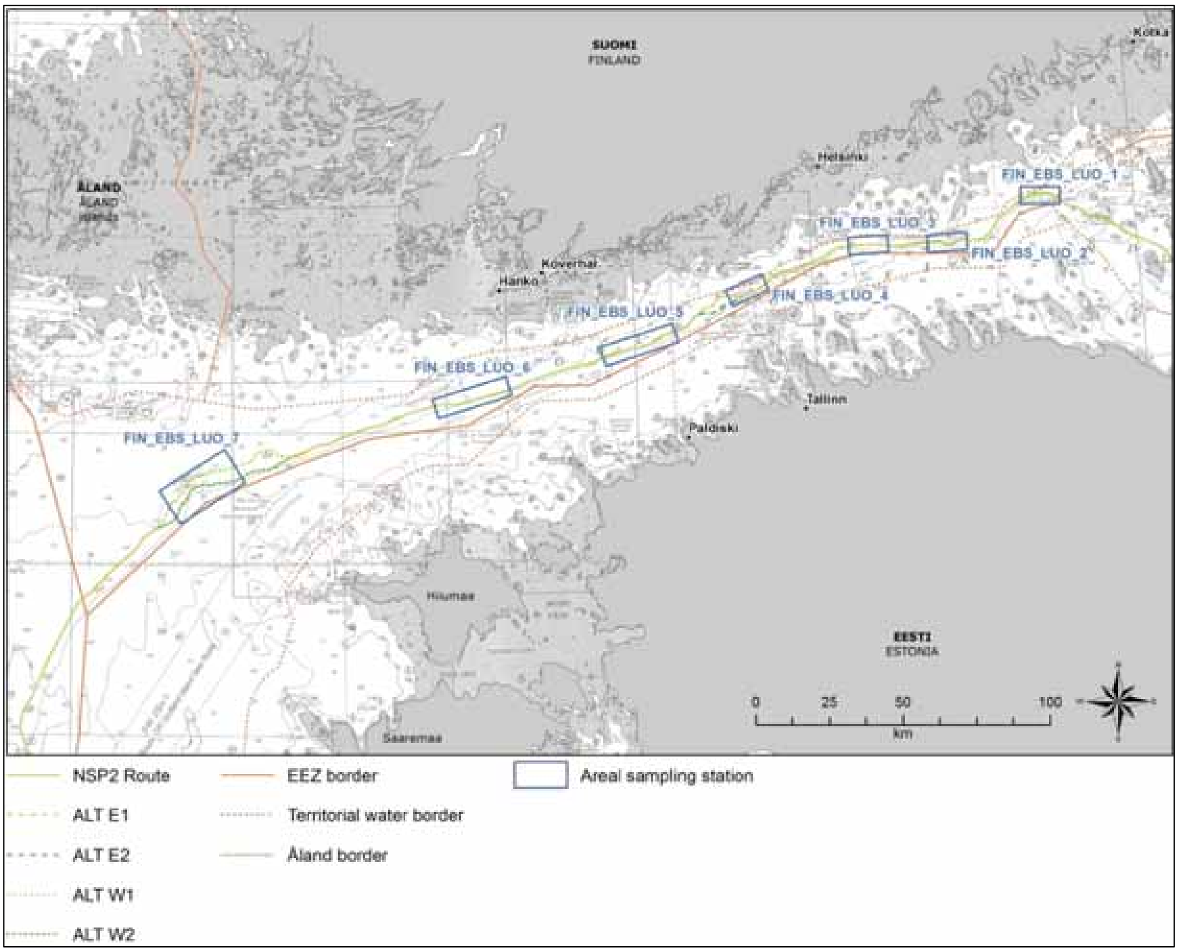


Figure 7-13. Location of the areal sampling stations along the survey corridor in the Finnish EEZ (Map Ramboll 2015a).

In order to describe the survey corridor, three approximate depth zones were identified along the survey corridor in the Finnish EEZ:

- 30–60 m, covering the middle and eastern sections of the pipeline route in the Gulf of Finland
- 60–80 m, covering the western section of the pipeline route in the Gulf of Finland and the Northern Baltic Proper
- >80 m, covering the westernmost section of the pipeline route in the Northern Baltic Proper

Table 7-9 presents the approximate surface areas of the different depth zones.

Table 7-9. Approximate depth zones in the survey corridor located in the Finnish EEZ.

Depth m	Area km^2	Proportion of total surface of the survey corridor %
0–30	0.2	0.01
30–60	345	25
60–80	437	31
>80	625	44

As can be seen from the table, the majority of the survey corridor in the Finnish EEZ is situated in the area of the deepest waters (>60 m). The depth zone, where conditions on the seabed should be most optimal for biota, forms approximately only 25 % of the total survey corridor in Finnish waters.

7.5 Hydrography

Salinity, temperature and oxygen have a significant influence on water quality and finally on the biodiversity of the Gulf of Finland. The vertical density difference caused either by salinity (halocline[4]) or temperature (thermocline) variations between the upper and lower layers inhibit mixing between surface and deep waters. It will also prevent oxygenated surface water from penetrating deeper water layers, but at the same time, hinders the transfer of phosphorus-rich waters from the lowermost layer to the surface layer. The strength of stratification is indicated by salinity or temperature difference between the surface and deep waters.

Salinity conditions in sea water in the Gulf of Finland vary to a relatively significant degree within an east-west axel. On the one hand, this is because the Gulf is connected to the Gotland basin without any sill (free intrusion of saltier water from the main Baltic Sea) and, on the other hand, in the east, River Neva brings large amounts of fresh water into the sea. In surface waters, salinity increases from zero in the easternmost part of the sea to 6‰–6.5‰ in the west. In the lowermost water layer, correspondingly, salinity varies between 0‰-5 ‰ (east), 5‰–8‰ (middle) and 7‰–9‰ (west). Halocline is normally present only in the middle and western part of the Gulf of Finland at a depth zone 60–80 m. However, if vertical differences in salinity are small (stratification is weak), halocline may disappear during autumn and winter storms *(Myrberg et al. 2006)*.

In the western and middle Gulf of Finland, the salinity stratification has strengthened in the deep sea areas since the 1990’s due to an increase in the near-bottom salinity (Figure 7-14). According to Raateoja and Setälä (2016), the existence of halocline has been very common

[4] Halocline is caused by a strong, vertical salinity gradient within a body of water. Because salinity (in concert with temperature) affects the density of seawater, it plays an important role in vertical stratification of a water column.

during the period 1996-2014 and, consequently, the occurrence of hypoxic events has increased in these areas.

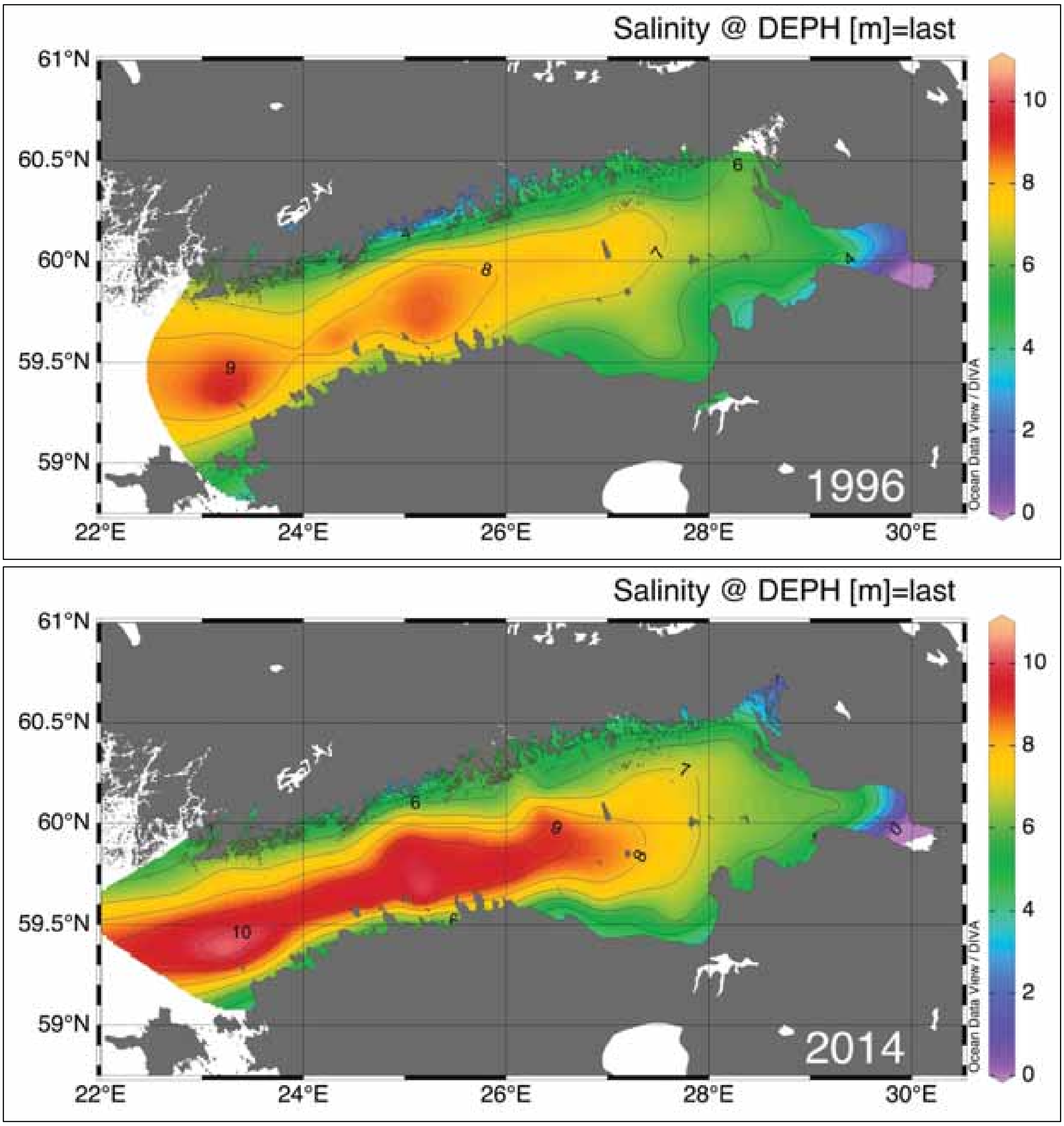


Figure 7-14. Near bottom salinity (g/kg) in 1996 (upper image) and 2014 (lower image) in the Gulf of Finland (Finnish Meteorological Institute).

Permanent halocline or thermocline during summer time, together with long-lasting input of nutrients from the catchment area, causes problems in oxygen levels near the seabed. Both slow renewal time of deep sea waters and an increase of bacterial breakdown of descending organic material contribute to oxygen depletion that may result to anoxia. When there is no more oxygen left in water, the end result is the formation of hydrogen sulphide that is a very toxic compound for biota. Moreover, in this situation, surface sediments rich in phosphorus (typical eutrophication phenomenon) after years of nutrient load, will release soluble phosphorus into the overlying water layer. It has been calculated that when poor oxygen conditions prevail, the amount of phosphorus flux from sediments (internal load) to overlaying waters is clearly larger than the annual external phosphorus load from the catchment area of the Gulf of Finland. Deep sea seabed sediments are typically such areas where the content of organic material is high. Total phosphorus concentration in the uppermost surface sediment is approximately 60 % higher than concentrations observed at a depth of 9–10 cm *(Lehtoranta 2003)*.

Changes in temperature and salinity profiles in a water column during different seasons in the western and eastern part of the Gulf of Finland are presented in Figure 7-15 and Figure 7-16.

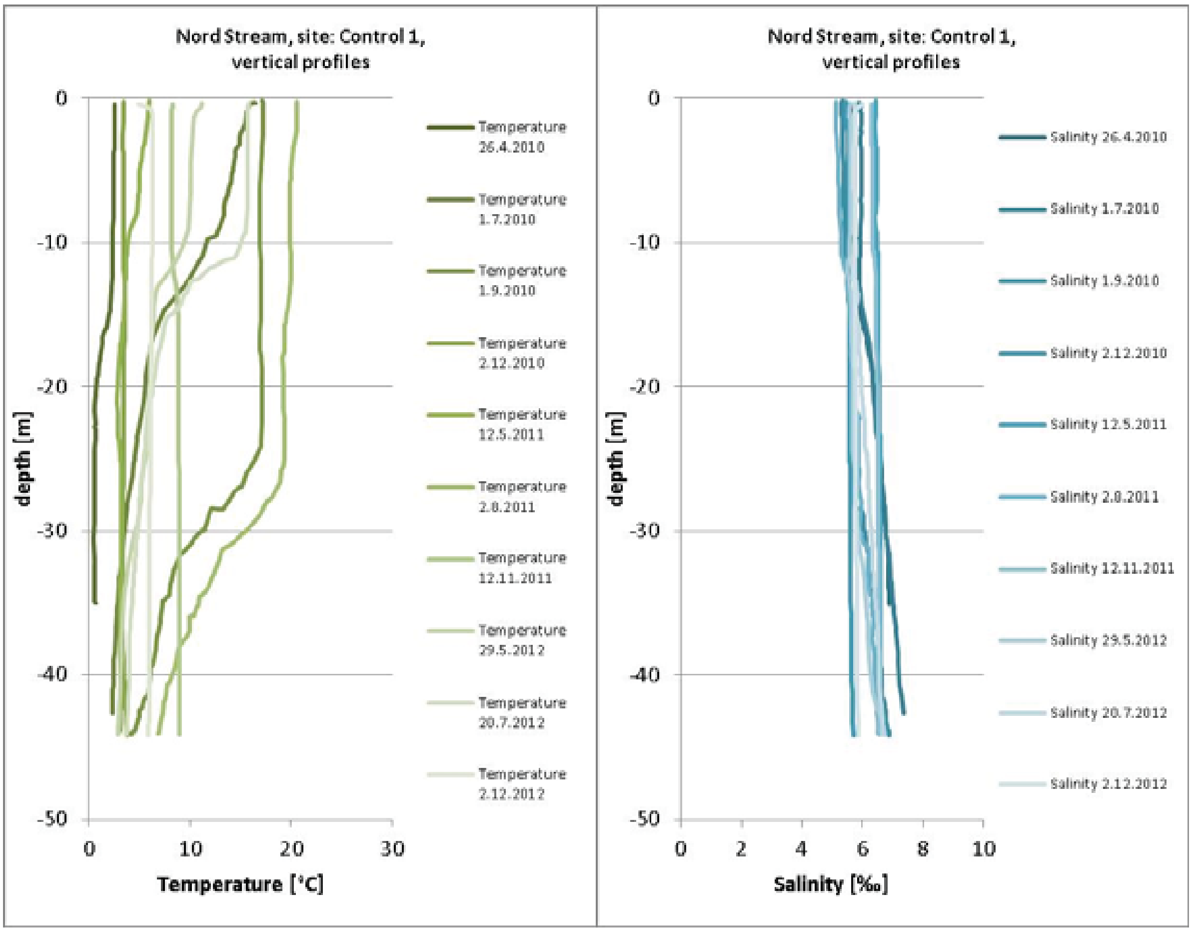


Figure 7-15. Variations in temperature and salinity profiles in a water column (depth 43 m) between spring 2010 and late autumn 2012 in the western Gulf of Finland (Table 7-17; Luode Consulting Ltd 2013a).

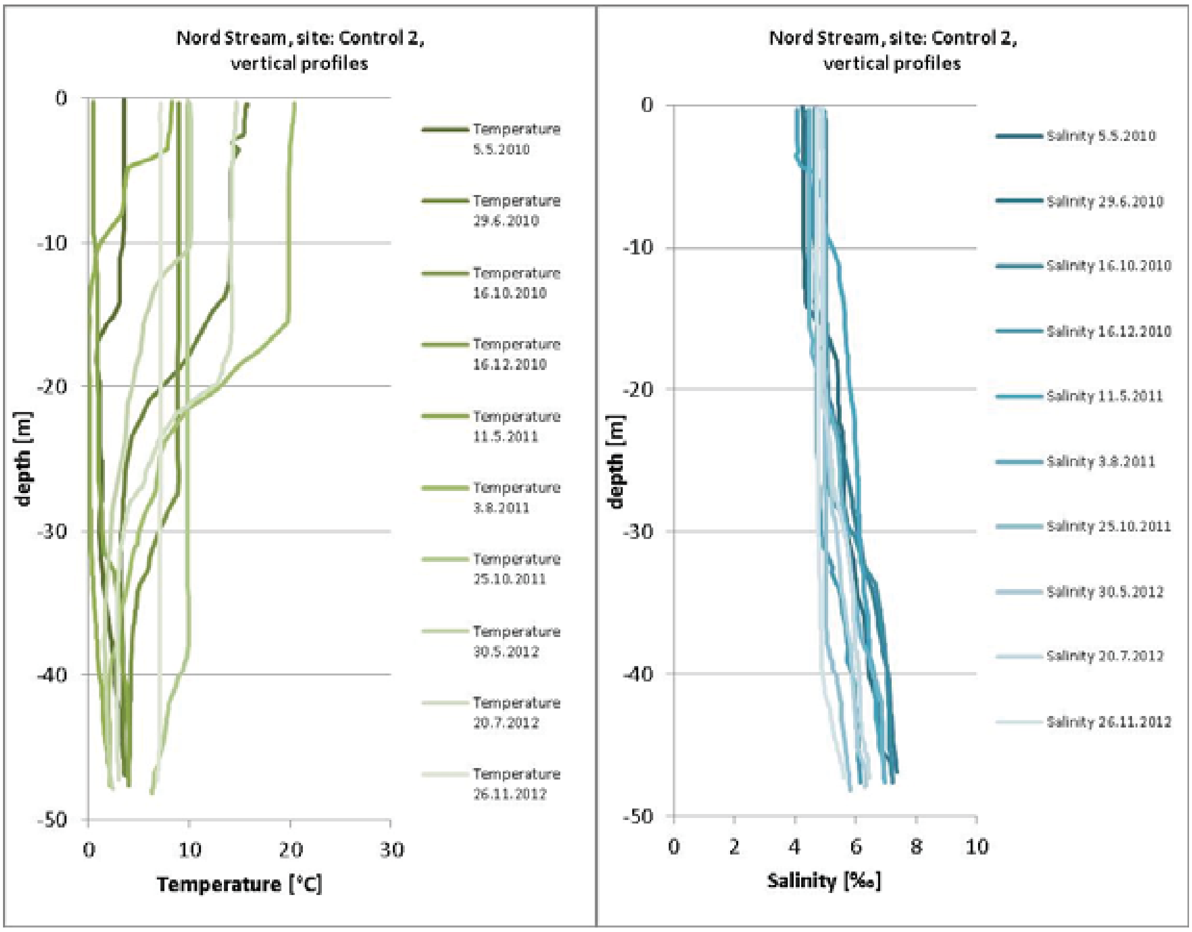


Figure 7-16. Variations in temperature and salinity profiles in a water column (depth 47 m) between spring 2010 and late autumn 2012 in the eastern Gulf of Finland (Table 7-17; Luode Consulting Ltd 2013a).

7.5.1 Ice conditions

The Finnish Ice Service of the Finnish Meteorological Institute (FMI) classifies the severity of the Baltic Sea ice seasons into three categories: mild, average and severe. A fourth category, extremely severe, can also be used. Classification is done according to the maximum extent of ice cover and is based on winters 1960–1961 to 2009–2010. Extensive movement of drift ice is typical in the open sea areas: in stormy conditions, a thin drift ice field can move 20–30 km in a single day. The motion results in an uneven and broken ice field with distinct floes up to several kilometres in diameter, leads and cracks, slush and brash ice barriers, rafted ice and ridged ice.

Ice coverage is complete in the Gulf of Finland and parts of the Northern Baltic Proper in average winters while mild winters result in only partial coverage (Appendix 12, Map CL-01-F). Figure 7-17 shows the ice conditions during the winter of 2015/2016 in the northern part of the Baltic Sea.

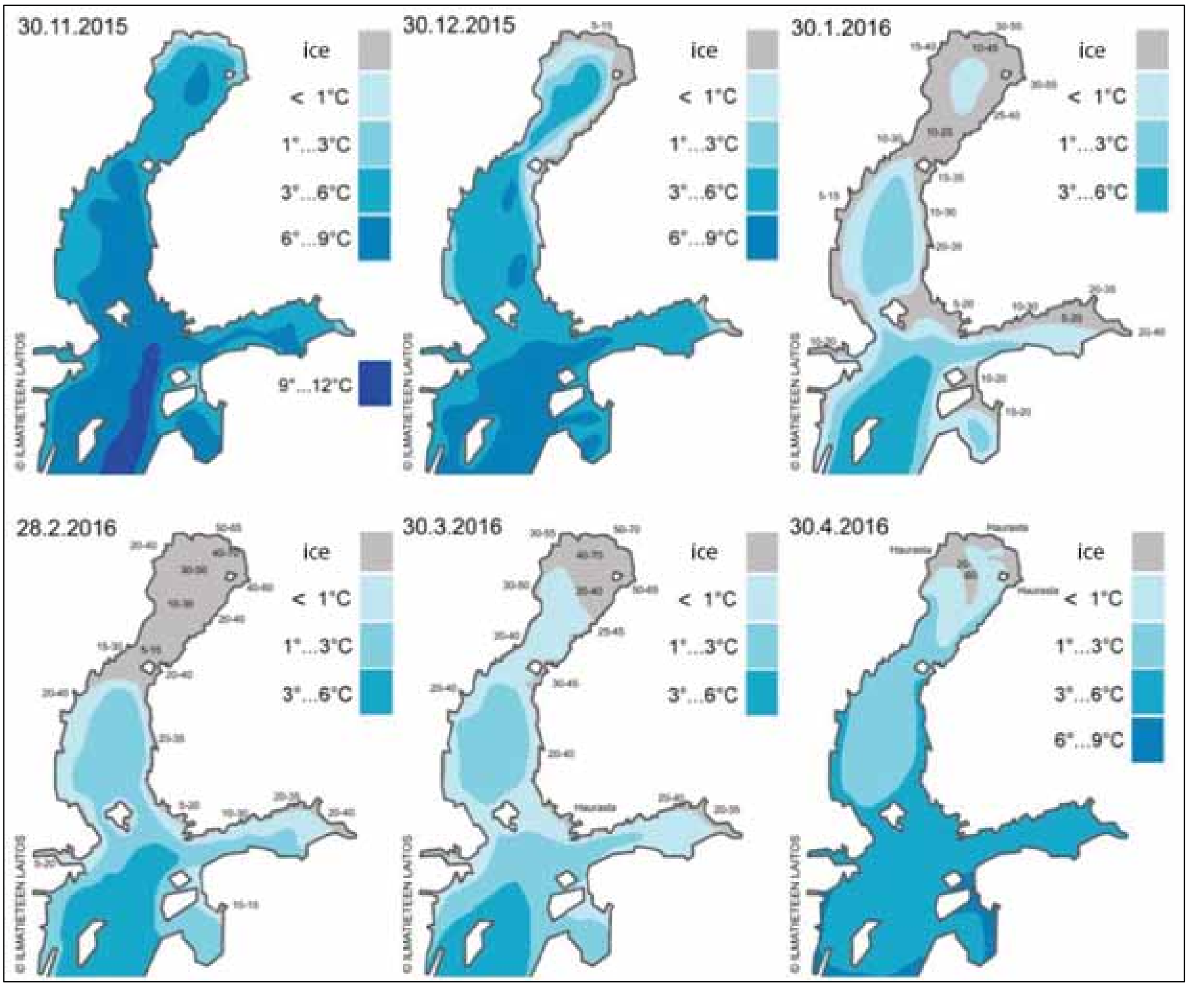


Figure 7-17. Ice formation in the Northern Baltic Sea in winter 2015/2016 (Finnish Meteorological Institute).

Normally, the melting season starts in April and proceeds from south to north. The ice winter 2015/2016 was very mild like some of the previous winters. The warming of the climate has been assessed to have an impact on the extent of the ice cover in the Baltic Sea.

7.5.2 Currents

The main force behind the currents in the Gulf of Finland is wind. However, also density-driven currents are important for the overall circulation pattern (pronounced horizontal density gradients in the east-west axel, caused by variations in salinity and temperature). Mean surface circulation in the Gulf of Finland is cyclonic (counter clockwise) with an average velocity of a few cm per second. The eastward inflow along the coast of Estonia takes place over the entire water column (most intense flow near the surface). Current velocities may vary between 1 and 4 cm s^{-1}, although values between 7 and 10 cm s^{-1} have been found near the surface *(Andrejev et al. 2004)*. Water is flowing westward out of the Gulf of Finland on the Finnish side (offshore the coast; mean velocity 8 cm s^{-1}). Outflow takes place at a water depth between around 10 m and 40–50 m. A schematic representation of the current pattern is shown in Figure 7-18.

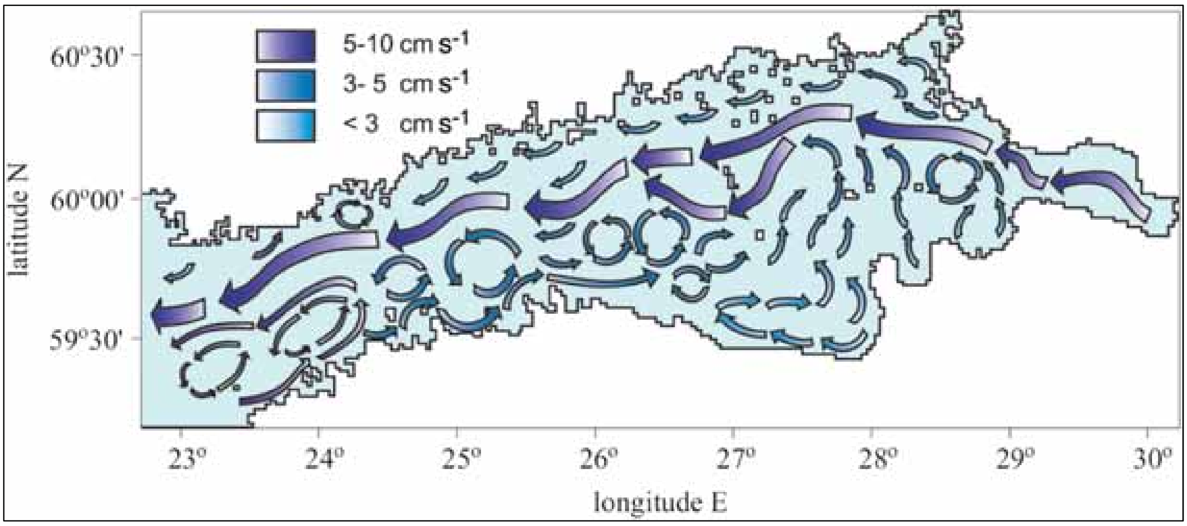


Figure 7-18. Schematic illustration of the mean circulation in the Gulf of Finland (after Andrejev et al. 2004).

As illustrated in Figure 7-18, the circulation patterns in the Gulf of Finland contain numerous meso-scale eddies. This circulation pattern can be found in both the mean and instantaneous flow field *(Soomere et al. 2008)*. The circulation in the eastern part of the central Gulf of Finland is mainly characterised by small-scale eddies. At depths exceeding 45 m, the effects of the seabed topography are in a major role in forming the small-scale vortices. In the western part, meso-scale cyclonic circulation patterns of about 60 km do occur. These currents are not seen in the surface layer *(Andrejev et al. 2004)*.

During the Nord Stream Project, current profiles were measured at the long-term monitoring stations (late 2009–late 2012, depth range 40–45 m) in the Finnish territorial waters and at some stations along the pipeline route in deeper water (Figure 7-19). Local current speeds in the water column were observed to vary in both space and time. The highest recorded current magnitude at the long-term stations in the layer nearest to the seabed varied from 37 cm s^{-1} (western area) to 51 cm s^{-1} (eastern area) illustrating the temporal variations.

In the open, deep sea waters of the Gulf of Finland, the average current speed near the seabed was 0.05 cm s^{-1} at the monitored sites (depth range 60–80 m) during the construction activities of the Nord Stream pipelines in 2010–2011. The highest single value recorded was 21 cm s^{-1}.

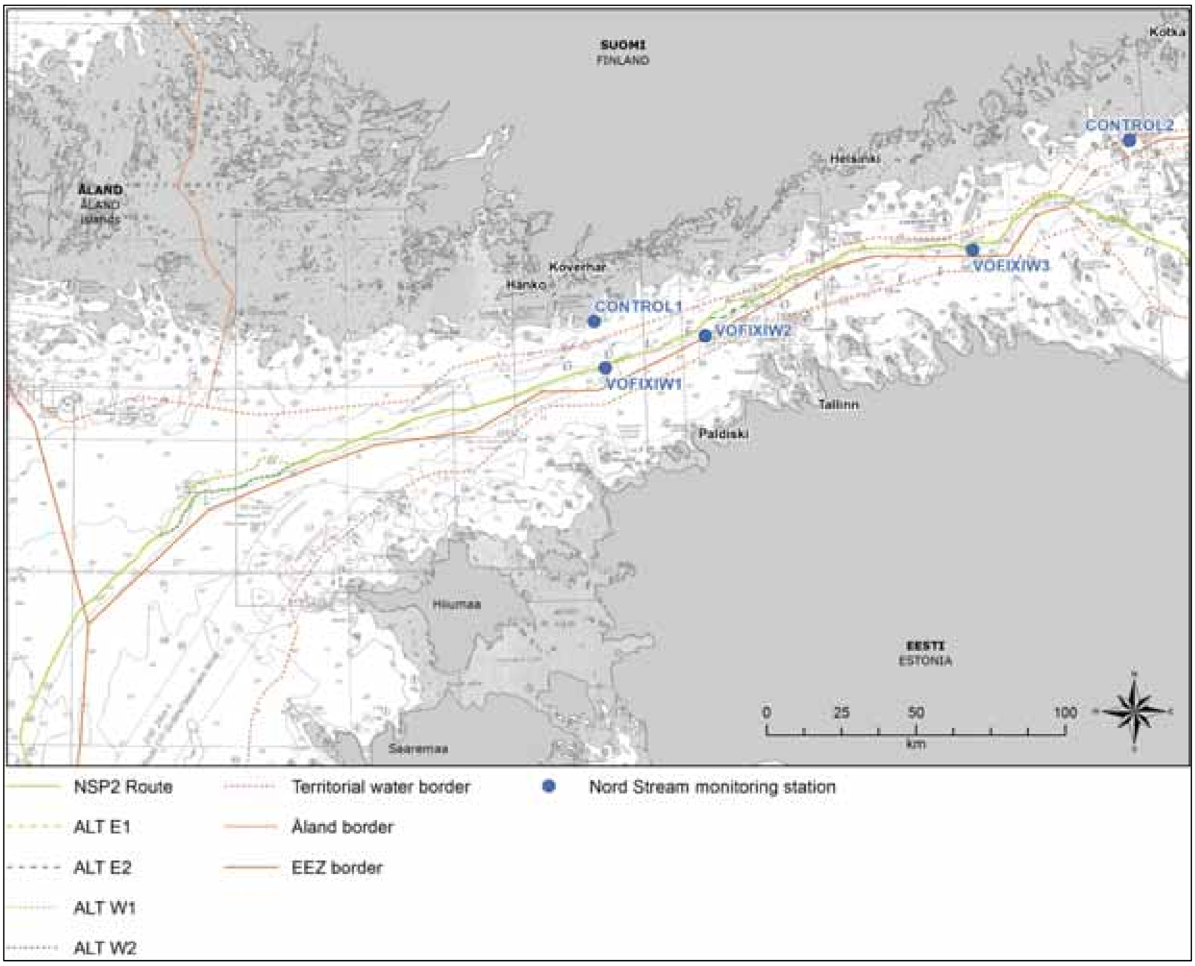


Figure 7-19. Location of Nord Stream monitoring stations in the Gulf of Finland.

Typically, current magnitudes increased and showed more variation towards autumn. There were periods (lasting months) when magnitudes were in many cases above 20 cm s^{-1} at the lowest 10 m water layer, while during spring time, currents were seen to be slow as is the case in general also during winter time (ice cover, low stratification). However, if the winter is mild and windy as in 2011–2012, ice formation is not as intense as during hard winters. Consequently, the frequency of periods when strong currents occurred near the seabed increased at both long-term stations *(Luode Consulting Ltd 2013a)*.

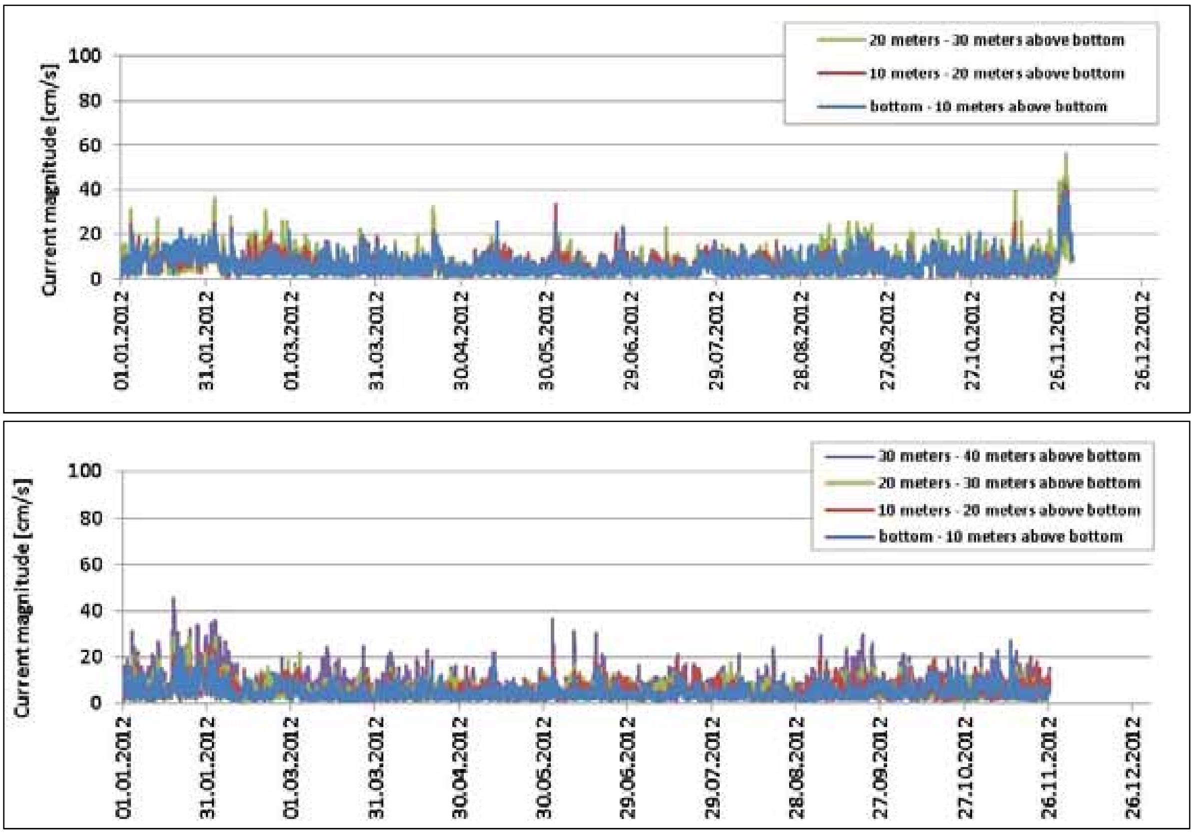


Figure 7-20. Recorded current magnitude at the long-term monitoring station Control 1 in 2012, water depth 41 m (above) and Control 2, water depth 47 m (below; Luode Consulting Ltd 2013a).

Average current magnitude at the long-term stations was observed to be 4–6 cm s^{-1}. This is in line with the above-mentioned magnitude of the cyclonic flow velocities.

The dominant current direction differs regionally confirming the presence of meso-scale eddies and/or local topographic influence of e.g. seabed outcrops. At *Control 1* station, currents were typically heading towards south-west, south and north-east, east. At *Control 2* station, no distinct dominant current direction could be found, although, the southeasterly direction was slightly more typical than other directions *(Luode Consulting Ltd 2013a*). Easterly and southwesterly current directions were most common at the monitoring stations during construction of the Nord Stream pipelines in the Finnish EEZ *(Ramboll, Witteveen+Bos and Luode Consulting Ltd 2012)*.

7.5.2.1 Environmental baseline survey

In December 2015, two fixed automatic monitoring stations were installed for current measurements (velocity and direction) along the survey corridor and one into shallower water nearer to the coastline (ADCP3, Figure 7-21). Locations of the stations in the open sea were situated near the Russian border in the eastern Gulf of Finland (ADCP1) and in the western part in the mouth of the Gulf of Finland (ADCP2).

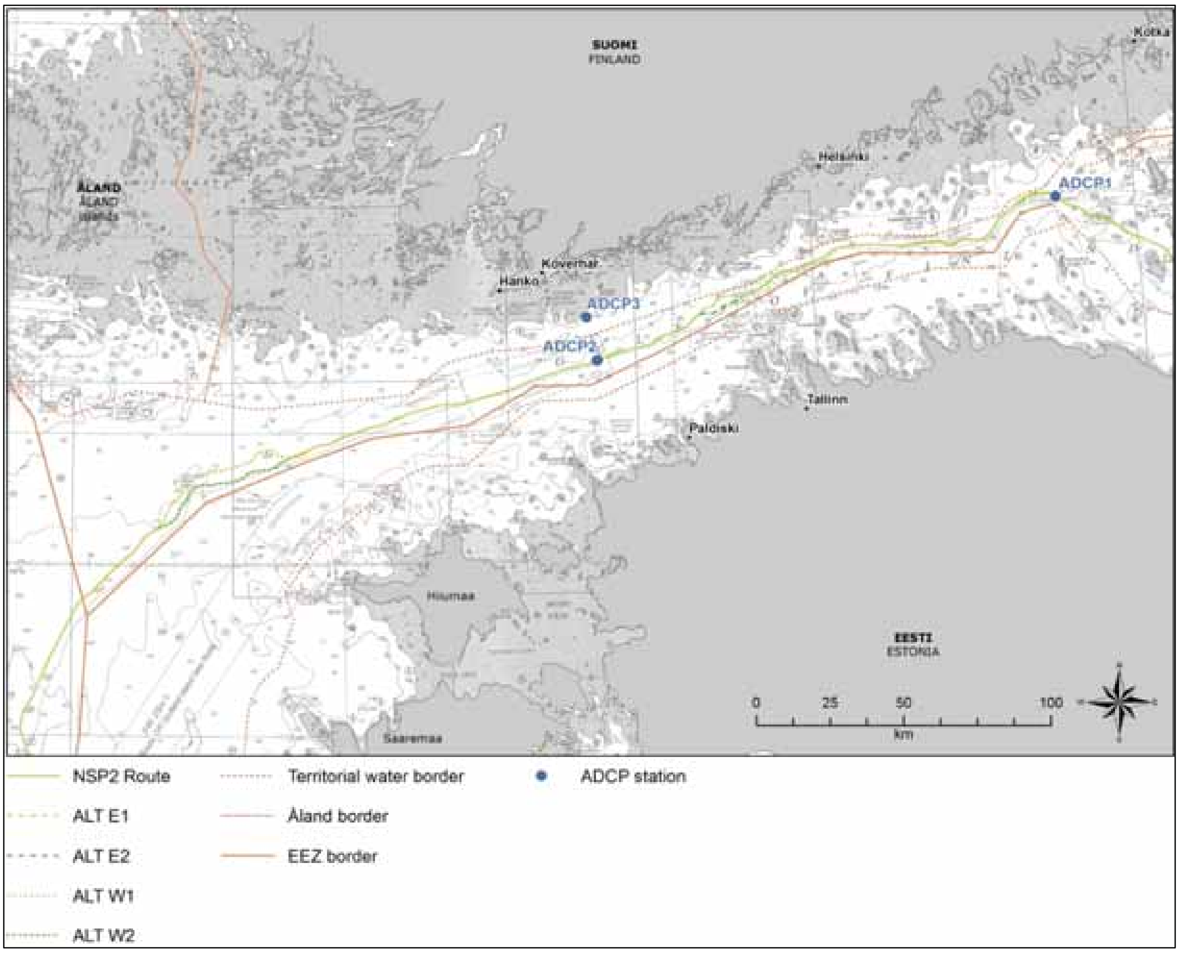


Figure 7-21. Location of the fixed monitoring stations (ADCP1 and ADCP2) in the survey corridor and at the reference site (ADCP3).

Time-series of currents were recorded from December 2015 to May 2016. The results for the lowermost 10 m water layer above the seabed are presented in Figure 7-22 and Figure 7-23.

The average current speed near the seabed for ADCP1 station was 7.3 cm/s and the maximum speed was 49.8 cm/s. The same values for ADCP2 were 10.6 cm/s and 79.5 cm/s and for ADCP3 5.9 cm/s and 29.6 cm/s, respectively (Figure 7-22).

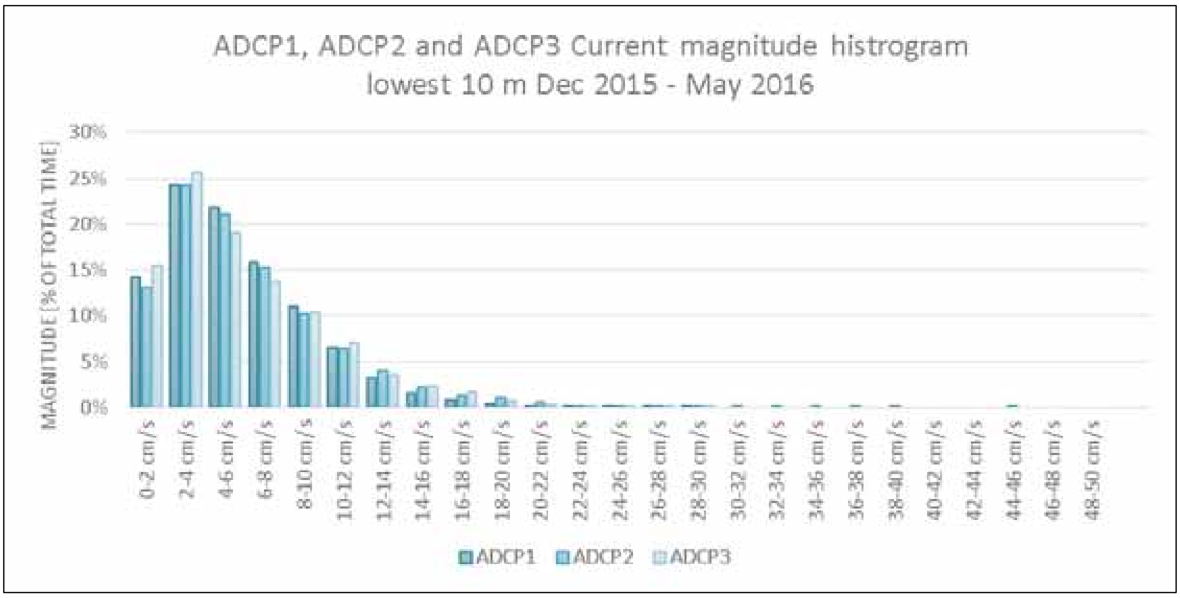


Figure 7-22. Current magnitude histogram from ADCP1—ADCP3 stations from December 2015 to May 2016 (Luode Consulting Ltd 2016a).

At ADCP1, in the bottom layer, the main current direction was north-east (N-E) and secondarily southwest-west (SW-W). At ADCP2 and ADCP3, the dominating current direction was southwest-west (SW-W) and secondarily northeast-east (NE-E) (Figure 7-23).

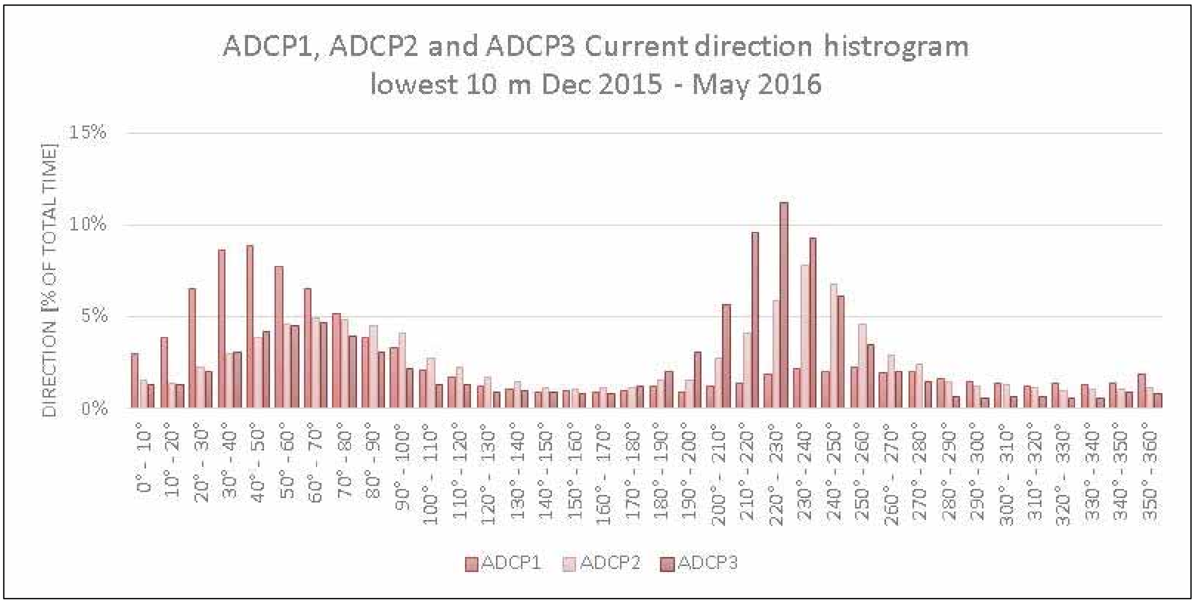


Figure 7-23. Current direction histogram from ADCP1 and ADCP2 stations from December 2015 to February 2016 (Luode Consulting Ltd 2016a).

Stratification in the water column effectively prevents wind induced currents from penetrating into deeper water layers. The situation is different during periods of weak stratification, as indicated by current monitoring.

7.6 Water quality

7.6.1 Heavy metals

During the environmental baseline study of December 2015, water samples were taken at each areal station located in the survey corridor (Figure 7-13). Concentrations of copper and zinc were clearly higher than the upper limit for the quality criteria of good seawater status according to Norwegian classification (Table 7-10). Average concentrations of other metals indicated a situation of no toxic effects. The Norwegian classification has been used because Finnish legislation only provides environmental quality standards for a few metals (EQS values in Table 7-10).

Table 7-10. Average concentration of dissolved heavy metals in seawater at the areal stations in December 2015. Sampling depth 1 m above seabed.

Metal	Average concentration in water	AA[5]-EQS values in the Finnish legislation*	Norwegian classification of metals in seawater (Bakke et al. 2010) $PNEC_{chronic}$**
	µg/l	µg/l	µg/l
Arsenic, As	1.7		2–4.8
Cadmium, Cd	<0.03	0.02 ***+ 0.2 = 0.22	0.03–0.24
Chromium, Cr	0.1		0.2–3.4
Copper	1.3		0.3–0.64
Lead, Pb	<0.1	0.03*** + 1.3 = 1.33	0.05–2.2

[5] Annual average

Nickel, Ni	0.5	1*** + 8.6 = 9.6	0.5–2.2
Zinc, Zn	<5.9		1.5–2.9
Mercury, Hg	<0.03		0.001–0.048

***** Government Decree 1308/2015 on substances dangerous and harmful to the aquatic environment

****** Upper limit of class represents concentrations above which long-term exposure may cause toxic impacts on species following chronic exposure

*** Background concentration

7.6.2 Nutrients

Water quality in the open sea of the Gulf of Finland at the HELCOM long-term stations has been monitored by the Finnish Environment Institute (SYKE). Between 2013–2015, the average total phosphorus concentration in the surface water was 23 µg l^{-1} and total nitrogen concentration 338 µg l^{-1} at stations LL5, LL6A and LL7S (Central Gulf of Finland). Corresponding values for bottom close waters at these stations were 101 µg l^{-1} and 396 µg l^{-1}, respectively. In December 2015, during the environmental baseline study, the average concentration for total phosphorus near the seabed was 39 µg l^{-1} and for nitrogen 403 µg l^{-1} at the areal stations *(Luode Consulting Ltd 2016a)*. Eutrophication indicator target values for nutrients in the Baltic Sea sub-basins are presented by HELCOM but they are in dissolved form and intended for winter time *(HELCOM 2014a)*.

At present, HELCOM target values are not reached in the open waters of the Gulf of Finland and, consequently, the physical-chemical status of these areas is classified as poor *(e.g. Andersen et al. 2011)*.

Total waterborne nutrient load into the Gulf of Finland in 2006 was approximately 5,000 tonnes of phosphorus (P) and 130,000 tonnes of nitrogen *(N) (HELCOM 2012a).* The portion originating from Finnish territories that ended up in the Baltic Sea between 2006–2011 was on average 72 % and 66 % of the above-mentioned figures, respectively. Phosphorus discharges into the eastern part of the Gulf of Finland have been remarkably decreased after the renovation of the community wastewater treatment plant in St. Petersburg. This can be seen as an improvement in water quality in that part of the sea.

7.6.3 Water transparency and suspended sediments

Transparency changes in the water column in the open Gulf of Finland will vary according to hydrological and weather conditions. During storms, in the lowermost water layer, when bottom-close currents become stronger, resuspension of sediment particles will quite dramatically increase concentrations of suspended matter and, hence, turbidity over the vast sedimentation areas.

Turbidity near the seabed was measured continuously at fixed stations during the years 2009–2012 at two locations in the Gulf of Finland (western and eastern part with a water depth 43 m and 47 m, respectively). The data were collected in connection with the construction of the NSP pipelines. Average turbidity level above the seabed at both stations was 1-2 NTU. Highest single value varied from 17.8 NTU (eastern station) to 22.6 NTU *(western station; Luode Consulting 2013a)*. Based on these long-term monitoring results it has been calculated that annual resuspension in the deep sea (40 m) areas of the Gulf of Finland is approximately 10 kg/m^2 (10,000,000 kg/1 km^2, respectively; *Luode Consulting Ltd 2013b*).

Also, after the algal blooms in the photic layer, changes in transparency in the deeper water layers are typical when organic material sinks to the seabed for bacterial breakdown. In general, eutrophication in the Gulf of Finland has greatly increased water turbidity (number of organic particles in water) and simultaneously decreased transparency.

Changes in turbidity profiles in a water column during different seasons in the western and eastern Gulf of Finland are presented in Figure 7-24.

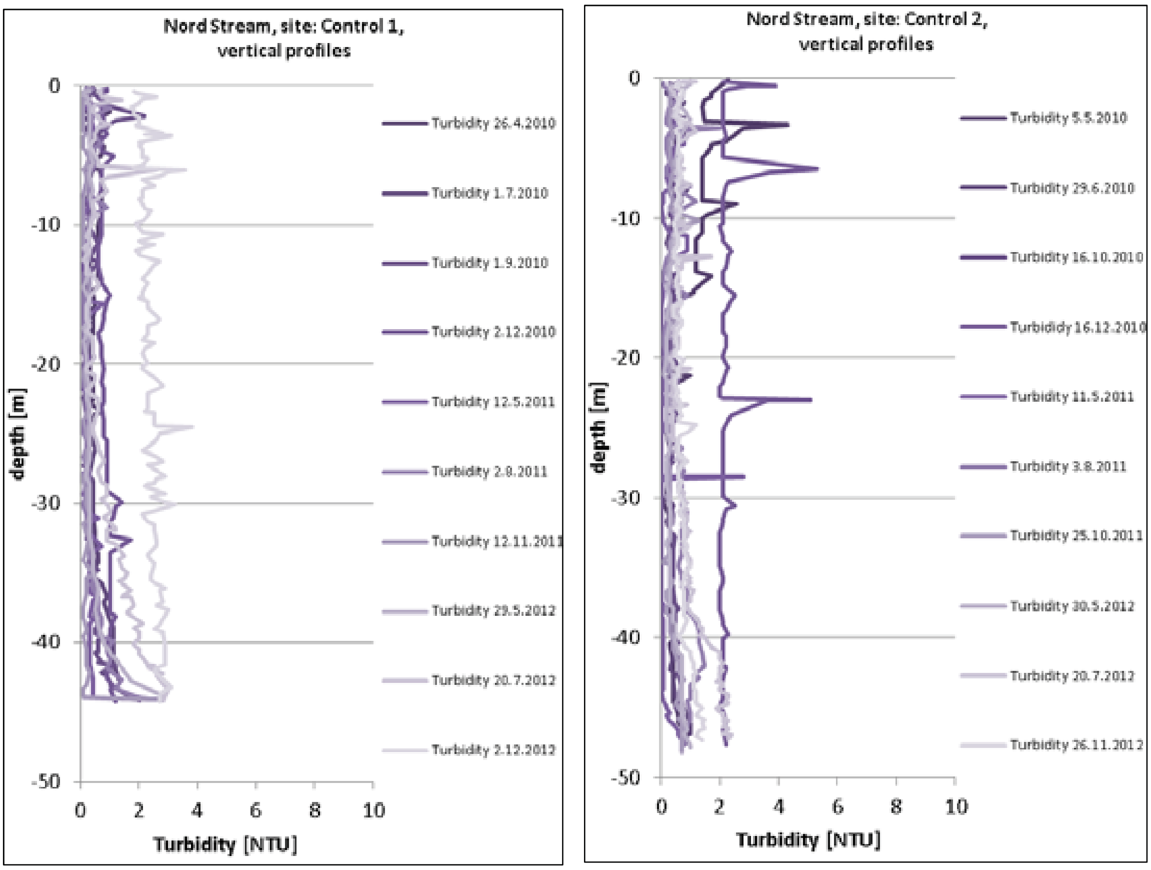


Figure 7-24. **Variations in turbidity profiles in a water column (from surface to bottom) between spring 2010 and late autumn 2012 in the western and eastern Gulf of Finland (Luode Consulting Ltd 2013a). The data was collected during service visits to the fixed monitoring stations.**

7.6.4 Oxygen conditions

In the early 1990s, in the open Gulf of Finland, there was a temporary improvement in oxygen conditions near the seabed when salinity decreased to a level where strong halocline weakened. The improvement in the oxygen situation was remarkable compared to many earlier years. As indicated in Figure 7-25, from the mid–1990s onward, oxygen concentrations in the open sea waters near the seabed have mainly been very low but fluctuating. Typically, annual variations in the oxygen concentration occur depending on hydrographical conditions in the overlaying water column during different seasons.

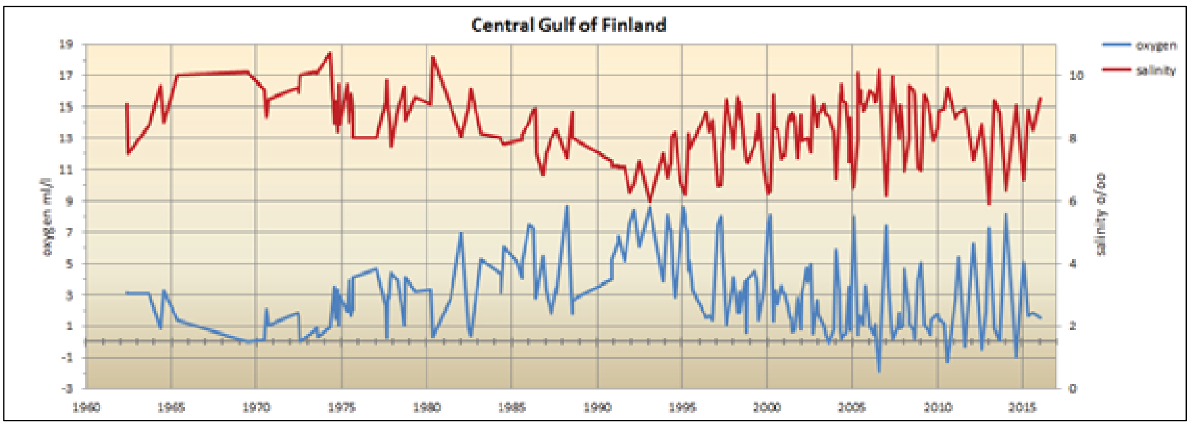


Figure 7-25. **Long-term variations in the oxygen concentration and salinity at one metre above the seabed in the vicinity of HELCOM station LL7. Negative oxygen levels are based on hydrogen sulphide measurements (Finnish Environment Institute 2011).**

In December 2014, oxygen rich saltwater intruded into the Baltic Sea through the Danish Straits. This was the third largest inflow since oceanographic observations commenced in the Baltic Sea in 1880. In theory, when the salt pulse reaches the oxygen-free deep basins of Bornholm and Gotland, existing oxygen-free water in turn is forced to protrude towards the Gulf of Finland. During the prevailing weather conditions of summer 2015, no low-oxygen and nutrient-rich deep sea waters from the main basin of the Baltic Sea reached the Gulf of Finland. Consequently, the oxygen situation in the open sea basins during summer 2015 was better than in the last ten years *(Finnish Environment Institute 2016e)*. Also, the extent of seabed areas where hydrogen sulphide is present (only in the mouth of the Gulf of Finland) greatly decreased as of summer 2014 (Appendix 12, Map WA-01-F).

However, at the end of 2015 and at the beginning of 2016, during the environmental baseline surveys, saline-rich water near the seabed was recorded in January to enter the mouth of the Gulf of Finland *(Luode Consulting Ltd 2016a)*. Salinity levels close to 11‰ were recorded 2–5 m above the bottom. As a result, a strong halocline was formed in the water column between 5–15 m above the seabed. During the stratification period, anoxic conditions prevailed near the seabed (Figure 7-26). The stratification disappeared at the same time (end of January) as the inflow of saline, anoxic water from the Baltic Proper ended. After this, the oxygen concentrations returned back to a good level. However, later in spring the oxygen concentrations decreased again to zero when salinity pulse returned into the sea area (Figure 7-26).

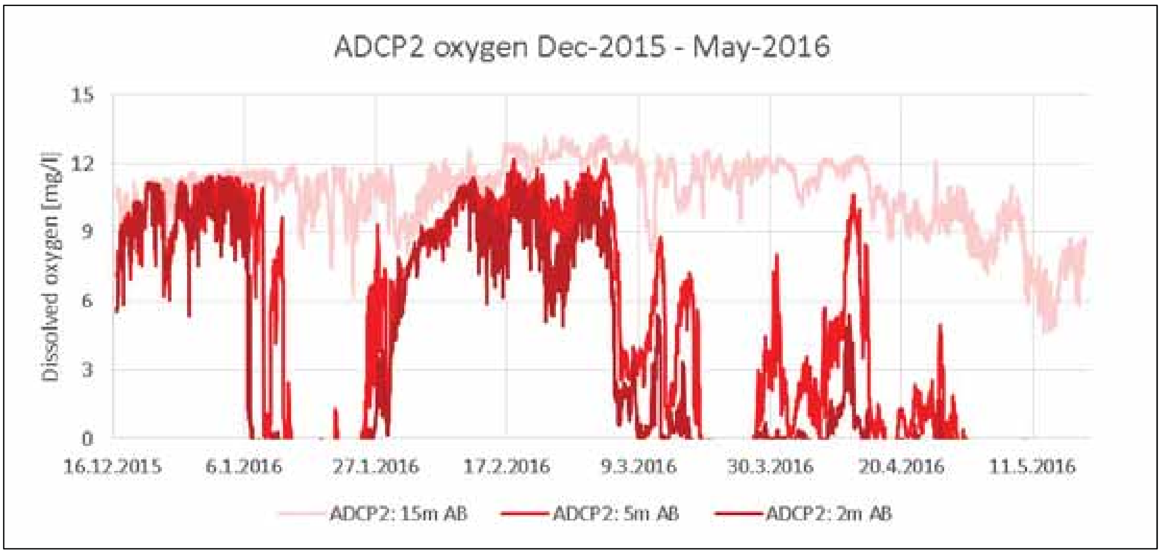


Figure 7-26 **Recorded dissolved oxygen concentrations from December 2015 to May 2016, near the seabed, in the middle of the mouth of the Gulf of Finland. AB = above bottom (Luode Consulting Ltd 2016a).**

7.6.5 Eutrophication

At present, eutrophication is the most important issue threatening the diversity of biota in the Baltic Sea. Moreover, climate change is forecasted to alter this brackish water ecosystem quite dramatically by decreasing the average salinity concentration. This may happen if the annual precipitation increases and the pattern changes as has been predicted (winter time runoff from the catchment area increases). This can cause increased nutrient discharges into the water body, an increase in algae growth and, finally, an increase in oxygen consumption during the bacterial breakdown of organic material after it has settled down onto the seabed. The result is increased internal phosphorus load from the seabed into the water (Figure 7-27).

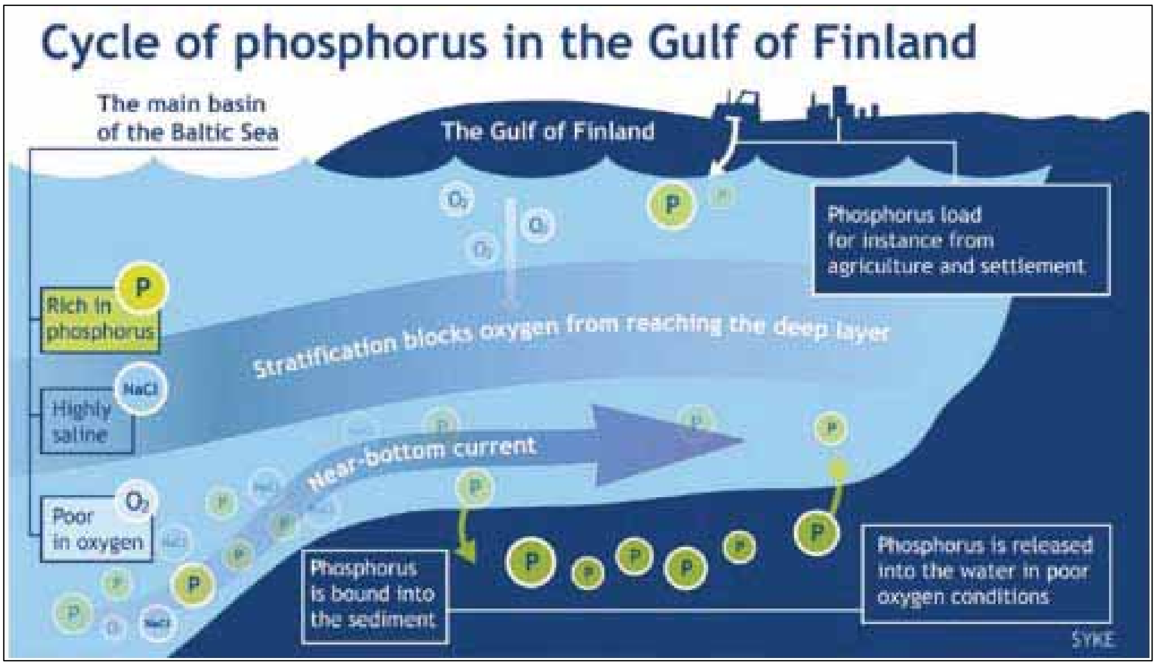


Figure 7-27. Cycle of phosphorus in the Gulf of Finland (SYKE in Raateoja and Setälä 2016).

7.7 Underwater noise

7.7.1 Physics of sound

Sound in water is a combination of travelling waves in which particles of the medium are alternately compressed and decompressed. The sound can be measured as a variation in pressure within the medium, which acts in all directions, and described as the sound pressure.

The fundamental unit of sound pressure is Newton per square metre, or Pascal (Pa). However, in expressing underwater acoustic phenomena, it is convenient to express sound pressure by way of a logarithmic scale termed the Sound Pressure Level (SPL). It is measured in decibels (dB).

Sound Pressure Level (SPL) $= 10 \cdot \log\left(\frac{P^2}{P_{ref}^2}\right) = 20 \cdot \log\left(\frac{P}{P_{ref}}\right)$, where

P is measured pressure (Pa)
P_{ref} is reference pressure

The reference pressure in water is defined as 1 micropascal (symbol μPa), whereas reference pressure in air is 20 micropascals. The SPL values (dB's) in water cannot be directly compared to those in air as a consequence of different reference pressures and the differences in impedance between water and air.

Impacts of underwater noise are often assessed by Sound Exposure Level (SEL) and Peak Pressure Level (PEAK).

SEL is a decibel measure for describing how much sound energy a receptor (e.g. a marine mammal) has received from an event and is normalised to an interval of one second. This means that long time exposure to low noise levels results in the same SEL during a short term exposure to high noise level if the total sound energy is equal in both cases. Doubling of exposure time or exposure to two identical noise events results in a 3 dB increase in SEL, because the energy is doubled.

PEAK is the maximum decibel value reached by the sound pressure at a given point in time. SEL was found to be a better indicator than PEAK for impacts on marine mammals and fish.

7.7.2 Ambient noise

Ambient noise is sound that is always present and cannot be attributed to any particular source. In addition to ambient noise, there is noise from distinct and identifiable sources such as shipping, mechanical installations and marine animals. All of this combined constitute the background noise in the sea.

The ambient noise sources of the sea environment include, e.g. rain falling on the ocean, bubbles entrained by breaking waves, wave interaction and the Earth's seismic activity. The noise from these sources comes from all directions and varies in magnitude, frequency, location and time.

The level of ambient noise depends on the sea state (the general condition of the free surface on a large body of water – with respect to wind, waves, swells and density dependent stratification), ranging, in particular, between 200 Hz and 50 kHz. The hertz (symbol Hz) is the unit of frequency. Frequency is most often measured in cycles per second, 1 Hz is one cycle per second.

Figure 7-28 exemplifies the spectral distribution of the sound pressure level of deep water ambient noise. Low frequency ambient noise from 1 to 10 Hz is mainly comprised of turbulent pressure fluctuations from surface waves and the motion of water at the boundaries. Between 10 and 100 Hz, distant anthropogenic noise (ship traffic etc.) begins to dominate, with its greatest contribution between 20 Hz and 80 Hz. In the region above 100 Hz, the ambient noise level depends on weather conditions with wind and wave related effects creating sound. The peak level of this band has been shown to be related to the wind speed expressed by Beaufort numbers 1–8 (sea state). Beaufort numbers can be transferred to metres per second (m/s) with a formula $v = 0.836\ B^{3/2}$ m/s, where v is the equivalent wind speed at 10 metres above the sea surface and B is Beaufort scale number. Beaufort number 1 results 0.8 m/s, 2 2.4 m/s, 4 6.7 m/s, 6 12.3 m/s and 8 18.9 m/s.

Ambient noise in shallow water can be different from deep sea, because of different acoustic propagation conditions. In the shallow waters, the deep water curves are, at best, an approximation to the levels found.

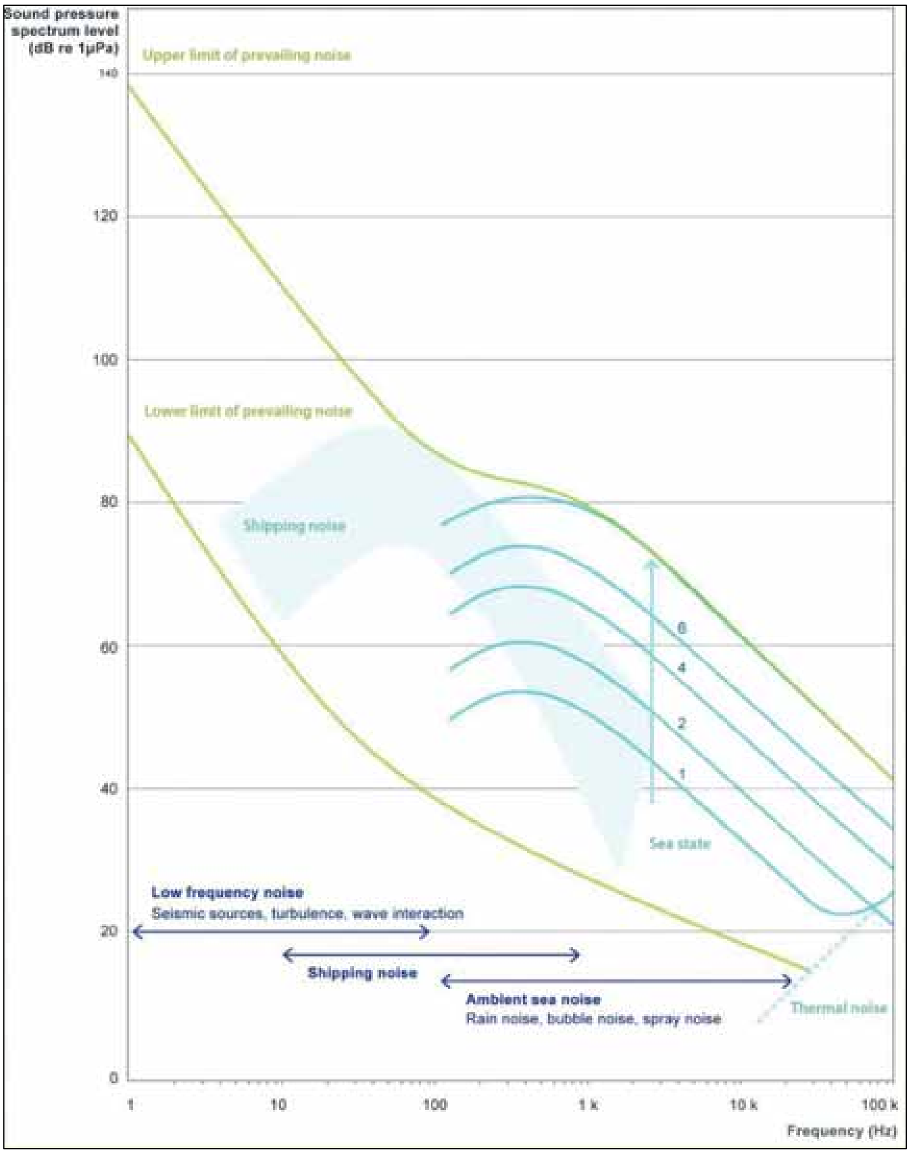


Figure 7-28. General expression of sound pressure spectral distribution in the deep sea (modified from Wenz 1962).

7.7.3 Underwater noise in the Baltic Sea

Underwater noise is currently the least understood impact on the marine biodiversity in the Baltic Sea. The main sources of underwater noise are commercial shipping, fishing, military activities, construction activities, seismic explorations, recreational boating and operational wind farms. Noise may carry long distances from known sources and, depending on intensity and frequency, may disturb marine mammals and fish. *(HELCOM 2010a)*

According to current knowledge, most of the Baltic marine area is impacted by a level of noise that is at least audible to biota or can mask the communication of animals (Figure 7-29).

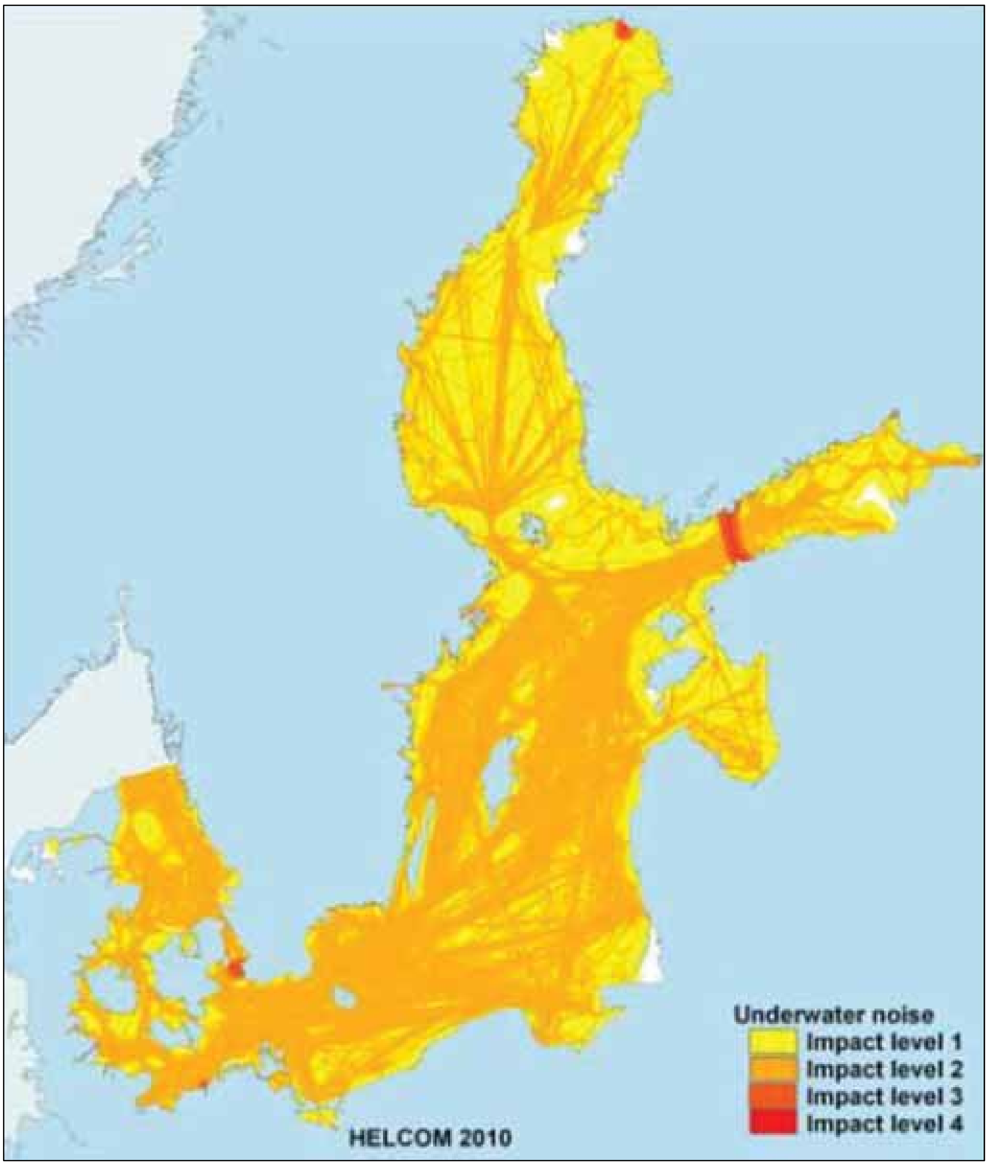


Figure 7-29. Distribution of underwater noise in the Baltic Sea during 2003–2007. Impact level 1 indicates that the noise is audible to biota; level 2 indicates that masking of communication occurs; level 3 indicates an avoidance reaction; level 4 indicates physiological impacts from construction work. (HELCOM 2010a).

The EU LIFE supported BIAS (Baltic Sea Information on the Acoustic Soundscape) Project was established in September 2012 to support a regional assessment of underwater sound in the Baltic Sea. The project has five objectives. The first is to raise awareness among authorities and managers. The second is to establish regional implementation of noise management. The third objective is to assess the level of underwater noise and to present the results as soundscape maps. The fourth objective is to establish regional standards and methodologies that will allow cross-border handling of data and results and, finally, to implement regional tools for handling underwater sound. *(BIAS 2015)*

In 2014, the BIAS project deployed 38 autonomous hydrophone rigs all over the Baltic Sea to measure the status of underwater noise. Survey positions are presented in Figure 7-30.

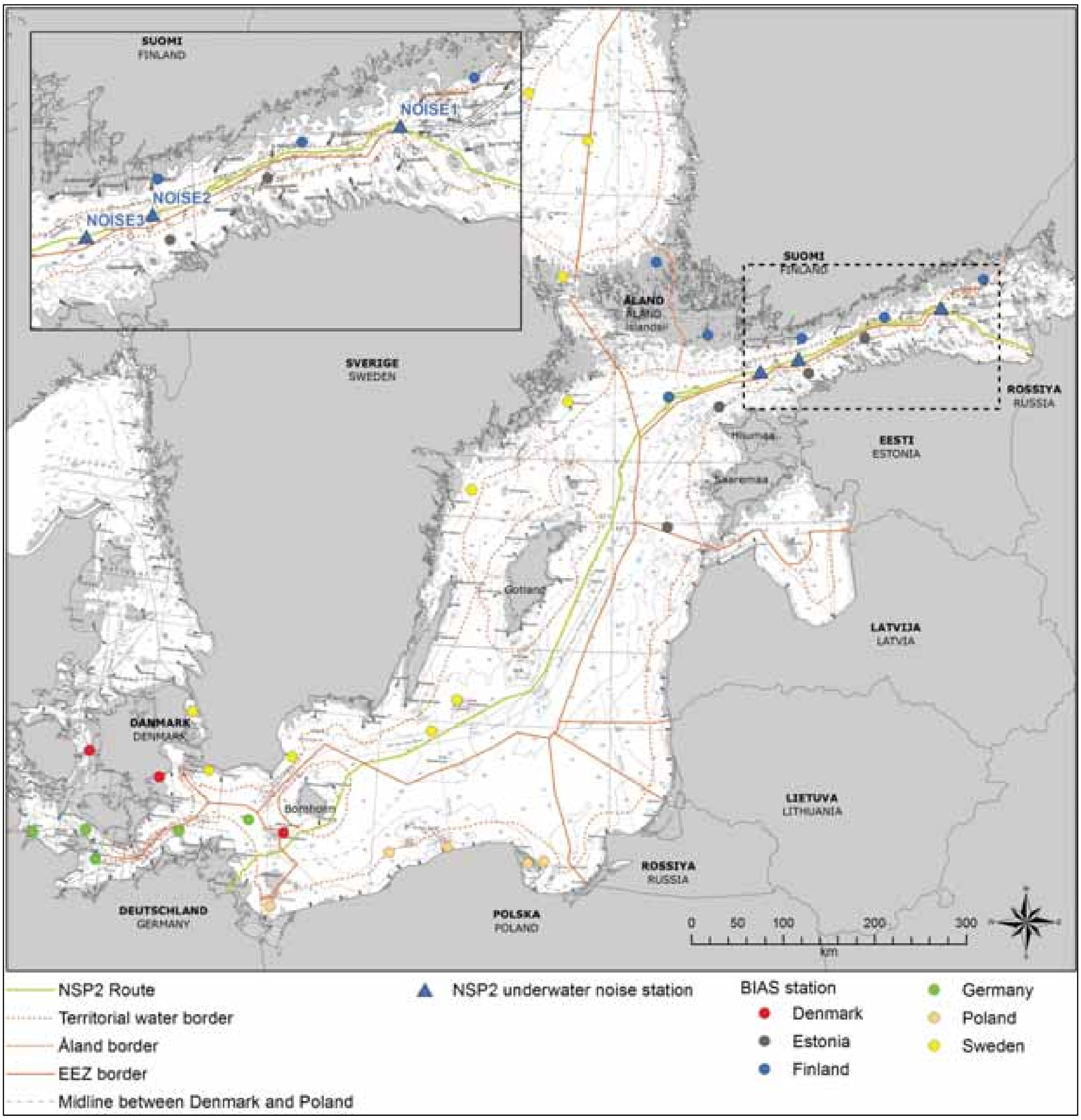


Figure 7-30. **Survey positions of underwater noise in the BIAS project. (BIAS 2015) and also the NSP2 underwater noise survey positions.**

The BIAS project measurement results are available in draft at the date of this report. These results have been extracted with the help of the BIAS soundscape planning tool, which was prepared within the EU LIFE Project Baltic Sea Information on the Acoustic Soundscape *(BIAS LIFE11 ENV/SE 841; www.bias-project.eu)*. The underwater noise level distribution (1/3 octave 125 Hz centred, sound level exceeding 50% of time) during March 2014 is shown in Figure 7-31.

Underwater noise level at this frequency varies mostly between 90 and 105 dB.

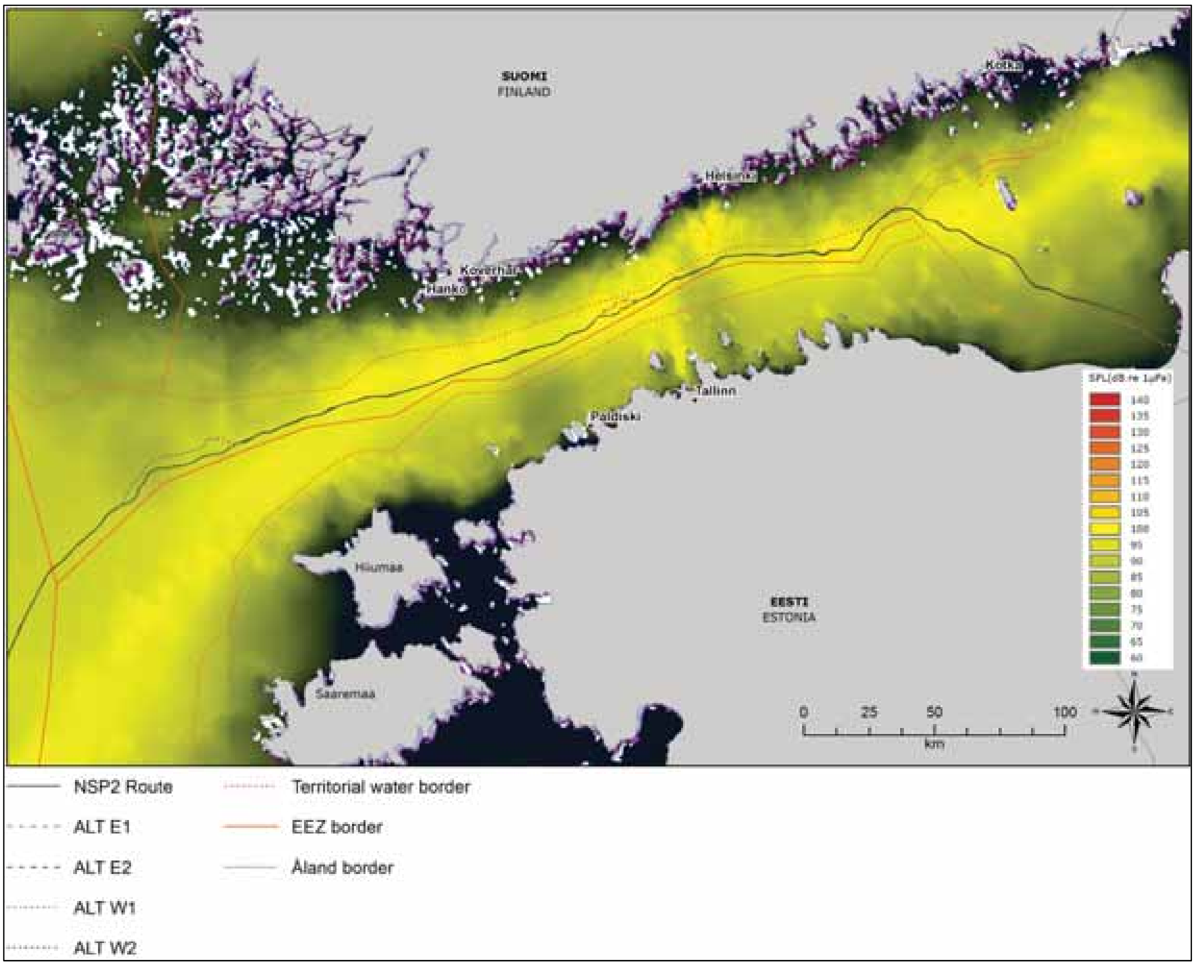


Figure 7-31. **Noise level distribution based on BIAS project results. 1/3 octave 125 Hz centered, sound level exceeding 50% of time (L50), during March 2014.**

A baseline for noise was obtained during the NSP2 environmental baseline monitoring campaign that took place between December 2015 and May 2016 *(Luode Consulting Ltd 2016a)*. Underwater noise was measured in three different locations (NOISE 1, NOISE 2 and NOISE 3), shown in Figure 7-32.

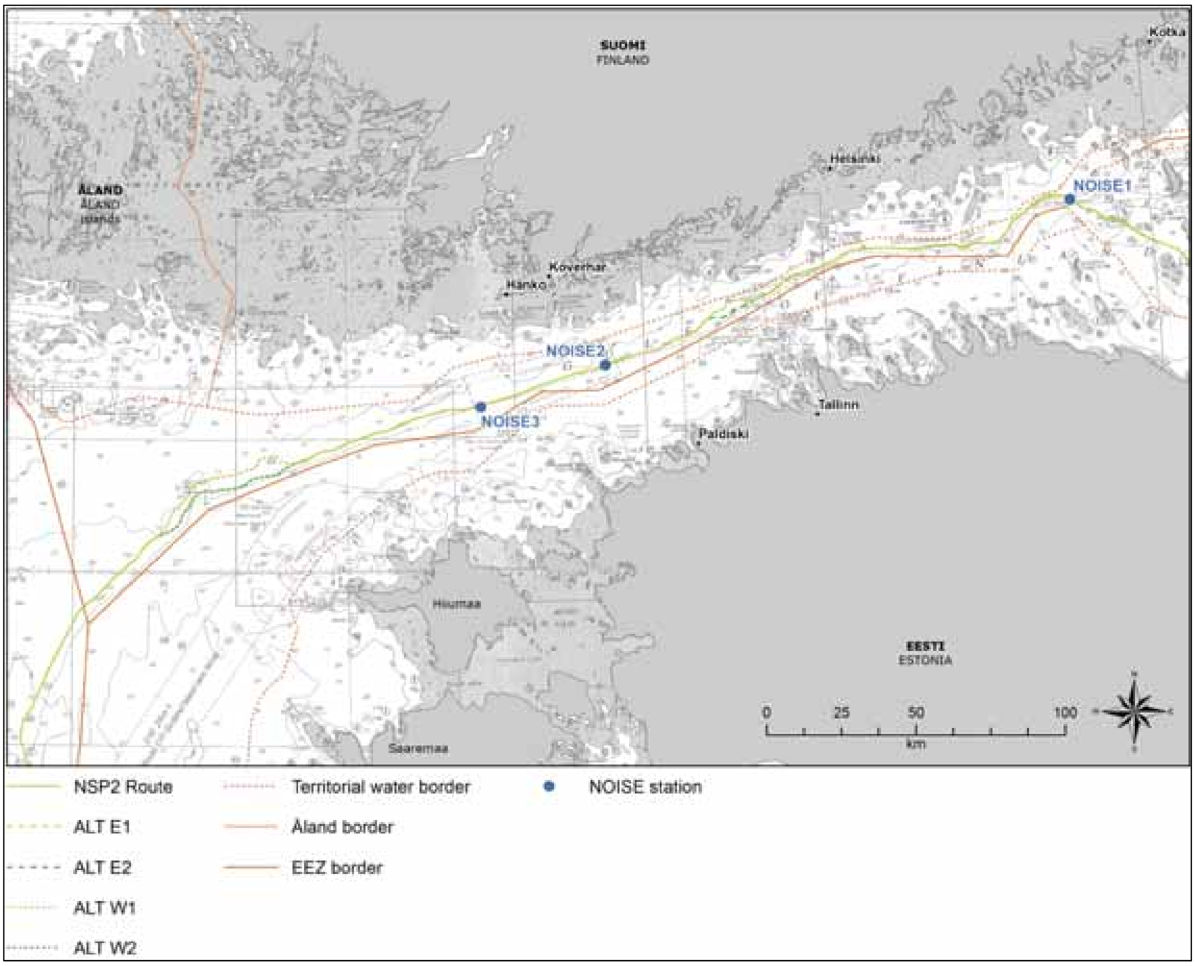


Figure 7-32. Survey positions of underwater noise during the NSP2 baseline survey (Luode Consulting Ltd 2016a), marked as NOISE1, NOISE2 and NOISE3.

Survey positions NOISE 1 and NOISE 3 were designed to measure noise near the existing NSP pipeline, and NOISE 2 further away from the pipeline. NOISE 1 was relocated closer to the pipeline in February 2016, and so the survey positions were redefined in the results as NOISE 1_1 and NOISE 1_2. NOISE 1_2 and NOISE 3 were measured at approximately 10 m distance above the pipeline.

Sound pressure levels were measured broadband (from 10 Hz to 10 kHz) and 1/3 octave bands centred on 63 Hz and 125 Hz. Broadband noise level variation is illustrated in Figure 7-33, showing 5 min average noise levels in all measurement positions (NOISE 1 referring there to NOISE 1_2).

Noise level varies in all positions between about 90 to 140 dB, although the bottom level in NOISE 3 is higher in the middle of the measurement period.

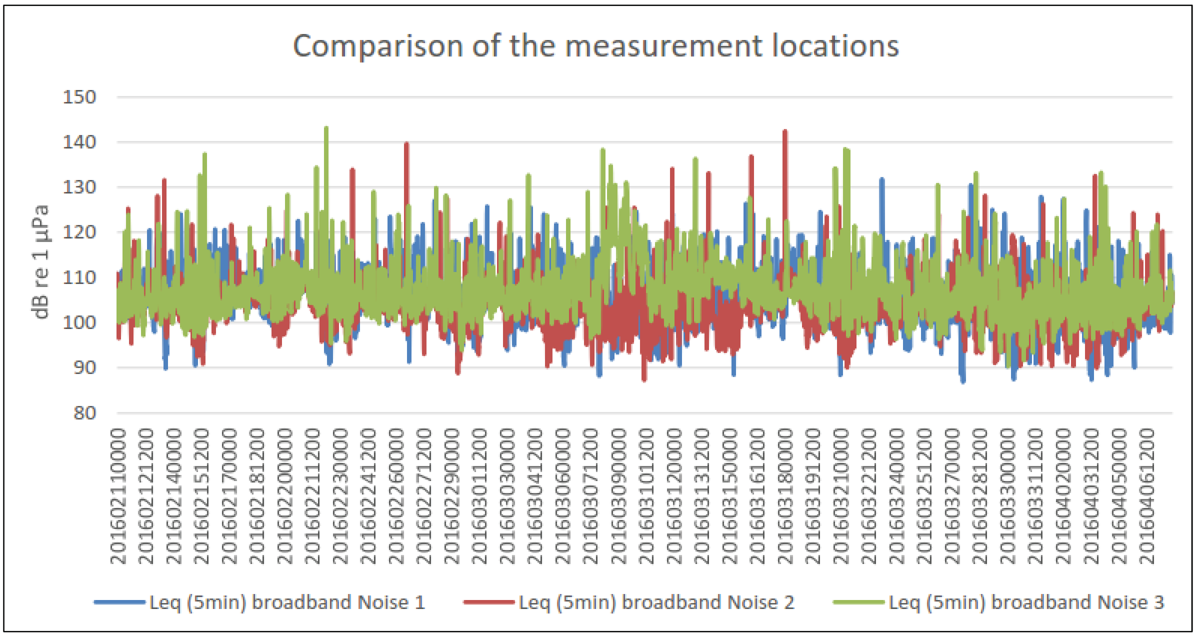


Figure 7-33. Broadband noise levels (LAeq, 5 min) at stations NOISE 1-3 during the measurement campaign.

Average noise levels over the whole measurement period are shown in Table 7-11. The lowest noise level, 110.4 dB, was measured at NOISE 1_1, and the highest at NOISE 2 and NOISE 3, 115.4 dB and 115.1 dB, respectively. At both measurement positions, vessel traffic is so active that at least a distant shipping noise can be heard virtually at all times.

Table 7-11. Average broadband noise levels in all measurement positions.

Location	Depth above bottom [m]	Monitoring Period	Leq (total) (10Hz–10kHz) [dB re 1 µPa]
NOISE1_1	10	20151218–20160208	110.37
NOISE1_2	10	20160211–20160407	110.86
NOISE 2	2	20151218–20160208	114.83
NOISE 2	10	20151218–20160208	115.06
NOISE 2	2	20160211–20160408	112.17
NOISE 2	10	20160211–20160518	113.92
NOISE 3	10	20160211–20160407	115.36

NOISE 1_2 and NOISE 3 positions were chosen to detect potential noise from the operation of the NSP pipelines. However, noise caused by pipeline operations could not be identified.

As a comparison, underwater noise was monitored in 2012 during Nord Stream's construction at Norra Midsjöbanken, situated approximately 50 km east of the southern tip of Öland in the Swedish EEZ *(Johansson and Andersson 2012)*.

Location "A1" was situated approximately 1.5 km from one of the main shipping lanes in the Baltic Sea. Hydrophones at this location recorded ambient noise dominated by shipping noise and were undisturbed by Nord Stream's activities. The other location, "B1", was situated approximately 1.5 km from the route of Nord Stream's second pipeline. Average ambient (background) broadband noise levels of between 116.5–116.6 and 110.9–111.5 dB re 1 µPa were estimated at locations A1 and B1, respectively. These results are very comparable to those measured during the Nord Stream 2 baseline survey, as shown in Table 7-11.

7.8 Pelagic environment (plankton)

Planktonic algae, phytoplankton, are minute unicellular organisms that form the base of the pelagic food web. These organisms, functioning as primary producers in the aquatic environment, can rapidly respond to changing nutrient regimes or other anthropogenic perturbations. In the food web they are an important food source for different sized zooplanktonic organisms. In the Baltic Sea, the highest phytoplankton diversity of about 1,565 taxa has been reported in the Gulf of Finland *(cf. Ojaveer et al. 2010)*. However, of these species, many are present only in very low numbers, which is typical for brackish waters. The number of zooplankton species in pelagial areas of the Gulf of Finland is over 40 taxa and the highest diversity is found in the easternmost coastal areas *(Raateoja and Setälä 2016)*.

In the Gulf of Finland, thermal stratification is highly variable in both space and time, and driven by the seasonal variability of the incoming solar radiation *(Alenius et al. 1998)*. In summer, the thickness of the upper mixed layer is typically ca. 10–20 m and thermocline, which diminishes intrusions of phosphorus-rich water into mixed layer, is lying underneath *(Alenius et al. 1998)*. Permanent halocline is situated deeper, at a depth zone of 60–80 m in the western and central parts of the Gulf of Finland. Thermocline as well as halocline functions as a barrier for sediment dispersion and concurrent nutrient / contaminant release during construction activities.

The abiotic factors are closely related to seasonal variation of plankton. In the central parts of the Gulf of Finland, the annual succession includes a spring bloom period, a summer minimum, a late summer bloom period, and sometimes also a modest autumn bloom (*e.g. Uusitalo et al. 2013*; Figure 7-34).

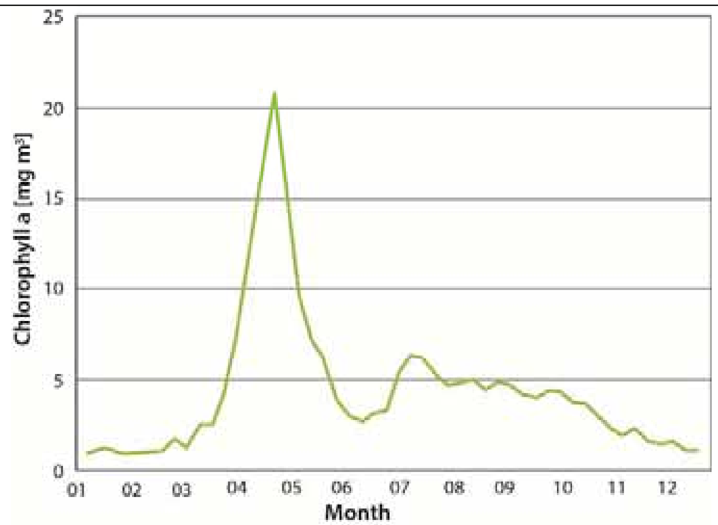


Figure 7-34. Seasonal succession of chlorophyll-a (describing phytoplankton abundance) in the western Gulf of Finland. The green line is the weekly average during 2000–2015. (After Alg@line).

During the winter period, the amount of light and mixing conditions in the water column are critical to phytoplankton growth, although there is a surplus of nutrient reserves (phosphorus and nitrogen) for algal production. During this time, the productivity and biomass of phytoplankton and zooplankton is low. Total irradiance increases during spring and thermocline starts to develop. This period of the year has normally the highest new production, meaning that algal production is dependent on existing nutrient reserves. Typical spring bloom taxa are diatoms and dinoflagellates. The magnitude of the spring bloom varies in the different sub-basins of the Baltic Sea, as well as between years, and is highest in the Gulf of Finland (Fleming and Kaitala 2006). During summer, phytoplankton is mainly using recycled nutrients as thermocline hinders nutrient transfer to productive photic layer. The predominant summertime taxa are typically filamentous cyanobacteria, dinoflagellates, autotrophic ciliates and nanoflagellates. The eutrophication process, that has been apparent in the Gulf of Finland for many years, has led to the intensification of the late-summer cyanobacteria blooms, although the spatiotemporal and yearly variation of bloom intensity is high *(Bruun et al. 2010)*. These potentially toxic blooms are typically formed by the nitrogen fixing species *Nodularia spumigena* and *Aphanizomenon flos-aquae*.

Zooplankton has a central position in the aquatic food webs constituting a major trophic link between primary producers and higher consumers, such as mysid shrimps and planktivorous fish *(e.g. Pomeroy 1974, Steele 1998)*. The most important taxa are rotifers, cladocerans and copepods. Of these, copepods *Acartia bifilosa* and *Eurytemora affinis* are the key species in the Gulf of Finland *(Ojaveer et al. 2010)*. Zooplankton biomass reaches its peak during late summer and early autumn.

Monitoring results of the NSP clearly suggest that turbidity, originating from construction activities was found to be limited to the lowermost 10 m water layer above the seabed *(Ramboll 2012b)* and, based on this finding, it is plausible that nutrients are functioning in the same manner. The lowermost layer is (in major parts of the pipeline route) somewhat deeper than seasonal thermocline or permanent halocline. Due to the long history of eutrophication, nutrient concentrations are constantly high in this water layer. On the basis of the monitoring results *(Ramboll 2012b)* and assessment in Subchapter 11.3, it could be concluded that impacts on the planktonic environment are *negligible (no impact)* and are not assessed further.

7.9 Benthic flora and fauna

The baseline is focused on benthic fauna as there are no macrophytes in the pipeline route due to high depth. The benthic communities of the Baltic Sea are composed of a mixture of marine, brackish water and limnic organisms. In the Baltic Sea, the latitudinal distribution and species diversity are limited and controlled by the decreasing salinity gradient towards the north *(e.g. Zettler et al. 2014 and references therein)*. Moreover, environmental factors such as temperature and, especially oxygen level near the seabed, are significant factors that control macrozoobenthos distribution and density *(e.g. Rousi et al. 2013 and references therein)*. Oxygen conditions (also Subchapter 7.5) in the Gulf of Finland are mainly driven by intrusions of oxygen-depleted stagnant water from the Central Baltic Sea basin that arise from saline water pulses from the Danish Straits that are pushing stagnant saltier water into the Gulf of Finland. This event can cause a dramatic decline in benthic animals as was seen, for example, during 1995–1996 *(Laine et al. 2007)*. Thus, distribution of benthos in the open sea is heavily dependent on salinity and oxygen fluctuations. Generally, most of the deeper sea areas in the Gulf of Finland are either permanently or semi-permanently hypoxic or anoxic, which is severely reducing macrofaunal species diversity.

7.9.1 Material and methods

The bathymetry along the survey corridor and the depth zones that were distinguished are described in Subchapter 7.4.3. Bathymetry in areal sampling stations where benthos was collected varied between 44–76 m, with the surface area of these stations varying between 30.3–56.6 km^2 (*Luode Consulting Ltd 2016a*, Appendix 4). According to Fugro Survey Limited (2016), the seabed sediments in the survey corridor are interpreted to be predominantly very soft clay and very soft to soft clay with occasional boulders. Occasional outcrops of hardground (glacial till/bedrock) occurs frequently, especially in the eastern part of the survey corridor *(Fugro Survey Limited 2016)*.

Zoobenthic community composition has been discussed in relation to different depth zones along the survey corridor (Subchapter 7.9.2). To describe benthos in these depth zones, monitoring data (HELCOM long-term data, monitoring results by Nord Stream and baseline survey results related to this EIA) were used. Source data and methods are presented in Table 7-12 and Figure 7-35.

Table 7-12. Source data for macrozoobenthos baseline.

Parameter	Study	Units	Methods	Location	Timing / frequency	Source
Abundance & biomass of species and individuals	HELCOM long-term monitoring stations	ind/m^2 species/m^2 mg ww/m^2	van Veen grab 3-5 replicates/location 1 mm and 0.5 mm sieves	HELCOM long-term stations: LL3A, LL4A, LL5, LL6A, LL7, LL9, LL11, LL12, LL19	Spring, 2009-2014 yearly	Benthos database: Open data source, Finnish Environment Institute, SYKE)
Abundance & biomass of species and individuals	Representativeness of HELCOM long-term monitoring stations situated close to the Nord Stream pipelines	ind/m^2 species/m^2 mg ww/m^2	van Veen grab 3 replicates/location 1 mm and 0.5 mm sieves	HELCOM stations: LL5, LL6, LL7 and their 2 parallel stations A and B	Study has been conducted once before installation of the first pipeline, twice per year in 2011 and annually between 2012-2015	Latest reports: G-PE-EMS-MON-193-SYKE12-A.docx G-PE-EMS-MON-193-SYKE13-A.docx
Abundance & biomass of species and individuals	Monitoring of benthic infauna in the Gulf of Finland -three year monitoring project (2013-2015) that evaluated the long-term impacts of construction of the Nord Stream pipelines	ind/m^2 species/m^2 mg ww/m^2	van Veen grab 3 replicates/location 1 mm and 0.5 mm sieves	Transect BENT2 (locations P1-P7) and Transect BENT3A (locations P1-P7)	Monitoring transects (7 locations each) have been monitored 2010 before and after rock placement at the tie-in site, before and after munitions clearance and annually between 2013-2015.	Latest report: G-PE-EMS-MON-500-BENFIN15-A.doxc. 28 March 2016.
Abundance & biomass of species and individuals	Environmental baseline survey 2015 – 2016 macrozoobent-hos	ind/m^2 species/m^2 mg ww/m^2	van Veen grab 1 or 3 replicates per sampling location (8 locations per 4 areal station) 1 mm and 0.5 mm sieves	FIN_EBS_LUO_1-4	Survey has been conducted twice, September 2015 and June 2016	Report: FIN_EBS_LUO_BEN_Analysis_v03_20160912 (Appendix 2 in Luode Ltd. 2016a, which is Appendix 4 in this EIA)
Benthos associated with hard bottoms	Environmental baseline survey of Nord Stream (2008) and environmental survey 2014	Seabed type species ind/m^2	Drop down videocamera	Continuous underwater video in transects near Sandkallan Natura 2000 area	7 transects during 2008 One transect during 2014	Reports: MMT 2008 MMT 2014

HELCOM long-term monitoring data and data from the baseline study (Table 7-12) were rearranged so that differences between the benthic communities (species richness, abundance and biomass) at different depth zones could be seen.

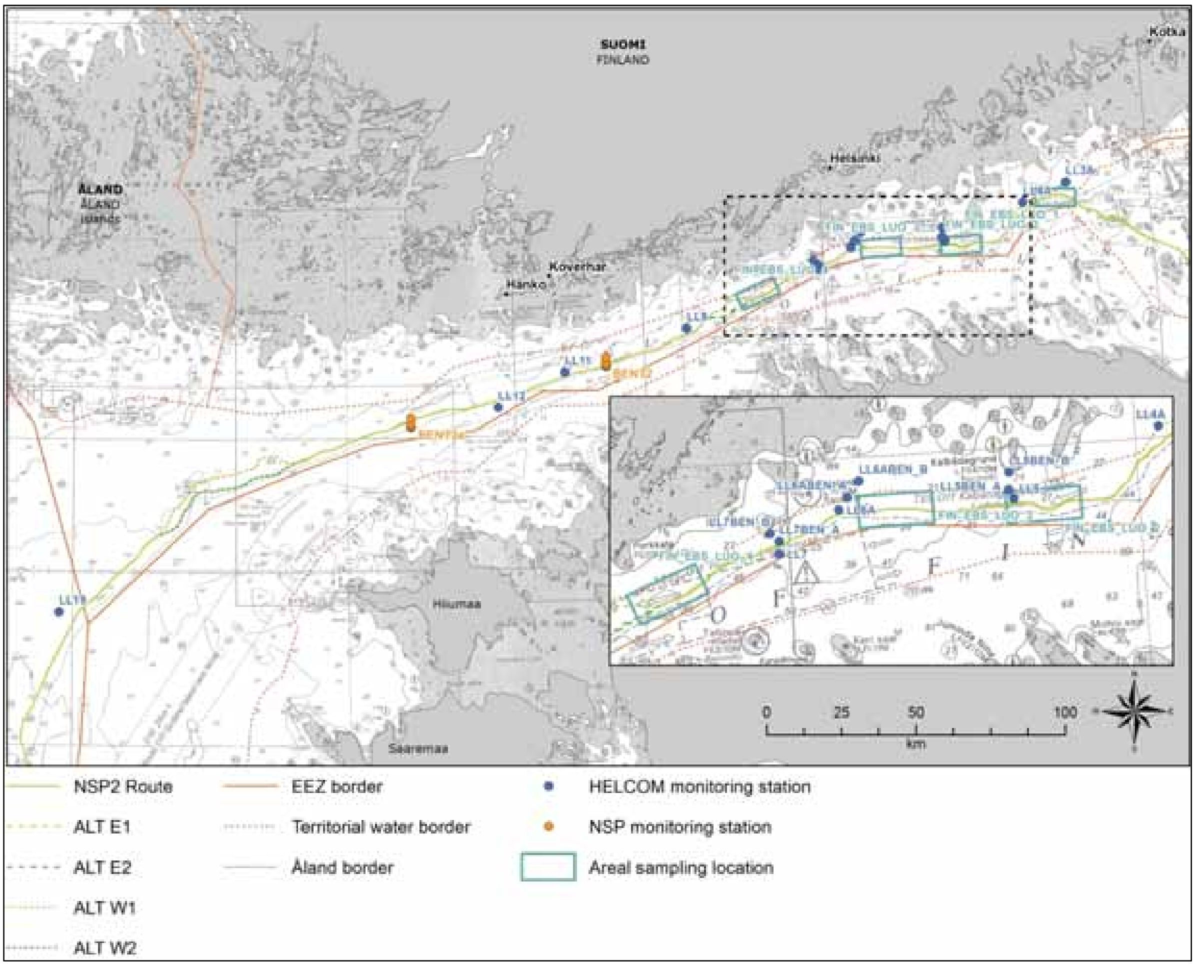


Figure 7-35. **Location of the benthos sampling points. Data was used to describe benthic communities along the survey corridor.**

7.9.2 Community composition along the depth gradient

7.9.2.1 Depth zone 40–60 m

This zone covers the middle and eastern sections of the planned pipeline route in the Gulf of Finland. Compared to deeper areas, the proportion of this zone of the survey corridor comprises ca. 25% (Table 7-9). No severe oxygen deficiency has been detected recently in the easternmost areas.

In the eastern and middle parts of the Gulf of Finland, this depth range was presented by LL4A HELCOM long-term monitoring station as well as at all FIN_EBS_LUO_1-LUO_4 areal sampling stations (Figure 7-35). In these areas, also harder soil types are present and, thus, no samples were possible to obtain from six locations (Appendix 4). The benthos community composition in relatively shallow locations (depth <60 m) are presented in Figure 7-36. During the baseline study in December 2015, the whole water column in all sampling sites was entirely mixed and, therefore, oxygen levels were good (range 10.3–11.6 mg O_2/l) at depths of 44 m – 60 m. However, odour emanating from hydrogen sulphide was detected from sediment samples in some locations, indicating fluctuations in oxygen levels near the seabed (Appendix 4). In June 2016, a clear formation of density dependent stratification was observed at all areal stations, resulting in poor oxygen conditions at several locations. These variations seem to be the major controlling factor of the zoobenthic communities in the study area (Appendix 4).

The diversity of the benthic communities at these depths is rather low with only a few opportunistic species dominating. One such genus is the non-native burrowing polychaetes *Marenzelleria* spp., which rapidly colonised the seabed in the Baltic Sea after its first appearance in 1985 (e.g. *Kauppi et al. 2015*). These worms live in the top sediments down to depths of 20 cm. They can spread very effectively into areas with quite different water depths and environmental conditions and they can survive even in sediments with extremely low oxygen content. Another polychaete species that can tolerate clear oxygen deficiency in its living environment is *Bylgides sarsi*. A marine bivalvia *Macoma balthica* normally dominates soft seabed found in many locations across the Baltic Sea. This species also tolerates hypoxia well *(Dries and Theede 1974)*. In contrast, crustacean amphipod *Monoporeia affinis* is often used as an indicator species as its youth stages are very sensitive to oxygen deficiency in the seabed. Also, a malacostraca *Saduria entomon* is commonly found on the seabed at this depth zone. Other species/taxa that have been observed are *Halicryptus spinulosus* (Priapulida), Mysidacea (very low numbers) and Ostracoda (Crustacea). The Baltic Sea scale inventory of benthic faunal communities revealed that this type of community structure is typical for the area *(Gogina et al. 2016)*.

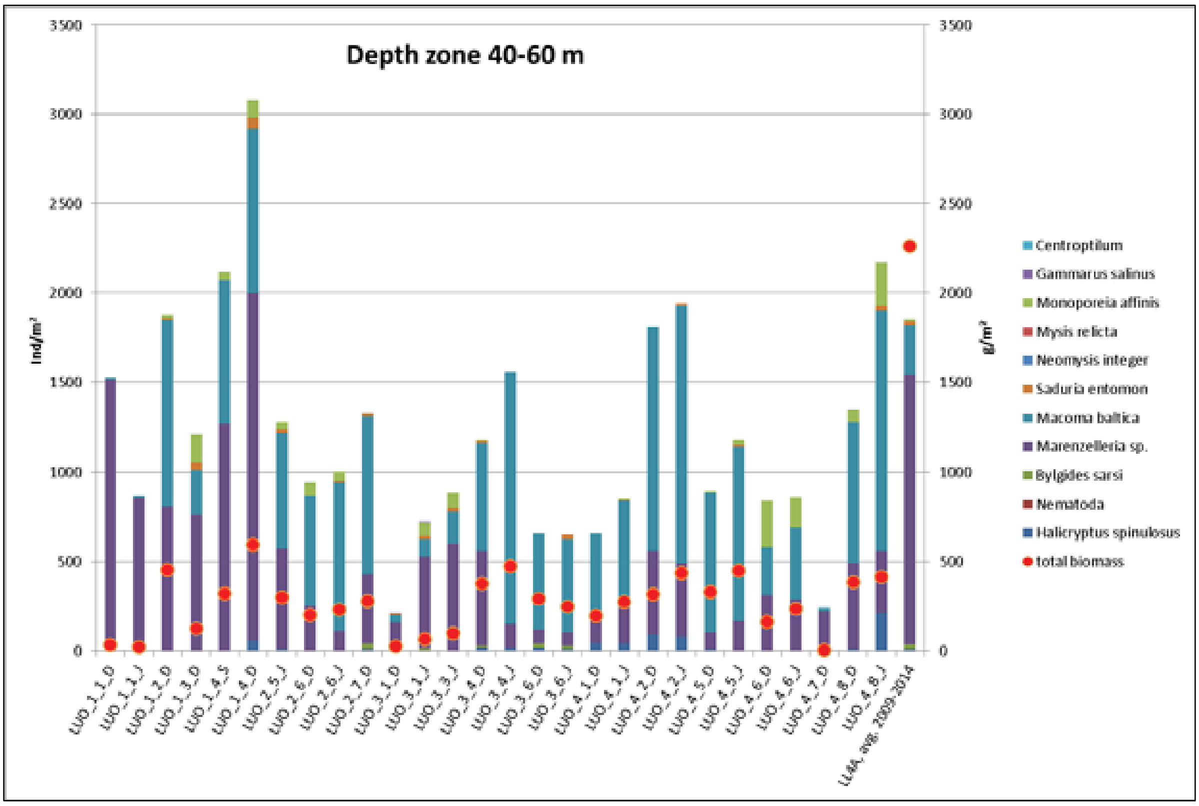


Figure 7-36. Species-specific abundances and total biomasses in a baseline survey (sampling areas FIN_EBS_LUO_1-4) in December (D) 2015, June 2016 (J) and at the HELCOM long-term monitoring station (LL4A). Sampling sites were situated at the depth zone 40–60 m.

Based on long-term data (HELCOM) and the baseline survey of this EIA (Appendix 4), *Marenzelleria* and *Macoma* were the most abundant taxa while other species/taxa were extremely scarce and only 7 taxa were detected. *Monoporeia affinis* was present in ca. half of the locations of the baseline survey. However, also lifeless sampling points were found. The environmental status was good or moderate based on the macroinvertebrate index (BBI) at most of the locations where *Monoporeia* was found (Appendix 4).

The Sandkallan Natura 2000 site (conservation criteria 1170 Reefs) is situated in the open sea in front of the City of Porvoo, approximately 1.9 km from the pipeline route. Generally, reefs are described as follows: *Reefs can be either biogenic concretions or of geogenic origin. They are* *hard compact substrata on solid and soft bottoms, which arise from the seabed in the sublittoral or littoral zones* *(European Commission DG Environment 2013)*. There are several reef-like formations in Sandkallan that are of geogenic origin. Typical for these formations is the zonation of benthic communities and relatively high diversity as well as abundance. Dominant species in these kinds of habitat are e.g. blue mussels (*Mytilus trossulus*), bay barnacles (*Balanus improvisus*), *M. baltica*, *S. entomon* and crustacean amphipods. In the deepest zones, at ca. 40-50 m depth, only a few colonies of polyps are present. The geophysical survey indicated that there are outcrops of hardground also on the pipeline route *(Fugro Survey Limited 2016)*. These outcrops could potentially function as reef-like formations, which would offer a more diverse environment for benthic fauna.

The benthic habitats in the area near Sandkallan have been surveyed in 2008 and 2014 (MMT 2014). These studies revealed that the seabed is mosaic-like and habitats often mixed. The main species identified were *S. entomon* and bivalves *M. baltica* and *M. trossulus*. According to a geophysical reconnaissance survey *(Fugro Survey Limited 2016)*, the size and frequency of outcrops of hardground is the highest in the eastern part of the survey corridor. These outcrops can rise up to 35 m above the surrounding seabed. These kinds of formations can be seen as potential reef-like habitats.

Similarly, at the entrance of Porkkala, there are sections where the water depth is lower than average. The potential reefs in the vicinity of the planned pipeline are presented in Figure 7-37 *(Finnish Environment Institute 2016c)*.

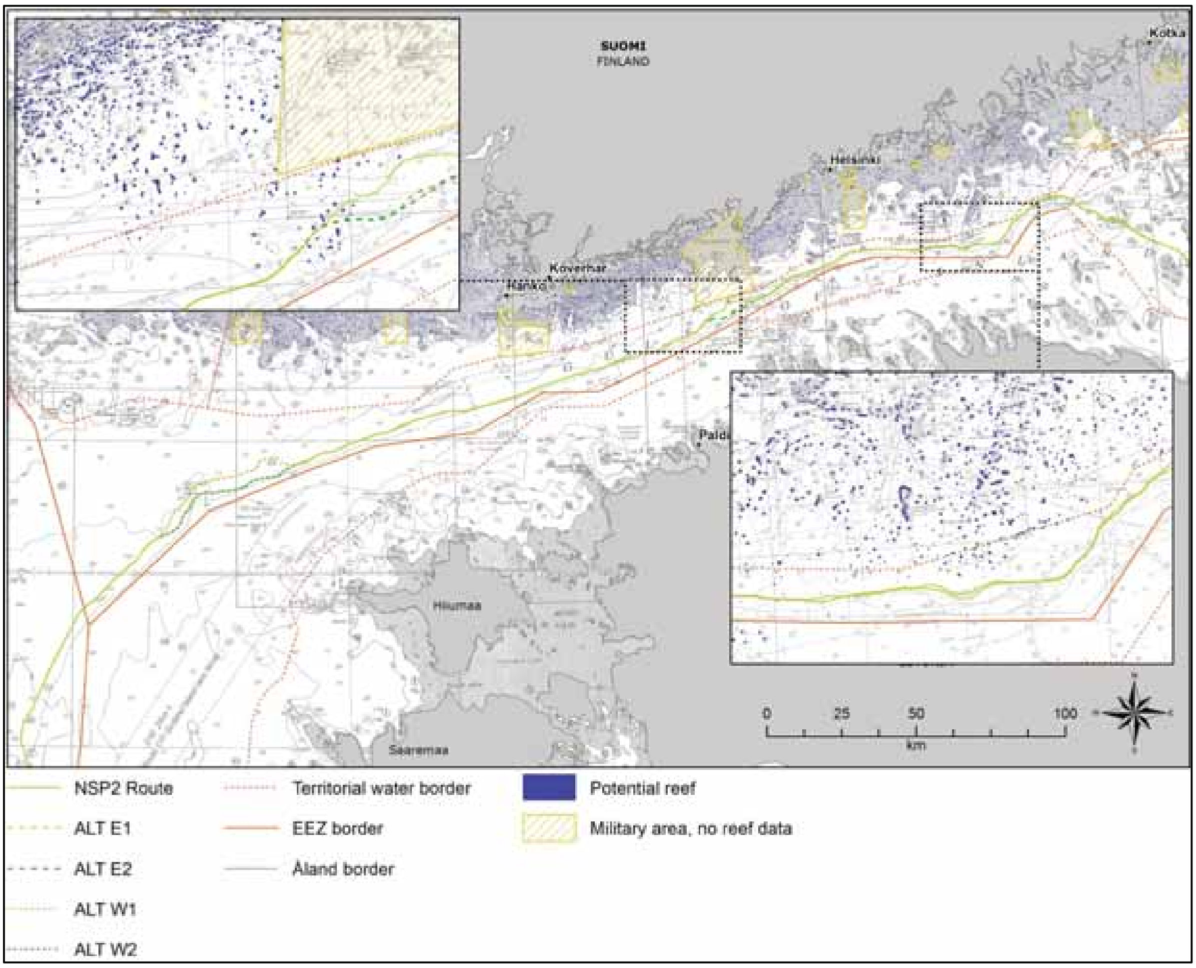


Figure 7-37. Potential reefs and reef areas in Finnish coastal and offshore areas (Finnish Environment Institute 2016c, VELMU; original source data from Geological Survey of Finland).

7.9.2.2 Depth zone 60 m–80 m

Physical and chemical conditions at this water depth are described in Subchapters 7.4–7.6. The proportion of this depth zone of the survey corridor is about 31% (Table 7-9). Oxygen-level near the seabed at these depths is generally low (Figure 7-38).

Monitoring of some selected HELCOM benthos stations between 2010 and 2015 by the Finnish Environment Institute revealed that oxygen concentration near the seabed varied significantly, but during most years, it has been too low to provide a suitable living environment for benthic species (Figure 7-38). Normally, the lowest oxygen levels occur during late summer.

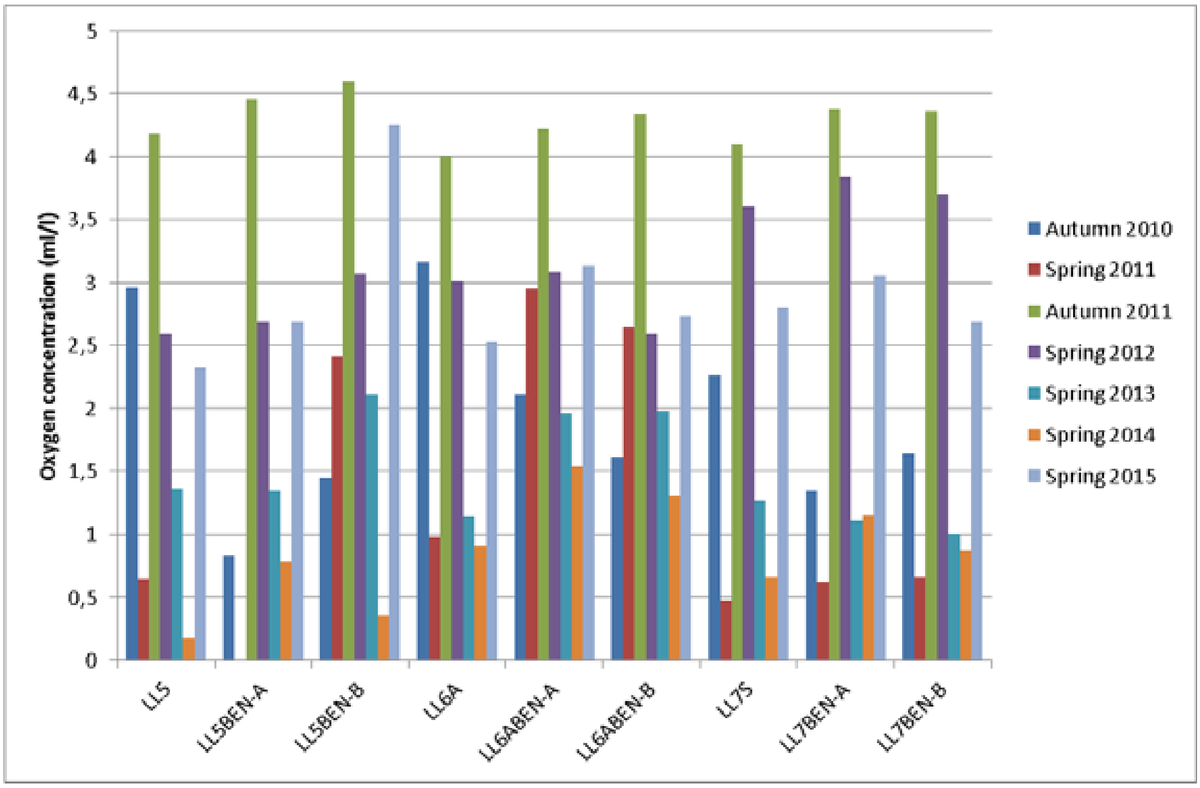


Figure 7-38. **Oxygen concentration (ml O_2/l [6;7]) in seawater 1 m above the seabed at the HELCOM benthos stations LL5, LL6A and LL7S and parallel stations between 2010–2015 (Finnish Environment Institute, Marine Research Centre 2015).**

Only a few opportunistic benthic species, such as *Marenzelleria* spp, can survive in conditions were oxygen is clearly diminished and at times anoxic conditions are prevailing. Community composition was generally very similar compared to the communities found at the 40 m – 60 m depth zone, but species-specific abundances and biomasses were much lower and some locations were lifeless (Figure 7-39). *(Open data source, Finnish Environment Institute SYKE, Finnish Environment Institute 2015e, Fish and Water Research Ltd 2016)*.

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[6] ml O_2/l = 1.43 mg O_2/l

[7] A critical level for biota is considered to be 2.0 ml/l (3.0 mg/l). When oxygen level falls below 1 ml/l (1.4 mg/l), bacteria shift to anaerobic metabolism that leads to the production of toxic hydrogen sulphide (Andersson 2014).

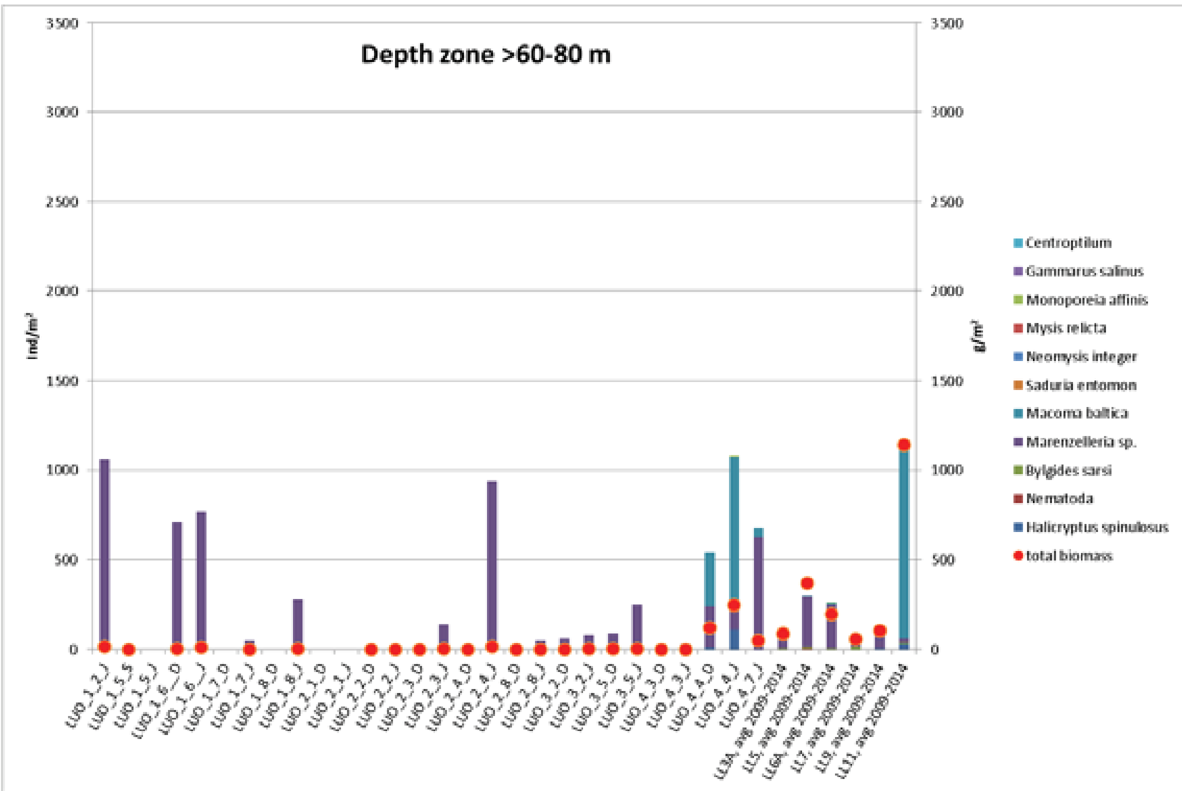

Figure 7-39. **Species-specific abundances and total biomass in the baseline survey (sampling areas FIN_EBS_LUO_1–4, Appendix 4) in December (D) 2015, June (J) 2016 and at the HELCOM long-term monitoring stations. Sampling sites were situated at the depth zone 60–80 m.**

These studies indicate that the abundance and diversity of benthic fauna remain low when living conditions are far from optimal. Moreover, even if the situation would temporarily improve, the species may not have enough time to reproduce effectively and recolonise the seabed.

7.9.2.3 Depth zone over 80 m

The physical and chemical conditions are described in Subchapters 7.4–7.6. The proportion of this depth zone of the survey corridor is about 44% (Table 7-9). Water mass is stratified year-round because of the permanent halocline. Due to the anoxic conditions and formation of hydrogen sulphide, the living conditions for benthic animals are intolerable. According to the HELCOM long-term benthos monitoring data (stations LL12, LL13, LL15, LL17, LL19), benthic animals have been totally absent at depths ranging between ca. 82–170 m *(Open data source, Finnish Environment Institute, SYKE)*.

7.10 Fish

The Baltic Sea is host to approximately 70 saltwater fish species and another 30–40 brackish or freshwater species that inhabit the innermost parts of the Baltic Sea and the coastal areas. In the Gulf of Finland and the Northern Baltic Proper (e.g. Figure 7-52 in Subchapter 7.17), the prevailing environmental conditions are suitable for only a few fish species. Low salinity is a limiting factor for many marine fish species. The low oxygen content or lack of oxygen in deeper areas limits the number of suitable habitats for demersal fish species.

In the open sea, along the pipeline route in the Gulf of Finland, the fish community is dominated by European sprat (*Sprattus sprattus* L.) and Baltic herring (*Clupea harengus* L.) and during the winter period, also by three-spined stickleback (*Gasterosteus aculeatus*). Migratory fish species, which spend most of their adult life in the sea, but spawn and spend their juvenile stage in rivers, are Atlantic salmon (*Salmo salar*), sea trout (*Salmo trutta* L.) and whitefish (*Coregonus lavaretus*).

The commercially exploited fish species in the Finnish project area are European sprat, Baltic herring and Atlantic salmon.

Baltic herring occur in large schools throughout the Baltic Sea with clearly different stocks in different areas. Herring tend to make seasonal migrations between coastal archipelagos and open sea areas, staying close to the coast during spring and autumn while spending summer in nutrient-rich open seas. Older herring move into deeper waters of the open sea during winter, whereas younger individuals tend to remain close to the coast. Herrings feed primarily on zooplankton, although older ones may feed on fish eggs and fry, e.g., cod eggs.

The Baltic herring uses large parts of the archipelago zone for reproduction; in the Finnish coastal area, 99.5% of the water area is suitable for larval production of the Baltic herring (Figure 7-40) *(Raateoja and Setälä 2016)*. However, the preferred spawning depth of herring is less than 10 m with hard bottoms covered by vegetation (Figure 7-41) *(Koli 1990, Kääriä et al.1997, Raid 1990)*.

Baltic herring is considered to be harvested sustainably and to have a good level of spawning-stock biomass *(ICES 2016)*.

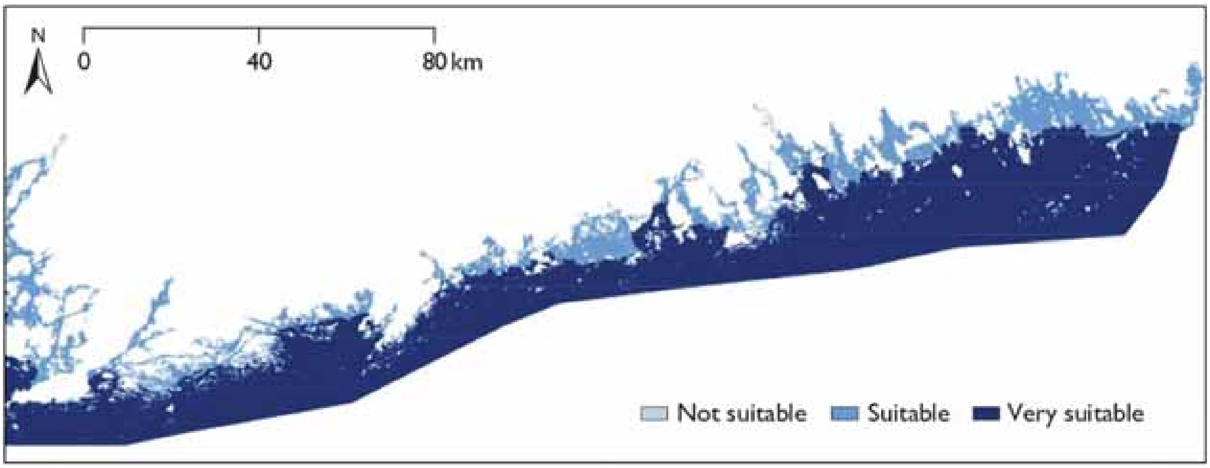

Figure 7-40. The reproduction habitats of Baltic herring on the northern coast of the GOF. Source: Natural Resources Institute Finland, VELMU programme, Kallasvuo et al. (submitted) (ref. in the Raateoja and Setälä 2016).

Sprat live in schools throughout the Baltic Sea, although they are not as common in the Bothnian Bay as in other areas. Sprat is an open-sea species and rarely found along the coast. Sprat migrate in open water areas, seeking out warmer water layers during different seasons because they freeze if the water temperature drops to below 2–3°C. During harsh winters, the distribution of sprat shrinks and the density of fish increases. Sprat eat zooplankton as well as cod eggs. *(ICES 2006)*

European sprat spawns in open waters, but often near the slopes of the basins. The deep areas of the Baltic Sea, such as the Bornholm Deep, the Gdansk Deep and the southern part of the Gotland Deep are important spawning areas. Spawning occurs from February to August, depending on the geographical area *(ICES 2016)*. In the Gulf of Finland and the Northern Baltic Proper, spawning occurs during the summer months *(Koli 1990)*. The eggs of the species require salinity above 5–6 PSU to develop, which limits spawning to the western part of the Gulf of Finland (Figure 7-42). Below this salinity level, the eggs sink to the bottom where the oxygen concentration is often too low for their survival.

According to the ICES (International Council for the Exploration of the Sea) assessment in 2016, the Baltic Sea sprat stock was harvested sustainably, which means that the fish stock is considered to be in a healthy condition *(ICES 2016)*.

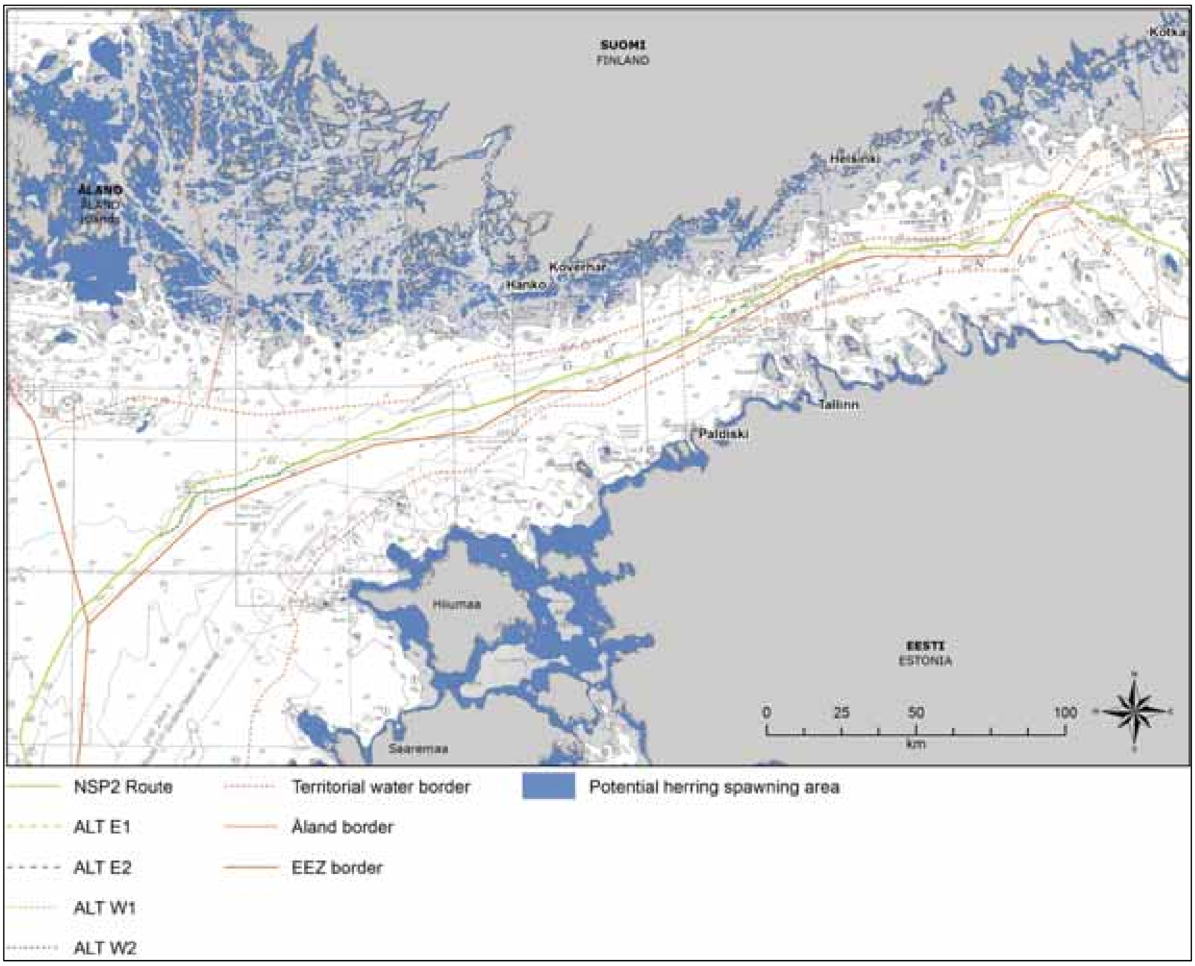

Figure 7-41. Preferred herring spawning areas (water depth under 10 m) in the Gulf of Finland and in the Northern Baltic Proper.

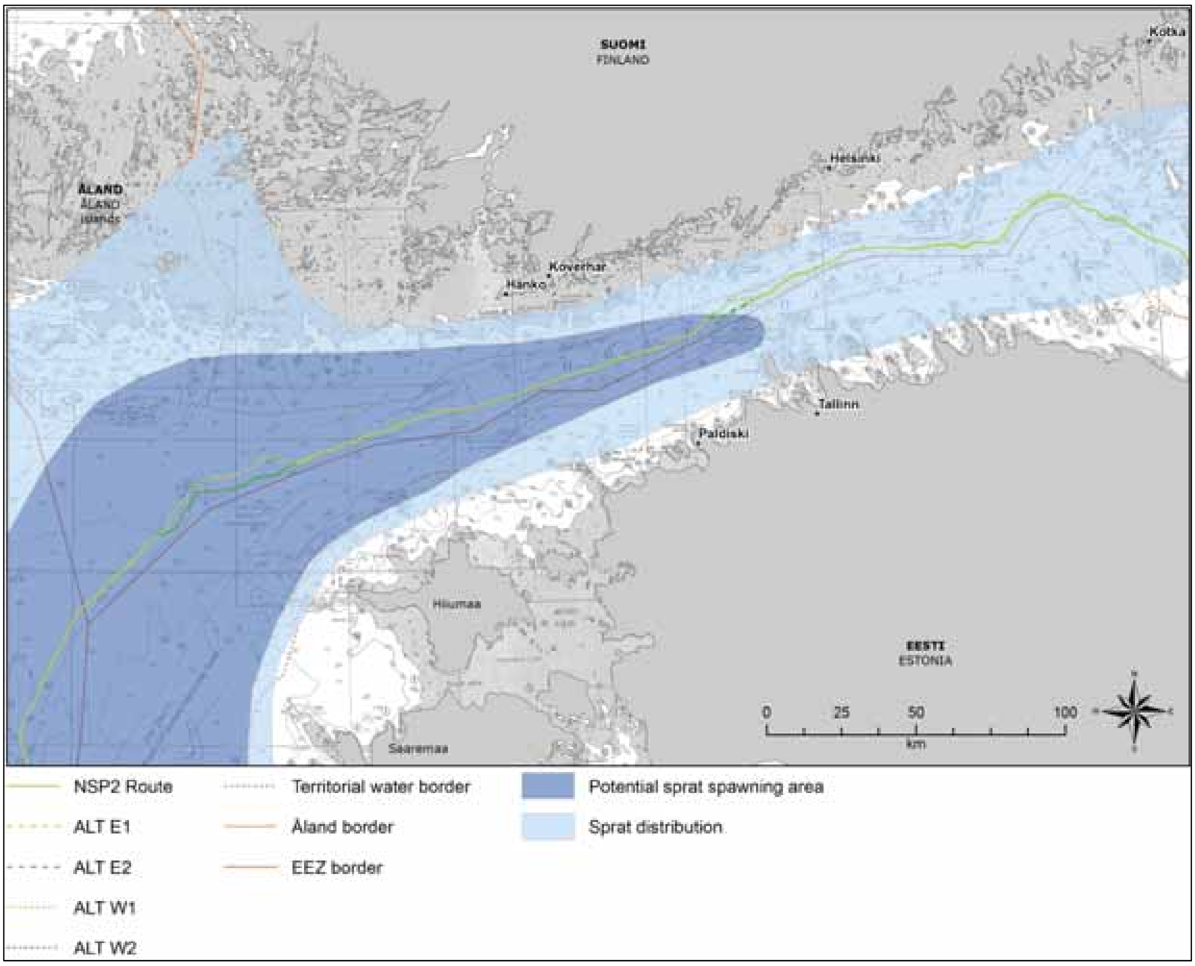

Figure 7-42 The principal distribution area of European sprat in the Gulf of Finland and the Northern Baltic Proper.

Salmon is an open-sea fish that migrates long distances from the remote reaches of the Bothnian Bay and the Gulf of Finland to the more central and southern parts of the Baltic Sea. Salmon breeds in rivers. At sea, salmon usually follow schools of herring and sprat. Salmon spend the first one to six years of their lives in the rivers where they are born before migrating to open seas. After spending one to four years in the open sea, salmon make their first spawning migration, returning to the river where they were born to spawn. There are approximately 30 rivers in the Baltic Sea region with wild salmon smolt production. Today, a majority of the Baltic rivers are unsuitable for salmon due to damming, mainly for hydroelectric power production. These obstructions prevent the spawning migration.

The distribution area of cod (*Gadus morhua*) reaches the planned project area in the Finnish EEZ but cod spawn does not tolerate the prevailing environmental conditions of low salinity and low oxygen saturation in the lower water layers. Therefore, the importance of cod is currently low for commercial fishery in Finnish waters.

Within the coastal zone there are commercially important catch species which also spawn along the coast in shallow areas. Commercially important species in the coastal fishery are whitefish, perch (*Perca fluviatilis*), pike (*Esox lucius*), pikeperch (*Sander lucioperca*) and burbot (*Lota lota*). These species form the majority of the catch of commercial coastal fishing and also the catch of recreational fishermen. These species are not found in the EEZ area of Finland.

7.10.1 Threaten fish species

According to the latest red list assessment of the Finnish fish species *(Urho et al. 2010)*, there are five threatened fish species that occur or may occur in the Finnish Nord Stream 2 Project area. The situation of migratory salmon (*Salmo salar*) stocks in rivers running into the Baltic Sea has improved and they were correspondingly transferred into a lower threat category, the category Vulnerable (VU). Anadromous sea trout (*Salmo trutta*) were transferred from the category Endangered to Critically Endangered as reproduction is unstable in most populations, due to intensive fishing targeting also immature individuals, migration obstructions and highly alternating discharges in rivers. For the same reasons, the situation of anadromous whitefish (*Coregonus lavaretus lavaretus*) has also weakened and it was transferred from the category Vulnerable to Endangered (EN). Eel (*Anguilla Anguilla*), which has declined dramatically throughout Europe, was categorised as Endangered (EN). And finally, catches of river lamprey (*Lampetra fluviatilis*) have recently decreased and the numbers of larvae have fluctuated, but the evaluated category, Near Threatened (NT), remained still unchanged.

7.10.2 Pollutants in fish

The presence of persistent organic pollutants (POP) in fish in the Baltic Sea has been monitored at EU level. The study called EU Fish II *(Hallikainen et al. 2011)* shows that concentrations of many POP compounds have declined in fish caught from the Gulf of Finland. Commission Regulation (EC) No 1881/2006 setting maximum levels for certain contaminants in foodstuffs prohibits the sale of fish and fish products containing concentrations exceeding 4 pg/g (wet weight) of dioxins (WHO-PCDD/F-TEQ). Finland and Sweden have a derogation to that prohibition and are allowed to sell large (>17 cm) Baltic herring in their own territories and salmon also to Latvia. Latvia also has a derogation which permits it to sell salmon products in its own territory that exceed the set concentrations for dioxin. The more recent Commission Regulation (EC) No 1259/2011 sets the maximum dioxin concentration at 3.5 pg/g (wet weight). The change to the dioxin limit value does not affect the above-mentioned derogations.

Wiberg et al. (2013) found no clear spatial variation in the dioxin levels in Baltic herring in the Bothnian Sea attributed to the migratory nature of the populations of the species within the sea area. Because herring is a pelagic offshore species, it will be primarily impacted by dioxins delivered to the water column via atmospheric deposition. Concentrations of dioxins in the target species of the offshore fishery in 2009, outside of the cities of Hanko and Kotka, are shown in Table 7-13.

Table 7-13. Dioxin (WHO-PCDD/F-TEQ) content (pg/g) in salmon, Baltic herring and sprat in the Gulf of Finland in 2009 (Hallikainen et al. 2011).

Species		The Gulf of Finland, Hanko			The Gulf of Finland, Kotka	
	Age, years	n	WHO-PCDD/F-TEQ	Age, years	n	WHO-PCDD/F-TEQ
Salmon	2 sea years	5	3.57	2 sea years	5	4.24–4.79
Baltic herring	1–9	50	0.65–1.63	2–7	50	0.91–3.70
Sprat	1–4	20	0.66–1.31	1–6	20	0.76–1.77

7.11 Marine mammals

There are four resident marine mammal species in the Baltic Sea; grey seal (*Halichoerus grypus grypus*), ringed seal (*Pusa hispida botnica*), harbour porpoise (*Phocoena phocoena*) and harbour seal (*Phoca vitulina*). Of these, the harbour seal is a southern Baltic Sea species and does not occur in Finland. Thereby, the focus is on the other three marine mammal species.

The total estimated Baltic populations of these species are (Teilmann and Sveegaard 2017, Appendix 8A and HELCOM 2016a):

- Harbour porpoise 500
- Ringed seal 11,500–17,400
- Grey seal 32,000–40,000
- Harbour seal 2,500

7.11.1 Nature conservation status

The conservation status of marine mammals that occur in Finnish waters are presented in Table 7-14.

Table 7-14. The conservation status of the grey seal, ringed seal and harbour porpoise (IUCN 2000, HELCOM 2016a, Rassi et al. 2010, Liukko et al. 2016).

	Conservation status		
Species	**IUCN red list**	**HELCOM red list**	**Finland red list**
Grey seal	LC		not listed[1]
Ringed seal	LC	VU	NT
Harbour porpoise	LC		
Baltic Sea subpopulation[2]		CR	RE
Western Baltic subpopulation[3]		VU	
Key for abbreviations (IUCN red list categories)			
EX	Extinct		
EW	Extinct in the wild		
RE	Regionally extinct		
CR	Critically endangered		
EN	Endangered		
VU	Vulnerable		
NT	Near threatened		
LC	Least concern		
DD	Data deficient		
NE	Not evaluated		

[1] The grey seal is no longer listed in the Finnish red list of threatened animals (Liukko et al. 2016)

[2] Baltic Proper subpopulation of harbour porpoise

[3] Belt Sea subpopulation of harbour porpoise

In addition, these marine mammals have also been listed in the EU Habitats Directive and in other international treaties, agreements and legislation to protect these species. The grey seal and the ringed seal are listed as a protected species in the EU Habitats Directive (Annex II and Annex V) and the Bern Convention (Appendix III). Annex II in the Habitats Directive is designated to animal species of community interest and the conservation of which requires the designation of special areas of conservation *(Rassi et al. 2010, HELCOM 2016a)*. Harbour porpoise has been listed in Annex II and IV of the EU Habitats Directive, Annex II of the Bern Convention, Annex II of the Bonn Convention and Annex II of the Washington Convention. Furthermore, the harbour porpoise is covered by the terms of the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS). The species listed in Annex IV are strictly protected.

Of the mentioned species, the grey seal and the ringed seal are found in the Gulf of Finland. Harbour porpoise is rare in the northern parts of the Baltic Sea main basin and the species does not breed in Finnish waters.

7.11.2 Grey seal

Population structure

Globally there are three separate population of grey seals; the Baltic population and populations in the Northeast and northwest Atlantic. The three populations are clearly genetically separate *(Graves et al. 2009, Fietz et al. 2016).* Also, some differentiation has been detected between the three main breeding areas in the Bothnian Bay, Gulf of Riga and Northern Baltic Proper, suggesting limited genetic exchange.

Abundance and distribution

The grey seal is currently the most abundant species in the Baltic Sea. According to the HELCOM (2016a) estimation of an annual population increase of 7.9%, it is assumed that the total population in the Baltic in 2014 was above 40,000. In 2014, the grey seal population in the Gulf of Finland was estimated to be about 1,100 individuals *(HELCOM 2016a, Natural Resources Institute Finland 2016a, Appendix 8A)*.

The Baltic grey seals are distributed from the northernmost part of the Bothnian Bay to the southwestern areas of the Baltic Proper. During the breeding period, the seals dwell on drift ice in the Gulf of Riga, Gulf of Finland, the Northern Baltic Proper and the Bothnian Bay or on the rocks in the nortwestern Baltic. The reproduction rate has gradually improved due to, among other factors, decreased levels of environmental contaminants. However, during last decades, the rate has decreased which may suggest that the population is near carrying capacity in the northern part of the Baltic Sea *(Helle 1984, Kauhala et al. 2014)*.

Satellite tracking indicates that grey seals typically move long distances and change location between seasons. Observations of tracked individuals have shown that they can move over 100 km within 24 hours. Typically, they move approximately 10 km per day when fishing around haul-out sites. Distribution of grey seals based on satellite tracking is shown in Map Atlas: MA-03-F. The grey seal is able to cross the open sea in the Gulf of Finland and use the open sea for foraging, but the densities of seals are highest close to the haul-out sites *(Dietz et al. 2003)*. However, latest results from tracking data has showed that the grey seals showed much stronger foraging and haul-out site fidelity than the ringed seals during the post-moulting season *(Oksanen 2015).*

Behaviour and reproduction

Grey seals feed in cold, open water and breed in a variety of habitats where disturbance is minimal, such as rocky shores, sandbars, sea ice and islands. These animals can dive rather deep when foraging near the seabed (ca. 70-90 m in western Scotland waters) *(Thompson & Fedak 1993)* but their diving depth is probably largely dependent on the area where they are foraging. The grey seals breed on ice or on land depending on the ice conditions. The breeding season takes place between February and April in the Gulf of Finland. The grey seal is mature at the age of 3–7 years. Females become mature usually younger than males, and they bear only one pup at a time.

In the Gulf of Finland, breeding areas depend greatly on ice conditions and are varying between years. Recently, winters have been mild and grey seals have bred on islands or in the eastern Gulf of Finland where ice cover has prevailed.

Grey seal pups are usually born later than ringed seal pups and they stay more openly on ice or on shore. The new born pups of both species have thick and warm light fur, which protects them from the cold air but is permeable to water. Therefore, the pups stay on ice or on land for the first weeks of their lives and may perish from exposure if they enter water too early. Because a new-born pup has to keep dry for 2–3 weeks, grey seals do not give birth on new ice or on a shattered moving ice field.

Grey seals mate in spring towards the end of the period of suckling, or when suckling has ended. For this reason, males appear in the breeding area in spring. After that period, seals gather to haul-outs, for the majority of the grey seal population, this means protected seal sanctuaries. Young seals may remain on ice flocks until April. Sveegaard et al (2017) have assessed that the highly critical period lasts from February until June, until the moulting period is over (Appendix 8B).

Feeding

Grey seals dive alone or in small groups and feed mainly on fish, like Baltic herring and vendace. Some individuals, especially adult males, may specialise in feeding on salmon or brown trout, which they can obtain from fishermen's nets or traps. This has caused locally some problems near coastal areas *(Ministry of Agriculture and Forestry of Finland 2007, Mänttäri 2011, Oksanen 2015)*.

Hearing, vision, touch/vibration, electro- magnetoreception

The senses have been described in more detail in Appendix 8A and references therein and are summarised here.

The senses of the grey seal are believed to be similar to other true seals. In this EIA, the harbour seal is used as a model regarding senses. The hearing system of seals is well adapted to aquatic life. The audiogram of harbour seals show good underwater hearing in the range from a few hundred Hz to approximately 50 kHz.

Seals have generally good vision, both at the surface and under water and seals are probably able to orient visually even at great depth.

Behavioural experiments have shown that seals are sensitive to particle movement in the water and, it is possible that they can detect the vortices and eddies left behind in the wake of a swimming fish using touch sense in their whiskers. This ability is important for catching prey.

There is no evidence of electroreception or the ability of seals to detect magnetic fields. The possibility of especially magnetoreception should, however, not be dismissed. These types of sensory systems can help marine mammals in orienteering.

Disturbance

Disturbance can be caused, for example, by snowmobile traffic, ice road or ship traffic. Escape distance varies (the distance moved by a seal individual due to disturbance). It is approximately 500 m in areas were seals are hunted, like the Bay of Bothnia *(Ministry of Agriculture and Forestry of Finland 2007)*. In the Gulf of Finland, some grey seal individuals are more adapted to humans. The escape distance of seals is dependent on the age of the seal and whether it is alone or in a pod.

The most critical period for the grey seal is from January to late March, when they are on ice during the calving and mating season.

The main threats to grey seals are fishing nets, environmental pollution, diseases, climate change, recreational boating and sea traffic. Grey seals can be hunted with special licence, and there are different yearly hunting quotas: Gulf of Finland (144 individuals), the Archipelago Sea (273) and the Gulf of Bothnia (633) *(Suomen riistakeskus 2016, http://riista.fi)*.

7.11.3 Baltic ringed seal

Population structure

The Baltic ringed seals form a genetically isolated population which separated from the Arctic water at the end of the last glaciation approximately 9,000-11,000 years ago. They are a northern species due to their dependence on sea ice. There are three geographically isolated groups; Bothnian Bay, Gulf of Finland and Gulf of Riga (Väinameri population and small population in Archipelago Sea), but no genetic differences have been found to occur between these subpopulations *(Palo et al. 2001, Härkönen et al. 2008)*. However, tracking studies have shown that at least one individual moved from the Bay of Bothnia to the Väinameri sea area *(Oksanen 2015)*, so gene flow may still exist.

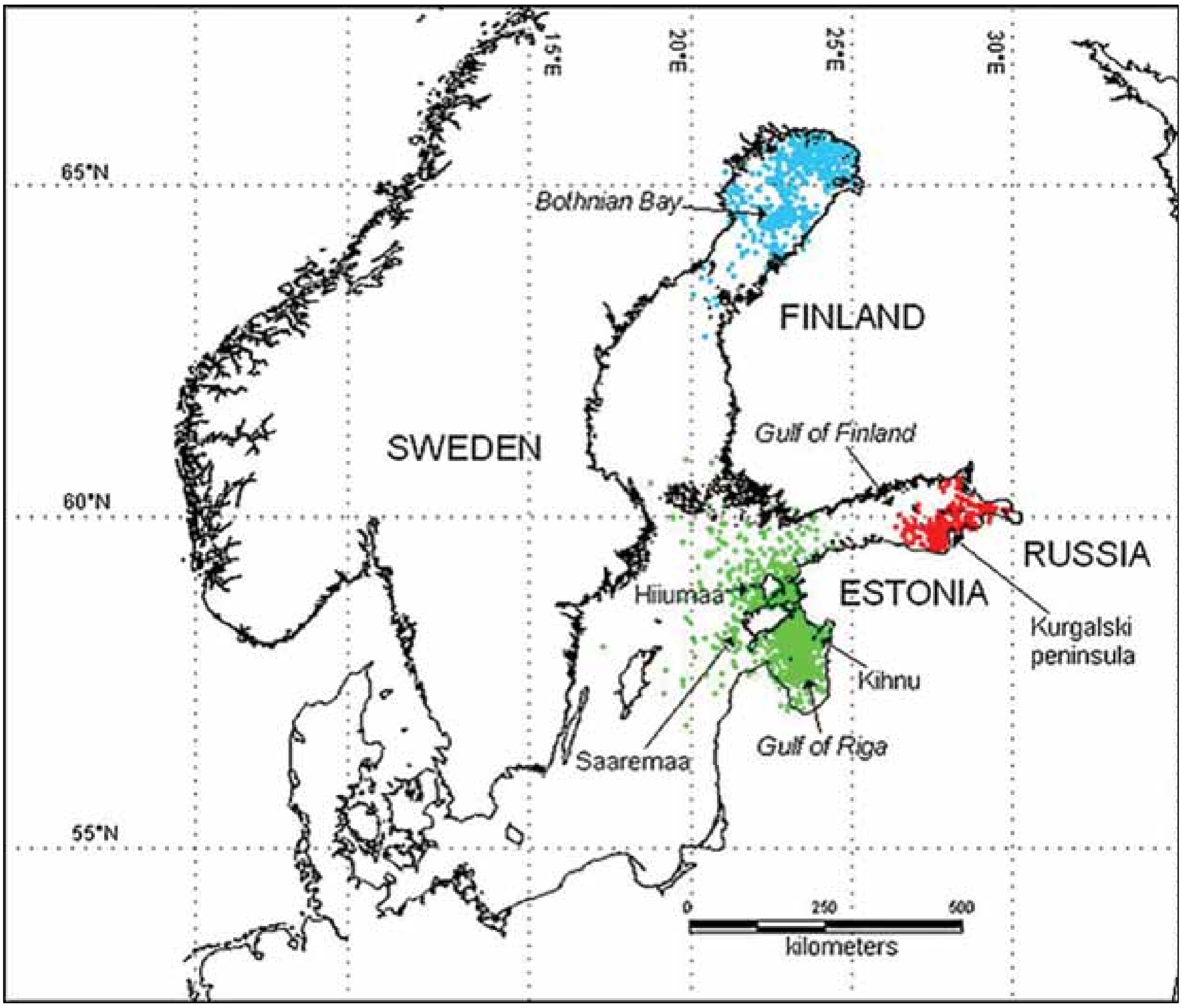

Figure 7-43. The Baltic Sea with locations of adult ringed seals tagged with Argos satellite transmitters in three geographically isolated groups: the Bothnian Bay (blue, 5 seals, 345 locations), the Gulf of Finland (red, 4 seals, 178 locations), and Estonian coastal waters (green, 10 seals, 812 locations) (from Härkönen et al. 2008).

Abundance and distribution

The ringed seal has previously been abundant in the Baltic Sea with an estimated population size of around 200,000 individuals at the beginning of the last century. The population has since severely declined, due to environmental pollution-induced illnesses and hunting until the 1970s, at which time only 3,000–5,000 ringed seals remained *(Harding and Härkönen 1999)*. Since 1988, the abundance in the northern breeding area in the Bothnian Bay has increased by 4.8% per year and aerial surveys in 2014 of ringed seals hauled out on the ice in April-May gave an estimate of ca. 8,000 hauled-out individuals *(HELCOM 2015c)* here. When correcting for the seals in the water, the total northern population of ringed seals in the Baltic Sea comprised around 11,500 individuals. However, in the spring of 2015, the ice conditions were exceptionally suitable during population count and a surprisingly high total number of hauled out individuals (17,400) were estimated to occur *(Natural Resources Institute Finland 2016a)*. This was almost twice as much as expected and the survey may not be completely comparable with the previous surveys. In this report, we will assume that the population is between 11,500 and 17,400 individuals.

Because of unfavourable ice conditions, there is no recent survey data on the ringed seals inhabiting the three southern breeding areas, the Finnish Archipelago Sea, the Gulf of Finland and the Gulf of Riga. A census in 2011 counted 50 individuals in the Gulf of Finland leading to a population estimate of ca. 100 *(HELCOM 2016a)*. This area was estimated at 300 individuals in the 1990s and may, thus, be in serious decline. The seals are most commonly found within Russian territorial waters, but a small part of the population lives and breeds on the Finnish side in the vicinity of the Russian border and also near Uhtja Island, Estonia. Other Estonian ringed seal sites in the Gulf of Finland are Kolga Bay and Krassi Island *(Keskonnaamet 2015)*.

In the Gulf of Riga, 1,400-1,500 ringed seals were counted in 2011 *(Härkönen et al. 2013)*. In the Archipelago Sea, the population size according to 2002-2011 censuses was estimated to be 200-300 individuals in the area *(WWF 2011)*.

Maps of satellite tracked seals are shown in the Atlas section (Appendix 12, Map MA-02-F). However, it should be noted that though this HELCOM data includes all satellite tracking data given to HELCOM, using this information to distribution analyses may be biased as not all scientists have provided their data to HELCOM and satellite tracking studies of seals have not covered all areas of the Baltic.

Satellite tracking data has given some evidence that the subpopulation of the eastern Gulf of Finland actually is a separated population, as are the populations at the Väinameri sea area (Gulf of Riga) and the Bay of Bothnia. Warmer climate means less ice and populations are divided between areas with the last ice and this can cause severe impacts on subpopulations *(Sundqvist et al. 2012)*. However, tracking studies have shown that one individual moved from the Bay of Bothnia to the Väinameri sea area *(Oksanen 2015)*, so gene flow may still exist. Earlier, a genetic study using microsatellite technique could not see genetic separation between the subpopulations *(Palo et al. 2001)*.

<u>Behaviour and reproduction</u>

Outside the post-moulting season, ringed seals are less dependent on their haul-out sites or fishing areas compared to grey seals, but ringed seals can move between several locations *(Oksanen 2015)*. During winter, seals are usually alone, spread across the ice fields. They are always wary of predators and often aggressive to other seals. Generally, the ringed seals are faithful to their home territories even though young individuals can wander further afield *(HELCOM 2016a, Natural Resources Institute Finland 2016a, Appendix 8A)*.

The need for fast ice or dense packice for breeding restrict the populations to areas with recurrent ice in winter. The pups of the ringed seals are born inside snow banks, in snow lairs, where they are invisible to predators and where the temperature is close to zero. The main breeding areas in the Gulf of Finland are found in easternmost areas. The breeding lasts from mid-February to mid-March. Females feed pups for 2–3 weeks and maintain an access opening in the ice field. As grey seal, the Baltic ringed seal is also very sensitive during the breeding season; the highly critical period lasts from February until June, until the moulting period is over (Appendix 8A). During summer, the ringed seals are gregarious, hauling out on rocks and islets.

<u>Feeding</u>

The diet of ringed seals consists of fish (i.e. herring, smelt, whitefish, sculpin, perch and three-spined stickleback) and benthic fauna such as crustaceans and bivalves *(Kauhala et al. 2011, Suuronen & Lehtonen 2012, Lundström et al. 2014)*.

<u>Hearing, vision, touch/vibration, electro- magnetoreception</u>

The senses of ringed seals have not been studied in detail. As for the grey seal, the harbour seal has been used as a model species regarding senses. More information can be found in Appendix 8A.

<u>Disturbance</u>

As ringed seals are dependent on ice and snow cover during breeding, ice-breaking activities – including noise, loss of breeding areas and visual disturbance can have negative impacts on breeding success. Climate change and the resulting diminishing ice cover could pose a severe threat to breeding success, especially for southern stocks (Gulf of Finland, the Archipelago Sea and the Väinameri area) *(Meier et al. 2004)*.

Presently, only little is known about the potential of human presence, underwater noise and airborne noise to cause disturbance. The lack of suitable ice conditions and possible bycatch due to commercial fishing have been identified to be the major threats for ringed seals, although the magnitude is unknown.

Ringed seal can be hunted by special licence in the Bay of Bothnia, and the quota between 2015–2016 was 100 individuals *(Suomen riistakeskus 2016, http://riista.fi)*.

7.11.4 Harbour porpoise

Population structure

There is no permanent harbour porpoise population in Finland. There is some evidence that three populations (or subpopulations) may exist in the Belt Sea and the Baltic Sea area, namely (1) the Baltic Proper; (2) the Western Baltic, the Belt Sea and Southern Gattegat (Belt Sea population) and (3) Skagerrak and the North Sea *(Galatius et al. 2012, Wiemann et al. 2010)*. However, these studies were not able to determine an exact boundary between populations.

Abundance and distribution

Based on the results of international harbour porpoise acoustic monitoring research *(SAMBAH 2016)*, where voices of harbour porpoises were recorded, the remaining number of individuals in the Baltic Proper was estimated to be ca. 500. In contrast, the total number of harbour porpoises in the N-E Atlantic continental shelf waters was estimated to be ca. 375,358 *(Hammond et al. 2016)*. This estimate includes all North Sea populations as well as the majority of the Belt Sea population. Thus, the harbour porpoise is generally the most numerous cetacean in Europe, although the Baltic Proper population is critically endangered.

During the winter period, distribution of harbour porpoises in the Baltic Sea is more widespread compared to the summer season. Breeding areas of the Baltic Sea porpoises are situated south of the Islands of Öland and Gotland (Baltic Proper subpopulation), and the sea area between Bornholm Island and Belt Straits (Belt Sea subpopulation). During summer season, most of the harbour porpoise observations are made in these areas *(SAMBAH 2016)*. During the SAMBAH projects, voices of harbour porpoise were recorded during autumn and winter south of the Åland Islands and in the Archipelago Sea. The number of recordings were low compared to southern parts of the Baltic Sea, but certainly some individuals visited Finnish territorial waters. Similarly, in Sweden some harbour porpoises have been observed north of Gotland during autumn and winter. The distribution of harbour porpoise is presented in Appendix 12, Map MA-01-F.

The Finnish Ministry of Environment launched a campaign in 2000 to collect data on opportunistic sightings of harbour porpoises from the public. During this campaign, observations were recorded in the central Gulf of Finland (near Helsinki) from 2000-2015, where few detections were made during the SAMBAH project 2011-2013. The higher number of observations in the Helsinki area are believed to be a consequence of the higher human population density resulting in more leisure boats and not a local harbour porpoise hot spot. Thus porpoises are likely found in low densities in most of the Gulf of Finland and Archipelago Sea. (Appendix 8B)

Behaviour and reproduction

The breeding period of Baltic harbour porpoises last from mid-June to the late August. The gestation period lasts 11 months and a single calf is born in the early summer. Females often give birth every year. Sea areas around Denmark are known to be reproduction areas for harbour porpoises. No specific harbour porpoise breeding areas have been identified in the Baltic Proper. The summer concentrations on the Midsjö Banks south of Gotland should be considered important for reproduction *(SAMBAH 2016, Appendix 8A)*.

Behaviour of harbour porpoises have been studied in Danish and adjacent waters *(Teilmann et al. 2007)*. The animals seek and catch their food by diving. The average number of dives is quite high 29/h in summer and 43/h in winter, respectively. This could be a response to a shift of available prey or an increased need for food intake due to the colder water. Harbour porpoises have been observed to dive to a depth of more than 100 m, but generally the depth does not exceed 50 m.

Feeding

The main food for harbour porpoises is fish. Their diet consists of herring, cod and eelpout but their diet varies both spatially and temporally.

Hearing, echolocation, vision, electro- magnetoreception

The senses have been described in more detail in Appendix 8A and references therein and are summarised here. All toothed whales have good underwater hearing and they use sound actively for navigation and prey capture (echolocation) and for communication. Harbour porpoise produce short ultrasonic clics and uses echoes of these voices for echolocation. They use this ability almost continuously. The hearing sensitivity of these animals is extremely high and that makes them very sensitive to underwater noise.

Cetaceans have good vision and their eyes are completely adapted to underwater and low light conditions. The occurrence of magnetic sense has not been studied in harbour porpoises. The possibility of this type of sensory system cannot be dismissed.

Disturbance

The harbour porpoise is considered extinct in Finland *(Liukko et al. 2016)*. Known threats to harbour porpoise are incidental catches (bycatch) by fishermen, harmful and persistent substances and disturbance from underwater noise.

7.11.5 Other mammal species

The otter (*Lutra lutra*) was earlier classified as threatened in Finland and it is listed in Appendix IV of Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. However, currently the otter population is categorised to be of least concern (LC) *(Liukko et al. 2016)*. These animals remain near the islands and, thus, the proposed project is not expected to have an impact on otters. Other species, like small whales and dolphins, have been reported but they are extremely rare and all sightings are exceptional.

7.11.6 Seal sanctuaries

Seal sanctuaries were established in state-owned sea areas in 2001 to protect mainly grey seals and their habitats *(Nature Protection Law 1096/1996, Decree 736/2001)*. Other purposes of these areas are to support seal population monitoring and to protect marine habitats. Some of the sanctuaries are important also for the protection of ringed seals, but in the Gulf of Finland ringed seals are very rare around these sanctuaries.

Table 7-15 presents the seal sanctuaries nearest to the pipeline route. Appendix 12 (Map MA-04-F) shows all conservation areas (seal sanctuaries, important grey seal areas, Natura 2000 sites) with seals as a basis for protection in the Gulf of Finland and the Archipelago Sea. These areas are additionally presented in Subchapter 7.13.

Table 7-15. Seal sanctuaries in Finnish waters nearest to the pipeline route.

Seal sanctuary	Area size, hectares	Shortest distance from NSP2 route, km
Sandkallan	5,568	12.4 (Line A), 12.6 (Line B)
Stora Kölhällan	2,052	17.0 (Line A), 17.3 (Line B)
Kallbådan	2,467	6.8 (ALT E1, Line A) 6.9 (ALT E1, Line B) 8.2 (ALT E2, Line A) 8.5 (ALT E2, Line B)

The nearest area, Kallbådan, is a small island with an old lighthouse, south west from the Porkkala Peninsula. Its protection is not as strict as other seal sanctuaries, because visiting the island is possible although only by permission. Still, illegal boating to the nearby islands is not uncommon. During recent years, 200–400 grey seals have been observed there *(Antti Below, Conservation biologist, Metsähallitus, pers. comm. 2016)*.

7.12 Birds

The Baltic Sea is an important breeding and wintering area for marine and coastal birds and is situated on a globally major flyway. About 40 out of 82 European seabird species breed in the Baltic Sea area. Although the total number of breeding pairs has risen, many of the breeding species show high population decrease, especially among waterfowl and wader species.

In the northern Baltic Sea, archipelago and wetlands are considered important breeding areas. Islands and small islets allow for the populations of many waterfowl and gull, tern and auk species to form breeding colonies. Shallow water areas and offshore banks provide feeding areas for several breeding, migratory and wintering species.

According to existing data, the Finnish EEZ is of limited value as a feeding or stop-over area for breeding and migrating birds but more so for wintering bird species. For many seabird species wintering in the Baltic Sea region, the migration and wintering seasons can be difficult to distinguish. Feeding areas of these species alter depending on ice conditions.

7.12.1 Breeding birds in the Gulf of Finland

The Gulf of Finland is an important breeding area for several species, although in Finland, the occurrence of marine and coastal species is mainly concentrated in the Archipelago Sea and the Kvarken Archipelago. Long-term monitoring indicates that marine and coastal bird populations have changed considerably. In general, the total number of breeding pairs and the number of species has increased from the 1930s to mid-1990s after which several populations have started to decline *(Hario and Rintala 2011)*. Most abundant species in the Gulf of Finland are the herring gull (*Larus argentatus*), the great cormorant (*Phalacrocorax carbo*), the common eider (*Somateria mollissima*), the mew gull (*Larus canus*), the arctic tern (*Sterna paradisaea*), the common tern (*Sterna hirundo*), the black-headed gull (*Larus ridibundus*) and the barnacle goose (*Branta leucopsis*). Canada goose (*Branta canadensis*), barnacle goose and the great cormorant are relatively new breeding species in the Gulf of Finland.

In the Gulf of Finland, the most important areas for breeding bird communities are the archipelagic parts, which are mainly situated ca. 10–30 km from the pipeline route. Only a few shallow water areas lie in the vicinity of the pipeline route. The importance of the closest shallow water areas as foraging areas during breeding season is unclear, but potential breeding species using these areas are mainly limited to the common eider (moulting areas), razorbill (*Alca torda*), common murre (*Uria aalge*) and the caspian tern (*Hydroprogne caspia*). Though there is a lack of detailed data concerning the nearest shallow water areas, the importance of these areas for the breeding species is likely to be relatively low due to the great distance from the coastal breeding areas.

7.12.2 Migration in the Gulf of Finland

The Baltic Sea region is situated on one of the major flyways in the northern hemisphere. Every year millions of birds follow the eastern coastline area of the Baltic Sea when travelling to and from breeding sites in northern Russia and Siberia. The northwestern part of Estonia is a significant bottleneck especially for migratory arctic waterfowl and seabirds. The Gulf of Finland is an important part of this flyway and the majority of birds migrate in the offshore area of the gulf, Estonian parts of the gulf having higher value than the Finnish parts (Appendix 12, Map BI-02-F). In springtime, migration is more apparent when most of the birds migrate during a relatively short period of time (mainly during late May and early June). The autumn migration season lasts much longer and the migration peaks are more subtle. Most important stop-over sites for migrating birds in the Baltic Sea region are wetlands, pastures and agricultural fields in the coastal areas of Baltic and the Gulf of Finland. Many migrating waterfowl species may use Baltic Sea offshore shallow water areas as stop-over areas during migration, most important shallow areas situtating in the coastal and archipelagic parts. The majority of migrating arctic birds pass the Finnish marine areas without stopping. However, during recent years, the number of stops made by e.g. long-tailed ducks (*Clangula hyemalis*) has increased – at least in coastal areas *(Ellermaa et al. 2011, Lehikoinen and Väisänen 2014)*.

7.12.3 Wintering birds

The majority of the European breeding bird species spend winters outside their breeding areas. The extent of migratory movements and locations of wintering areas depends mainly on accessibility and amount of food resources. Other factors affecting species spatial arrangement include e.g. temperature. On a large scale, movements of species and locations of the wintering areas can be seen as optimisation of benefits over costs. The most important marine wintering areas are situated in the southern parts of the Baltic Sea *(Skov et al. 2011)* while the Gulf of Finland has less importance for the wintering of red-listed species. However, the importance of the Gulf of Finland as a wintering area may increase in the future *(Lehikoinen and Väisänen 2014, Lehikoinen et al. 2013)*

As a wintering area, the Gulf of Finland accommodates especially several waterfowl species and its importance is predicted to increase in the future. Most significant waterfowl wintering areas are situated in the Åland region with wintering populations being usually smaller in the Gulf of Finland. The phenomenon is explained mainly by the extent of fast ice, which usually does not cover the southern parts of the Åland region.

The majority of the wintering waterfowl species use shallow waters less than 10 m deep. Based on information gained from a literature review, only two species, the velvet scoter (*Melanitta fusca*) and the long-tailed duck, use primarily deeper habitats; 10–35 m deep marine areas *(Skov et al. 2011)*. Nevertheless, in the coastal areas of Finland, areas less than 10 m deep seem to be the most important wintering sites also for the long-tailed duck *(Ellermaa et al. 2011, Mikkola-Roos, personal communication, 7 January 2016)*. During the winter, distributions change according to ice conditions. Long-term winter bird censuses in Finland are conducted mainly in coastal areas and the Åland Archipelago, while information from offshore areas is scarce. Hence, the total number of wintering populations in Finnish sea areas is still somewhat unclear (e.g. *Aunins et al. 2013*). Despite these deficiencies, winter bird census data clearly shows an increase of wintering populations for several waterfowl species, the main reasons being global warming and species´ population growth *(Lehikoinen and Väisänen 2014, Lehikoinen et al. 2013)*. Especially the increase in early winter temperatures has resulted in delayed migration and shifts in wintering distribution towards the north-east in the Baltic Sea *(Fraixedas et al. 2015, Meller et al. 2016)*. During the past 5 years, the wintering population of long-tailed duck has increased in the Gulf of Finland and high population concentrations have been detected mainly in the outer archipelago areas of Helsinki and Kirkkonummi *(Finnish Environment Institute 2016a, Ellermaa et al. 2011)*. Recently, during late autumns, great numbers (12,000 individuals) of long-tailed ducks have also been observed in Stora Kölhällen and nearly all shallow water areas (4–6 m deep) west of Stora Kölhällen area seem to be more or less important feeding areas for the species *(Antti Below, personal communication, 4 March 2016)*. Stora Kölhällen is situated in the Sandkallan Natura area.

In January and February 2016, the Finnish Environment Institute conducted wintering population counts in the Gulf of Finland as part of a Baltic-wide winter survey. During the survey, fast ice extended from Helsinki to eastern parts of the Gulf of Finland, whereas west from Helsinki, fast ice was detected only in the coastal areas. At offshore areas, the total number of birds was low and consisted mainly of herring gulls. *(Markku Mikkola-Roos, personal communication, 30 March 2016)*

7.12.4 Protected and threathened bird species in the Gulf of Finland

Several bird species met in the Gulf of Finland are included in Annex I to the EU Birds Directive or are protected by the national Nature Conservation Act. All breeding bird species in Finland are included in the national evaluation of threatened species. Additionally, HELCOM has separately evaluated the conservation status of bird species met in the Baltic Sea region. The IUCN has evaluated the conservation status of bird species on a global scale.

Species under strict protection are mentioned in the national Nature Conservation Act. The deterioration and destruction of a habitat important for the survival of a species under strict protection is prohibited. In the Gulf of Finland, four species under strict protection breed regularly; greater scaup, white-tailed eagle (*Haliaeetus albicilla*), southern dunlin (*Calidris alpine schinzii*) and common murre (*Uria aalge*). In the region of Gulf of Finland, breeding areas of all species except the white-tailed eagle are situated in the outer archipelago areas. White-tailed eagle breeds also in the mid-archipelago and seldomly also in continental areas. Strictly protected species use mainly archipelago areas during their breeding season, but the habitat use of common murre differs from other mentioned species. The species is known to forage also in offshore deeper water areas (50–100 m depth) and the foraging range can be tens of kilometres. *(Piatt & Nettleship 1985, Cairns, ym. 1987)*

Several coastal and marine species are included in Annex I to the EU Birds Directive. Only one of these species, the Caspian tern use shallow habitats (less than 30 m deep) located in offshore areas more or less regularly as feeding areas. Four species met regularly in the Gulf of Finland are assessed to be threatened on a global scale: the long-tailed duck, steller's eider (*Polysticta stelleri*), the common pochard (*Aythya ferina*) and the velvet scoter. All four species are considered to be vulnerable (VU) and all species, except the common pochard, regularly use offshore areas.

Many of the wintering populations in the Baltic Sea region are on the Red List *(HELCOM 2013b)*. HELCOM red-listed species, which also use offshore shallow water areas, include common eider, steller's eider (*Polysticta stelleri*), long-tailed duck, common scoter (*Melanitta nigra*), velvet scoter, red-breasted diver (*Gavia stellata*) and black-breasted diver (*Gavia arctica*). The Finnish national red list assessment includes several threatened seabird species. E.g. tufted duck (*Aythya fuligula*), greater scaup, velvet scoter, common murre and common guillemot are considered as endangered species (EN) and the common eider as a vulnerable species (VU).

Threatened species have various current and future threats. A single species is usually assessed to have several threats. These may be severe as standalone threats or have severe cumulative consequences on levels of population together with other threats. The most important threats for species using offshore areas are considered to be hunting, pollution, especially oil spills, habitat changes along migratory routes and wintering areas *(Tiainen et. al. 2015)*. HELCOM has also identified bycatch, ecosystem invasion by alien species, marine construction and waterway traffic to pose threats to several wintering species in the Baltic Sea *(HELCOM 2013b)*.

7.12.5 Important Bird and Biodiversity Areas (IBA) and other important bird areas

The Important Bird Areas Programme of BirdLife International aims to identify, monitor and protect key sites for birds all over the world. Important Bird and Biodiversity Areas (IBAs) are chosen by using internationally agreed criteria and aim to form a coherent network for birds. Finnish Important Bird Areas (FINIBAs) include all nationally important bird areas in Finland. FINIBA and IBA areas partly overlap. FINIBA areas are chosen by criteria created in cooperation by BirdLife Finland and the Finnish Environment Institute. MAALI areas are a third notable categorisation and includes regionally important bird areas. Nearly all offshore MAALI areas are included either in IBA or FINIBA areas and none of the MAALI areas are situated closer to the planned pipeline route than any IBA or FINIBA areas. Both FINIBAs and IBAs are shown in Appendix 12 (Map BI-01-F).

Table 7-16 and Appendix 12 (Map BI-01-F) present Important Bird Areas in Finnish coastal areas nearest the pipeline route. All FINIBA areas that do not overlap with IBA areas are located further than 10 km from the pipeline route.

Table 7-16. Important Bird Areas in Finnish coastal areas nearest the NSP2 pipeline route.

Important Bird Area	Area code	Nearest distance from the NSP2 Route, km
Eastern Gulf of Finland National Park	FI072	23.5 (Line A)
Pernaja Outer Archipelago	FI075	12.6 (Line A)
Porvoo Outer Archipelago	FI077	20.2 (Line A)
Espoo Helsinki Shallows	FI098	13.5 (Line A)
Kirkkonummi Archipelago	FI082	8.2 (ALT E1)
Tammisaari and Inkoo Western Archipelago	FI080	14.5 (Line A)
Hanko Western Archipelago	FI081	21.2 (Line A)
Örö–Bengtskär	FI099	25.0 (Line A)
Korppoo and Nauvo Southern Archipelago	FI089	39.1 (Line A)

Part of Natura 2000 sites are designated as Special Protection Areas (SPA) under the Birds Directive. SPAs include the most important areas for bird species mentioned in Annex I of Bird Directive and regularly occurring important migratory species. SPAs in the Finnish marine areas are listed with other Natura 2000 sites in Subchapter 7.13 and presented with more detailed information in Appendix 5. The location of SPAs in Finnish marine areas is presented in Appendix 12 (Map PA-01-F).

7.13 Protected areas

Several protected areas are located in Finnish waters in the Gulf of Finland and the Archipelago Sea. The protection status of the areas varies: some are established by national legislation, some by international conventions or directives and some by international or national programmes. Protected areas are presented in the following subchapters. Sources used are the OIVA-database and HELCOM *(Finnish Environment Institute 2015a; HELCOM 2015b)*.

Protected areas in the Gulf of Finland and the Archipelago Sea are mainly located on the coastal areas within territorial waters. Of these, only three Natura 2000 sites extend into the Finnish EEZ: Sea area south of Sandkallan, Luodematalat and Länsiletto.

The NSP2 pipeline route does not cross any of the protected areas. The Sea Area South of Sandkallan Natura 2000 site is the closest with a minimum distance of approximately 1.9 km from the pipeline route (Figure 7-44). All other protected areas are located at a distance of more than 8.1 km from the survey corridor.

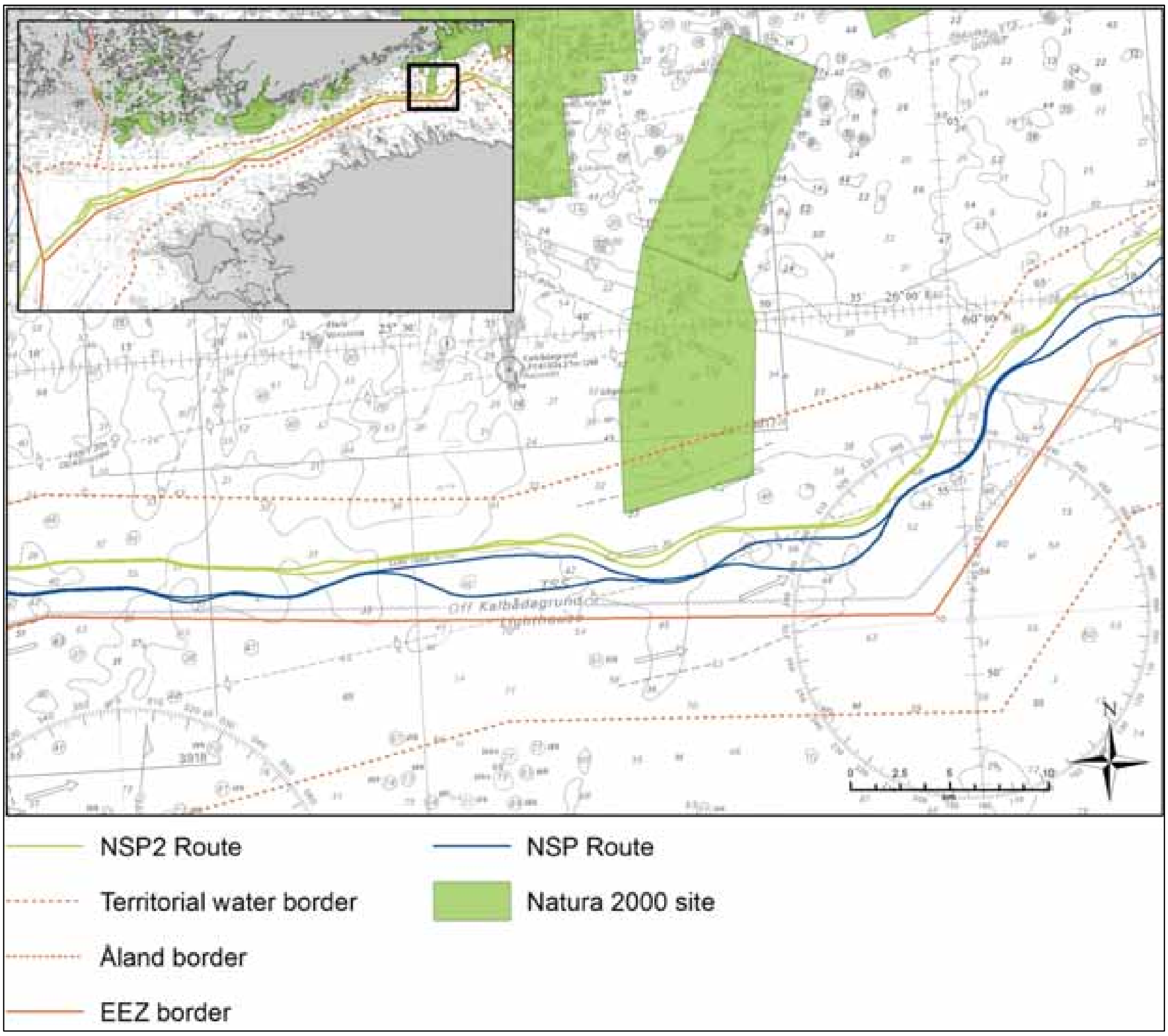

Figure 7-44. Location of the Nord Stream 2 Project in relation to the Natura 2000 site of "Sea area south of Sandkallan, Porvoo (Nord Stream 2 AG).

7.13.1 Natura 2000 sites

Natura 2000 is a network of protected areas established by the European Union. The aim is to protect threatened species and habitats in the EU. The network includes Special Areas of Conservation (SAC) based on the Habitats Directive (892/43/ETY) and Special Protection Areas (SPA) under the Birds Directive (79/409/ETY). Sites of Community Importance (SCI) are areas proposed by a member state to the European Commission to be included in the Natura 2000 network.

There are numerous Natura 2000 sites in the Gulf of Finland and the Archipelago Sea (Appendix 12, Map PA-01-F). Three of them extend to the Finnish EEZ. For the Saaristomeri (FI0200090 and FI0200164) and the Tulliniemi Bird Protection Area (FI0100006) extensions of the sites has been proposed (Appendix 12, Map PA-01-F). Table 7-17 lists the Natura 2000 sites which are located nearest to the NSP2 pipeline route. More detailed information on listed Natura areas is presented in Appendix 5.

Table 7-17. Natura 2000 sites in Finnish waters nearest to the pipeline route. Asterisk (*) refers to a non-confirmed, new protection basis of a Natura site.

Natura 2000 site	Category	Area code	Area size, hectares	Nearest distance from NSP2 route, km	Seal species as a legal basis for protection
Eastern Gulf of Finland Archipelago and Waters	SPA/SAC	FI0408001	95,628	23.5 (Line A)	ringed seal* grey seal
Luodematalat	SAC	FI0400002	4,452	18.0 (Line A)	
Länsiletto Area	SAC	FI0400001	2,036	26.9 (Line A)	
Pernaja and Pernaja Archipelago	SPA/SAC	FI0100078	65,760	13.1 (Line A)	ringed seal* grey seal
The Sea Area South of Sandkallan	SAC	FI0100106	7,468	1.9 (Line A)	
Söderskär and Långören Archipelago	SPA/SAC	FI0100077	18,219	12.5 (Line A)	grey seal
Kirkkonummi Archipelago	SPA/SAC	FI0100026 and FI0100105	14,234	13.0 (Line A)	
Kallbådans Islets and Waters	SAC	FI0100089	1,520	8.1 (ALT E1, Line A) 9.8 (ALT E2, Line A)	grey seal
Inkoo Archipelago	SPA/SAC	FI0100017	203	16.5 (ALT E1, Line A) 18.8 (ALT E2, Line B)	
Tammisaari and Hanko Archipelago and Pohjanpitäjänlahti Marine Protected Area	SPA/SAC	FI0100005	52,630	17.8 (Line A)	grey seal
The Hanko Eastern Offshore Area	SAC	FI0100107	11,098	13.7 (Line A)	
Tulliniemi Bird Protection Area	SPA//SAC	FI0100006	2,566	29.0 (Line A)	
Örö	SAC	FI0200913	376	38.4 (Line A)	
Saaristomeri	SPA/SAC	FI0200164 and FI0200090	59,842 and 49,735	27.4 (Line A)	ringed seal grey seal
Proposed extensions of existing Natura 2000 sites					
Tulliniemi Bird Protection Area	*SPA/SAC*	*FI0100006*	*11,165 and 11,265*	*23.3 (Line A)*	
Saaristomeri	*SPA/SAC*	*FI0200164 and FI0200090*	*162,346 and 152,223*	*14.5 (Line A)*	*ringed seal grey seal*

7.13.2 National parks

The aim of national parks is to protect the most valuable areas in Finland, both nationally and internationally, as well as their species, habitats and landscape. They are open to the public, but they are maintained in as natural a state as possible.

There are several national parks in the Gulf of Finland and the Archipelago Sea (Appendix 12, Map PA-04-F). Table 7-18 lists the national parks which are located nearest to the NSP2 pipeline route.

Table 7-18. National parks in Finnish waters nearest to the pipeline route.

National park	Area code	Area size, hectares	Nearest distance from NSP2 Route, km
The Eastern Gulf of Finland National Park	KPU050007	95,600	23.5 (Line A)
The Tammisaari Archipelago	KPU010001	52,000	18.2 (Line A)
The Archipelago Sea National Park	KPU020002	500,000	26.5 (Line A)

7.13.3 HELCOM Marine Protected Areas

HELCOM (Helsinki Commission, Baltic Marine Environment Protection Commission) has defined HELCOM Marine Protected Areas (HELCOM MPAs). The aim of these areas is to protect valuable marine and coastal habitats in the Baltic Sea. In Finnish coastal areas, these habitats follow the Natura 2000 area boundaries.

Table 7-19 lists the HELCOM MPAs which are located nearest to the NSP2 pipeline route. Appendix 12 (Map PA-03-F) shows the HELCOM MPAs in the Gulf of Finland and the Archipelago Sea.

Table 7-19. HELCOM Marine Protected Areas in Finnish waters and coastal areas nearest to the pipeline route.

HELCOM Marine Protected Areas	Area code	Area size, hectares	Nearest distance from NSP2 Route, km
The Eastern Gulf of Finland Archipelago and waters	145	95,689	23.5 (Line A)
Luodematalat	394	4,452	19.7 (Line A)
Länsiletto Area	393	2,035	29.8 (Line A)
Pernajabay and Pernaja Archipelago MPAs	161	72,134	13.1 (Line A)
Söderskär and Långören Archipelago	159	20,478	12.5 (Line A)
The Sea Area South of Sandkallan	372	7,467	1.9 (Line A)
Kirkkonummi Archipelago	158	14,226	13.0 (Line A)
Tammisaari and Hanko Archipelago and Pojo Bay MPAs	144	58,728	17.8 (Line A)
Open Sea Area Southeast from Hanko	392	11,085	13.7 (Line A)

7.13.4 UNESCO areas

UNESCO Biosphere Reserves are areas recognised under UNESCO's the Man and the Biosphere Programme to promote sustainable development based on local community efforts and sound science. In Finland, there is one UNESCO Biosphere Reserve, the Finnish Archipelago Sea (Table 7-20 and Appendix 12, Map PA-03-F).

Table 7-20. UNESCO site in Finnish waters and coastal areas nearest to the pipeline route.

UNESCO site	Site type	Area size, hectares	Distance from NSP2 Route, km
The Finnish Archipelago Sea	Biosphere Reserve Area	420,000	19.9 (Line A)

7.13.5 Seal sanctuaries

Seal sanctuaries were established in state-owned sea areas in 2001 to protect grey seals and their habitats. Some of the sanctuaries are important also for the protection of ringed seals.

Table 7-21 presents the seal sanctuaries nearest to the NSP2 pipeline route. Appendix 12 (Map MA-04-F) shows all seal sanctuaries in the Gulf of Finland and the Archipelago Sea.

Table 7-21. Seal sanctuaries in Finnish waters nearest to the NSP2 pipeline route.

Seal sanctuary	Area size, hectares	Distance from NSP2 Route, km
Sandkallan	5,568	12.4 (Line A)
Stora Kölhällan	2,052	17.0 (Line A)
Kallbådan	1,520	8.1 (ALT E1, Line A) 9.8 (ALT E2, Line A)

7.13.6 Ramsar sites

The Convention of Wetlands of International Importance or Ramsar Convention is an intergovernmental treaty adopted in 1971. It provides a framework for the conservation and use of wetlands and their resources. Ramsar sites are wetlands designated by contracting parties to the List of Wetlands of International Importance. In Finnish waters, Ramsar sites follow the boundaries of Natura 2000 sites.

Table 7-22 present Ramsar sites nearest to the NSP2 pipeline route. Appendix 12, Map PA-02-F, shows all Ramsar sites in the Gulf of Finland and the Archipelago Sea.

Table 7-22. Ramsar sites in Finnish coastal areas nearest to the NSP2 pipeline route.

Ramsar site	Area code	Area size, hectares	Distance from NSP2 Route, km
Aspskär Islands	3FI001	728	23.8 (Line A)
Söderskär and Långören Archipelago	3FI002	18,219	12.5 (Line A)
Bird Wetlands of Hanko and Tammisaari	3FI016	55,196	17.8 (Line A)

7.14 Non-indigenous species

Non-indigenous (NIS) species are defined as "species or lower taxa occurring outside of their natural range (past or present) and dispersal potential (IUCN 2000). Some of these species have become invasive, which means that the population of certain species undergoes an exponential growth stage and concurrent very rapid expansion. Establishments of a number of NIS populations can be seen as biocontamination of the native Baltic ecosystem because the invaders have caused alterations in the taxonomic structure of the native communities. There are also so called cryptogenic species, which refers to species that cannot be reliably demonstrated as being either introduced or native.

A good example of NIS, which have fairly recently invaded the Baltic Sea, is the benthic *Marenzelleria* spp. that has become common in many soft-bottom habitats. This species has caused significant changes to benthic communities especially in areas affected by hypoxia, where the original communities are reduced or absent (invasive history and ecological characteristics of this species is presented in Subchapter 7.9). Other quite recent invasive species with a rapid extension over large sea areas in the Baltic Sea include pelagic (plankton) species such as the fishhook water flea *Cercopagis pengoi*, which was found in the Gulf of Finland in 1992 and in the Finnish territorial waters have intermittently impeded fishing by clogging fishing nets *(Kivi 1995, Raateoja and Setälä 2016)*. This species affects the pelagic food web through effective predation of smaller-sized zooplankton, food competition with native invertebrates and planktivorous fish, but on the other hand, it has turned out that this species has become an important food source for Baltic herring *(Antsulevich and Välipakka 2000, Raateoja and Setälä 2016)*.

The number of NIS is ca. 118 in the Baltic and about 90 of these are established in the Baltic Sea *(HELCOM 2012b)*. The number is relatively high in the Gulf of Finland where new species are, for example, introduced by ships in large harbours. Therefore, in the Gulf of Finland, the numbers are highest in coastal areas, although there are species that are also present in offshore areas. The amount of new NIS in the Finnish waters increased clearly in the period of 1990–2010, and it is believed that the majority of species have arrived via shipping *(Rolke et al. 2013)* Figure 7-45. Altogether 38 non-indigenous species have been recorded in the Gulf of Finland *(Raateoja and Setälä 2016)*. In the Baltic Sea, the increased invasion rate can be related, for example, to increased number, size and speed of ships, which enables the better survival of organisms during the voyage. Further reasons include use of separate ballast tanks (where water is less polluted) and also opening of channels and intentional introductions for aquaculture *(HELCOM 2009)*. Also, consequences of eutrophication and climate change have facilitated many of the community changes favouring establishments of NIS *(Raateoja and Setälä 2016)*.

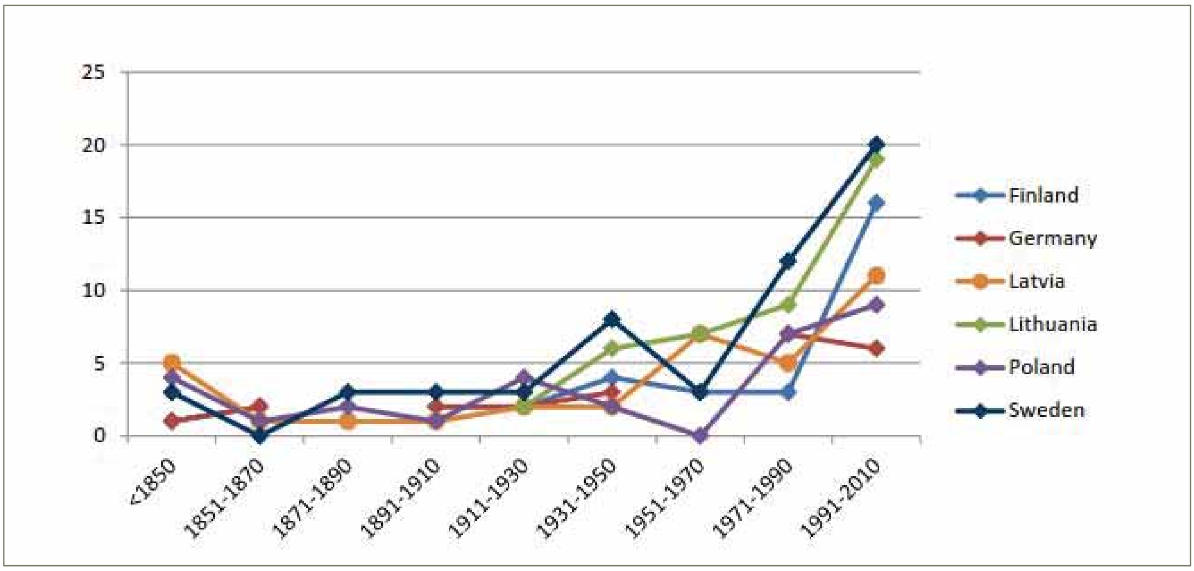

Figure 7-45. Rates of detected new non-indigenous species in the Baltic Marine area for 20-year intervals between 1850-2010. After Rolke et al. 2013.

7.15 Biodiversity

The term biodiversity can be used in different contexts and with different meanings. From a biological point of view, the formal definition is: "variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" *(Convention on Biological Diversity 1993)*.

In the Baltic Sea, all species in different trophic levels are contributing to biodiversity and according to HELCOM (2010a), a favourable biodiversity status of the Baltic Sea can be expressed as: (1) natural marine and coastal landscapes, (2) thriving and balanced plant and animal communities and (3) viable populations of species. In the next chapters, different components of biodiversity and their functioning is summarised with a focus on the Finnish pipeline section and adjacent areas. In compliance with the MSFD (Subchapter 11.20), the described biodiversity components are species, habitats and the ecosystem.

7.15.1 Species

The Baltic Sea is a relatively young ecosystem with an "ecological age" of only about 8,000 years and, thus, primary successional processes are on-going and there are still ecological niches vacant for immigration *(Bonsdorff 2006)*. The system, especially offshore areas, is species-poor compared to truly marine waters, which is due to the low number of species endemic to brackish water, and because both marine and limnic species are living in the range of their physiological tolerance. Generally, the number of species decreases from south to north along the descending salinity gradient. For example, compared to the truly marine Skagerrak area, the Baltic Sea has far fewer benthic species and functional groups *(Norling et al. 2007)*. This is also valid for the offshore areas of the Gulf of Finland and the Baltic Proper, both of which are regarded as species-poor systems. In the offshore areas of the Gulf of Finland, *Monoporeia affinis*, non-native *Marenzelleria* spp. and *Macoma balthica* can be regarded as the key benthic species *(Gogina et al. 2016)*. In terms of functionality, non-native *Marenzelleria* spp. (deep-burrowing, deposit-feeding polychaeta) is presently one of the key species in the northern Baltic. This species has not only increased functional diversity (e.g. habitat modifications) but is probably also able to occupy new niches and increase overall abundance, biomass and diversity *(Norling et al. 2007)*.

Despite low species numbers, the Baltic Sea is considered a highly dynamic system, which during the past 100 hundred years has undergone variations in salinity, oxygen and temperature with changes in the abundance and distribution of pelagic and littoral species and communities *(Altheit et al. 2005)*.

The relevant species and communities in the Finnish section have been presented in more detail in Subchapters 7.8.-7.11 and are not covered here. In contrast, the general interactions between species/communities and the habitats in which they live are described in the following chapters.

7.15.2 Habitats

Generally, habitats describe the abiotic characteristics of an environment and the associated biological communities. In marine environments, habitats are defined on the basis of abiotic factors such as temperature, salinity, oxygen concentration, light availability and seabed morphology (areas with high variety of ladscapes and habitats provide more ecological niches for species to settle and, thus, higher diversity). In the Gulf of Finland and Northern Baltic Proper, the main factors driving species distribution are considered to be salinity, temperature, oxygen concentration and seabed morphology.

Only a minor portion of the Finnish pipeline section passes across hard-bottom habitats that are favourable for benthic life (<60 m wather depth) and, in these areas, a higher species diversity is expected to occur. Additionally, potential reef habitats are found near the Sandkallan Natura 2000 site and at the entrance of Porkkala. Although the variety of niches available in this type of habitat would offer the possibility to a greater number of species to establish, the poor oxygen concentration is still the most important regulating factor.

The Finnish pipeline section is mainly situated in rather deep offshore areas with large areas of soft seabed sediments. In deep offshore areas, oxygen deficiency is often prevailing and, while virtually no species are found on the seabed, a number of species can live or otherwise use the pelagial areas (specifically pelagic organisms such as plankton and pelagic fish species but also foraging seabirds and marine mammals). Most relevant habitats such as important haul-out and foraging areas of marine mammals and important bird areas occur, however, at shallow water areas near the coastline.

Abiotic conditions and seabed morphology are described in more detail in Subchapters 7.4. and 7.5. Biotic conditions, habitats and associated assemblages are presented in Subchapters 7.8–7.13.

7.15.3 Ecosystem: communities and functioning of the food web

Communities are assemblages of species within an ecosystem. The species composition within the community and communities in the ecosystem influences processes such as productivity, stability and trophic interactions in the food web and ultimately overall functioning of the ecosystem *(HELCOM 2009)*.

Stability refers to two concepts. Resistance measures how much a system can resist changes and resilience measures how quickly a system recovers from disturbance and returns to a steady state. Typical for resilient systems is the ability to recover to the original state after disturbance. A number of studies in natural and experimental conditions have shown how an ecosystem with a high natural diversity better regulates and adapts to changing conditions such as climate change and is more resilient to disturbances *(Hooper et al. 2005)*. In contrast, low diversity can make the system more sensitive to disturbances. Although the Baltic Sea and the Gulf of Finland are generally species-poor, it has been shown that the Gulf of Finland is resilient to trophic pressures *(Gustafsson et al. 2012, Raateoja and Setälä 2016)*. For example, a deterioration of the ecosystem function that was caused by eutrophication was noticed decades after the commencement of the elevated anthropogenic nutrient load. Similarly, the ecosystem currently shows a certain level of resilience to decreasing trends of nutrient load. These responses suggest that there is a complicated network of mechanisms that regulate the outcome *(Raateoja and Setälä 2016)*.

The Finnish section of the planned pipeline is situated in the offshore environment in the Finnish EEZ. This environment harbours several pelagial communities such as phytoplankton and zooplankton communities (Subchapter 7.8), fish communities (Subchapter 7.10) and zoobenthos communities (Subchapter 7.9). Bird communities are mainly found in more shallow coastal areas but they may rest in offshore areas during migration (Subchapter 7.12). Similarly, marine mammals are mostly found near their haul-outs in coastal areas (Subchapter 7.11) but some individuals may visit the more open environments.

Together these communities are forming the food web with a variety of trophic interactions between primary producers (phytoplankton in pelagial food webs) that comprises the first trophic level and consumers. In the Gulf of Finland, zooplankton assemblages form an important link transferring energy from primary producers to fish larvae and planktivorous fish (herring, sprat), both of which are essential food for e.g. salmon. Marine mammals, birds and large fish are top predators and form the highest trophic level.

Figure 7-46 provides a simplified illustration of the trophic interactions within offshore areas.

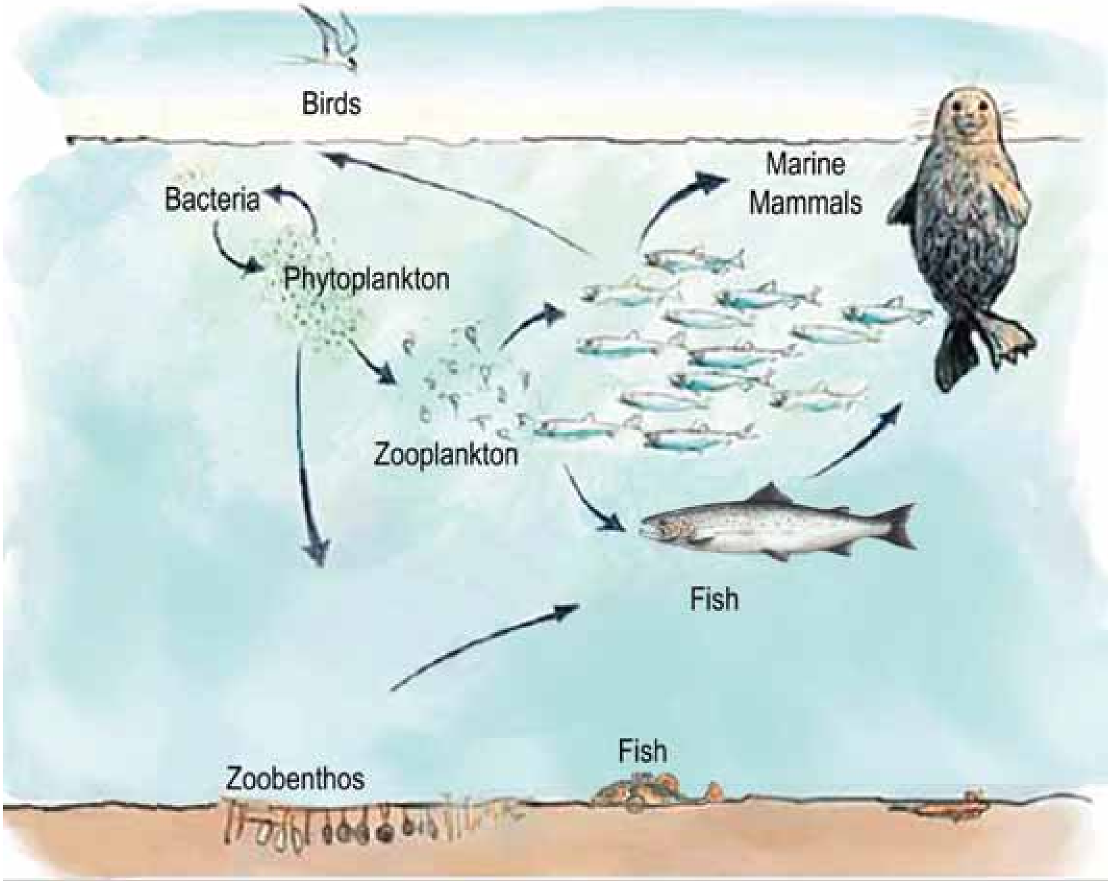

Figure 7-46. Schematic presentation of the simplified food-web structure in the pelagial areas in the Baltic Sea. (redrawn after HELCOM 2010a).

Presently, the good environmental status of the food webs in Finnish waters has not been approached (for GES, see Subchapter 7.2.1).

7.15.4 Biodiversity status

Increased anthrophogenic pressures on the Baltic have contributed considerably to the changes in biodiversity and, currently, there are a number of species and habitats that are considered as threatened and/or are declining *(HELCOM 2009)*.

The overall preliminary status of biodiversity has been assessed using the HELCOM Biodiversity Assessment Tool BEAT for different regions of the Baltic Sea *(HELCOM 2009, HELCOM 2010a)*. The tool groups the indicators according to the three HELCOM Ecological Objectives relevant to biodiversity, namely, marine landscapes (habitats), communities and species. Indicators that were most regularly used to assess biodiversity status are related to macrophytes, benthic animals and fish, on the level of both communities and species. In a limited number on cases, also indicators related to birds, phytoplankton and zooplankton have been used. On the level of landscapes, indicators are related, for example, to the areal distribution of biotopes *(HELCOM 2010a)*.

Within the Finnish EEZ, the preliminary status of the biodiversity in the Gulf of Finland and in the northern Baltic Proper is at an "unacceptable" level, changing from moderate to bad (Figure 7-47). Eutrophication has turned out to be the the most significant pressure with impacts at all trophic levels such as increased primary production and prevalence of bloom-forming cyanobacteria and low diversity of benthic animals due to hypoxia *(HELCOM 2009)*. At the same time, the dual effect of eutrophication and overfishing has changed fish communities so that smaller fish species (e.g. sprat) are dominating and the abundance of large predatory fish has severely declined.

It has to be noted that a "bad" status reveals that the biodiversity has changed in a direction that negatively impacts the marine ecosystem: although the number of species has not necessarily declined, the species composition may have changed due to, for example, invasive species replacing native ones. This may have a long-term impact on the resilience or resistence of the ecosystem to environmental perturbation (Subchapter 7.15.3).

Additionally, it should also be noted that by definition, ecosystems are capable of supporting different services. Therefore, some areas with "bad" status due to severely declined benthic diversity may, nevertheless, be important e.g. as resting and wintering for seabirds *(HELCOM 2010a)*.

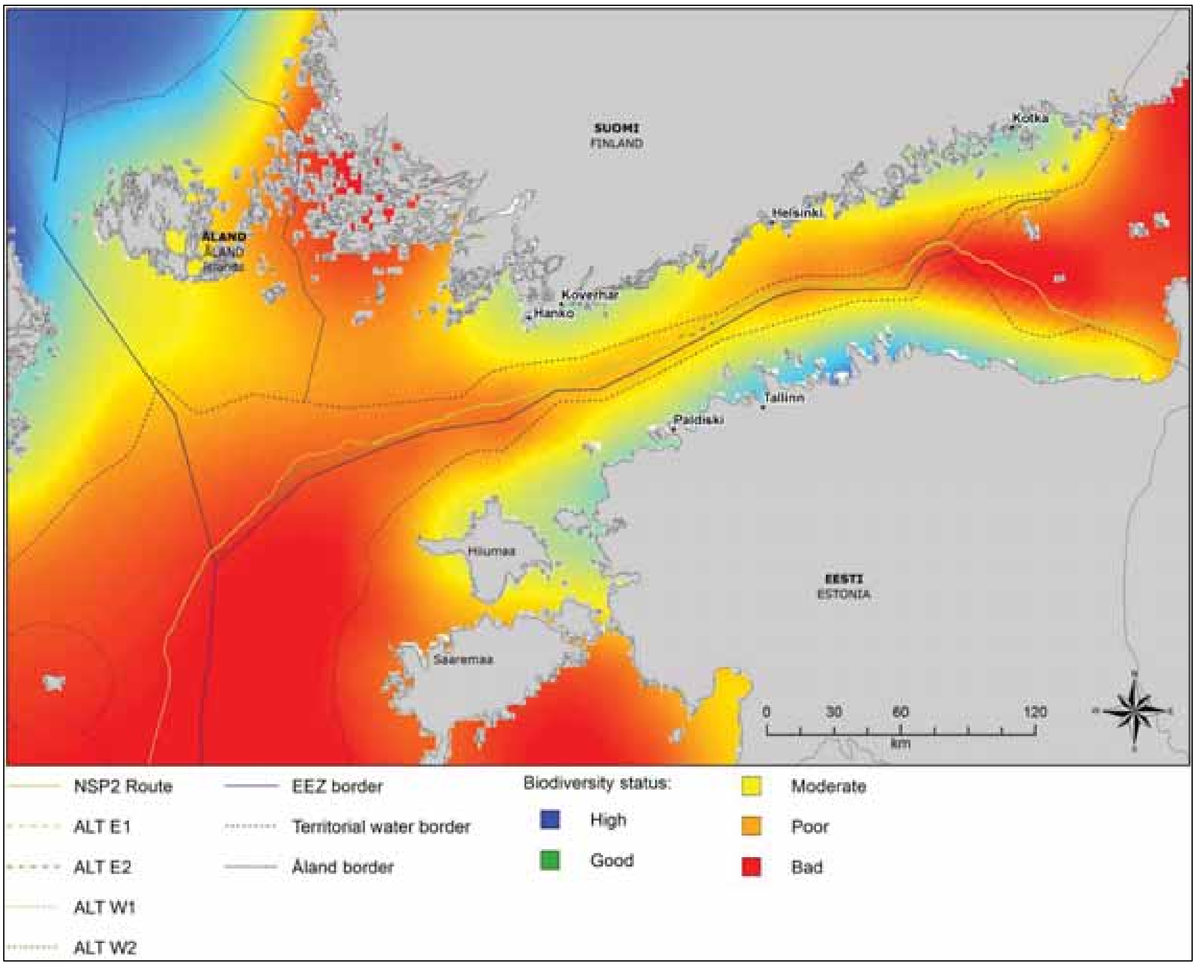

Figure 7-47. A preliminary integrated classification of biodiversity status of the Baltic Sea. Areas in blue and green represent areas with an "acceptable biodiversity status), while areas in yellow, orange and red represent areas with an "unacceptable biodiversity status". (After HELCOM 2010a).

7.16 Ship traffic

7.16.1 Ship traffic density in the Gulf of Finland

The main routes in the Gulf of Finland are traffic in the eastbound and westbound traffic lanes, the traffic between Finland and Estonia, eastbound and westbound coastal traffic and inbound and outbound traffic to and from ports.

Vessels navigating in the eastbound or westbound traffic lanes are well-organised by Traffic Separation Schemes (TSS) (Figure 7-48). Traffic Separation Schemes route ships into dedicated lanes. Conflicts may arise when vessels are crossing a TSS or arriving or departing a TSS due to a port visit. Main crossing traffic is ferry traffic between Helsinki–Tallinn; 10 daily departures plus

12 daily departures by fast crafts from April to December *(Port of Helsinki 2016)* and Hanko–Paldiski; 8 weekly departures *(Port of Hanko 2016)*.

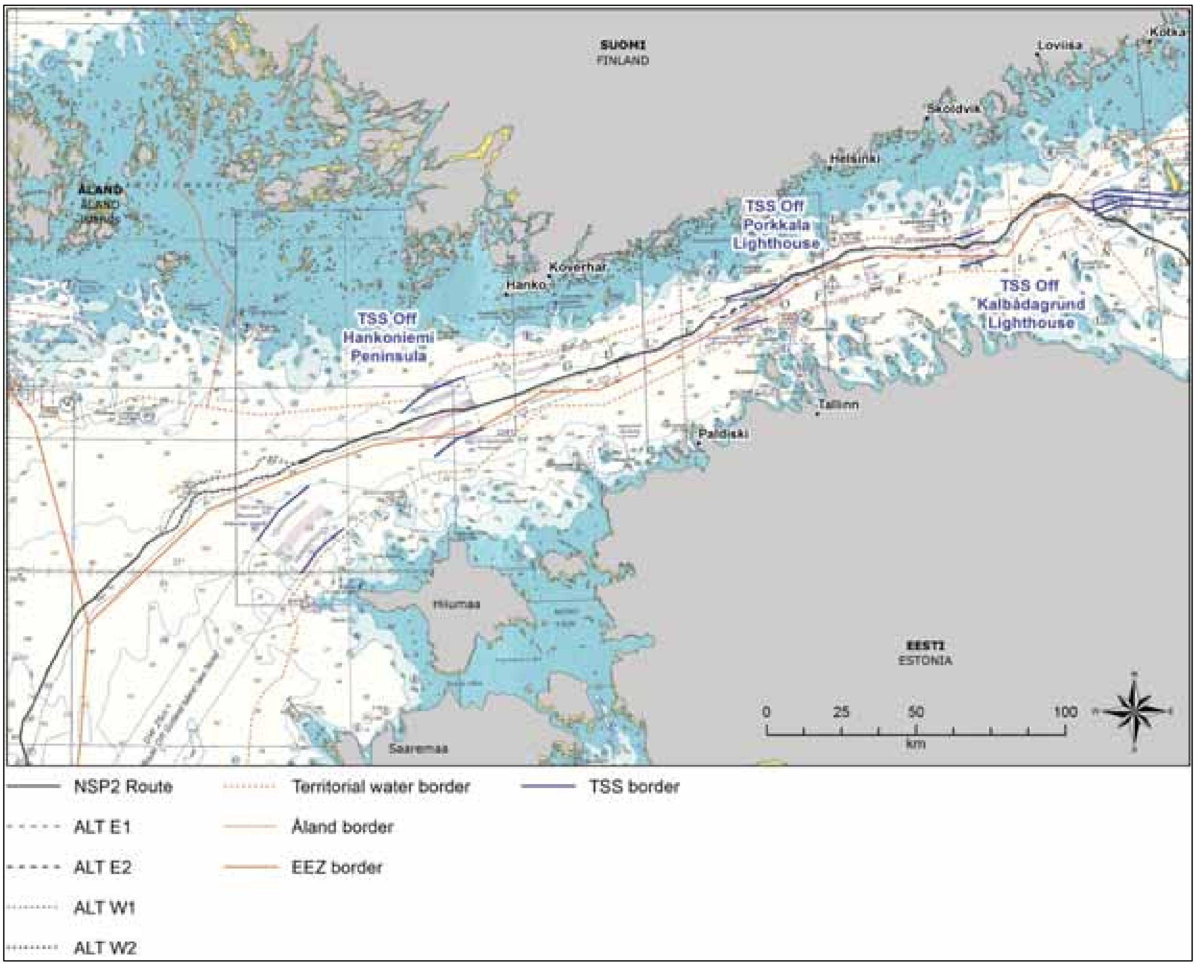

Figure 7-48. Navigational sea chart showing reference and alternative routes of NSP2 in the Finnish EEZ.

The pipeline runs close to or within the following TSSs in the Finnish part of the Gulf of Finland:

- TSS Off Kalbådagrund Lighthouse;
- TSS Off Porkkala Lighthouse;
- TSS Off Hankoniemi.

Passenger ferry traffic on routes Helsinki–Mariehamn–Stockholm (2 daily departures) and Tallinn–Stockholm are not typically using traffic lanes. Traffic to and from Mariehamn are mostly passenger ferries between Finland and Sweden, which have a short stopover.

The westbound traffic lane passes the Finnish EEZ and is controlled by the Finnish Transport Agency as part of the GOFREP system (Subchapter 7.16.3). This traffic lane is outbound traffic from the ports of the Gulf of Finland, which includes a considerable number of crude oil export transports from Russia *(Finnish Environment Institute 2015b)*.

An overview of ship traffic density is shown in Figure 7-49 and Appendix 12 (Map SH-01-F) representing ship traffic density according to the Automatic Identification System (AIS). The AIS system is compulsory for vessels over 300 GT (typical length over 25 m). It can be concluded that the majority of vessels use the main channels that go through TSS, but there is also considerable traffic outside of the main channels.

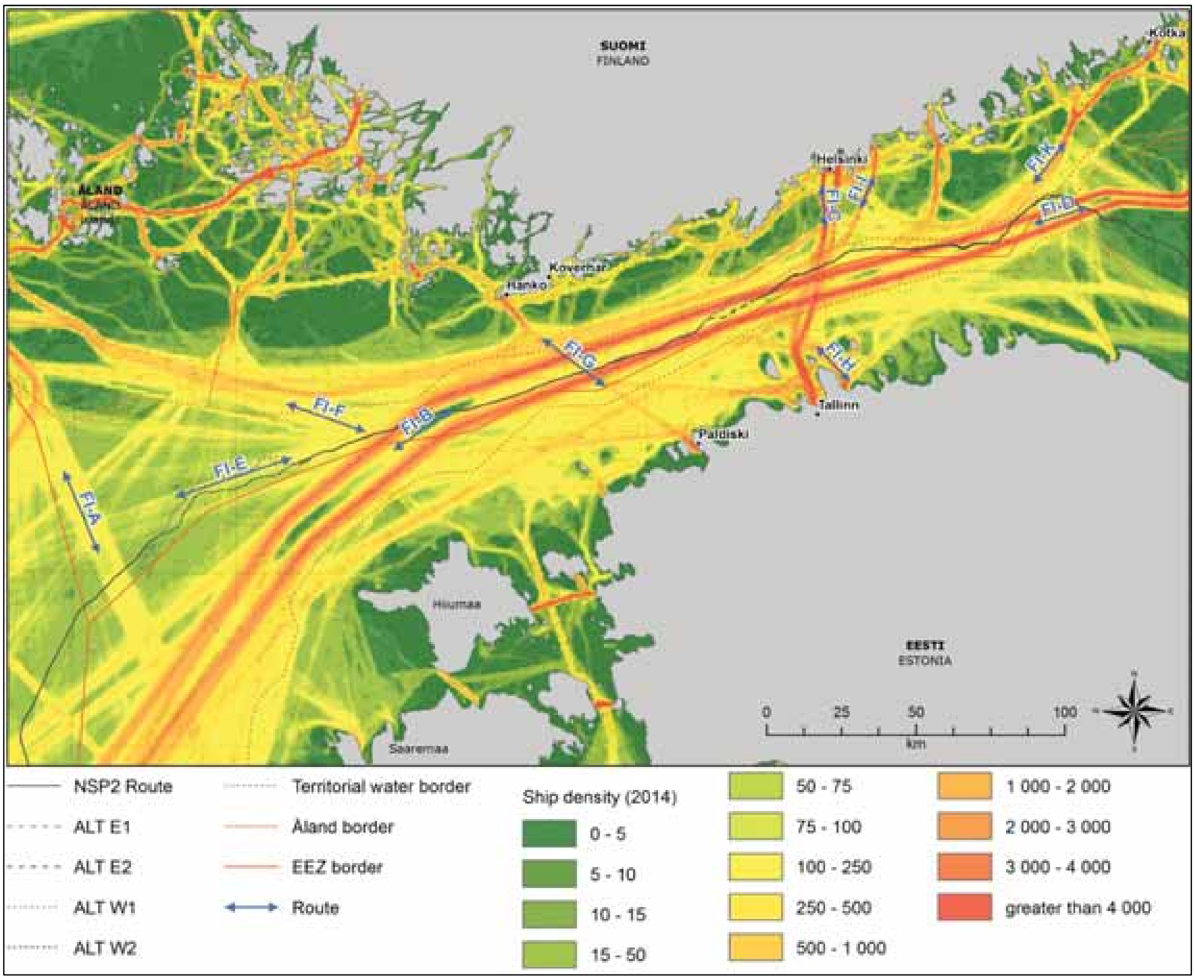

Figure 7-49. Ship traffic density in the Finnish EEZ.

For the Finnish EEZ, 11 routes have been identified. Only the routes influencing the pipeline directly and with a significant traffic load will be described in this report. These include:

- Route FI-B/FI-D. This route is the main traffic route in/out of the Gulf of Finland. In the Finnish EEZ, the ship traffic on this route will run parallel to the pipeline.
- Route FI-C. This route carries mainly the ferry traffic between Helsinki and Tallinn. The pipeline will cross this route more or less perpendicularly.

Figure 7-50 illustrates the annual ship movements on the routes of interest in the Finnish EEZ in 2014 and the forecast for the same routes in 2025.

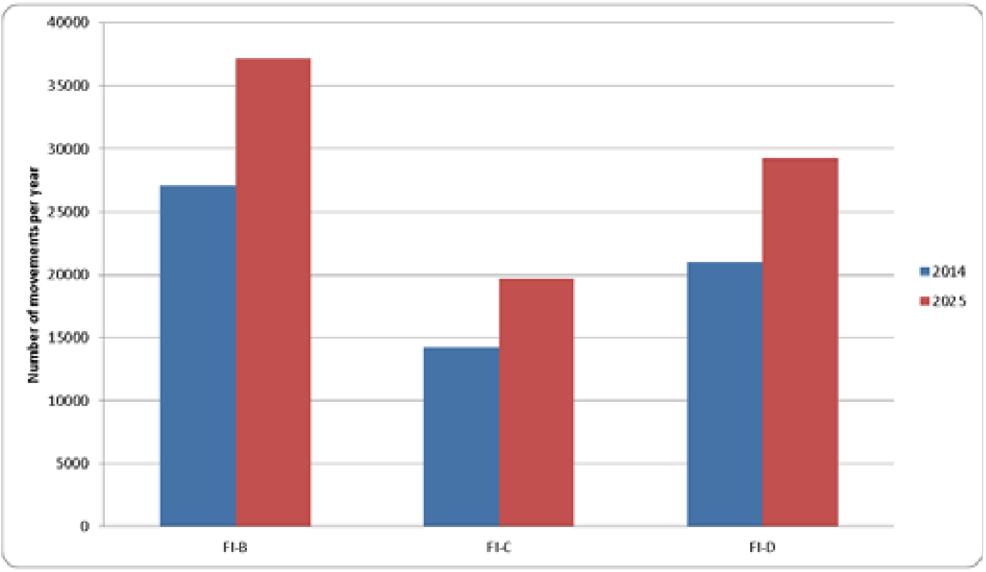

Figure 7-50. Annual ship movements on primary routes in the Finnish EEZ.

Route FI-B/FI-D is the main traffic route going west to east to/from Russia. In 2014, there were around 27,000 movements at FI-B and approximately 21,000 movements at FI-D. The difference in the number of movements is mainly due to the traffic exiting the main route to enter harbours such as Kunda and Tallinn in Estonia and Helsinki, Tolkkinen and Kotka in Finland. The annual ship movements are forecast to increase by 37 % to 37,100 movements at FI-B and by 39 % to 29,200 movements at FI-D by 2025. The majority of the traffic is comprised of cargo vessels (60 %), followed by tankers (30 %). With regard to length, about 14 % of the vessels at FI-B and 16 % of the vessels at FI-D are smaller than 100 m and approximately 66 % are between 100 m and 200 m for both routes. The remaining vessels on both routes are 200 m or longer.

Route FI-C comprises mainly ferry traffic between Helsinki and Tallinn. In 2014, there were approximately 14,200 movements. The annual ship movements are forecast to increase by 38 % to approximately 19,700 by 2025. The majority of the traffic is comprised of passenger vessels (76 %). With regard to length, about 23 % of the vessels are smaller than 100 m and approximately 64 % are between 100 m and 200 m. The remaining 12 % of the vessels are 200 m or longer.

7.16.2 Traffic to Finnish ports

There are five major port areas in Finland which create ship traffic to the project area:

- The archipelago area (Naantali, Turku, several small ports and crossing traffic from the Bay of Bothnia).
- The Hanko area (Hanko, Inkoo and several small ports)
- The Helsinki area (Western Harbour, Vuosaari, and several small ports)
- The Kilpilahti area (Oil refinery and Tolkkinen)
- The Kotka area (Kotka, Hamina, Loviisa)

Table 7-23. Vessel traffic in ports (number of vessels in 2015) (Finnish Transport Agency 2016a).

Port areas	Vessel arrivals
The Kotka area	2,574
The Kilpilahti area	916
The Helsinki area	8,279
The Hanko area	1,736
The archipelago area	3,068
Total	**16,573**

7.16.3 Vessel Traffic Service

Vessel Traffic Service (VTS) is organised in order to improve traffic flow and safety. VTS includes information, navigational assistance and traffic organisation. VTS provides services which support the approach to and departure from ports.

The deep sea service is provided by the Gulf of Finland is a Mandatory Ship Reporting System (GOFREP) service which has shared responsibility areas between Finland, Estonia and Russia. The traffic centres Tallinn Traffic, Helsinki Traffic and St. Petersburg Traffic monitor the shipping movements for GOFREP. GOFREP is a mandatory ship reporting system, adopted by the IMO (MSC.139 (76) and MSC.231 (82)), in accordance with SOLAS Regulation V/11 *(Finnish Transport Agency 2016b)*.

Related local VTS services in Finland are provided by Kotka VTS, Helsinki VTS, Hanko VTS and the Archipelago VTS. Most of the pipeline route is in the GOFREP area and the dense traffic area is also covered by local VTS services as seen in Figure 7-51. The pipeline route will be in Russian, Finnish and Estonian GOFREP responsibility areas, which requires co-operation between these services.

Search and Rescue Regions (SRR) are presented in Figure 7-51. SRR regions distribute responsibility of search and rescue operations between countries.

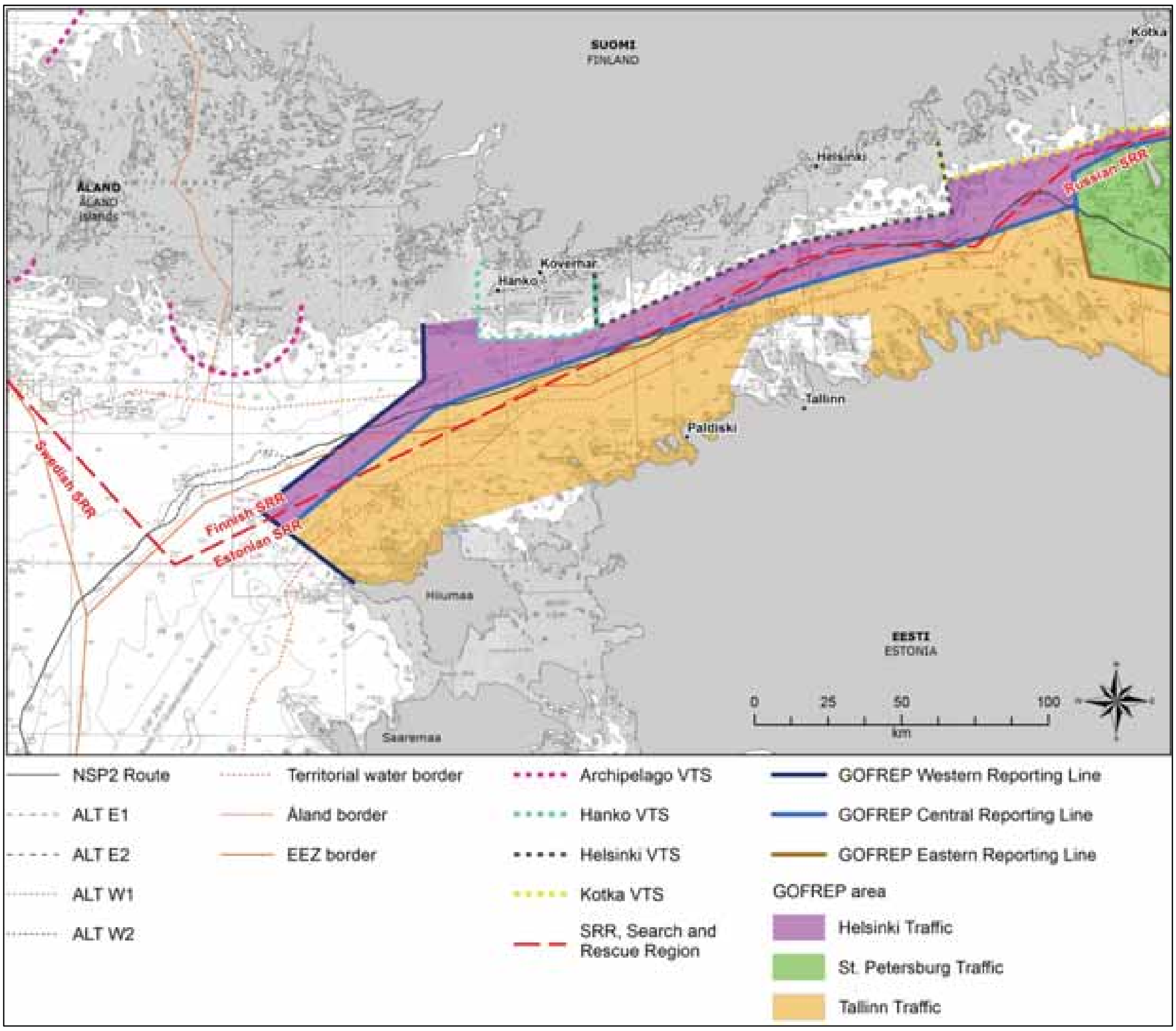

Figure 7-51. GOFREP, VTS and SRR areas (Finnish Transport Agency 2010, Finnish Environment Institute 2015c).

7.17 Commercial fishery

The register of professional fishermen (nowadays The register of commercial fishermen) in Finland included 1,153 fishermen who operate in the sea area bordering the Gulf of Finland and the Northern Baltic Proper in 2015 (Figure 7-52); *(Natural Resources Institute Finland 2016b)*. A quarter (25 %) of them earned at least 30 % of their income from fishing. The number of professional fishermen was highest in southwest Finland. Professional fishery in the Gulf of Finland and in the Northern Baltic Proper includes both coastal and offshore fishing. Offshore fishing is comprised of trawling and long-line fishing. In the coastal areas, mostly nets and trap nets are used.

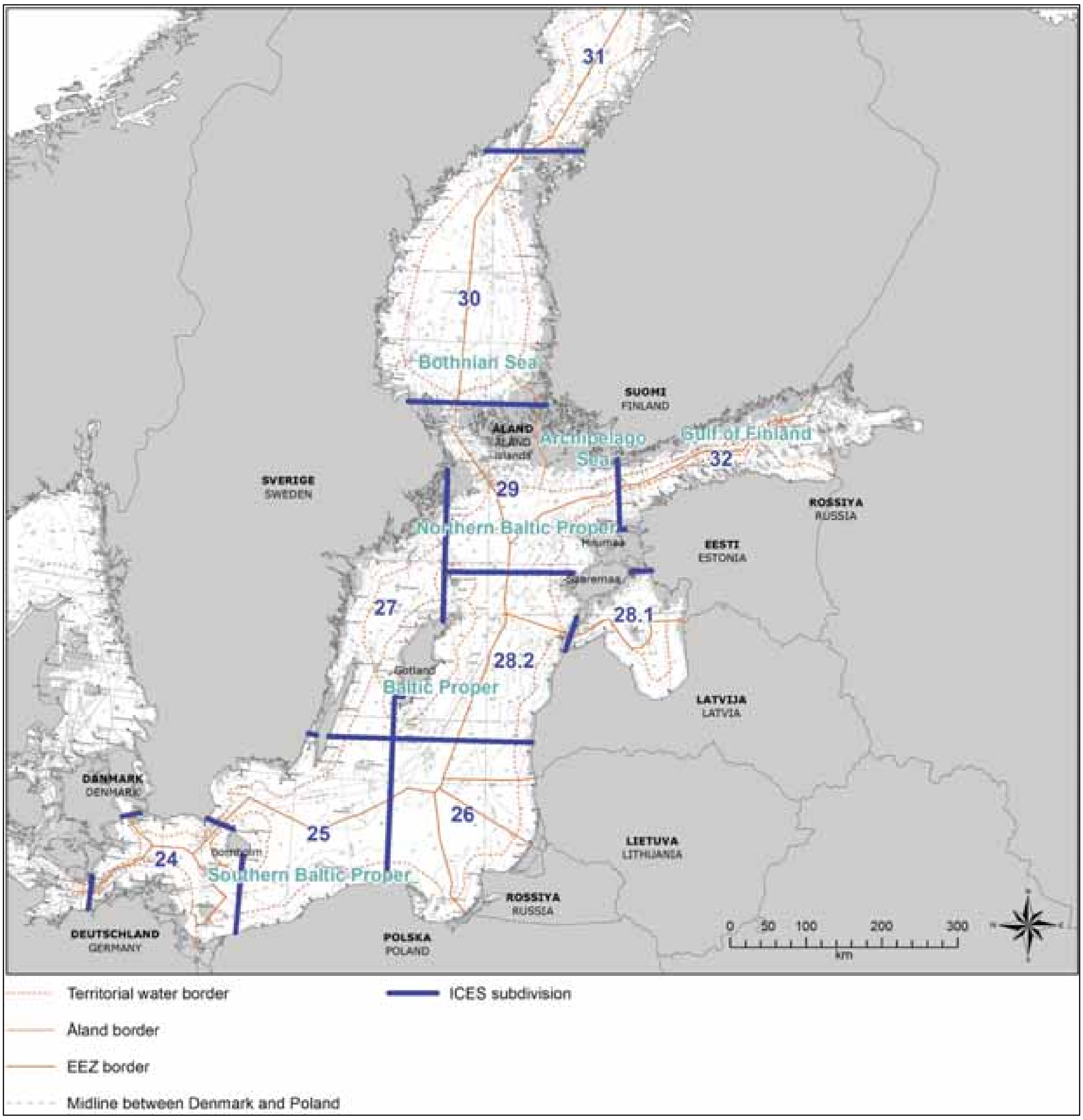

Figure 7-52. Geographic areas and the ICES subdivisions in the Baltic Sea.

There were 1,506 commercial fishing vessels operating in Finnish waters on the southern coast of Finland in 2015 (Table 7-24). The majority of operating vessels are from the southwest parts of Finland. Nearly all of the fleet consisted of small coastal fishery boats under 10 m in length. According to Finnish law (Act 690/2010), offshore fishing vessels must be over 12 m in length. In 2015, there were 41 commercial fishing vessels over 12 m in length that were registered in the south, southeast and southwest coast of Finland.

As part of the baseline study of the Nord Stream 2 Project, a fishery questionnaire was sent out to those Finnish offshore trawlers that have been registered to use trawl gear in the area of the planned pipeline route during 2014–2015. Using information supplied by the ELY Centre for Southwest Finland, a total of 26 trawl companies were contacted of which 8 responded to the query. Results of the trawler questionnaire are reported in Appendix 11A.

Table 7-24. The number of Finnish commercial fishing vessels of varying size in 2014 and 2015 registered in the southern waters of Finland. (Natural Resources Institute Finland 2016b)

Sea area	Length of vessel	2014	2015
Southeast region	<10 m	123	108
(Gulf of Finland)	10–12 m	23	22
	12–18 m	8	6
	18–24 m	0	0
	24–40 m	0	0
	>40 m	0	0
Uusimaa region	<10 m	284	230
(Gulf of Finland)	10–12 m	38	29
	12–18 m	4	3
	18–24 m	2	2
	24–40 m	3	3
	>40 m	0	0
Southwest region	<10 m	1,043	757
(Gulf of Finland/Archipelago Sea)	10–12 m	41	29
	12–18 m	11	9
	18–24 m	7	7
	24–40 m	5	6
	>40 m	2	2
Åland region	<10 m	282	275
(Northern Baltic Proper/Archipelago Sea)	10–12 m	14	15
	12–18 m	2	0
	18–24 m	1	2
	24–40 m	1	1
	>40 m	0	0
Total number of vessels over 12 m in length		46	41
Total		1,894	1,506

Trawls are the principal gear type used in commercial fishery in the open waters of the Baltic Sea. Mid-water (pelagic) trawls are used to capture Baltic herring and European sprat and are also used by Finnish fishermen in the offshore areas of the Gulf of Finland and the Northern Baltic Proper. Mid-water trawls are used in the middle water column but can be used near the seabed as well when schools of fish are located in deep water. Mid-water trawling is operated either by a single vessel or as a pair trawl involving two vessels. A trawl is a cone-shaped net towed using long warp wires. The lateral opening of a trawl net is maintained by two trawl boards or doors when carrying out single trawling and the vertical opening is maintained by clump weights (Figure 7-53).

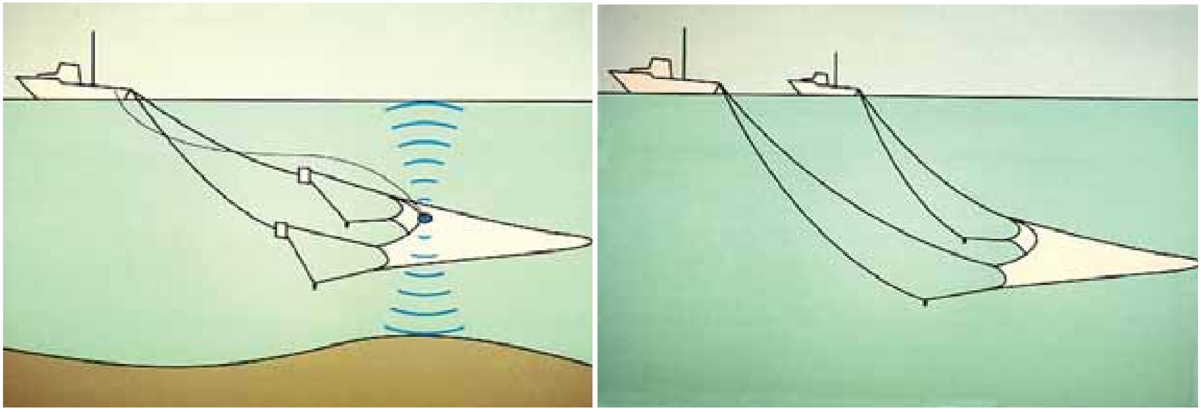

Figure 7-53. A mid-water trawl towed by a single vessel and a pair of vessels. An echo sounder is used to measure the depth of the net. Clump weights in front of the net help to maintain vertical opening (FAO 2015).

Bottom trawling is not applied in the Finnish EEZ, although some fishermen are registered to have been using it. The term bottom trawling refers in Finland nowadays to near-bottom, mid-water trawling in contrast to real bottom trawling where trawl gear is literally dragged over the seabed *(Raitaniemi and Manninen 2014)*. Real bottom trawling is practiced in the southern and middle parts of the Baltic Sea where cod and flat fish stocks are abundant enough for commercial exploitation. In the important mid-water trawling areas, at the mouth of the Gulf of Finland, the near-bottom waters are nowadays in an anoxic state (Subchapter 7.5) reducing the opportunity for near-bottom fishing in the area. The target fish species Baltic herring and sprat are pelagic fish, meaning they are not living on the seabed but are rather found in the open water column where they migrate between upper and lower water layers in search of their diet plankton.

Trawl fishing areas in the Finnish EEZ were examined by analysing the satellite tracking (VMS) data of fishing vessels requested from the ELY Centre for Southwest Finland. The requested data consisted of trawl vessels operated under the Finnish flag that have reported fish catch from the Finnish EEZ in the Gulf of Finland or from the Northern Baltic Proper during 2010–2015. The data was reduced by taking into account only satellite track points registered during vessel trawling speed (2–4 knots). Combined trawling pattern of the Finnish trawler fleet indicates the mouth of the Gulf of Finland to be the most important trawling area in the Finnish project area. Within the EEZ area, intensively trawled paths in both East-West and North-South directions are located outside of the City of Hanko. However, trawling has been conducted within nearly all of the EEZ area. Figure 7-54 shows that the Finnish trawl fishery is concentrated mainly in the Bothnian Sea outside of the Nord Stream 2 Project area.

Experiences from NSP show that fishermen can co-exist with the pipeline. So far, no gear has been reported lost or damaged even though there have been collisions between pipeline and trawl gear according to NSP's external pipeline inspections *(DeepOcean 2015)* There are numerous clear marks on the surface of the pipelines which are interpreted to have originated from trawl boards. Natural embedment of the pipeline has in most locations – depending on the seabed conditions significantly reduced the risk and inconvenience for near-bottom trawling activities. In addition, according to analyses of the trawling pattern of the Finnish offshore trawler fleet, the NSP pipelines have not changed the proportion of trawling activities in the area of the pipelines *(Ramboll 2015f)*.

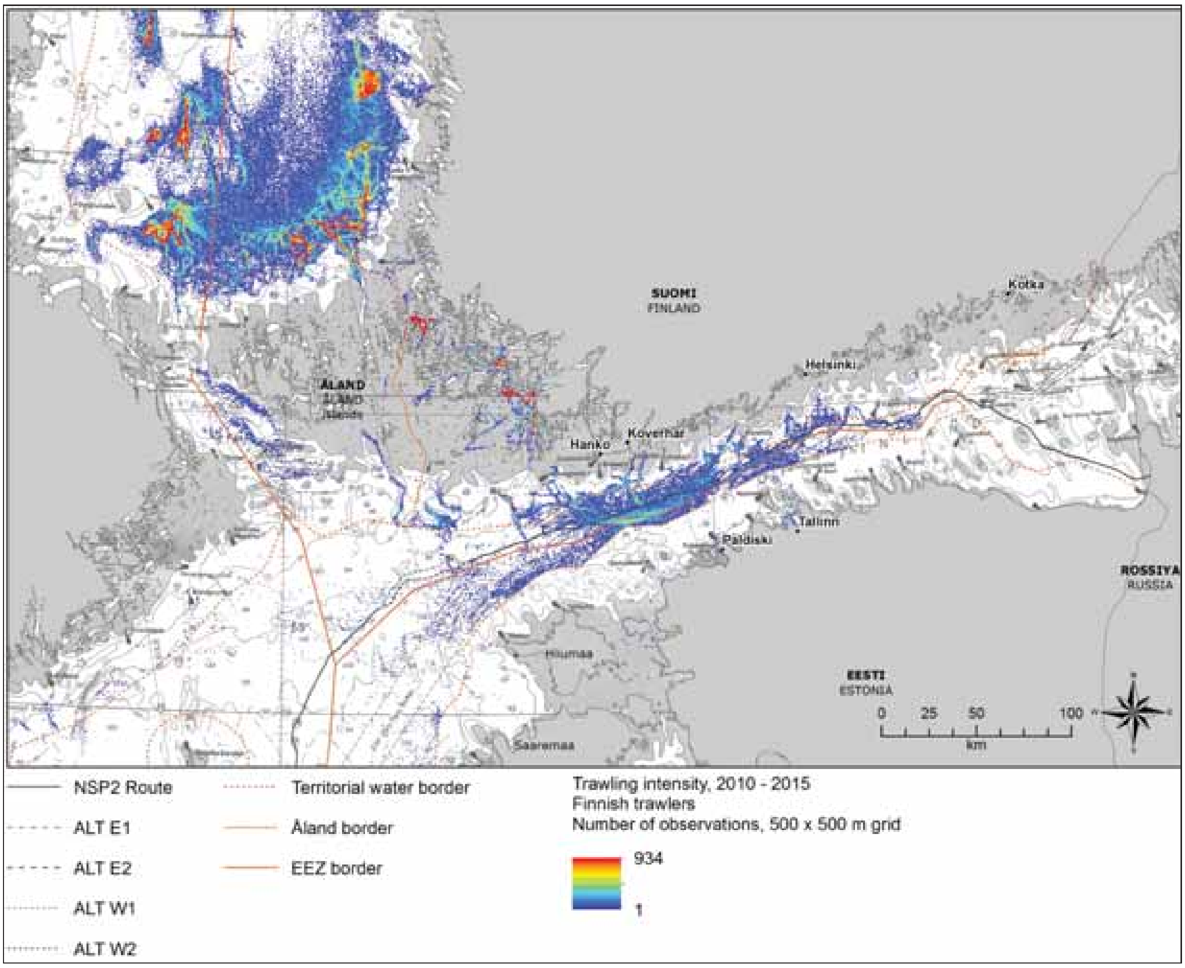

Figure 7-54. Trawling pattern of the Finnish trawler fleet during 2010-2015. Vessel movements only by trawling speed 2–4 knots. (Data from the ELY Centre for Southwest Finland).

Long-line fishing is used to catch salmon in offshore waters. Salmon long-lining is carried out in the upper water layers near the surface with drifting gear.

European sprat and Baltic herring are commercially the most important catch species, comprising about 95 % by weight of the total commercial catch in the Finnish EEZ fisheries in the Gulf of Finland, the Archipelago Sea and the Northern Baltic Proper (Appendix 12, Map FC-02-F). By far the most important area for the Finnish Baltic herring catch is the Bothnian Sea. However, a larger role is played by the Gulf of Finland with respect to sprat fishing (Table 7-25, Appendix 12, Map FC-03-F).

Table 7-25. The Finnish catch of Baltic herring and sprat from different areas of the Baltic Sea in 2015 (Natural Resources Institute Finland 2016b). ICES subdivisions, Figure 7-52.

	2015			
ICES subdivision	**Baltic herring (1,000 kg)**	**%**	**sprat (1,000 kg)**	**%**
24 The west side of the southern Baltic	0	0	0	0
25 The middle of the southern Baltic	22	0	352	3
26 The east side of the southern Baltic	0	0	0	0
27 West of Gotland	550	0	480	4
28 East of Gotland	102	0	76	1
29 The Archipelago Sea	26,096	23	4,369	40
30 The Bothnian Sea	95,636	84	2,140	19
31 The Bothnian Bay	4,417	4	0	0
32 The Gulf of Finland	4,621	4	4,457	40
Total	**113,876**	**100**	**11,056**	**100**

The total value of commercial marine fishery in the Gulf of Finland and in the Northern Baltic Proper by Finnish fishermen was on average 4.39 M€ per year between 2010–2014 (Appendix 12, Map FC-07-F). About one third of the total catch was Baltic herring, one third was sprat and one third consisted of other species. The average catch by value by Finnish commercial fishermen by ICES rectangles during 2010–2014 are presented in the Atlas maps (Appendix 12, Map FC-06-F). Fishing vessels from other EU Member States, other than Swedish, are also allowed to fish in the Finnish EEZ, in the area west of the Hanko Peninsula. Swedish fishing vessels are entitled to fish also in the Finnish Eastern EEZ area and in the Finnish Territorial Sea (Appendix 12, Map FC-04-F). By economic value, the Estonian catch forms the largest proportion of the fish catch in the area of the Gulf of Finland and the Northern Baltic Proper (Table 7-26, Appendix 12, Map FC-07-F).

Table 7-26. Monetary value of the fish catch by country in the area of the Gulf of Finland and the Northern Baltic Proper.

	The average annual fish catch between 2010–2014	
Country	**M€**	**%**
Denmark	1.43	8
Estonia	7.15	38
Finland	4.86	26
Germany	0.63	3
Latvia	0.02	0
Lithuania	0.18	1
Poland	0.40	2
Sweden	4.24	22
Total	**18.91**	**100**

Recreational fishery is concentrated mainly in the coastal and archipelago areas. In offshore areas, salmon trolling is also practised on a small scale by recreational anglers.

7.18 Munitions

The Baltic Sea is an area with a history of significant strategic naval importance. The legacy of World War I and World War II is the presence of conventional and chemical munitions. The estimated number of mines laid in the Baltic Sea is over 170,000. Many of these have been cleared during the years, but many tens of thousands of mines may remain in the Gulf of Finland *(Nord Stream AG 2013)*. In addition to the strategically placed mines, remnants of marine warfare such as torpedoes, artillery shells and air dropped bombs can be encountered. There is no available information on chemical munition dump sites in the Finnish EEZ. No chemical munitions were found during the Nord Stream Project in the Finnish EEZ.

The most common mines deployed were contact mines. There are three types; moored, bottom and drifting contact mines. Moored contact mines are connected to a release system deployed on the seabed and are designed to float at or near the surface. Mines that are still attached to the anchor have failed to release or filled with water on deployment.

The mines were deployed in lines by various navies. The lines were deployed at various times with the mines designed to float at varying depths, thus, creating complex curtains. Databases are available that define the locations of mine lines. Although databases are incomplete, they still provide guidance with respect to areas of elevated risk *(Nord Stream AG 2009)*. Figure 7-55 presents the current knowledge of munitions densities in the Gulf of Finland and Northern Baltic Proper.

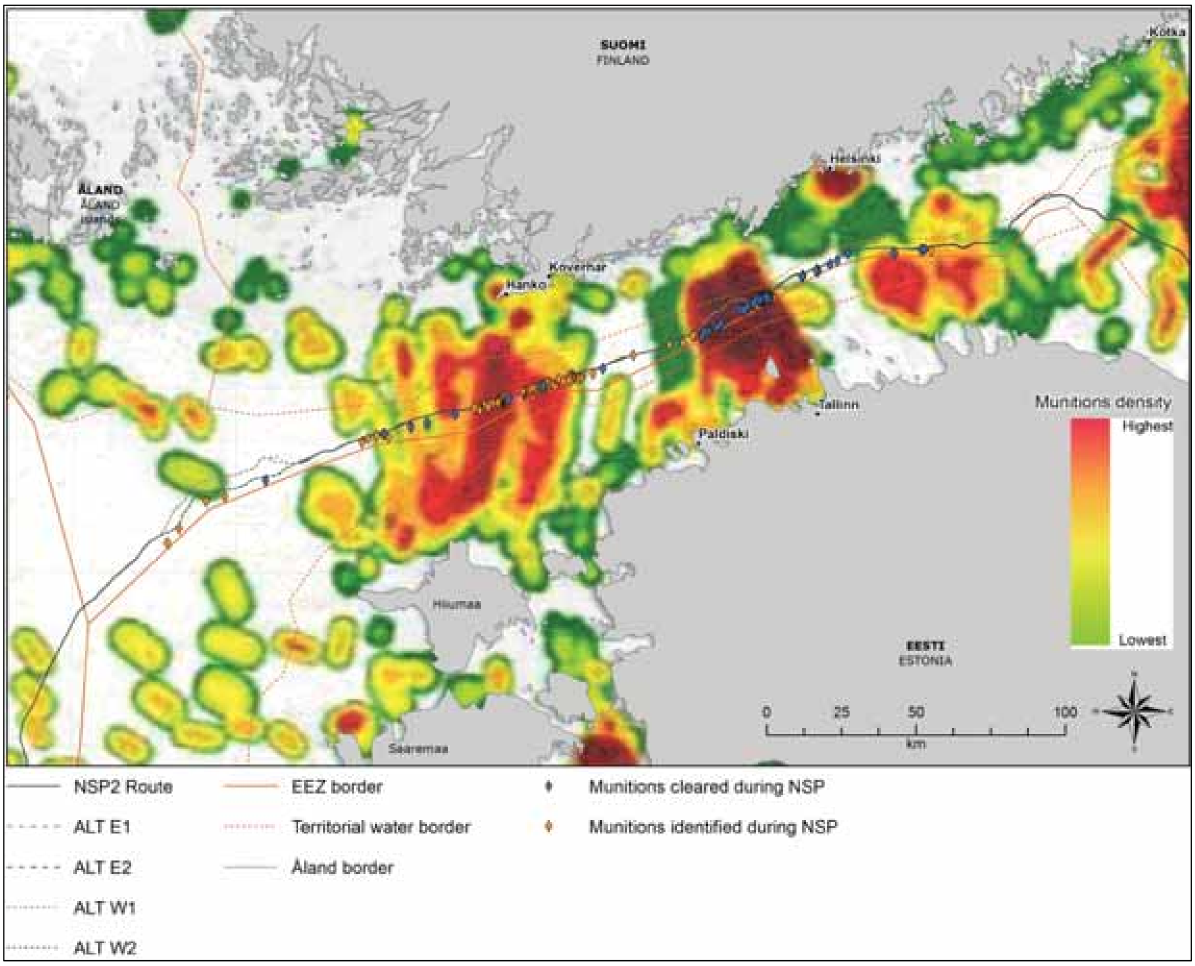

Figure 7-55. Munitions density in the Gulf of Finland and the Northern Baltic Proper (source: HELCOM) and locations of the munitions that were identified and cleared during the Nord Stream Project (source: Nord Stream AG).

In preparation of the construction of the Nord Stream pipelines in the Finnish project area, a total of 49 munitions were cleared through detonation and six were relocated (Figure 7-55). Figures Figure 7-56 to Figure 7-59 show the most common types of munitions cleared during the Nord Stream Project within the Finnish EEZ, but also torpedoes, projectiles and depth charges were identified within the Finnish EEZ. Based on the Nord Stream experience and the number of munitions remaining in the Gulf of Finland and the Northern Baltic Proper, it is expected that the number of munitions requiring clearance during the Nord Stream 2 Project is in the similar order of magnitude as during the Nord Stream Project. The exact number, types and locations of munitions requiring clearance will be defined following the completion of the munitions screening survey within the pipeline installation corridor and the visual inspection of items identified within the security corridor (Subchapter 4.1.3). This information will be presented in the permit applications.

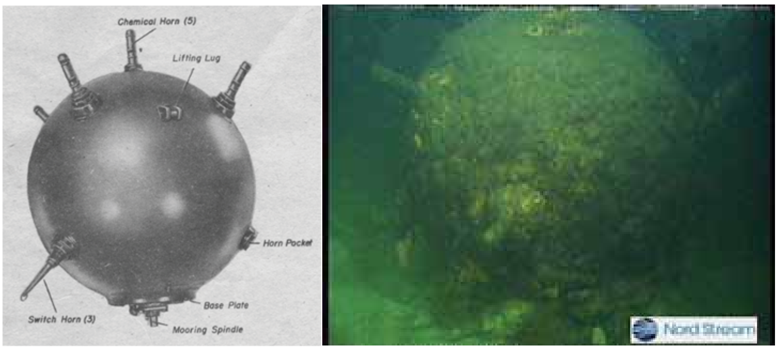

Figure 7-56. German UMA mine, a moored contact mine with a charge weight of 30 kg, developed in 1928. A total of 12 mines of this type were cleared during the Nord Stream Project (Witteveen+Bos 2011).

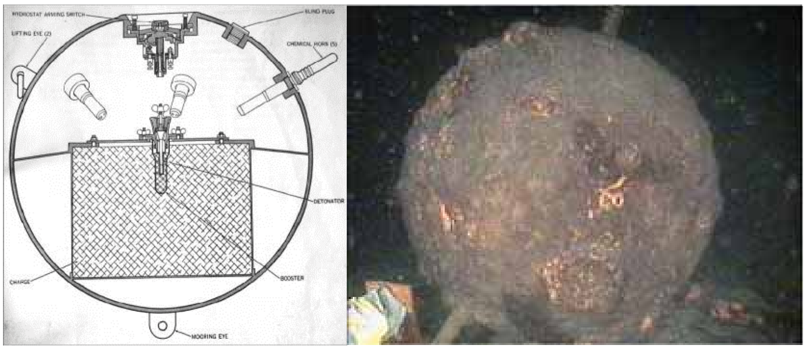

Figure 7-57. German EMC and EMC II mine, a moored contact mine with a charge weight of 250 kg, introduced in 1924. A total of 6 mines of this type were cleared during the Nord Stream Project (Nord Stream AG 2009, Witteveen+Bos 2011).

Figure 7-58. Russian buoyant contact mine type M-08/39 with a charge weight of 115 kg, developed in 1908 and the primary Russian mine used in WW1. A total of 5 mines of this type were cleared during the Nord Stream Project (Witteveen+Bos 2011).

Figure 7-59. Russian air dropped bomb type FAB-100 with a charge weight of 42 kg, introduced in 1940 and widely used in WW2. A total of 11 bombs of this type were cleared during the Nord Stream Project (Witteveen+Bos 2011).

7.19 Barrels

There are barrels and other containers located on the seabed in the Gulf of Finland and the Northern Baltic Proper. Barrels are found especially in the vicinity of shipping lanes as these have been thrown overboard from vessels.

In the Finnish EEZ, a total of some 630 barrels and other containers were found within the installation and anchoring corridors of the Nord Stream pipelines. The condition of the barrels varied greatly. The majority of the barrels were either broken or otherwise open. A number of the barrels appeared completely intact and closed and so are likely to contain the original contents. Figure 7-60 shows barrels in varying conditions identified during the Nord Stream Project. At any rate, potential contaminants in barrels will eventually be released into the environment when currently intact containers breach due to corrosion. *(Ramboll 2010)*

As barrels are found in detailed surveys, it is not possible at this stage to assess how many barrels will be identified inside the installation or anchoring corridors. The exact number will be known during the permitting phase when visual inspections have been performed.

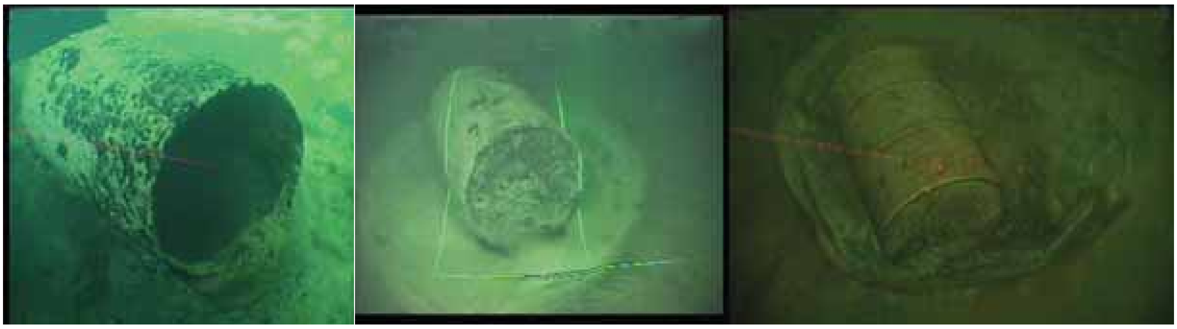

Figure 7-60. Examples of barrels in varying condition lying on the seabed (Ramboll 2010).

7.20 Military areas

Military areas located in the Gulf of Finland and the Archipelago Sea include both restricted and danger areas for aviation as well as restricted areas of the Finnish Navy. These are shown in Appendix 12 (Map MI-01-F).

The restricted areas of the Finnish Navy are located in territorial waters but a few of them are close to the border of the EEZ. Two areas, Upinniemi and Hanko, are located on the border of the EEZ. The pipeline route does not go through any of the restricted areas. The restricted areas do not limit movement within the area, except for movement in the proximity of marked military targets located within the restricted area. As an example, the following activities are subject to prior approval within a restricted area: scuba diving, fishing with fishing tackle dragged along the bottom, anchoring other than pleasure craft outside anchorage points marked on Finnish sea charts and movement in public water areas outside of public thoroughfares and 100 m closer to such land areas used by the Finnish Defence Forces at which landing, according to law, is prohibited. *(Act on Territorial Surveillance, Section 17)*

Some restricted areas within the Finnish airspace (R areas) are located above Finnish territorial waters. These areas will be activated when their use so requires. It is mandatory to have a permit to fly into R areas. The pipeline route does not enter into R areas.

Some airspace danger areas (D areas) are also located within the Finnish EEZ. These are areas where activities dangerous to aircraft may occur. One of the D areas extends into the Estonian EEZ. Movement in the D areas is not restricted. The pipeline route passes through D areas at three locations: for an 18 km section south of Helsinki, for an 8 km section of ALT E1 pipeline route south of Porkkala and a 47 km section at TTS off Hankoniemi Peninsula and to the west of it.

7.21 Existing and planned infrastructure

7.21.1 Pipelines

Nord Stream Pipelines 1 and 2 run through the Finnish EEZ from Russian territorial waters to the Swedish EEZ. They were constructed between 2010–2012. The pipelines transport natural gas from Russia to Germany passing through the Russian, Finnish, Swedish, Danish and German EEZs and entering the territorial waters of Russia, Denmark and Germany. The length of the section of each pipeline in the Finnish EEZ is 375 km. Pipeline 1 was taken into operation in 2011 and Pipeline 2 in 2012. Technically, the pipelines are similar to the planned Nord Stream 2 pipelines.

The NSP2 pipeline route enters the Finnish EEZ from Russian territorial waters south of the Nord Stream pipelines before crossing both pipelines close to the Russian border (crossing locations a are few hundred metres from the border). The pipeline route runs north of the Nord Stream pipelines for the remaining part of the Finnish section, where the distance from the northern Nord Stream pipeline to the proposed pipeline route varies from 0.2–6.6 km.

Balticconnector is a planned natural gas pipeline connection between Inkoo in Finland and Paldiski in Estonia. The purpose of the pipeline project is to interconnect the Finnish and Estonian natural gas distribution networks. According to preliminary plans, construction and pipeline installation will take place between 2018–2019 and commissioning is expected late 2019 (Baltic Connector Oy 2017). The planned route of the Balticconnector pipeline crosses the NSP2 pipeline route south of Inkoo.

See Appendix 12 (Map IN-03-F) for Nord Stream pipeline routes and the planned pipeline route of Balticconnector.

7.21.2 Cables

Several power and telecommunications cables run in the Finnish project area. Twenty-four existing cables and two planned cables cross the pipeline route. Five of the existing cables are inactive and six are unknown cables. Table 7-27 presents all these cables. Appendix 12 (Map IN-01-F and Map IN-02-F) shows cables in the Gulf of Finland, the Northern Baltic Proper and the Archipelago Sea.

Cables laid after the construction of the Nord Stream pipelines are:

- Estlink 2, a power cable between Finland and Estonia laid in 2012.
- UPT/KS-SFOTS, a telecommunications cable between St. Petersburg and Kaliningrad, Russia, laid in 2012. Within the Finnish EEZ, the cable route runs parallel to the Nord Stream pipelines and the NSP2 pipeline route for the most part, and crosses the NSP2 pipeline route 2-4 times (depending on the route alternatives) in the Finnish EEZ.
- C-Lion1 (Sea Lion), a telecommunications cable between Finland and Germany. The cable was laid in 2015 in Finnish waters. The cable route runs close to the Nord Stream pipelines and the NSP2 pipeline route in the Finnish EEZ south of Helsinki to the border of the Swedish EEZ and crosses the NSP2 pipeline route twice in the Finnish EEZ.

Swedish Eastern Light AB is planning an offshore optic fibre cable between Sweden and Germany via Finland, the Baltic countries and Poland. No more details are available of the planned project.

Table 7-27. Active, inactive and planned cables that cross the pipeline route (source: Nord Stream 2 AG, Nord Stream AG, Finnish Transport Agency and Ramboll).

Cable	Type	Route	Status	Number of crossings with Line A	Number of crossings with Line B
48 (found in 2008)	Unknown	Unknown	Unknown	1	1
1 (found in 2005)	Unknown	Unknown	Unknown	1	1
UNID3	Unknown	Unknown	Unknown	2	2
UCCBF	Military	St. Petersburg (Russia) – Kaliningrad (Russia)	Inactive	5	5
Estlink 2	Power	Anttila (Finland) – Püssi (Estonia)	Active	1	1
Jollas-Leningrad	Telecommunications	Jollas (Finland) – St. Petersburg (Russia)	Inactive	2	2
C-Lion1 (Sea Lion)	Telecommunications	Helsinki (Finland) – Markgrafenheid (Germany)	Active	2	2
Linx (east)	Unknown	Unknown	Planned	1	1
FEC 2	Telecommunications	Lauttasaari (Finland) – Randvere (Estonia)	Active	1	1
Pangea	Telecommunications	Helsinki (Finland) – Tallinn (Estonia) and Sandhamn (Sweden) – Hiiumaa (Estonia)	Active	2	2
EE-SF2	Telecommunications	Helsinki (Finland) – Tallinn (Estonia)	Active	1	1
IP-Only	Telecommunications	Helsinki (Finland) – Tallinn (Estonia) – Hanko (Finland)	Planned	2	2
FIN-EST Out of use 2	Unknown	Finland – Estonia	Inactive	1	1
FIN-EST Out of use 1	Unknown	Finland – Estonia	Inactive	1	1
S15b_Tallinn-Helsinki KP 230	Telecommunications	Tallinn (Estonia) – Helsinki (Finland)	Inactive	0	1
EE-SF3	Telecommunications	Lauttasaari (Finland) – Meremoisa (Estonia)	Active	1	1
UESF2	Telecommunications	Helsinki (Finland) – Hanko (Finland)	Active	2	2

Cable	Type	Route	Status	Number of crossings with Line A	Number of crossings with Line B
Estlink 1	Power	Espoo (Finland) – Harku (Estonia)	Active	1	1
UESF1	Telecommunications	Helsinki (Finland) – Hanko (Finland)	Active	2 or 0 *	2 or 0 *
FEC 1	Telecommunications	Porkkala (Finland) – Kakumae (Estonia)	Active	1	1
BCS North Segment B2	Telecommunications	Helsinki (Finland) – Hanko (Finland)	Active	2 or 0 *	2 or 0 *
UPT/KS-SFOTS	Telecommunications	St. Petersburg (Russia) – Kaliningrad (Russia)	Active	4 or 2 **	4 or 2 **
Unknown_ R13 (found in 2015/2016)	Unknown	Unknown	Unknown	1	1
EE-S1	Telecommunications	Stavsnäs (Sweden) – Tahkuna (Estonia)	Active	1	1
Unknown_ R15 (found in 2015/2016)	Unknown	Unknown	Unknown	1	1 or 0
Unknown_ R16 (found in 2015/2016)	Unknown	Unknown	Unknown	1	1

* 2 crossings with sub-alternative ALT E1, no crossings with sub-alternative ALT E2

** 4 crossings with sub-alternative ALT W1, 2 crossings with sub-alternative ALT W2

7.21.3 Extraction and spoil dump areas

Three permitted gravel extraction sites for sea sand and gravel exist in Finnish territorial waters in the Gulf of Finland and the Northern Baltic Proper: Itätonttu, Soratonttu (off the shore of Helsinki) and Merisora Loviisa (off Loviisa) *(Ministry of Economic Affairs and Employment 2015c)*. There are also existing spoil dump sites in Finnish territorial waters: off Loviisa, Helsinki, Espoo and Ingå. The shortest distance between the gravel extraction and spoil dump sites and the pipeline route is approximately 10 km.

Appendix 12 (Map IN-01-F) shows the extraction and spoil dump areas in Finnish waters in the Gulf of Finland.

7.21.4 Wind farms

There are no wind parks near the pipeline route. According to the Uusimaa Wind Power Study *(Helsinki-Uusimaa Regional Council 2014)*, two areas located in the marine area were selected for further study. Both areas are located in territorial waters. With minor changes to the borders, these same areas are designated as areas suitable for wind power production in the proposal of the phased regional plan 4 for the Uusimaa Region *(Helsinki-Uusimaa Regional Council 2016)* (Appendix 12, Map IN-01-F). The proposal of the phased regional plan 4 for the Uusimaa Region was on display during November and December 2016. The finished plan proposal will be sent to the Ministry of Environment for confirmation during 2017. The distance from the nearest suitable wind power area to the pipeline route is more than 10 km.

7.22 Scientific heritage

7.22.1 Long-term monitoring stations

In Finnish waters, in the Gulf of Finland and the Northern Baltic Proper, there are numerous long-term monitoring stations managed by several countries surrounding the Baltic Sea. Different parameters related to e.g. water quality are measured regularly from these stations to monitor the status of and changes in the marine environment. Long time series of measurements compose an important data source and can be considered as scientific heritage.

Most of the long-term stations are managed by the Finnish Environment Institute (SYKE). Most of these stations are part of the HELCOM monitoring (COMBINE – Cooperative Monitoring in the Baltic Marine Environment, MORSE – Monitoring of Radioactive Substances). According to information received from SYKE and other data sources, there are 19 long-term monitoring stations located within a 5 km distance from the pipeline route. Four of them are located within 1.0 km of the pipeline route. In the Finnish EEZ, there are also long-term stations managed by Estonia or Sweden. Table 7-28 and Appendix 12 (Map SC-01-F) present the monitoring stations located nearest to the pipeline route in Finnish waters.

Table 7-28. Long-term monitoring stations from east to west located nearest to the pipeline route in Finnish waters. For benthos stations situated less than 2 km distance from planned pipelines, distances for Line A and Line B are presented (orange) (source: Finnish Environment Institute).

Station	Water depth (m)	Country	Parameters	Nearest distance from NSP2 Route	
				From pipeline	Distance, km
LL3A	68	Finnish	Benthos, radioactive substances	Line A	4.2
F1 *	81	Estonian	Water quality, benthos	Line A	4.2
LL4A	57	Finnish	Benthos	Line A	2.4
LL5	69	Finnish	Benthos	Line A Line B	1.0 1.1
LL6A	72	Finnish	Benthos	Line A Line B	0.8 0.9
LL7D	101	Finnish	Water quality	Line B	1.9
LL7S	71-78	Finnish	Benthos	Line A Line B	1.6 1.4
LL9	66	Finnish	Benthos	Line A	2.1
JML	80	Finnish	Water quality, benthos, radioactive substances	Line B	3.5
CTD_JV_1	127	Finnish	Water quality	Line B	3.0
LL11	67	Finnish	Water quality, benthos	Line A Line B	1.4 1.5
H1 **	81	Estonian	Water quality, benthos	Line B	2.4
LL12	82	Finnish	Benthos	Line B	2.3
25	98	Estonian	Water quality, benthos	Line A	2.9
BY27	165	Swedish	Water quality	Line A (ALT W2) Line B (ALT W1)	0.5 4.2
TPDEEP ***	199	Finnish	Water quality	Line A (ALT W1) Line A (ALT W2)	3.4 8.8
AALTO_PI	98	Finnish	Water quality	Line A (ALT W1) Line A (ALT W2)	4.2 6.2
NCB ****	175	Finnish	Water quality	Line B	1.4

* Approximately same location as LL3A

** Approximately same location as LL12

*** Used for calibration of CTD instruments and other sensors

**** Not measured regularly

7.22.2 Whale remains

During the Nord Stream Surveys in 2007–2008, the remains of a potential whale skeleton were found partly embedded in the seabed.

At the request of the Finnish National Board of Antiquities, five bone samples were retrieved for further research. The samples were analysed in Denmark and the Netherlands to determine the age of the find and the species in question.

The results of the carbon-14 analyses indicated that the age of the bone is approximately 6,000 years. However, DNA analyses of the bone were unable to reveal the species.

The whale remains are located at a 620 m distance from the pipeline route (Appendix 12, Map SC-01-F).

7.23 Cultural heritage

Cultural heritage can be defined as "all vestiges of human existence and consisting of places relating to all manifestations of human activity, abandoned structures and remains of all kinds, as well as all the portable cultural material associated with them" *(ICOMOS 1990)*. Underwater traces of past human activity are called underwater cultural heritage. Historical wrecks of ships and other vessels, parts of them and their cargo make up the larger part of underwater cultural heritage. Together with their surroundings, underwater sites form a maritime cultural landscape.

Underwater cultural heritage means all traces of human existence having a cultural, historical or archaeological character which have been partially or totally under water, periodically or continuously, for at least 100 years *(UNESCO 2001)*. According to the Antiquities Act, ship wrecks discovered in the sea or in inland waters, which can be considered to have sunk over one hundred years ago, or parts thereof, are officially protected *(National Board of Antiquities 2016)*. Although the NSP2 pipeline implementation extends beyond the territorial waters and the boundaries of national legislation, the project aims to comply with national law and the EIA protocols. Also international conventions such as the United Nations Convention on the Law of the Sea (UNCLOS) and the UNESCO Convention on the Protection of Underwater Cultural Heritage emphasize the importance of international collaboration in the protection of underwater cultural heritage in waters extending beyond territorial limits. All underwater finds bearing archaeological, historical and cultural significance should, therefore, be protected as material evidence of past human societies.

Underwater cultural heritage in the Finnish EEZ consists mainly of wrecks. During the Nord Stream Project, during the years 2005–2009, several wrecks were surveyed in the Finnish EEZ. The wreck register maintained by the Finnish National Board of Antiquities (FNBA) includes additional wrecks in the Finnish EEZ. During the Nord Stream 2 Project Nord Stream 2 AG has performed extensive surveys for special bottom structures including wrecks using, e.g., sidescan sonar (SSS) and video inspection. The methods are described in Subchapter 4.1.3. The data has been evaluated by national experts.

Based on the Kokko (2016a and 2016b) documents, several sites in the Finnish EEZ have been deemed to be of cultural historical interest. The first phase of the archaeological evaluation of underwater cultural heritage (UCH) in the Finnish EEZ resulted in a list of 82 potential UCH sites within the 374 km long Finnish section of the Nord Stream 2 pipeline survey corridor. Twenty-three targets were found within the ±250 m area closest to the proposed pipeline and , hence, subjected to detailed high-resolution inspections. During the detailed inspection surveys of phase II, six new potential UCH targets were discovered in the area.

All 29 potential UCH targets within the ±250 m area around the pipeline have been assessed in greater detail and targets with no UCH relevance have been cast out. As a result of the detailed inspection, the number of UCH targets within the ±250 m area is confirmed as two and consisting of an 18th century merchantman (S-R15-02960) and a late 18th-early 19th century cannon barge (S-R05-7978). Two inspected Word War II sites have been included in the UCH target listing as being of historical interest and significance, even though they do not meet the 100-years+- UCH age criteria . The inspected World War II sites are a cargo supply ship, possibly from World War II (S-R11-2395), as well as an anti-submarine net installation (consisting of two investigated sections, S-R09-09806 and SD-Alt1-3372).

Table 7-29 presents significant UCH sites and potential or significant World War II historical sites in the Finnish project area found less than 250 m from the pipeline route. Appendix 12, Map CU-01-F shows those 4 sites on a map with an accuracy of a survey block (30 km long section of a pipeline).

Table 7-29. Significant UCH and World War II historical sites found less than 250 m from the pipeline route. Target S-R11-2395, which is closest at a 253 m distance from the pipeline route, is included in the table due to applying the precautionary principle.

Target (NSP2 ID)	Category	Description	Value	Pipeline offset to A and B lines*	Pipeline offset to A and B lines**	Protection
S-R05-7978	Wreck (wooden barge)	Probably a cannon barge from the late 18th-early 19th century.	Age >100 years. Significant UCH site.	152 m (Line A) 65 m (Line B)	147 m (Line A, debris) 58 m (Line B, debris)	A 50-m minimum safety perimeter is recommended for the wrecksite. A post-pipelay inspection is recommended for the site due to the relatively short offset distance to line B routing.
S-R09-09806 (SD-Alt1-3372)	Barrage (anti-submarine net)	A sections of the "western" and "eastern" parts of the "Walross" anti-submarine net (barrage) from World War II.	Significant World War II historical site.	131 m (Line A) 228 m (Line B)	0 m (Line A and Line B) Extends across the pipeline routes A and B	Detrimental interventions with the site must be minimised. A post-pipelay inspection is recommended as both A and B line routings are likely to cross the net installation.
S-R11-2395	Wreck (steel, motor vessel)	A badly devastated steel-hulled motor vessel. The vessel is of a cargo ship type, possibly a sea-going barge fitted with lifting cranes.	Potential World War II historical site.	386 m (Line A) 311 m (Line B)	296 m (Line A, debris) 253 m (Line B, debris)	Due to the vast scatter of debris, a 250 m safety perimeter is recommended for the site.
S-R15-02960	Wreck (wooden sail-ship)	Wooden merchantman from the 18th century.	Age >100 years. Significant UCH site.	233 m (Line A) 372 m (Line B)	220 m (Line A, debris, stern) 342 m (Line B (debris, bow)	A 50 m minimum safety perimeter is recommended for the site.

* Offset to the center of the main wreckage/target
** Offset to the closest point of the target (scattered debris, loose objects etc.)

Figure 7-61. **Still image from ROV video of S-R05-7978. © MMT**

Figure 7-62. **ROV video still image of S-R09-09806. © MMT**

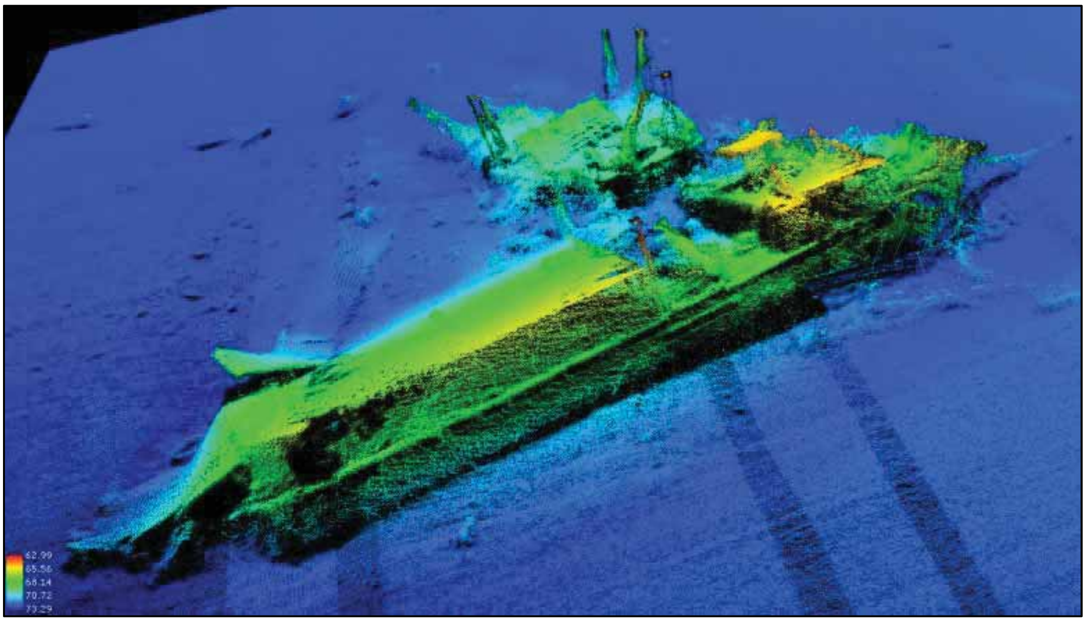

Figure 7-63. Point cloud image of S-R11-2395. © MMT

Figure 7-64. ROV video still image of S-R15-02960. © MMT

The potential targets of cultural historical interest and potential World War II historical sites found 250–1,000 m away from the pipeline are presented in Table 7-30. The table shows targets which have been surveyed by sidescan sonar and interpreted by an archaeologist during the first phase of the archaeological evaluation. A 50 m minimum safety perimeter is proposed for every target of cultural historical interest listed in this table. As an exception, a 100 m safety perimeter is recommended for target S-R15-02955 due to the length of the site. The targets not of cultural historical interest are not shown in the table. The complete lists and descriptions of the surveyed and evaluated targets are included in the documents Kokko 2016a and 2016b.

In addition, the Finnish EEZ in the western Gulf of Finland includes the wreck of Estonia at a distance of 5.6 km from line A.

Table 7-30. Potential targets of cultural historical interest and potential World War II historical sites found at a 250–1,000 m distance from the pipeline. Targets in survey blocks R12–R16 are situated in or in the vicinity of the anchoring corridor. Target S-R11-2395, which is located more than 250 m from the pipeline route, is included in Table 7-28.

Target (NSP2 ID)	Category	Age estimate	Closest distance from NSP2 route
S-R05-08000	Possible a degraded wreck	Unknown	499 m (Line B)
S-R05-08001	Possible wreck (small boat or large object)	Unknown	266 m (Line B)
S-R05-08003	Wreck (wooden sailing ship)	Unknown	359 m (Line A)
S-R05-7977	Wreck (large vessel)	1850–1950	466 m (Line A)
S-R05-08005	Object	Unknown	901 m (Line A)
S-R06-5869	Wreck	Unknown	696 m (Line A)
S-R06-5868	Wreck (possible German World War II motor torpedo boat)	World War II / modern	818 m (Line A)
S-R06-09951	Object	Unknown	582 m (Line A)
S-R06-09952	Possible wreck	Unknown	721 m (Line A)

Target (NSP2 ID)	Category	Age estimate	Closest distance from NSP2 route
S-R06-09953	Possible wreck	Unknown	364 m (Line A)
S-R07-27601	Wreck	Unknown	706 m (Line A)
S-R07-27604	Object	Unknown	493 m (Line B)
S-R07-27588	Wreck (wooden sailing ship)	Unknown	394 m (Line B)
S-R07-27587	Wreck (wooden sailing ship)	Unknown	326 m (Line B)
S-R08-32242	Wreck (wooden sailing ship)	Unknown	522 m (Line B)
S-R09-09802	Possible wreck	1900s	351 m (Line A)
S-R09-09803	Possible wreck	Unknown	990 m (ALT E1, Line B)
S-R09-09804	Barrage (section of S-R09-09806)	1943-1944	696 m (ALT E1, Line A)
S-R10-0452	Wreck (wooden sailing ship)	>100-year-old	751 m (Line A)
S-R12-00816	Wreck (steel/motor vessel)	World War II / post-war era	566 m (Line A)
S-R13-04613	Possible wreck	Unknown	995 m (Line B)
S-R13-04614	Wreck (wooden sailingship)	>100 years (confirmed site, NSP1)	960 (Line B)
S-R14-06530	Possible wreck	World War II / post-war era	589 m (ALT W2, Line B)
S-R14-06532	Possible wreck	>100 years	810 m (ALT W2, Line B)
S-R14-06536	Object	Unknown	271 m (ALT W2, Line B)
S-R15-02952	Possible wreck	>100 years	850 m (ALT W2, Line B)
S-R15-02953	Possible wreck	1900s	790 m (ALT W2, Line B)
S-R15-02955	Wreck (steel/motor vessel)	World War II	365 m (ALT W1, Line B)
S-R15-02961	Wreck (submarine)	Post-war era	963 m (ALT W1, Line B)
S-R15-02950	Possible wreck	1900s	757 m (ALT W1, Line B)
S-R16-00973	Wreck (wooden motor vessel)	3.11.1988 (possibly trawler "Mitzy", unconfirmed)	890 m (Line A)
S-R16-03082	Possible wreck	>100 years	882 m (Line A)

7.24 People and society

The tourism sector in Finland has been steadily growing in recent years. In 2014, 7.6 million foreign visitors visited Finland and the number of tourists has doubled since the year 2000. Most of the tourists in Finland are domestic but the figures do include foreign visitors, the majority of which, measured by the number of overnight stays, are from neighbouring counties Russia and Sweden. *(Ministry of Economic Affairs and Employment 2015a)*

The islands in the Finnish Archipelago are popular tourist attractions, which together with coastal areas, also host a large number of recreational and summer cottages. The main attractions and activities are related to nature and leisure activities such as recreational fishing, sailing and bathing. Leisure tourism in southern Finland and in the archipelago is highly seasonal and concentrated to the holiday season during the summer. There are several recreational areas and national parks in the Gulf of Finland (Subchapter 7.13). According to the Roadmap of Tourism 2015–2025, the development of especially international tourism, by enhanced branding of the Finnish Archipelago, will be one of the focus areas in the near future. *(Ministry of Economic Affairs and Employment 2015b)*

Based on a residential survey of the coastal areas in Finland (Appendix 11B), the majority of people consider the environmental status of the Gulf of Finland and the sea, as an element of the scenery, to be very important. The value of the Gulf of Finland in terms of tourism, recreational use and commercial fishing was also considered important (Figure 7-65).

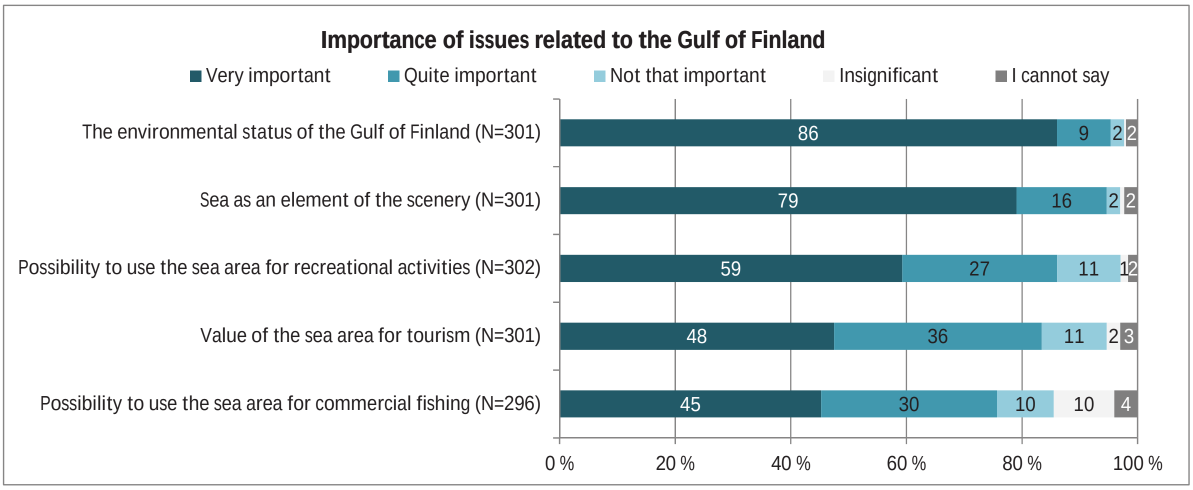

Figure 7-65. Opinions of respondents to the Coastal Survey on issues related to the Gulf of Finland.

Shopping tourism and cruises between Helsinki and Tallinn have continuously increased in popularity. In 2014, an estimated 8.2 million passengers travelled between Helsinki and Tallinn. Overnight cruises between Finland and Sweden are also popular. According to the Port of Helsinki statistics, there are nearly 300 cruise ships and up to 420,000 cruise passengers visiting Helsinki annually. International cruise ships dock at the South Harbour, Katajanokka, West Harbour and Hernesaari *(Port of Helsinki 2015)*.

8. BASELINE ONSHORE

This chapter describes the present status within the area for NSP2 ancillary onshore activities in Kotka and Hanko.

8.1 Baseline Kotka region

The present state of the onshore area in the Kotka region is presented below.

Potential quarries

For the assessment it has been assumed, that the rock is quarried from Rudus Oy Rajavuori quarry in Kotka and Destia Oy Kyytkärri quarry in Pyhtää, which were used during the NSP Project.

8.1.1 Land use

8.1.1.1 Regional plan

Mussalo

The City of Kotka is part of the Kymenlaakso Region in southern Finland. A phased regional plan has been developed for the region and was validated by the Ministry of the Environment in 2008, 2010 and 2014. The city is located on the southern coast as well as on islands immediately adjacent to the coast. An extract from the phased Kymenlaakso regional plan for commercial and maritime areas (Figure 8-1) shows that the southeastern part of Mussalo Island is designated as a harbour traffic area. The Mussalo Wastewater Treatment Plant is designated as a municipal utilities maintenance area. Due to large-scale industrial handling of hazardous chemicals at the Mussalo terminal, the port area has specific consultation procedures for land use planning in accordance with the SEVESO II Directive (96/82/EC) *(Kymenlaakso Regional Council 2015)*. Companies that are currently dealing with hazardous chemicals at Mussalo terminal are Oiltanking Sonmarin Oy, Stanoil Oy, Kotka Bunker Oy and City of Kotka, Mussalo depot *(Tukes 2014 and Port of HaminaKotka 2015)*. Kymenlaakso regional land use planning for 2040 has commenced. The plan is being drafted and the target for issuing the final plan is in 2019. The participation and assessment scheme was under public hearing until the end of September 2016. The objective of the regional plan 2040 is to collate all the previous up-dated versions of partial plans into one plan, to improve legibility and clarity and to emphasise the strategic nature of the plan (Kymenlaakso Regional Council 2016). According to the Land Use and Building Act (5.2.1999/132), in this case, the detailed plan overrides the regional plan.

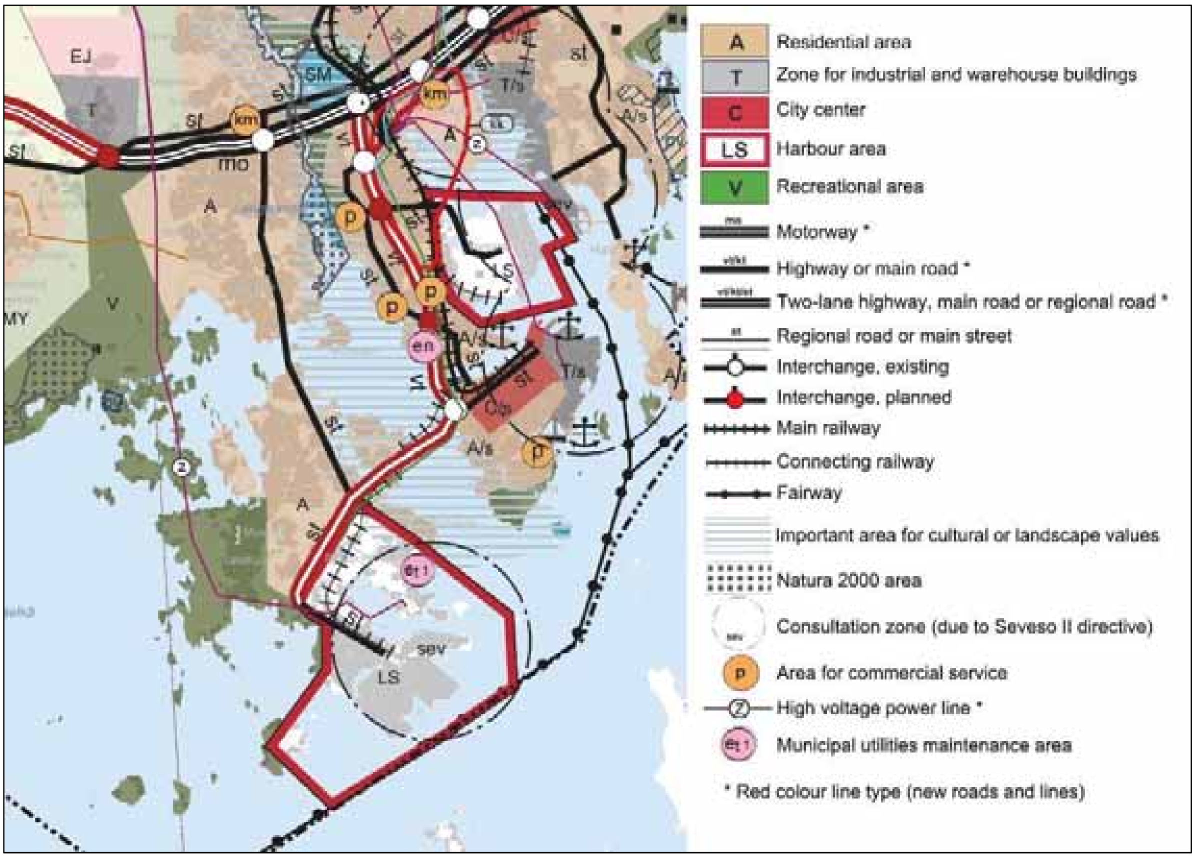

Figure 8-1. Extract from the Kymenlaakso regional plan for commercial and maritime areas (Kymenlaakso Regional Council 2015).

Potential quarries

For the assessment it has been assumed that the rock is quarried from Rudus Oy Rajavuori quarry in Kotka and Destia Oy Kyytkärri quarry in Pyhtää, which were used during the NSP Project. In the phased regional plan (validated by the Ministry of the Environment in 2008, 2010 and 2014), the Rajavuori area is designated as an industrial area (T). On the northern side of the quarry there is an area designated for waste treatment (EJ). A power line runs on the eastern side of the quarry as well as an area designated for agriculture and forestry with special environmental values (MY).

In the regional, plan the Kyytkärri area is designated as an area for agriculture and forestry (M).

8.1.1.2 Local master plan

Mussalo

The Kotka Town Council has approved a partial local master plan of Mussalo in 1992 (Figure 8-2). It has been drawn up as a local master plan with no legal consequences. The strategic local master plan for Kotka–Hamina is being drafted and the target for issuing the final plan is in 2017. The draft for the local master plan has not yet been made public. The participation and assessment scheme was under public hearing between 1 February and 11 March 2016. *(Kotka–Hamina Region 2016)*

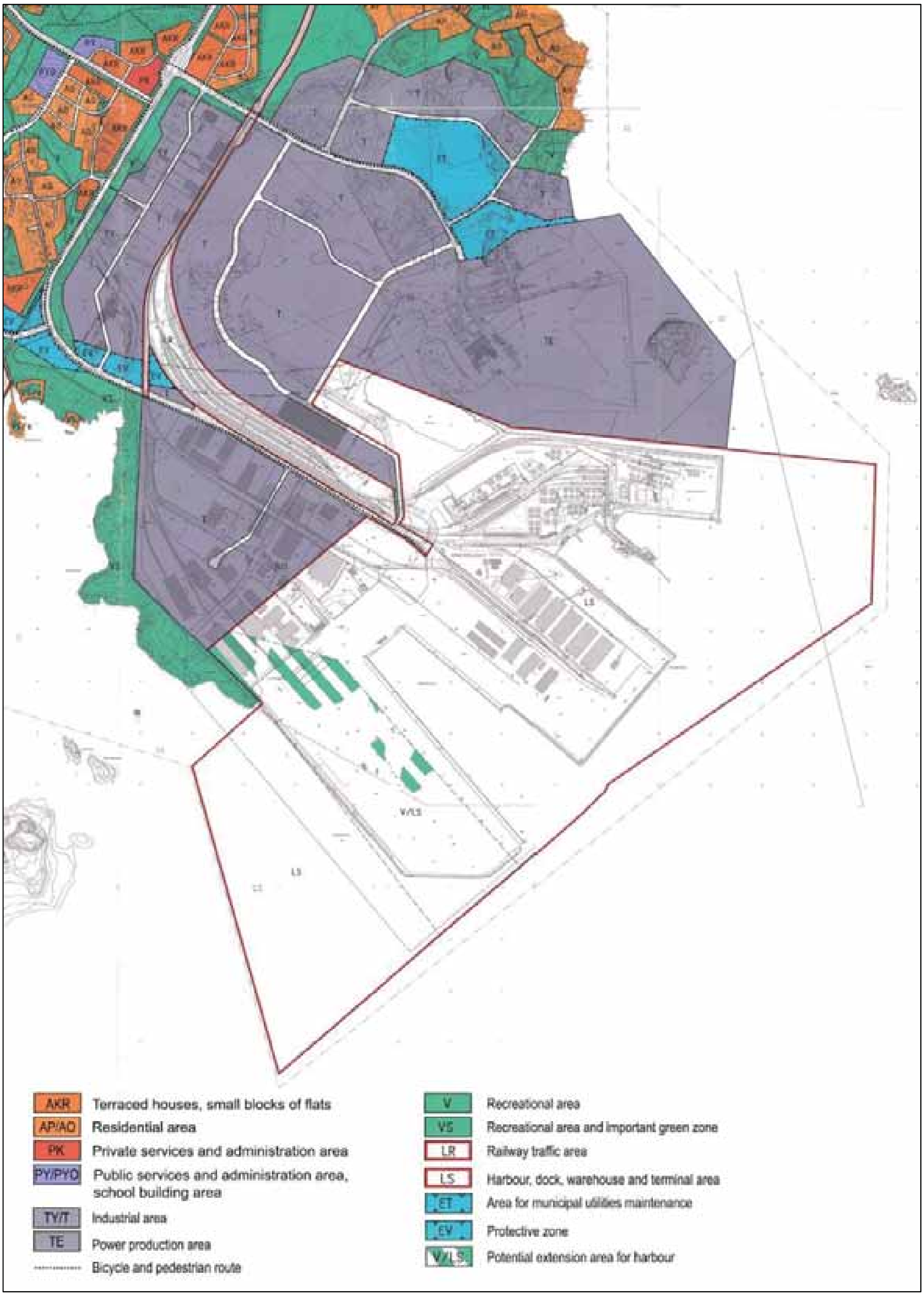

Figure 8-2. Extract from the partial local master plan of Mussalo (City of Kotka 1992).

<u>Potential quarries</u>
There is no local master plan for Rajavuori or Kyytkärri areas.

8.1.1.3 Local detailed plan

Mussalo

The Kotka Town Council approved the local detailed plan of the Mussalo area in 1999. There are several detailed plans of Mussalo and the surrounding areas dating from 1986 to 2011. A summary of the current planning situation is presented in Figure 8-3. A large area servicing Mussalo Harbour is designated as a zone for harbour traffic and another area of almost an equivalent size is designated as a zone for industrial and warehouse buildings. According to the City of Kotka Planning Department, there are no plans to change the zoning of the Mussalo area *(City of Kotka 2015a)*.

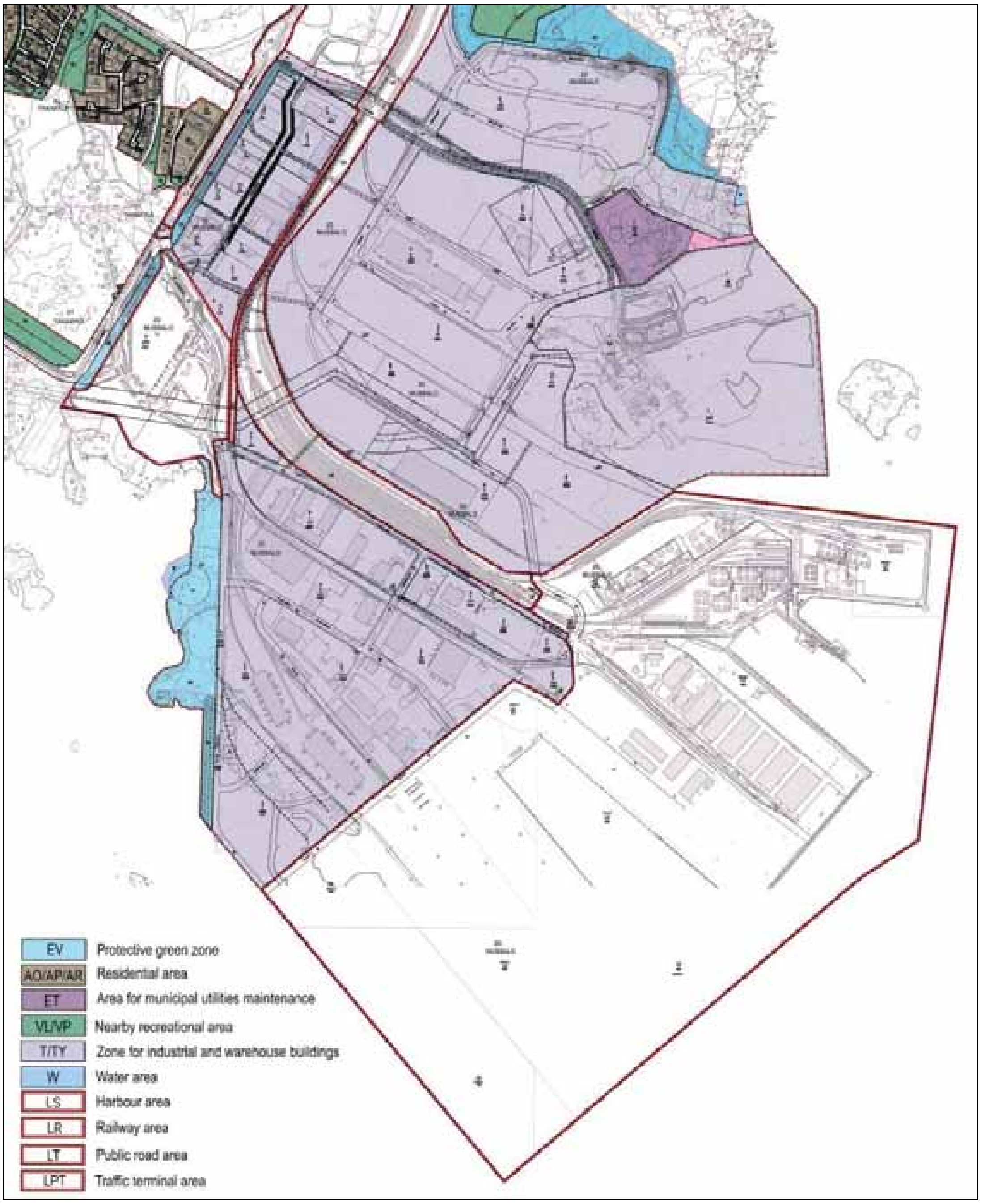

Figure 8-3. Extract from the local detailed plan of Mussalo, Kotka (City of Kotka 2013).

Potential quarries

There is no local detailed plan plan of Rajavuori or Kyytkärri areas.

8.1.1.4 Operations located in and in the vicinity of Mussalo Harbour

Mussalo Harbour (including Jänskä quay) and Palaslahti Industrial Area are situated in the southeastern part of Mussalo Island. The nearest residential area, Ristiniemi, is situated about 0.3 km from the planned operations at Jänskä quay and 0.8 km from the planned coating plant. The nearest summer cottages are located also in Ristiniemi about 0.4 km from the Jänskä Quay.

The regional Road 355 (Merituulentie) runs from Mussalo Harbour through Mussalo and continues as Road 15 (Hyväntuulentie) to the intersection of Highway 7 (also Subchapter 8.1.6).

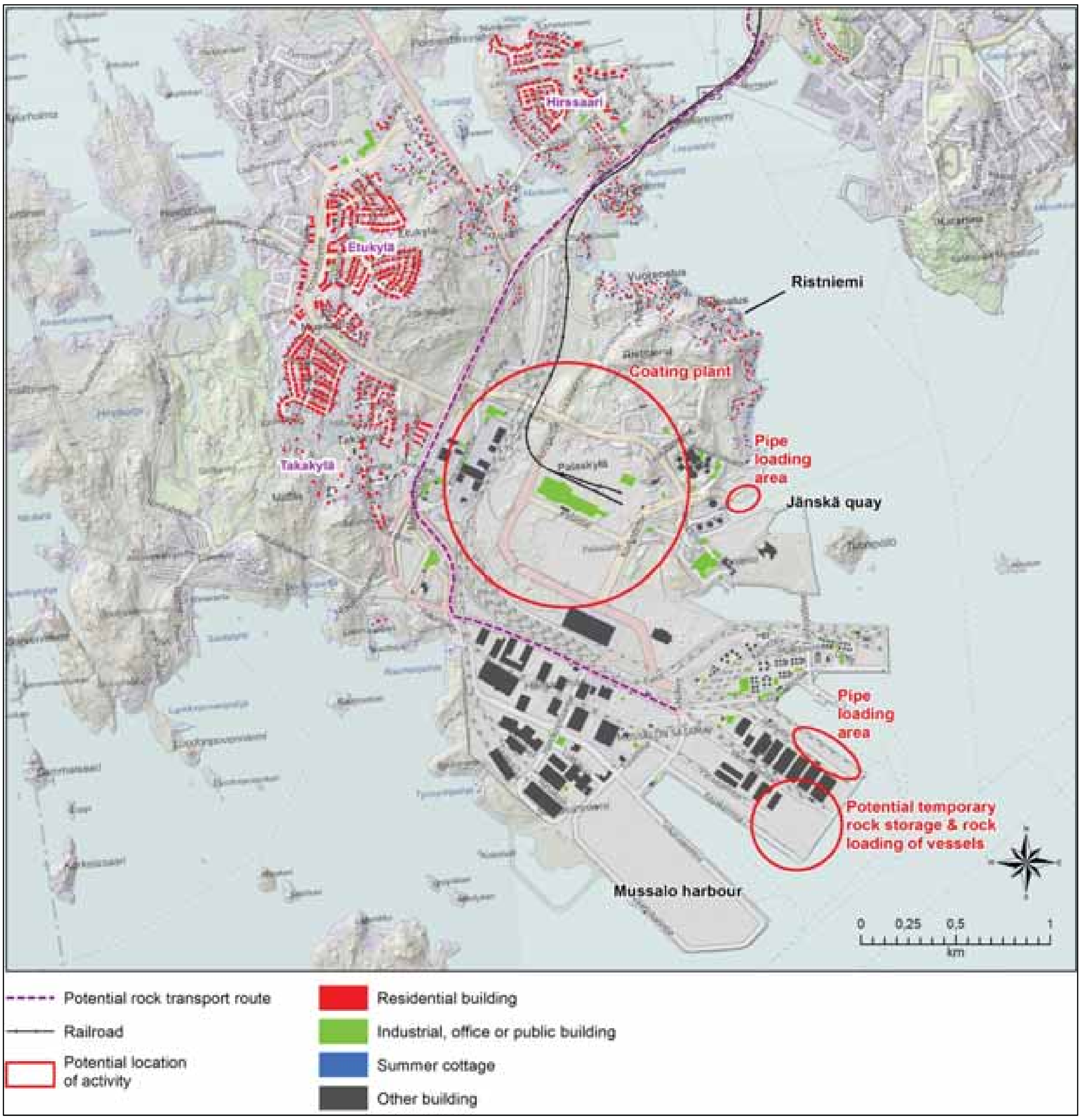

Figure 8-4. Residential, recreational, industrial, office and public buildings located in the vicinity (about 1 km) of the port.

8.1.1.5 Mussalo Harbour and Palaslahti industrial area

Mussalo Harbour is the newest port in the Port of HaminaKotka, which is by far the largest general port in Finland. Mussalo consists of a container terminal (annual capacity of 1 million teu), a dry bulk terminal, a liquid bulk terminal and full harbour services. The port also includes the Jänskä Quay, which was used to handle pipes for the Nord Stream Project. Next to the port area are the industrial and logistics areas of Hanskinmaa and Palaslahti.

The coating plant is situated in the middle of the Palaslahti Industrial and Logistics Area. Nearest other operations in the industrial area are the Mussalo Wastewater Treatment Plant and the Kuusakoski Metal Recycling Plant (Figure 4-25).

Mussalo has comprehensive domestic and international transport connections by road, rail and sea. The port is open 24 hours a day, 365 days a year and allows vessels with a maximum draught of 15.3 m to enter the harbour. The port is also kept open during the winter period, as icebreaking is provided, when necessary. The port includes a container terminal, a bulk terminal and a liquid terminal. Mussalo Harbour has a total of over 2,800 m quays and 22 berths. There is on-going work on landfills on the southwest side of the port for container terminal expansion. The Port of HaminaKotka operates management systems certified to the ISO 9001 and ISO 14001 standards. *(Port of HaminaKotka 2015)*

8.1.1.6 Potential quarries

Both quarries at Rajavuori and Kyytkärri are existing quarries with valid permits according to Environmental Protection Act and Land Extraction Act. Both quarries are located on the northern side of Highway 7 (E18) as Rajavuori is located approximately 500 m and Kyytkärri approximately 700 meters north of Highway 7. There are several other rock quarries/rock industrial operators in the Rajavuori area besides the Rudus Oy quarry. The Rudus quarry is the largest quarry in the region. The other quarries in Rajavuori region have total extraction volumes of approximately 100,000-300,000 m^3 each. The Heinsuo Waste Treatment and Landfill Facility is located approximately 500 m north from Rajavuori quarry.

8.1.2 Soil, bedrock and groundwater

Mussalo

The bedrock of Mussalo Island is mostly Vyborgite, typical "Rapakivi" granite. Currently, the soil of the Mussalo Harbour area and the industrial area comprises largely fill material, gravel moraine or sand moraine. Along the rock transport route, bedrock and soil properties are similar to Mussalo Island with the exception of less fill. No classified or other groundwater areas are located on Mussalo Island. *(Finnish Environment Institute 2015a)*.

Potential quarries

No classified groundwater areas in Rajavuori or Kyytkärri quarry areas exist. The closest classified groundwater areas (Siltakylä 0562401 and Kangasmäki 0562403 important ground water areas) are located approximately 3.5 km southwest from the quarry areas. *(Finnish Environment Institute 2015a)*

8.1.3 Air quality

Air quality in the Kotka region is affected by various sources such as power plants, pulp and paper mills, harbours and transboundary emissions. Pulp mills and ship traffic produce the largest emissions. For details see Figure 8-5. Direct and indirect emissions from road traffic are significant in heavily operated harbour areas and also particulate emissions from wood burning to heat residential buildings. Street dust emissions were exceptionally high in 2015 in Finnish cities, including the Kotka area.

According to the monitoring results from recent years, air quality in Kotka has been mostly good or satisfactory. Typically, the air has had quite low annual and monthly concentrations of particulate matter (PM_{10}), nitrogen oxides (NO_X) and total reduced sulphurs (TRS). Short-term concentrations during abnormal conditions have occasionally been high. In summary, air quality in Kotka does not differ from the air quality of similar cities in Finland. In the long run, air quality has been stable or slightly improved. *(City of Kotka 2015b and City of Kotka 2016a)*

Ship traffic causes significant amounts of emissions to air from Mussalo Harbour. Air quality at Mussalo Harbour has last been monitored in 2013 using a mobile monitoring station (Figure 8-5). The station was located adjacent to the liquid bulk terminal. Air quality was mostly good or satisfactory. Handling dry bulk materials at the harbour could be seen as high peak concentrations of particulate matter from time to time. A comparison of monitoring results from Mussalo and a comparison between air quality guideline and limit values is shown in Table 8-1 Limit values are applied only to residential areas, but they are presented here for purposes of comparison. *(City of Kotka 2014)*

Table 8-1. Air quality monitoring in Mussalo Harbour in 2013 and a comparison between guideline and limit values (Government Decree 480/1196, Decree on Air quality 38/2011). Also, concentrations measured at the Rauhala monitoring station are presented for purposes of comparison. (City of Kotka 2014)

Substance	Guideline value/limit value	Statistical definition	Measured concentrations (% of the guideline/limit value)
Particles PM_{10}	Guideline value 70 μg/m^3	2nd largest daily value of the month (1 exceedance per month allowed)	Mussalo: 61 μg/m^3 (87%) Rauhala: 46 μg/m^3 66%)
	Limit value 40 μg/m^3 (for protection of health)	1 year	Mussalo: 15 μg/m^3 (38%) Rauhala: 14 μg/m^3 (35%)
	Limit value 50 μg/m^3 (for protection of health)	24-hours (35 days exceedance per year allowed)	36th largest 24-h average Mussalo: 26 μg/m^3 (52%) Rauhala: 24 μg/m^3 (48%) 7 exeedings in Mussalo 1 exceedance in Rauhala
Particles $PM_{2.5}$	Limit value 25 μg/m^3 (for protection of health)	1 year	Mussalo: 11 μg/m^3 (48%)
Nitrogen dioxide (NO_2)	Limit value 40 μg/m^3 (for protection of health)	1 year	Mussalo: 14 μg/m^3 (35%) Rauhala: 11 μg/m^3 (28%)
	Limit value 200 μg/m^3 (for protection of health)	1 hour 18 hours exceedance per year allowed	19th largest hourly value Mussalo: 84 μg/m^3 (42%) Rauhala: 81 μg/m^3 (41%) No exceedings in Mussalo or Rauhala
Nitrogen oxides (NO, NO_2)	Limit value 30 μg/m^3 (for protection of ecosystems and vegetation)	Calendar year	Mussalo: 22 μg/m^3 Rauhala: 22 μg/m^3

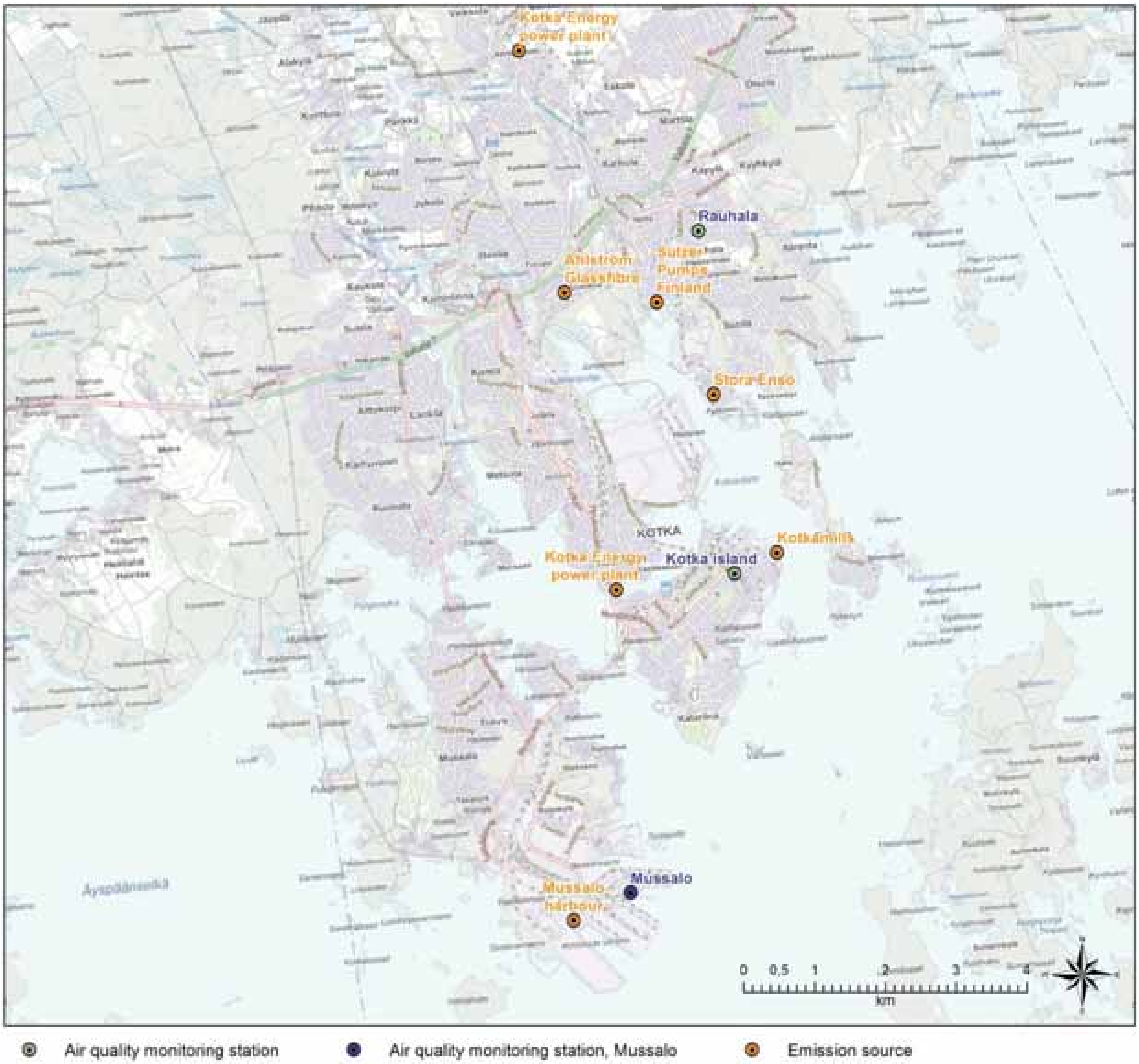

Figure 8-5. Most important emissions sources and monitoring stations of air quality in Kotka (according to City of Kotka 2016a and City of Kotka 2014). Mussalo monitoring station was in use only in 2013.

The local air quality in Rajavuori and Kyytkärri areas is mainly impacted by traffic and rock quarrying industries.

8.1.4 Noise

The main source of noise in the Kotka region is Highway 7 (E18) and city streets. The motorway between Loviisa and Kotka opened for traffic in 2014. Road planning has been done with the aim to reduce noise levels by road alignment and noise abatement measures (barriers, fences, embankments). There is also other noise generating heavy industry near Kotka City Centre, such as Kotkamills Oy near Kantasatama. Operations at Mussalo Harbour generate noise from cargo handling and traffic. Noise measurements made in 2014 at Vehkaluoto and on the Leppäkari Islands approximately 500 m southeast from the harbour area indicated that noise levels on the islands were mainly below the daytime noise limit value of 50 dB, but due to the margin of error caused by weather conditions, it remains uncertain whether the limit value was exceeded or not. (Ramboll 2014a). There is also a rock extraction site of Kotka City in Palaslahti, which could cause noise, but active quarrying is not ongoing at the moment.

The noise levels due to traffic (traffic load data from 2015) on road Hyväntuulentie (15) and road Merituulentie (355) are presented in Figure 8-6.

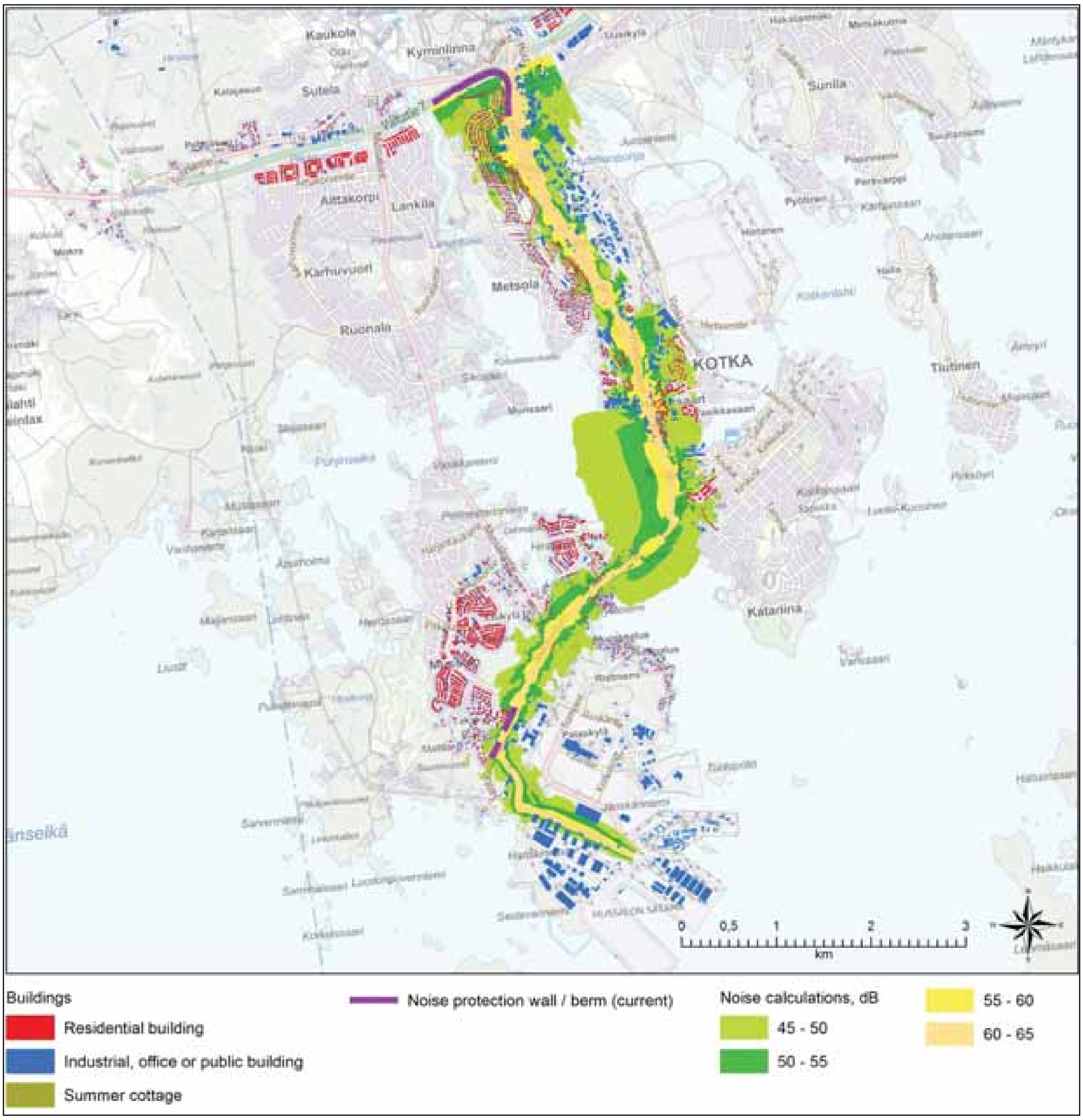

Figure 8-6. Noise levels due to traffic (2015 traffic) on Hyväntuulentie and Merituulentie.

Rock quarrying in potential quarries in Rajavuori and Kyytkärr cause noise from drilling, blasting, crushing, loading and transport of rock materials.

8.1.5 Biotic environment and protected areas

There are no Natura 2000 areas in the immediate vicinity of Mussalo Harbour, the industrial site or the area through which the rock transport will take place. The main thoroughfare from Mussalo Harbour passes through a Natura 2000 area (ID FI0480001 "Itäisen Suomenlahden saaristo ja vedet"). Also, there are two, small, nature conservation areas: "Lehmänsaari" (YSA200556) and "Sarvenniemenkari" (YSA051521). *(Finnish Environment Institute 2015a)* Lehmänsaari is also included in the herb-rich forest conservation programme (LHO050137). The distance to Sarvenniemenkari from Mussalo Harbour is approximately 1.8 km and the distance to Lehmänsaari from Mussalo Harbour is approximately 2.8 km. Esker Conservation Area of "Kaunissaaren Suurkarinharju (HSO050051)" is located nearly 10 km from Mussalo on the island of Kaunissaari.

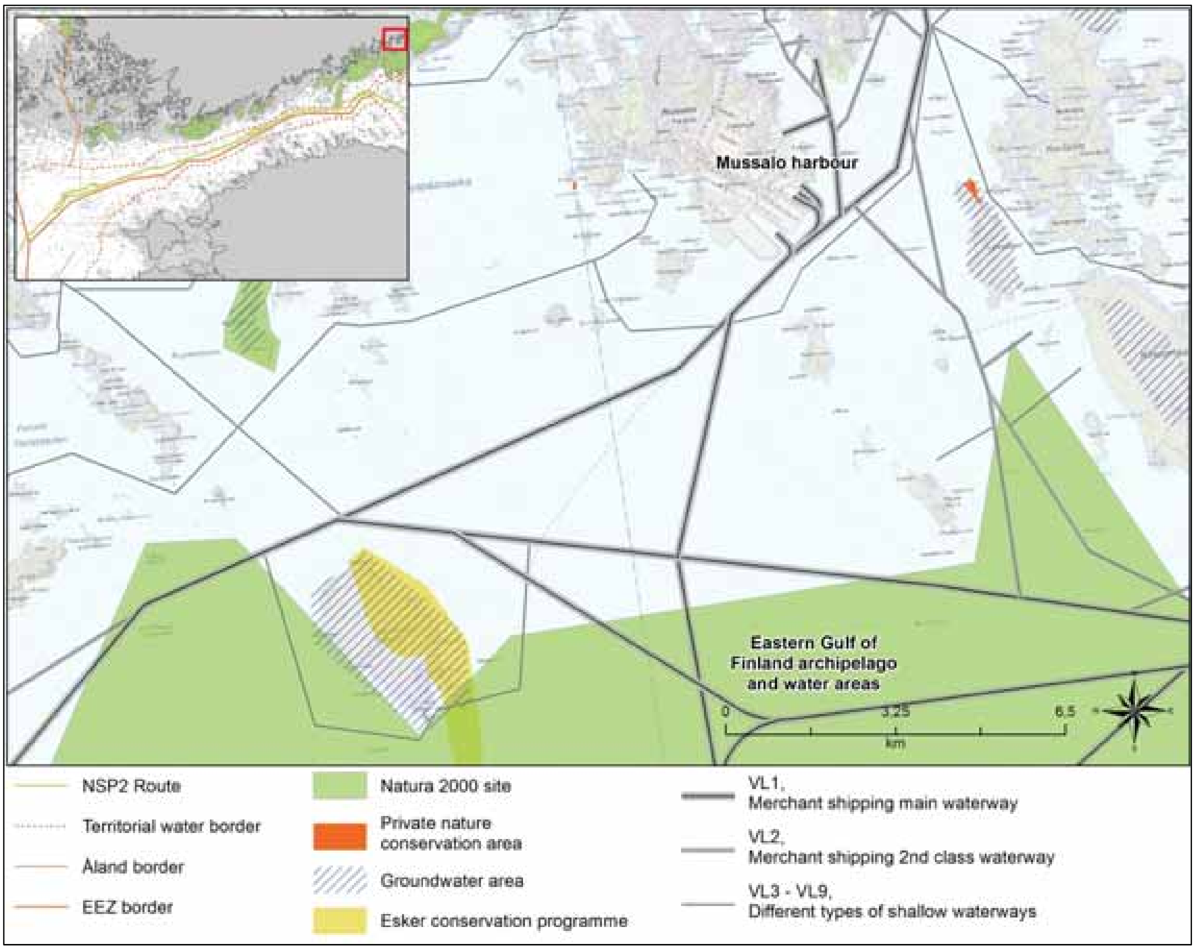

Figure 8-7. Nature conservation areas and classified groundwater areas surrounding Kotka.

<u>Potential quarries</u>

The closest Natura 2000 area is the Heinlahti (FI0416006) Bird Protection Area approximately 2 km southwest from Rajavuori and Kyytkärri. There is a private nature protection area of Kantolankallio (YSA230780) approximately 1 km southwest from Kyytkärri quarry. *(Finnish Environment Institute 2015a)*

8.1.6 Traffic, safety and health

This chapter describes the roads which could be impacted by rock transport to Mussalo Harbour from Kyytkärri and Rajavuori quarries. Impacts include also those arising from noise and social impacts in the event that rock transport will not be from the mentioned quarries. Traffic from Kyytkärri quarry is directed via Heinsuontie to Highway 7 (E18). Rajavuori quarry is located near Highway 7 (E18) and traffic is directed via Heinsuontie and via an interchange to Highway 7 (E18).

Road traffic from Highway 7 to Mussalo Harbour is directed via Road 15 (Hyväntuulentie) and Road 355 (Merituulentie). Road 15 is a single-carriageway, four-lane road having a speed limit of 70 km/h. It has two signal controlled at-grade junctions (Metsola and Paimenportti). The average traffic volume on Road 15 in 2015 was 21,100 vehicles per day (1,500 heavy vehicles per day). The capacity of the road is adequate most of the time, but two at-grade junctions and, especially Paimenportti junction, may cause queuing and delays during peak hours. Pedestrians and cyclists are segragated to dedicated roads and have no level crossing with vehicle traffic.

Between 2010 and 2015, a total of 72 traffic accidents were reported on Road 15 between Haukkavuori intersection and Highway 7. Twelve of these led to personal injuries, but there wereno fatalities. Accidents were spread evenly and there were no clear accumulation points.

Road 355 is a single-carriageway, two-lane road having a speed limit of 50 km/h. Between Haukkavuori intersection and Mussalontie junctions are signal-controlled and between Mussalontie and Mussalo Harbour unsignalled. Road 355 connects Mussalo Harbour and nearby industrial areas to Road 15 and also provides a connection from Hirssaari and Etukylä residential areas to Kotka City Centre. The average daily traffic volume on Road 355 was between 6,000–9,500 vehicles (1,300–1,500 heavy vehicles; *Finnish Transport Agency 2016c*). Pedestrians and cyclists are segragated to dedicated roads, but have three level crossings with vehicle traffic at Tökkärintie, Jänskäntie and Takakyläntie junctions. These pedestrian ways are not significant routes for schools or daycare centres. At Norssalmi Bridge, a pedestrian way is separated merely by a kerb which increases the feeling of unsafety.

Between 2010 and 2015, a total of 22 traffic accidents were reported on Road 355 between Haukkavuori intersection and Mussalo Harbour. Six of these led to personal injuries, but there were no fatalities. Accidents were spread evenly and there were no clear accumulation points.

Road 355 is recognised as one of the potential bottlenecks potentially impeding growth of Mussalo Harbour. The road is congested during peak hours with the situation expected to escalate if traffic volumes grow as forecasted. Functionality problems also lead to decreased traffic safety. Main problems causing congestion are several at-grade junctions and their vertical geometry, which requires heavy vehicles to depart uphill. This is problematic especially during winter conditions. To solve these issues, the Centre for Economic Development, Transport and the Environment of the South-Eastern Finland has commenced the drafting of a general plan to upgrade of Road 355. The general plan aims to remove stops of heavy vehicles as well as to separate freight traffic and local traffic. It also proposes actions for noise barriers and pedestrian safety improvements. The general plan has been completed in 2016. Construction would begin after 2025. *(Finnish Transport Agency 2016c, Southeast Finland ELY Centre 2017)*

A resident survey of environmental nuisances caused by the operations in the port area and in the industrial areas of Mussalo Harbour was carried out in 2012. The questionnaire was delivered to 261 households and the response rate was 49 %. The majority of respondents felt that traffic, especially the daytime road traffic, is the most common nuisance caused by the operations at the port and the industrial areas. The second most common nuisance was harm to the living environment. According to the survey results, nuisance caused by the port and industrial areas has increased in the past five years excluding the disturbance caused by vibration and odour. *(Lindroos 2012)*

A resident survey was conducted in Kotka as a part of this EIA between April–May, 2016 targeting people living at a distance of 0–2 km from the main road transportation network to and from Mussalo Harbour going through regional Road 355 (Merituulentie) and Road 15 (Hyväntuulentie). The majority of the respondents were satisfied with current traffic safety in their living environment regardless of the mode of transport. However, the main disturbance (congestion, noise, dust) respondents experienced from the operations at the Palaslahti Industrial Area and Mussalo Harbour was caused by heavy traffic to and from the harbour. Thus, findings related to heavy traffic were similar to the findings of a resident survey carried out in 2012. (Appendix 11C)

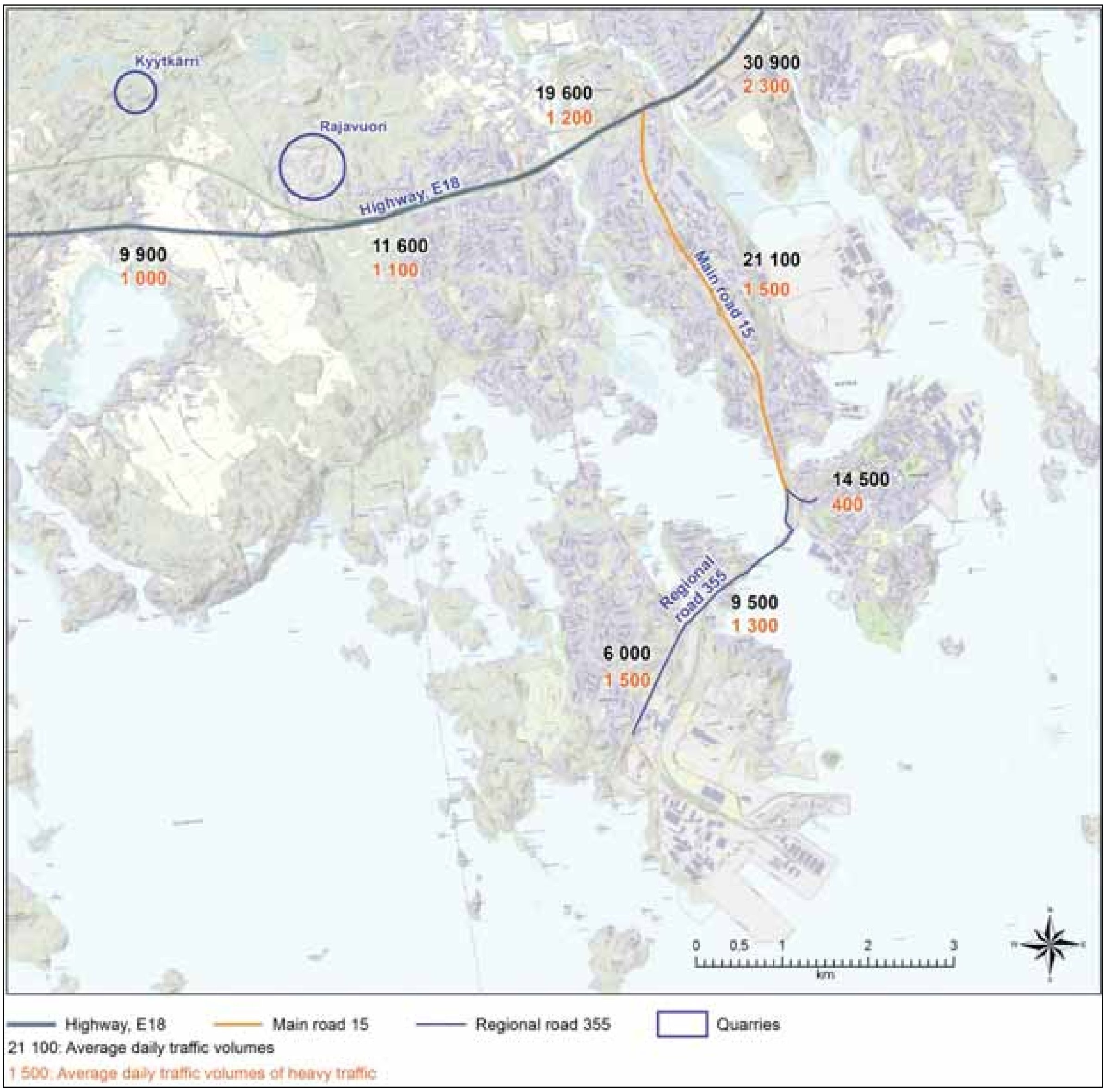

Figure 8-8. **The average daily traffic volumes in 2015 (Finnish Transport Agency 2016d). Figures for all traffic (black numbers) and heavy traffic (red numbers) are presented. Distance to Mussalo Harbour from potential quarries is approximately 16 km.**

Residential areas, Hovinsaari Power Plant (157 MW) belonging to Kotka Energia and the sweetener manufacturing facility of Danisco are situated on the western side of Road 15 (Hyväntuulentie) along the rock transport route. Also, the Central Hospital of Kymenlaakso is situated nearby. The eastern side of Road 15 (Hyväntuulentie) is characterised mainly by small-scale industrial areas (Hovinsaari – Jylppy – Huunantie). On the eastern side, there is a railway yard and beyond that the Hietanen Harbour.

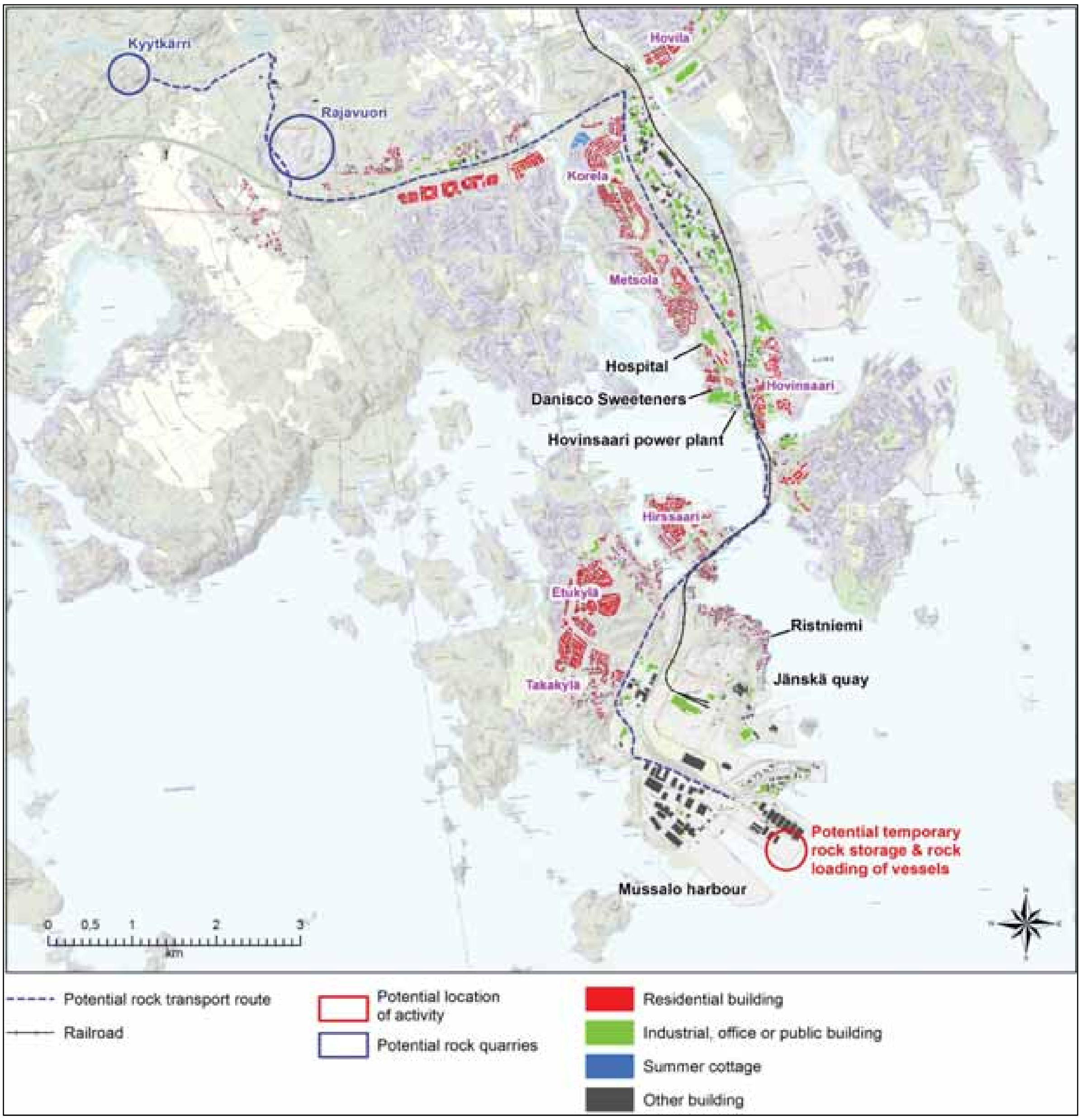

Figure 8-9. **Residential, recreational, industrial, office and public buildings located in the vicinity (about 1 km) of the potential rock transport route.**

8.1.7 People and society

Mussalo

The City of Kotka is located on the coast of the Gulf of Finland at the river delta of River Kymijoki. Kotka is part of the Kymenlaakso Region located in southern Finland. Kotka is located 130 km east from Helsinki and 290 km west from St. Petersburg. The main E18 Highway runs through Kotka. The city centre of Kotka is located on Kotkansaari Island. The other centre is Karhula. Kotka has a population of about 55,000 and covers an area of 950 km^2 of which 678 km^2 is water. The population density is 202 inhabitants per km^2. At the moment (June 2016), the unemployment rate in Kotka is high at 21.4 % i.e. 5,275 unemployed (SVT 2016a). The average unemployment rate in Finland is 7.8 %. *(Statistics Finland, www.stat.fi)*.

Mussalo Island is characterised by a harbour and an industrial area and the coastline of Mussalo Island has been intensively constructed as a harbour area. The harbour is brightly lit at night. The rest of the island is characterised by forests, parks and residential areas with mostly detached and attached houses. The total population of Mussalo Island at the end of 2013 was 3,639. Hirssaari Island located between Mussalo and Kotkansaari Islands along Road 355 has a population of 907 with residential areas located along the road on both sides. As mentioned in Subchapter 8.1.1, the nearest residential area, Ristniemi, is situated about 0.3 km from the planned operations at Jänskä Quay and 0.8 km from the planned coating plant. The nearest summer cottages are located also in Ristniemi about 0.4 km from Jänskä quay and 0.8 km from the planned coating plant. The distance to Road 355 (Merituulentie) from the nearest residential buildings is 20 m and 60 m from the nearest summer cottages. The majority of people on Mussalo Island live in Etukylä, where Mussalo elementary school and four kindergartens are also situated. Mussalo elementary school is located 1 km from Road 355 and 2 km from the planned coating plant. The nearest kindergarten is located 0.3 km from Road 355 and 1.9 km from the planned coating plant. In Mussalo, there are no elderly care homes, but a hospice for disabled youth is located in Etukylä 1.2 km from Road 355 and 2.5 km from the planned coating plant. Another major residential area is Takakylä on the west side of Road 355 leading to Mussalo Harbour. A map of the residential areas is presented in Subchapter 8.1.1 on land use (Figure 8-4).

According to the Kotka Survey (2016), respondents were mainly satisfied with the possibilities for outdoor activities, scenery, air quality, general safety and calm living environment. However, employment possibilities and the municipal economy were considered poor. (Appendix 11C)

In Kotka, many people are aware of the planned project-related activities including the pipe coating plant that operated in Kotka during the Nord Stream pipeline project 2010–2012. The majority of the respondents (79 %) of the Kotka Resident Survey indicated that they had at least some knowledge about the pipe coating and storage activities that took place in Mussalo Harbour and Palaslahti Industrial Area in 2010–2012. While 80 % of the respondents (N=308) had lived in the area during the operations, only 14 % of all respondents remembered noticing changes in their living environment which they considered most likely to have been caused by activities at the Palaslahti coating plant.

As indicated by respondents, the most notable changes in the living environment arising from the operations at the coating plant and the harbour were positive impacts on the municipal economy and employment (Figure 8-10). The negative impacts were mainly related to heavy traffic, traffic congestion, increase in noise levels and dust emissions.

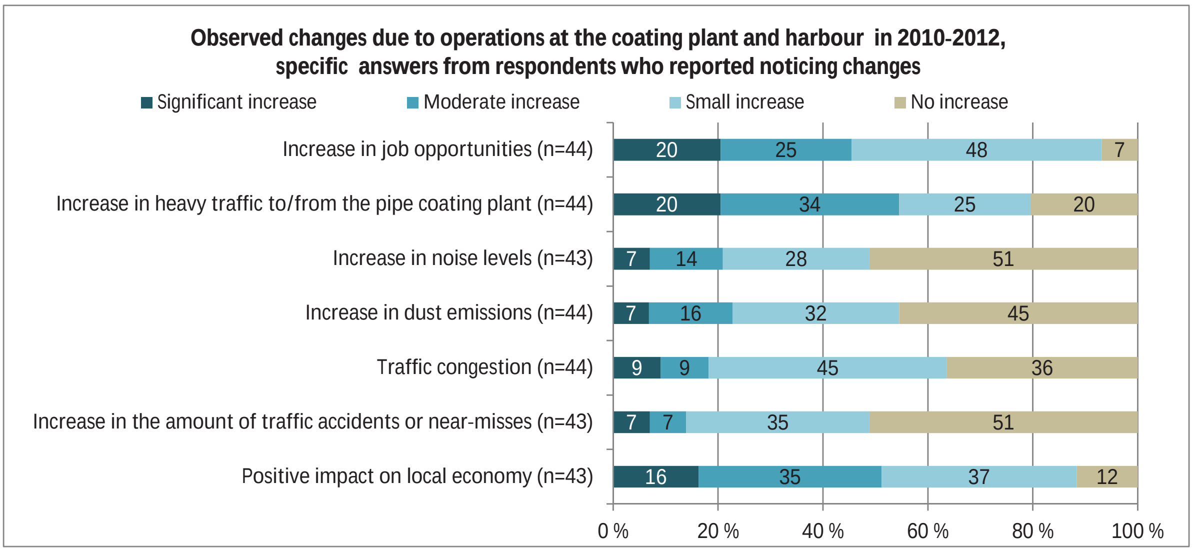

Figure 8-10. Observed changes in the living environment arising from operations at the coating plant and the harbour in 2010–2012 by respondents who remembered to have experienced changes.

Area around the potential quarries

The closest residential houses are located approximately 300 m southeast and southwest from Rajavuori. The closest residential houses to Kyytkärri quarry are located approximately 1 km south of the quarry.

A skiing route for recreation runs on the eastern side of Rajavuori. There are horse riding areas in Petäjäsuo and Katajasuo. The closest school and daycare center are located on the southern side of Highway 7 (E18) approximately 2 km from Rajavuori.

People living near the Rajavuori area have reported some incidents related to quarrying to the local environmental authorities of the City of Kotka in recent years. Because there are several actors in the area, it is in some cases unclear whose activities have caused the reported nuisance. Between 07/2009–09/2012, there were a total of 51 complaints. One was reported in 2009, 11 in 2010 and 31 during 2011. In 2012, there were 8 complaints. When observed in quarters, the clear spikes can be seen in April–June (7 complaints) and October–December (18 complaints) in 2011. Majority (29) of the complaints concerned blasting. Rest of the complaints were related for example to noise, dust and vibration and were split quite even (4–5 mentions each). *(City of Kotka 2016b)*

8.1.8 Tourism and recreation

Tourism in Kotka is mostly concentrated to the holiday season during the summer with emphasis on maritime traditions and leisure activities. Recreational activities such as sailing, boating, leisure fishing, and cruises to the archipelago are closely linked with the use of the shores and sea area of the Eastern Gulf of Finland. There are numerous islands in the Eastern Gulf of Finland National Park that have historic value and are used for recreational purposes. Leisure fishing in Kotka is practiced in Kymijoki and its rapids, but also in the sea areas. Marinas located closest to Mussalo Harbour and Palaslahti Industrial Area are on Santalahti, Hirssaari and on Kotkansaari. *(Southeast135 2016)*

According to statistics, the number of visitors staying overnight in the City of Kotka in 2016 was around 56,500 between January and June *(Southeast135 2016)*. In addition to this figure, there is a notable numbr of visitors staying in Kotka only for a day, for example, on a shopping trip from Russia. The number of daytime visitors does not appear in the official statistics.

Many tourist attractions in Kotka are marine-related. The Kotka Maritime Festival is a nationally known summer event, with about 200,000 visitors annually *(Southeast135 2016)*. The Kotka Maritime Festival is organised yearly on the last week of July. The City of Kotka is also known for a vast number of urban parks. On the Kotkansaari island nine parks offer opportunities for outdoor recreation and exploration. The largest park is Katariina Seaside Park, a 20-hectare recreational area built around the 18th-century Svensksund fortress ruins. The park is located on the seashore 2 kmm north-east of Mussalo Island and Jänskä Quay. Santalahti recreational area is located on Mussalo Island, approximately 3 km west of the harbour. A running/skiing trail is located on Mussalo Island in the forested area which is also used for orienteering.

8.1.9 Landscapes and cultural heritage

Kymijoen Laakso (Kymijoki River Valley) is a nationally important landscape. The valley is 18,000 hectares in area and located in the areas of Anjalankoski, Elimäki, Kotka, Kuusankoski, Pyhtää and Valkeala. Kymijoen Laakso is a diverse and cultural-historically stratified landscape. In Langinkoski, there is an imperial fishing lodge from the 19th century. The landscape of Kyminkartano is a nationally important cultural heritage site on the bank of Kymijoki River dating back to the Middle Ages. Munkholma is an island in Kymijoki River with a chapel from the 1790s.

Kotkansaari is a nationally important cultural heritage site in the area of the present city centre. The city plan of Kotkansaari was originally developed by K. Järnefelt 1878–1879. There are various buildings dating back to the 19th century in Mussalo, Etukylä and Takakylä. Ruins of fort constructions of Ruotsinsalmi sea fortress from the 18th century are located in Tiutinen. The Sunila factory area represents a functionalistic design from the 1930s.

The nationally important landscapes and cultural heritage sites in the vicinity of the Kotka onshore activities and transport route are presented in Figure 8-11.

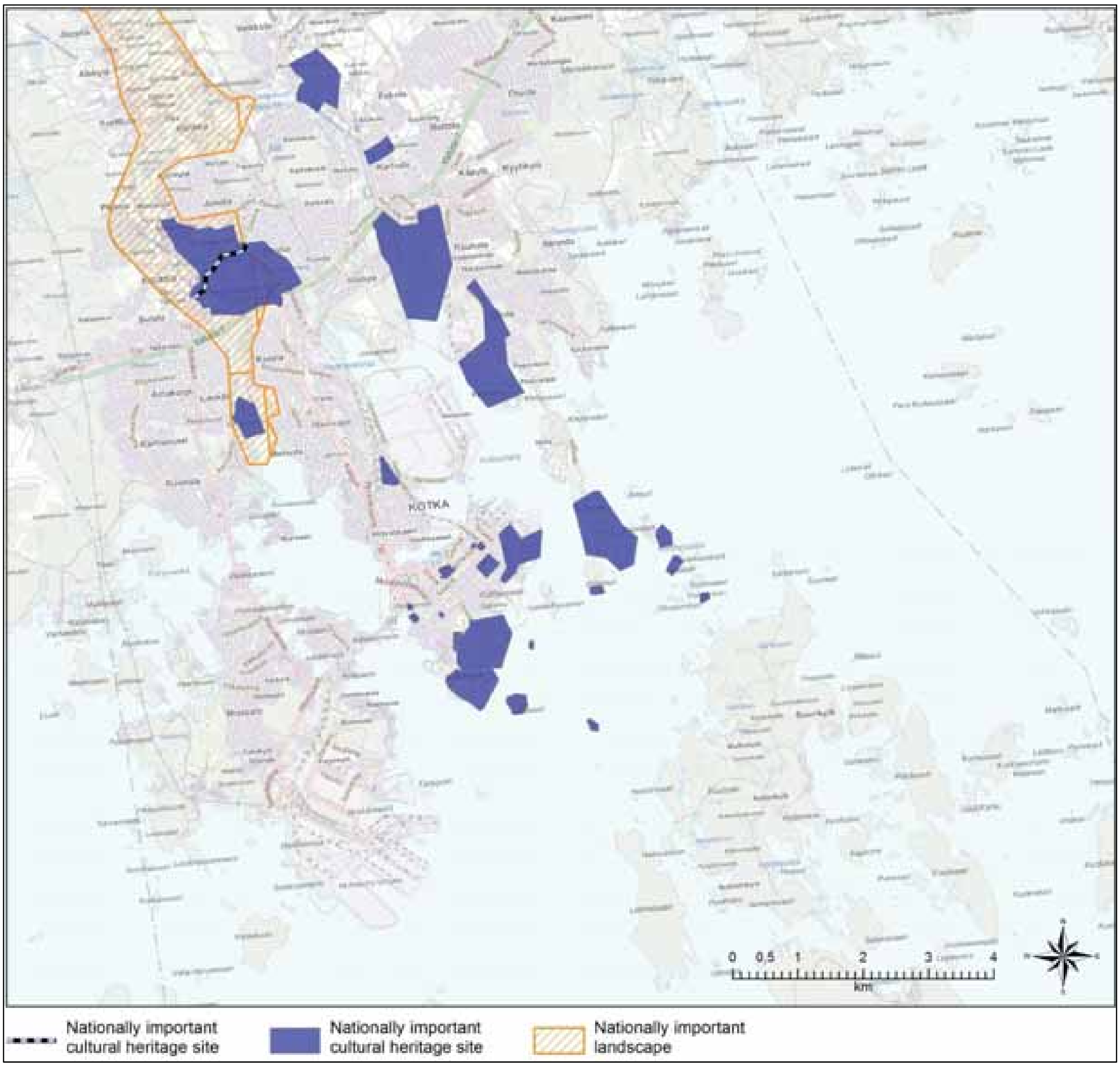

Figure 8-11. Nationally important landscapes and cultural heritage sites (Finnish Environment Institute 2016b).

8.2 Baseline Hanko region

The present state of the onshore area in the Koverhar, Hanko, region is presented below. The operations at Koverhar include interim pipe storage and shipping.

8.2.1 Land use

8.2.1.1 Regional plan

Koverhar, Hanko, is part of the Uusimaa Region in southern Finland. According to the Comprehensive Regional Land Use Plan for Uusimaa, Koverhar Harbour is designated as an area for transport. The industrial area west of the harbour is designated as an industrial area. The area is part of a military noise area where daytime (7.00 am–10.00 pm) noise levels may exceed 55 dB LAeq. The sea area in the immediate vicinity of the harbour is a designated Natura 2000 area and the harbour and industrial area are surrounded by a classified groundwater area and a military area. An extract from the combined regional plan is shown in Figure 8-12. A phased Regional Land Use Plan No. 4 for Helsinki–Uusimaa Region is being drafted at the Uusimaa Regional Council. The plan covers the entire region and is intended to apply until the year 2040. According to the current draft plan, Koverhar Harbour will be designated as an industrial area and a harbour area. *(Uusimaa Regional Council 2016)*

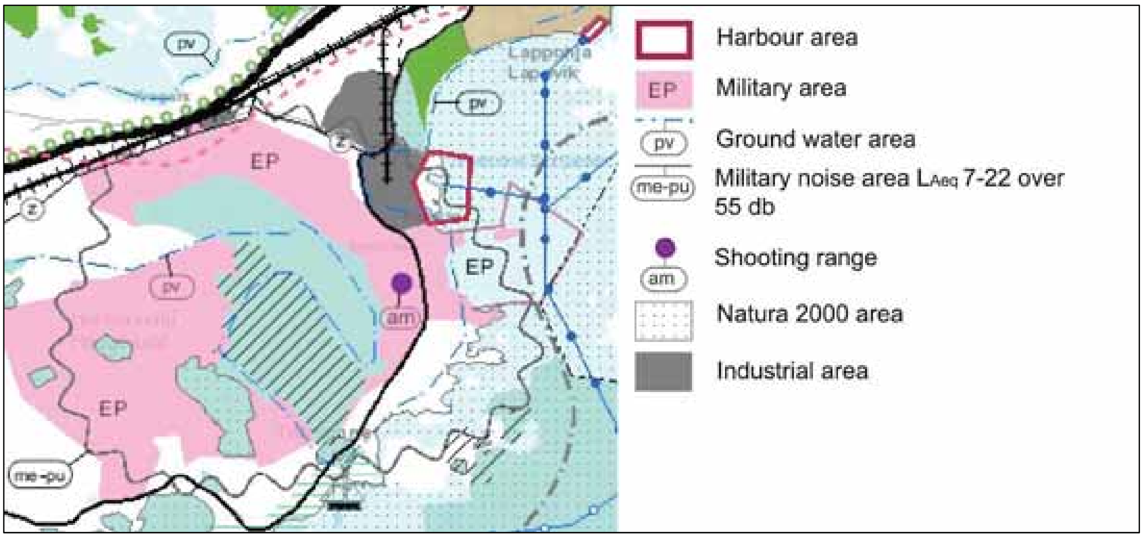

Figure 8-12. Extract from the Regional Land Use Plan for Uusimaa (Source: Uusimaa Regional Council 2016).

8.2.1.2 Local master plan

In the local master plan (Lappohja–Koverhar Local Master Plan 2001), the area is designated as an industrial area (T) and a harbour area (LS). The eastern side is designated as a harbour area as well as a Natura 2000 area (LS(na)), Figure 8-13. There is a classified groundwater area surrounding the Koverhar industrial area and a groundwater intake plant is located north of the industrial area (VO-4).

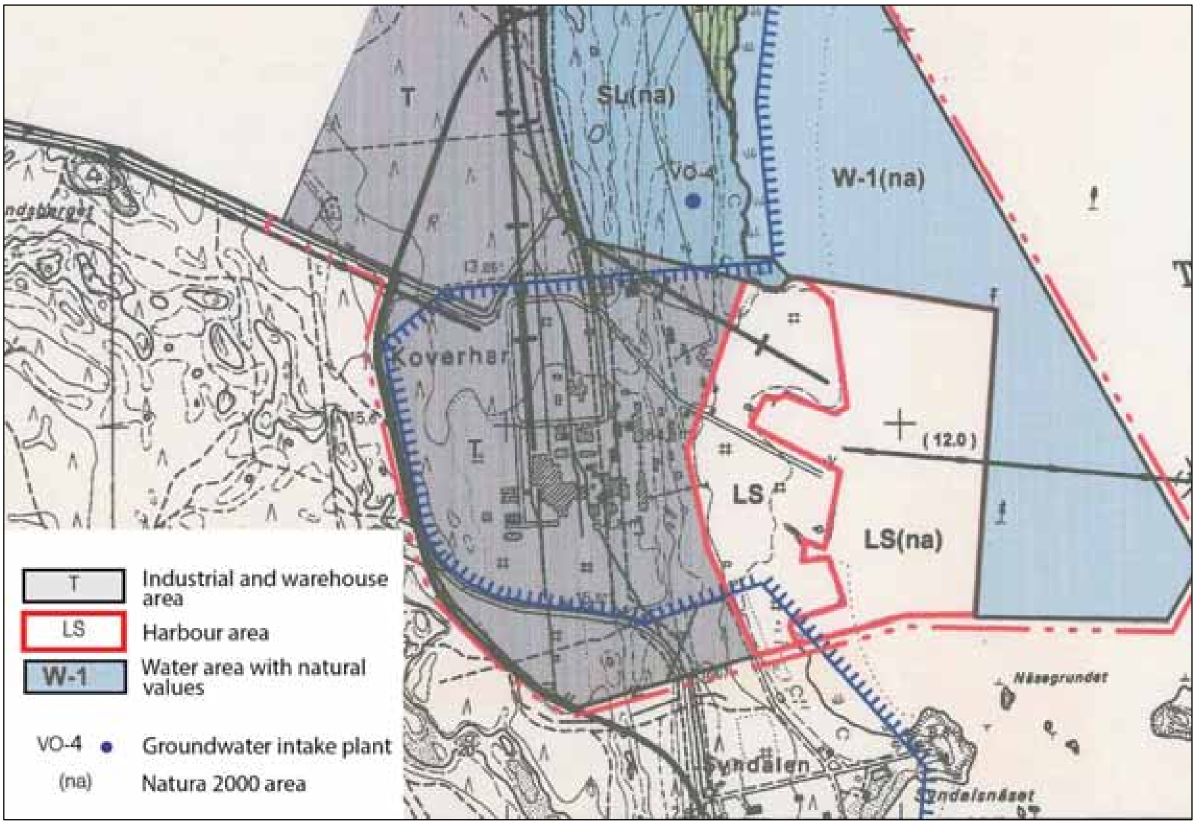

Figure 8-13. Extract from the Local Master Plan 2001 (City of Hanko 2016a).

8.2.1.3 Local detailed plan

There is no local detailed plan for Koverhar. Preparation of a local detailed plan for Koverhar Harbour and industrial area commenced in 2015. The aim is to develop Koverhar Harbour and create opportunities for small and medium-sized enterprises. A proposal for the zoning plan was made public in June 2016. The harbour area and industrial area are designated as a harbour area (LS) in the draft plan. The harbour area has been excluded from the groundwater area (pv). The seaside of the harbour is designated as a Natura 2000 area. There is a new road alignment to the harbour (LT) (Figure 8-14). *(City of Hanko 2016a and 2016b)*

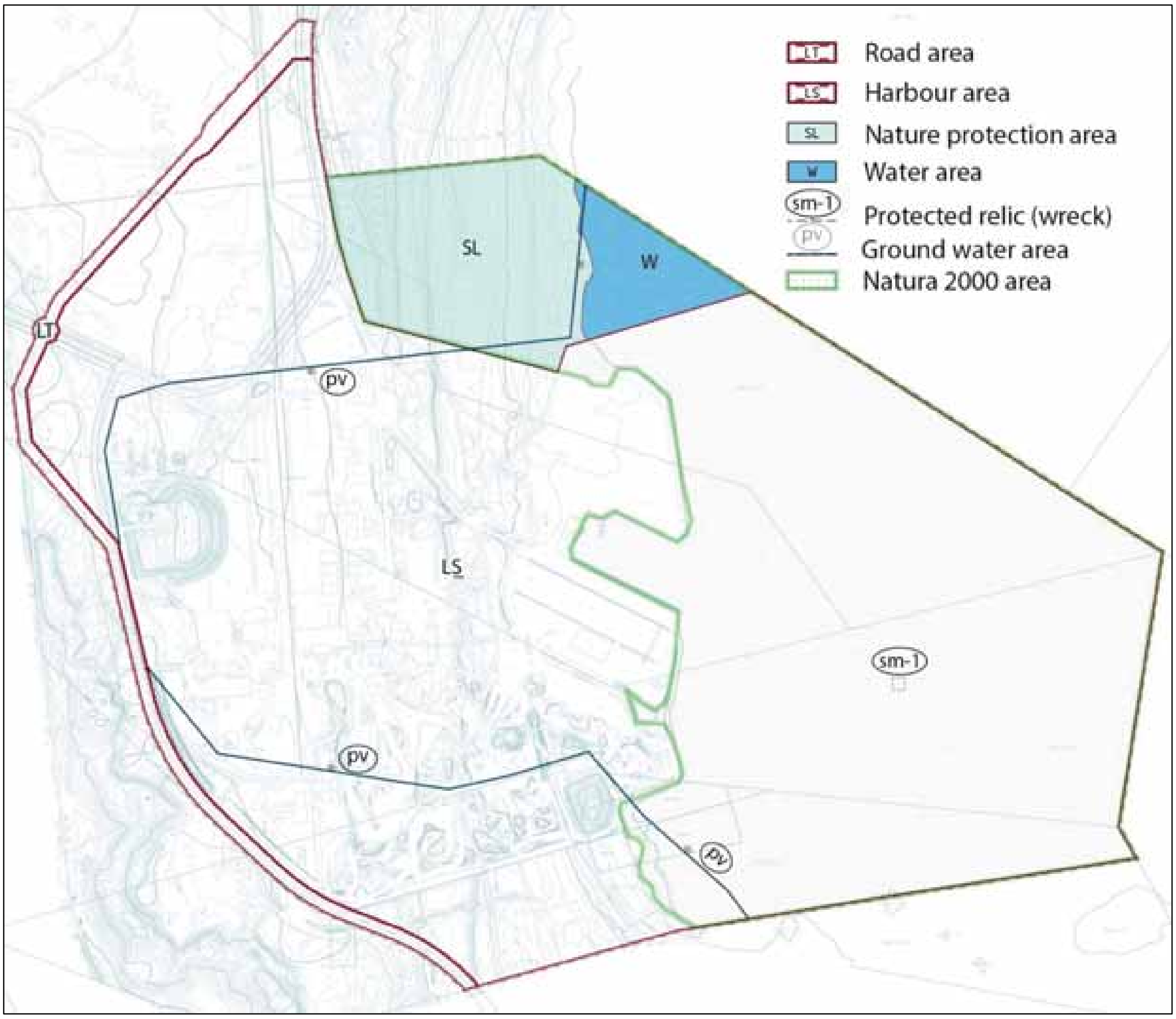

Figure 8-14. Extract from the proposed local detailed plan of Koverhar (City of Hanko 2016b).

8.2.1.4 Operations located in and around the site

Koverhar Harbour is part of the Port of Hanko. The two other industrial harbours of the Port of Hanko are located 17–20 km southwest from Koverhar. Koverhar is an industrial harbour including two quays that have a combined length of 240 m. The fairway to Koverhar and beyond to Skuru and Ekenäs branches at Koverhar (a fairway leading to Koverhar Industrial Harbour and a fairway leading to Skuru). There is regular ship traffic to Skuru Harbour in Raseborg. Current ship traffic to Koverhar Harbour is low but the Port of Hanko is planning to develop the harbour. The development of the harbour is independent of the NSP2 Project. There are water permit applications pending in the Regional State Administrative Agency of Southern Finland for deepening the harbour basin, building a new quay and for renovating the existing bulk-quay at Koverhar Harbour.

Koverhar Harbour allows vessels with a maximum draught of 9.0 metres to enter the harbour. There are connections by road and rail to Koverhar industrial area immediately adjacent the harbour. *(Ovako Wire Oy Ab 2006, City of Hanko 2016b)*.

Koverhar Steel Factory (FNsteel Oy Ab) was closed in 2012 and the industrial area is mainly administered by the City of Hanko. Most of the steel factory buildings have been demolished in 2014–2016 *(City of Hanko 2016b)*

8.2.2 Soil, bedrock and groundwater

Hanko Peninsula comprises a mixture of Precambrian bedrock and end-moraine complex Salpausselkä I. In Koverhar, soil consists mainly of sand.

There are several important classified groundwater areas surrounding Koverhar industrial and harbour areas (Figure 8-15). The groundwater table in Koverhar industrial area is approximately 10 m below ground level. *(Finnish Environment Institute 2016b)*

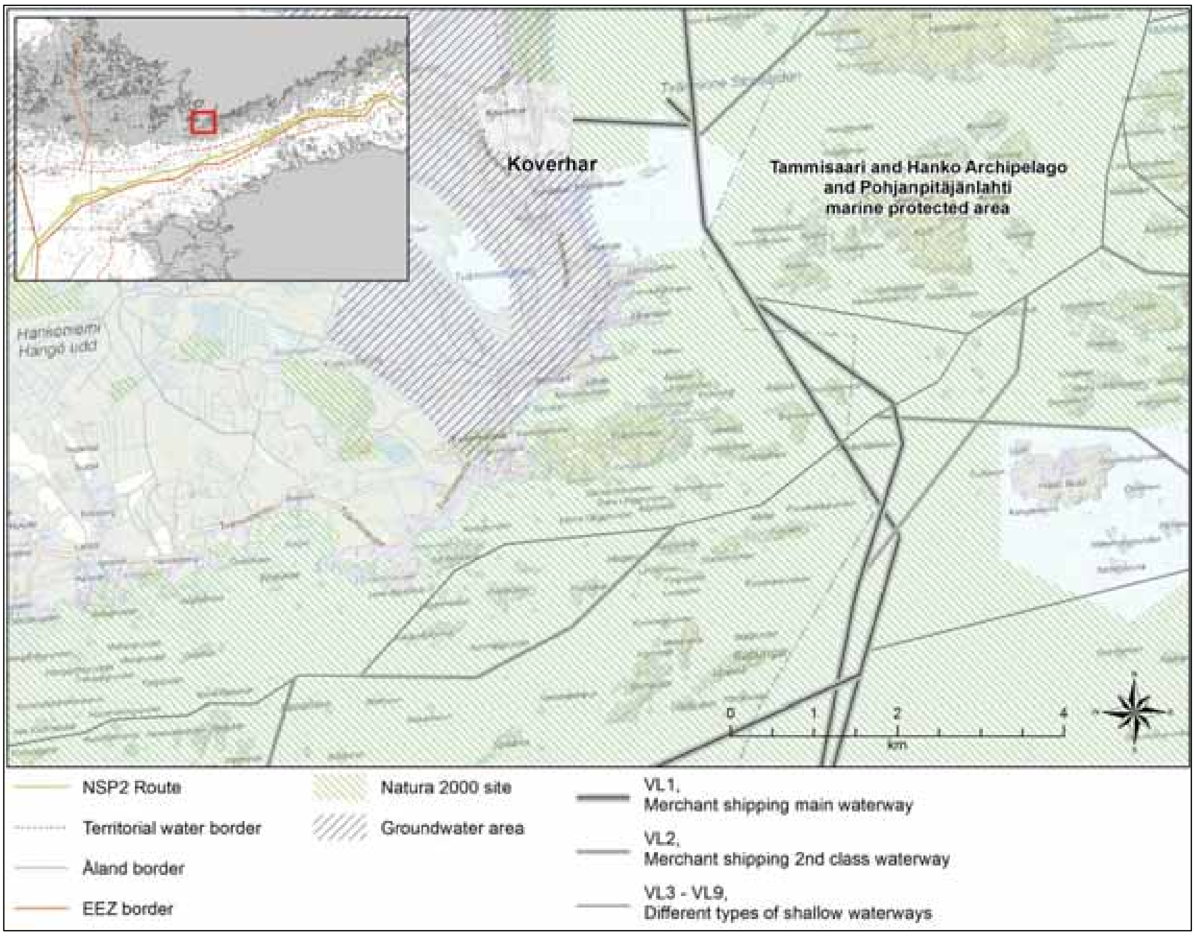

Figure 8-15. Nature conservation areas and classified groundwater areas surrounding Koverhar (Finnish Environment Institute 2016b).

8.2.3 Air quality

Air quality in Hanko is mainly considered good. Air quality is affected by various sources such as industry, harbour operations, heating, energy production, transport and transboundary emissions. Emissions have an annual variation and there is no clear trend in emissions levels in recent years. The closure of the Koverhar Steel Factory can be seen in the emissions reduction of nitrogen oxides and particulate matter. Monitoring of general air quality in Hanko (concentrations in air) has not been conducted in recent years. In 2009, nitrogen dioxides (NO_2) were measured in Hanko City Centre and the annual average concentrations were low (8–13 $\mu g/m^3$ NO_2) compared to the threshold value of 40 $\mu g/m^3$. Emissions from the Port of Hanko are presented in Table 8-2. *(Aarnio et al. 2014)*

Table 8-2. Emissions from the Port of Hanko in recent years (according to Aarnio et al. 2014). Emissions include all harbours of the Port of Hanko, not only Koverhar.

	2009	2010	2011	2012
	tonnes/year	tonnes/year	tonnes/year	tonnes/year
Nitrogen oxides	440	509	578	549
Particulates	12	14	17	15
Sulphur dioxide	147	174	192	184

8.2.4 Noise

Military activities in Koverhar and Syndalen areas are a source of noise. Heavy artillery firing exercises are conducted throughout the year (between 7am–10pm). According to noise modelling, noise levels at the harbour and industrial area during firing exercises are 50–60 dB (LAeq). Current traffic in the area is so low that traffic noise is not significant. *(City of Hanko 2016b)*

8.2.5 Biotic environment and protected areas

The sea conservation area and Natura 2000 areas of Tammisaari and Hanko Archipelago and Pohjanpitäjänlahti (FI010005) are located in the immediate vicinity of Koverhar Harbour (Figure 8-15). An area part of the shore conservation programme called Pohjanpitäjänlahden rannikko (RSO010002) and the nationally valuable aeolian sand and littoral deposits of Nicklundsberget–Tvärminne and Lappvikmalmarna are also located in the immediate vicinity of Koverhar Harbour.

8.2.6 Traffic and safety

A road network serves the harbour. Road traffic from main Highway 25 is directed via Road Koverharintie or Road Viskontie. The average traffic volumes in 2015 on main Highway 25 were 3,600 vehicles per day (540 heavy vehicles per day). In 2015, the average traffic volume on Road Koverharintie was 360 vehicles per day (of which 30 were heavy vehicles per day). The average traffic volume on Road Viskontie in the same year was 130 vehicles per day (of which 10 were heavy vehicles per day) *(Finnish Transport Agency 2016d)*. Related to the project and planned operations in Koverhar, the road traffic conditions need to serve merely the passenger traffic, as all the pipes are transported by vessels.

8.2.7 People and society

Hanko is a city of 8,800 inhabitants. Koverhar is situated 15 km from the city centre. The closest residential area to Koverhar is village Lappohja, approximately 2.5 km northeast from Koverhar. Lappohja has approximately 700 inhabitants. The village has an elementary school, kindergarten and an educational centre, which is located on the seashore. Syndalen, an area used for military exercises, including firing ammunition, is located south of Koverhar industrial area and the harbour. A few residential homes are located on the other side of the military area, approximately 2 km south of Koverhar. Nearby islands such as Ekö, Hermansö and Koö accommodate mainly holiday homes with the nearest being approximately 2 km away. *(City of Hanko 2016c, Finnish House Owner's Association 2016)* At the end of June 2016, the unemployment rate in Hanko was at 13.9 % i.e. 554 unemployed *(SVT 2016b)*. The average unemployment rate in Finland is 7.8 %. *(Statistics Finland 2016)*

Currently, entrepreneurship activities in the area of Koverhar are few as the Koverhar Steel Factory (FNsteel Oy Ab) has been closed since 2012 and the industrial area is mainly administered by the City of Hanko. In Lappohja, SSAB Europe has a steel factory and ViskoTeepak, a packaging manufacturer for the food industry, is located along Viskontie. The aim of the local detailed plan (in preparation) is to develop Koverhar Harbour area and create opportunities for small and medium-sized enterprises.

8.2.8 Tourism and recreation

The City of Hanko, being the southernmost point of Finland, is surrounded by the sea. The city has a long history associated with seafaring. Tourism is mostly concentrated on the holiday season during the summer. Restaurants, accommodation and various activities for tourists are mainly centred near Hanko City Centre. Hanko Airport is located in Täktom at ca. 8 km distance from Hanko City Centre and is actively used by the Hanko Flying Club and the Skydive Finland. Next to Hanko Airport is a golf course, Hangon Golf.

Hanko offers good surroundings for boating and sailing as well as for other maritime leisure activities. Hanko has 130 km of coastline, of which 30 km consists of beaches with fine sand. The nearest beach from Koverhar is located on the southside of Lappohja about 2 km from the harbour. There are plenty of islands on the seashore of Hanko. Possibilities to visit lighthouses or to see grey seals attract visitors. There are several marinas in Hanko both for guests and for the local residents. The Eastern Harbour (Itäsatama) with 400 moorings is the largest marina in Finland located around 15 km from Koverhar. The annual Hanko Regatta is one of the largest sailing events in Finland with around 200 boats participating in the event. *(Hanko – Hangö 2016)*

The sea area in the immediate vicinity of Koverhar Harbour is a Natura 2000 area. Ekenäs Archipelago National Park is located around 6 km east from Koverhar and is popular among people interested in boating, canoeing and leisure fishing. The Helsinki–Hanko shipping route runs through the park and the only way to get to the park is by boat. Within the park, there are three nature rails on the islands of Älgö, Modermagan and Jussarö. *(Metsähallitus 2016)*

8.2.9 Landscape and cultural heritage

The Koverhar area is characterised by harbour and industrial operations. A former steel factory site, the harbour area and large storage areas form the landscape. Most of the structures of the steel factory have been demolished. Approximately 10 buildings remain (e.g. electrical substation) at the site. *(City of Hanko 2016b)* There are no nationally important cultural heritage sites near Koverhar, Figure 8-16.

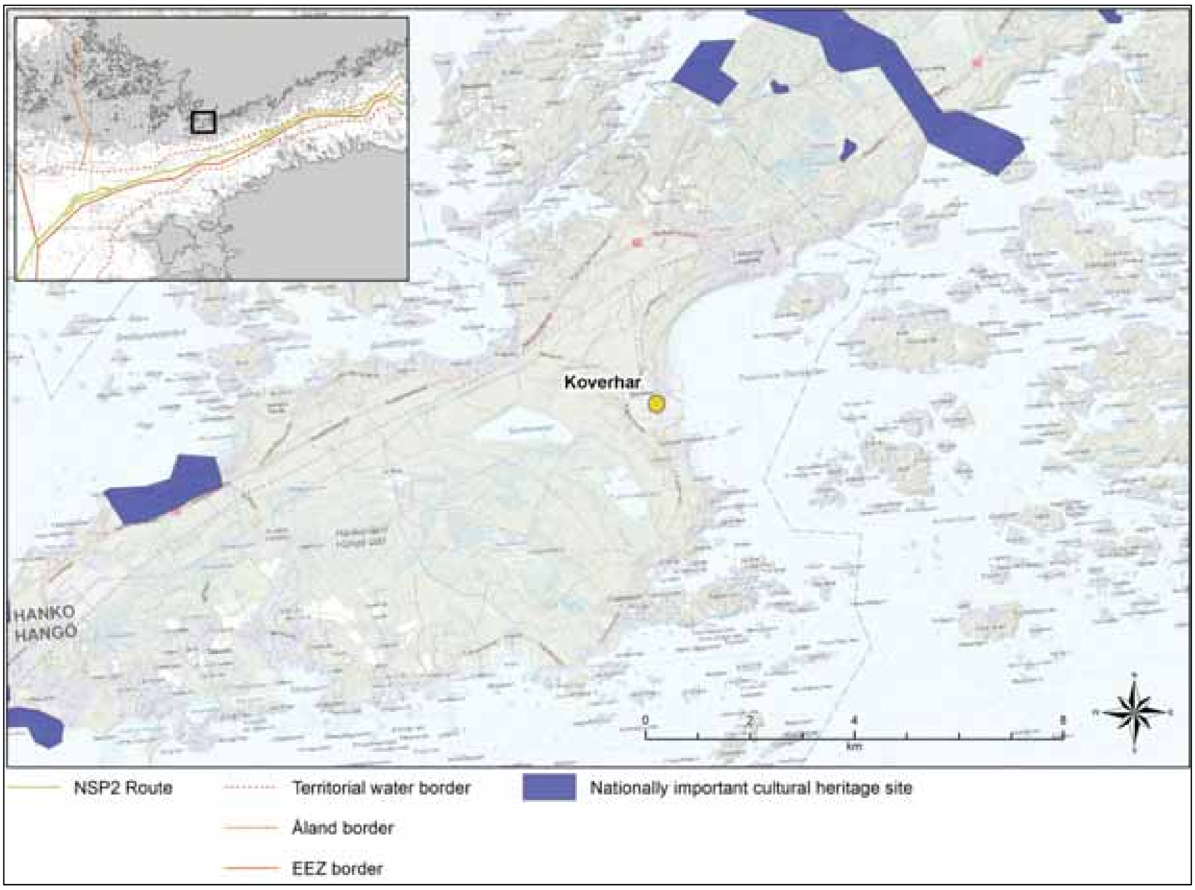

Figure 8-16. Nationally important cultural heritage sites in Hanko near Koverhar (yellow circle) (Finnish Environment Institute 2016b).

9. TRANSBOUNDARY BASELINE

9.1 Introduction

Nord Stream 2 Project activities in the Finnish EEZ have the potential to cause transboundary impacts on the neighbouring countries of Russia, Estonia and Sweden. Also other countries are potentially impacted if they are fishing in the Finnish EEZ.

The current state of the marine environment in these three neigbouring countries adjacent to the Finnish EEZ is described in this chapter. Environmental conditions are quite similar on both sides of the Finnish EEZ border in the Gulf of Finland (Subchapters 7.4–7.6). The review focuses on those receptors that could actually be impacted during the pipeline construction or operation phases and therefore to a maximum distance of about 50 km.

The discussion on Estonia also contains the information on the social aspects related to the marine environment in general.

9.2 Methods and data used

Identification of potentially significant impacts and receptors that should be included in the transboundary baseline and assessment is based on spatial extension of the impacts as well as the temporal aspects (duration of the resulting impacts). The extension of the impacts and, thereby, the size of the potential impact areas are dependent on the character of the impacts and the receptors to be impacted. As regards physical or chemical transboundary impacts, the most far-reaching impacts relate to underwater noise and the effect of that on marine mammals. In contrast, water quality changes arising from sediment dispersion will be limited to the nearby marine areas on the Finnish EEZ border.

Impacts originating from project activities in Finland are assessed based on modelling results of sediment dispersion and underwater noise. Environmental studies have been carried out in Sweden and in Russia. The experience and knowledge gained from NSP monitoring is utilised in Estonia and Sweden. Information of international ship traffic in the Finnish EEZ is described in Chapter 7.16. Statistics of fishery in the Finnish EEZ have been collected from national authorities around the Baltic sea. Social impacts were monitored in Estonia related to NSP2 and the results are summaried in this chapter. The data was gathered during a citizen survey conducted in spring 2016. The information sources used are presented in Table 9-1.

Table 9-1. Information used to define the potential transboundary impact areas of the neighbouring countries and to describe the current state of the marine environment in these areas.

Information source	Russia	Estonia	Sweden	Other countries
Sediment dispersion model	x	x	x	x
Underwater noise model	x	x	x	x
Environmental baseline study	in 2015 and 2016	-	in 2015	-
Nord Stream monitoring results	-	x	x	-
Ship traffic information	x	x	x	x
Fishery information from national statistics	x	x	x	x
Citizen survey	-	Spring 2016	-	-

9.3 Russia

9.3.1 Bathymetry, seabed sediments and water quality

In general, the water circulation pattern in the eastern Gulf of Finland is influenced by the flow of the River Neva and by water exchange with other parts of the Gulf. Neva is the largest river in the catchment area, accounting for 75 % of the total inflow into the Gulf of Finland (Ehlin 1981). Although the easternmost part of the Gulf of Finland is quite shallow, the depth conditions near the Finnish EEZ border are quite similar compared to those on the Finnish side (Figure 9-1).

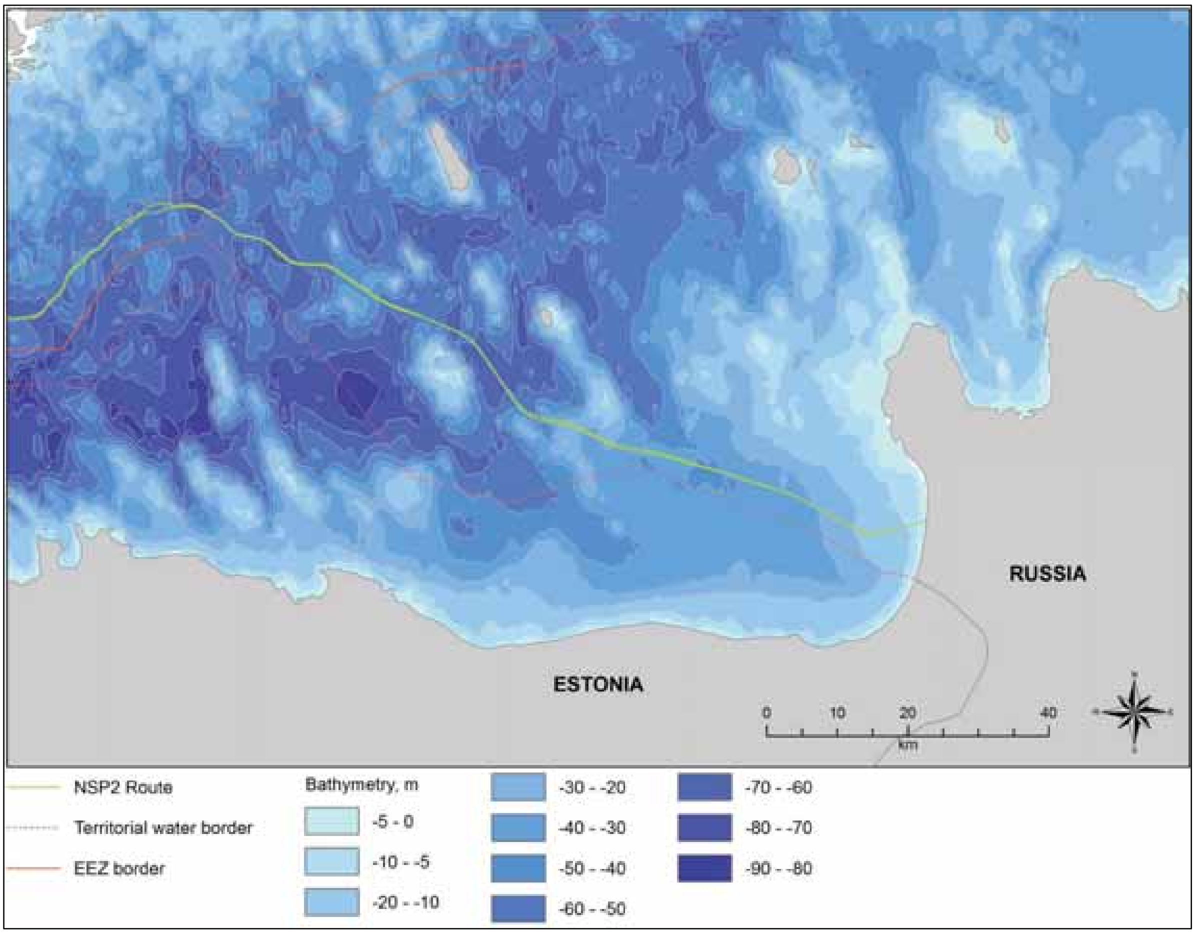

Figure 9-1. Bathymetry in the Russian territorial waters.

The nearest environmental baseline sampling stations in the 2015 and 2016 surveys were situated about 0.5 km from the Finnish EEZ border (Figure 9-2).

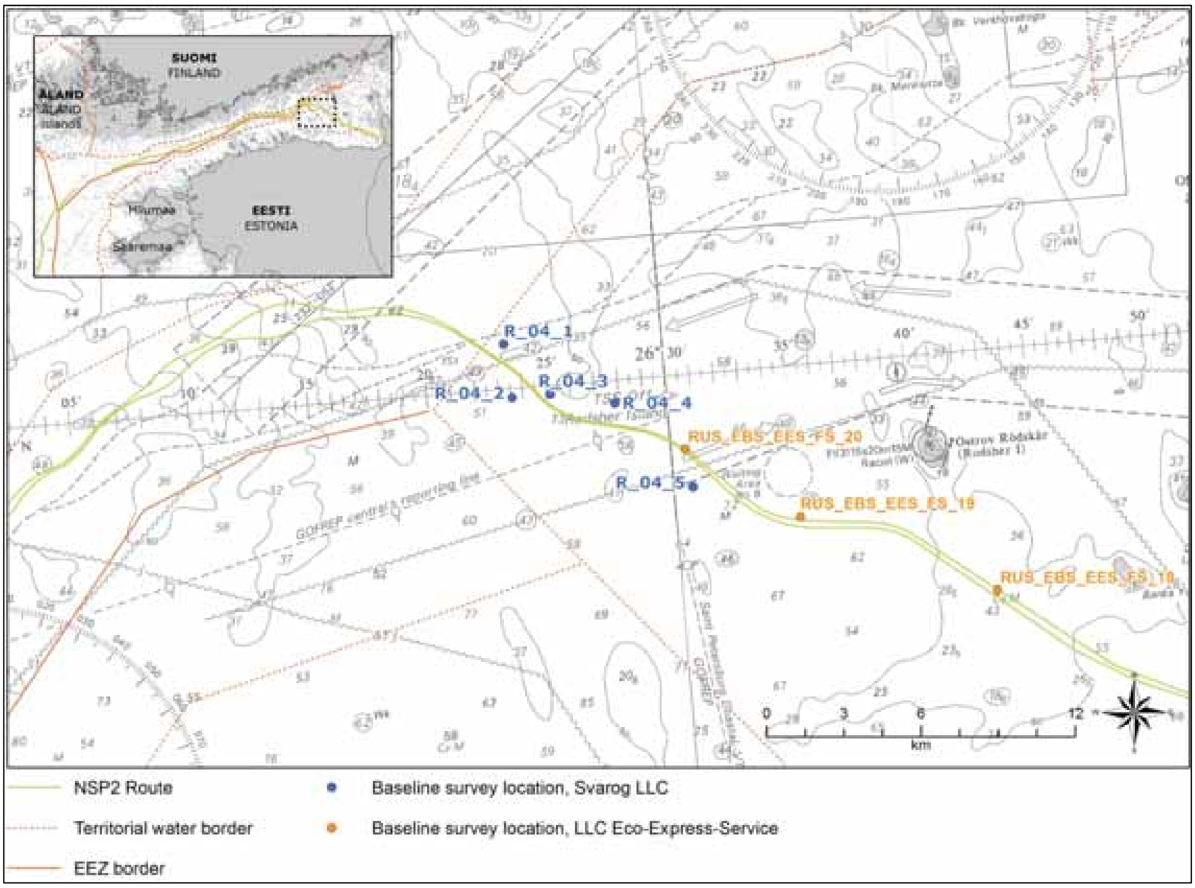

Figure 9-2. The environmental baseline sampling stations in Russian waters nearest to the Finnish EEZ border.

In late autumn 2015, the water column was typically vertically mixed. Therefore, the oxygen concentration was also good near the seabed (10.9 mg/l). In general, chemical oxygen demand (COD), sulphates, chlorides, mercury, magnesium, oil products and phenols were elevated compared to the permissible concentrations (SanPiN 2.1.5.2582-10). Other heavy metal concentrations were low in the whole water column. Concentrations were normally 1 µg/l or less, depending on the metal in question. However, zinc concentrations (5–13 µg/l) were analysed from the water column *(Eco-Express-Service LLC 2016a)*.

The mosaic-like seabeds are typical near the border region of the Finnish EEZ and Russian territorial waters. The seabed is mainly composed of hard bottom complexes and hard clay. Sand and mixed deposits are also found *(Eco-Express-Service LLC 2016b)*. The estimated impact area of dioxins/furans in the accumulation areas of seabed sediments, which originate from Kymijoki River, also reaches Russian territorial waters (Figure 9-3).

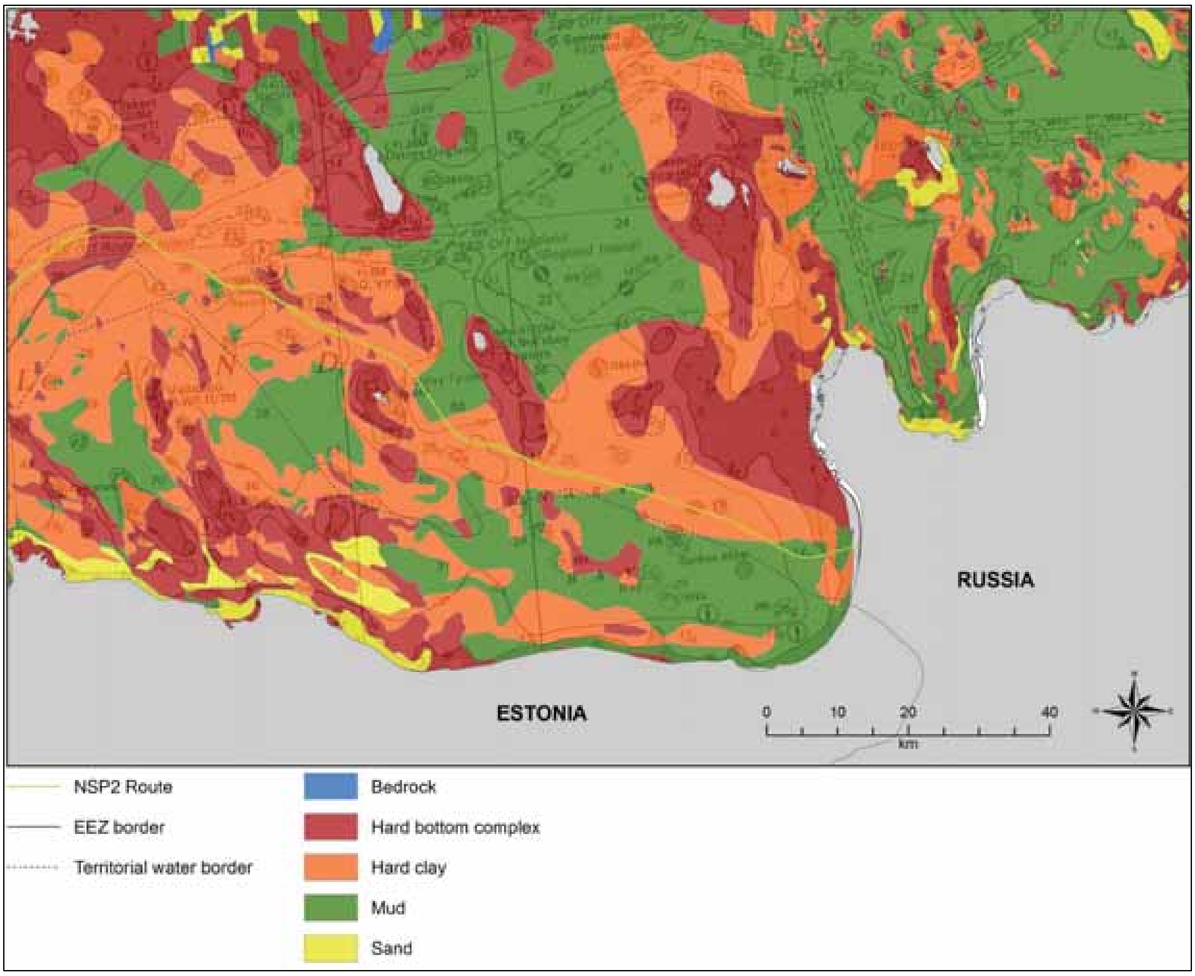

Figure 9-3. **Seabed properties in Russian waters near the Finnish EEZ border.**

The sediments adjacent to the Finnish EEZ border are rather commonly contaminated by heavy metals and hydrocarbons *(Eco-Express-Service LLC 2016b)*. In these areas, contamination varies between tolerable to very hazardous pollution by these substances. According to the survey results in the vicinity of the Finnish border, concentrations of heavy metals were approximately at the same level as in Finnish waters (Table 9-2).

Table 9-2. **Heavy metal concentration in the surface sediment (0–30 cm) during environmental baseline surveys (Eco-Express-Service LLC 2016b, Luode Consulting Ltd 2016b). Sampling stations are presented in Figure 9-2.**

Concentration (mg/kg dry weight)	As	Hg	Cd	Co	Cr	Cu	Pb	Ni	Zn
Average	2.77	0.13	1.23	11.0	11.2	28.1	24.5	22.1	110
Median	1.91	0.11	1.34	10.6	10.4	29.5	22.8	23.2	96.1
Standard deviation	1.71	0.05	0.32	2.36	4.84	9.17	23.5	6.8	39.5
n (samples)	17	6	11	15	17	17	17	17	17

9.3.2 Underwater noise

The baseline data regarding underwater noise is based on the EU LIFE supported BIAS project established in September 2012 (BIAS 2015). More detailed information regarding underwater noise is given in Subchapter 7.7.3.

9.3.3 Benthos

Community structure at the stations nearest to the Finnish EEZ border was very similar compared to within Finnish waters. Biomass and species-specific abundances were low. Only few taxa were detected: polychaeta *Marenzelleria* spp., marine bivalvia *Macoma balthica*, crustacean amphipoda *Monoporeia affinis* and malacostraca *Saduria entomon*. Oxygen conditions were poor in many of the studied offshore stations *(Eco-Express-Service LLC 2016c)*.

9.3.4 Fish

As on the Finnish side of the border, the fish community is dominated by European sprat (*Sprattus sprattus L.*) and Baltic herring (*Clupea harengus L.*) and during winter period, also by the three-spined stickleback (*Gasterosteus aculeatus*) (Subchapter 7.10).

9.3.5 Marine mammals

Russian waters are currently inhabited by two seal species, the Baltic ringed seal (*Pusa hispida botnica*) and the grey seal (*Halichoerus grypus*). The nature conservation status for these species in Russia are presented in Table 9-3.

Table 9-3. Nature conservation status for seals in Russia.

Species	Red list of the Russian Federation	Red list of Leningrad Oblast	Red list of St. Petersburg
Ringed seal	Category 2: numbers show a steady downward trend	Category 2: Endangered subspecies, EN	Category 1: Critically endangered, CR
Grey seal	Category 1: a species, which numbers have declined to a critical level, with habitats shrinking across the entire area of distribution	Category 2: Endangered subspecies, EN	Category 3: Vulnerable, VU

There are no known haul-out sites for ringed seals or grey seals in Russian waters near the Finnish EEZ border (Figure 9-4 and Figure 9-5). The main such sites are found further away near Kurgalsky.

During the winter period ringed seals can be found in the northern part of the eastern Gulf of Finland, where the ice conditions are best for calving. Ringed seals seek solid ice areas with snow cover.

After the breeding season, individuals move south to suitable resting areas, which are usually shallow and rocky shores around islands (Figure 9-4). Grey seals perform the same kind of seasonal movements, but in the winter they breed usually in areas of drift or cracked ice and closer to the open sea (Figure 9-5). Depending on ice conditions, grey seals are found in the eastern part of the Gulf of Finland if the winter is mild and there is less ice cover. During colder winters, breeding grey seals may be found in the western part of the Gulf of Finland outside the Russian territorial waters *(Eco-Express-Service LLC 2016d)*.

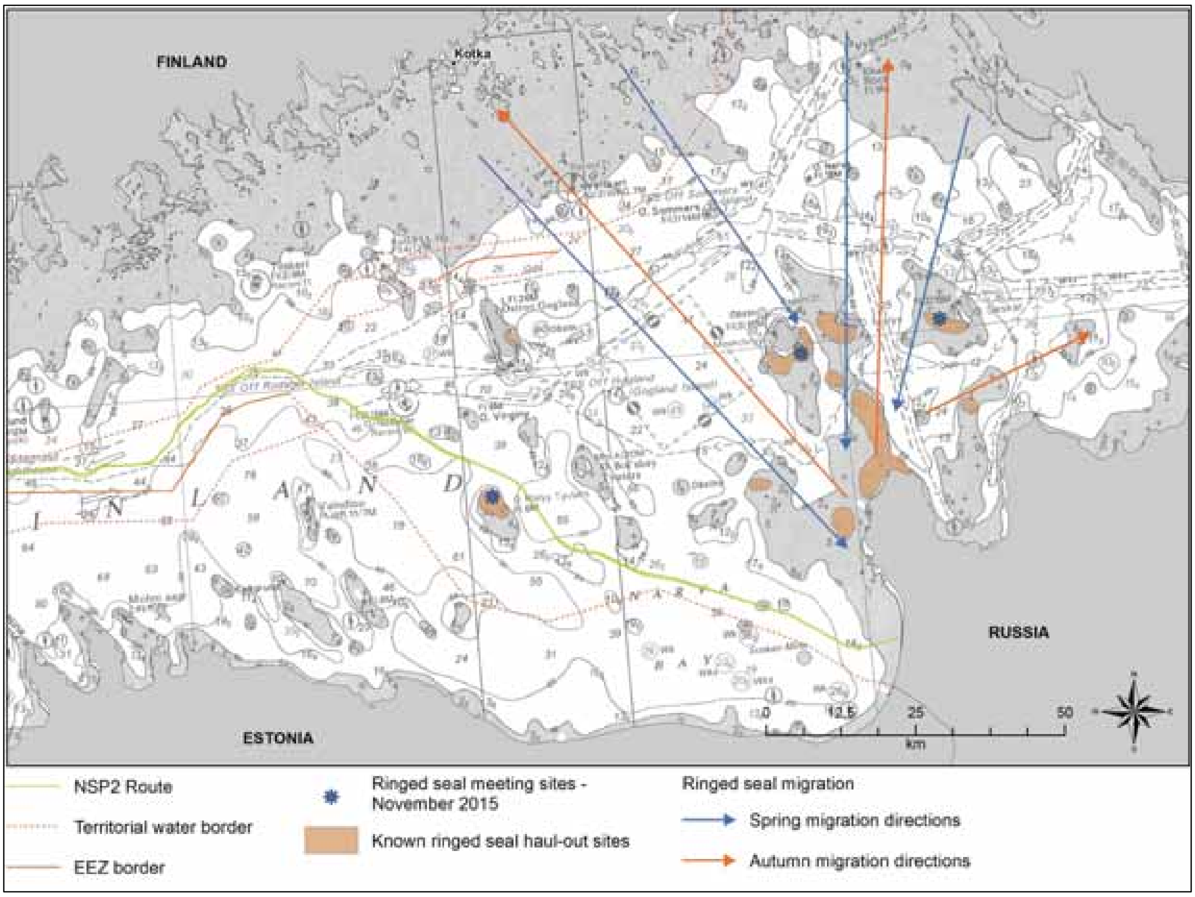

Figure 9-4. Presence of ringed seal populations in Russian territorial waters and potential migration routes (Eco-Express-Service LLC 2016d).

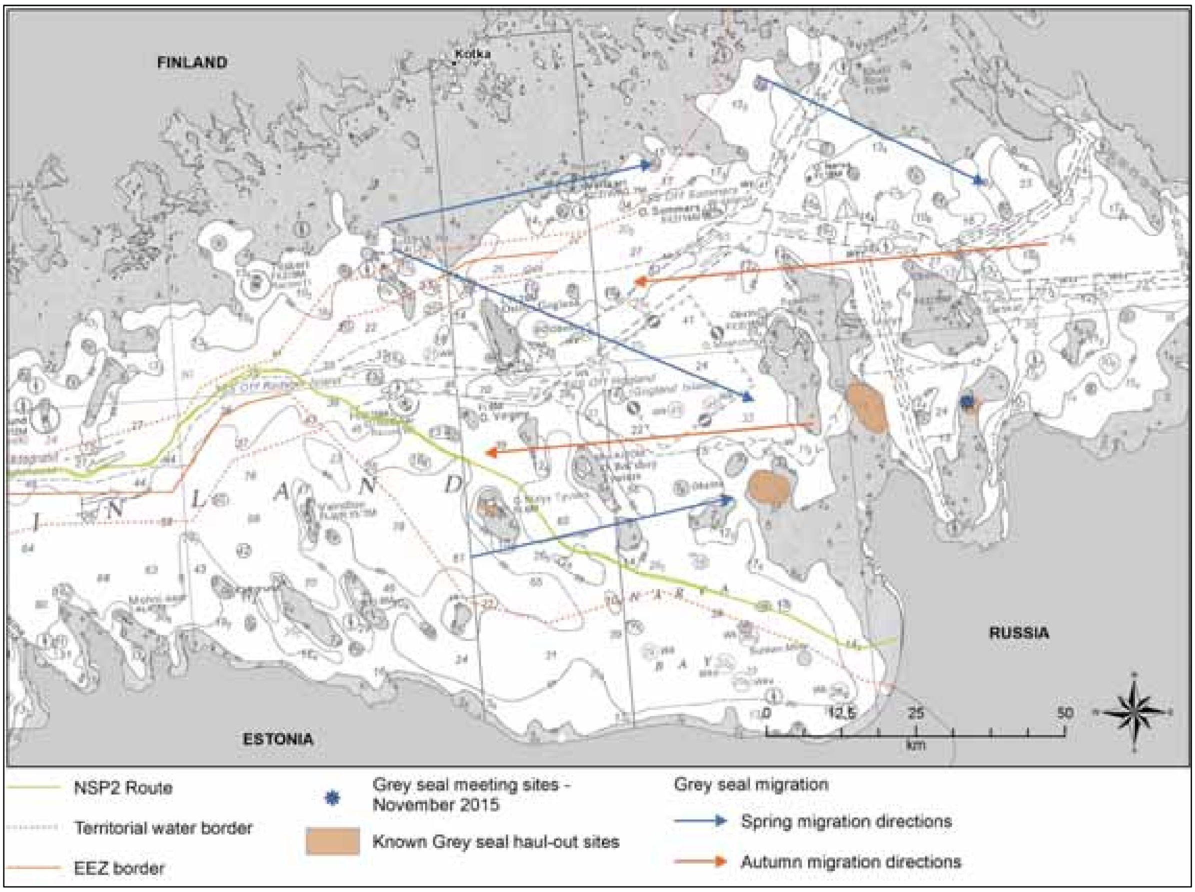

Figure 9-5. Presence of grey seal population in Russian territorial waters and potential migration routes (Eco-Express-Service LLC 2016d).

The distributions of grey seals and ringed seals were studied in April and May 2016 by the St. Petersburg Research Center of the Russian Academy of Sciences *(Verevkin & Bublichenko 2016)* using aerial surveys. All detected seals were found at haul-out sites. During observations in April, 20 ringed seals and 91 grey seals were detected. During May, the respective abundances were 5 ringed seals and 270 grey seals. The numbers of ringed seals were small in comparison to the results of previous spring surveys. All ringed seals were found at the typical places used for moulting: at the Kurgalsky Peninsula and the northern rocks of Moshchny, Maly and Maly Tyuters. Grey seals were also found in their usual haul-out sites (Figure 9-4 and Figure 9-5).

According to opportunistic visual sightings (Finnish Ministry of the Environment), very low densities of porpoises is likely present all year along the NSP 2 route in Russia.

9.3.6 Birds

Migratory and breeding bird populations in the Russian parts of the Gulf of Finland have been studied between 1988–2016. Along with this data, the data collected in separate surveys concerning the Nord Stream 2 Project has been gathered and analysed to evaluate and assess the importance of the Russian offshore and coastline areas in the vicinity of the project area *(Eco-Express-Service LLC 2016d, Verevkin and Bublichenko 2016)*.

Two areas of importance for birds have been recognised near the EEZ border, less than 30 km from the Finnish EEZ. Rodsher Island is situated approximately 16 km from the pipeline route in the Russian territorial waters and the Virginy Islands are ca. 25 km away from the pipeline route. These islands have greater importance in the breeding season than in the migrating seasons. The Virginy Islands area is an important breeding area for gull and tern species and the area also has razorbill, common guillemot and common murre (Uria aalge) colonies. The Rodsher Island has a similar species composition, although the total number of breeding pairs is smaller. According to data on migration seasons, the areas of the Virginy Island and Rodsher Island hold approximately 200-1500 bird individuals each (the total number being smaller in Rodsher) with the majority being great cormorants and *Laridaes*.

According to collected data, offshore areas near the Finnish EEZ, and offshore areas on the whole, have quite low importance as stopover sites during the migration seasons. It should be noted that the most valuable areas for migrating birds in the Russian part of the Gulf of Finland are located at a distance of 25 km or more from the planned pipeline route.

9.3.7 Protected areas

Several protected areas are located in the Russian parts of the Gulf of Finland. All protected areas are either Regional Nature Reserves or State Nature Reserves. No Nature Reserves are situated in the vicinity of the Finnish EEZ. The nearest Nature Reserve area is The Ingermanland State Nature Reserve, approximately 26 km west of the Finnish EEZ. The second nearest Nature Reserve area is the Gogland Regional Nature Reserve, approximately 33 km west of the Finnish EEZ. Both Ingermanland and Gogland Nature Reserve areas are planned Nature Reserves and the establishment of protection for both areas lies in the future.

9.3.8 Existing infrastructure or other targets

There are no long-term monitoring stations to be potentially impacted in the Russian waters near the Finnish EEZ border. There are three telecommunication cables in the Russian territorial waters that goes between Kaliningrad (RU) and St. Petersburg (RU), Karlslund (DK) and Kingisepp (RU) as well as between Helsinki (FI) and St. Petersburg (RU). There are no other known infrastructure objects near Finnish border in the Russian territorial waters.

9.3.9 Ship traffic

Ship traffic in the Gulf of Finland and in the Northern Baltic Proper is described in Subchapter 7.16.

9.3.10 Fishery

Intense trawling and fixed-net fishing of Baltic herring is performed in Russian territorial waters. Trawl fishing is performed in the very western part of the area, near the Finnish border. The only allowed trawl method is pelagic trawling. Use of bottom trawls is prohibited *(Federal Fishery Agency 2015)*. Russian fishing vessels are not allowed to fish in the Finnish EEZ.

9.4 Estonia

The data describing the conditions of the Estonian transboundary baseline is taken from monitoring reports issued during the construction and operation of the Nord Stream pipeline, as monitoring stations were also located in Estonian waters. In addition, Finnish EIA baseline data is used, where appropriate. In order to describe the baseline for the socio-economic environment, a public opinion survey was conducted in Estonia by Saar Poll OÜ from November 2015 to March 2016.

The scope of the baseline is determined based on the potential impact area derived from the sediment spill modelling report and the underwater noise modelling report. In the case of the socio-economic environment, the counties most related to the Baltic Sea are under discussion.

9.4.1 Marine strategic planning (Estonia)

Environmental targets for the Estonian Marine Strategy were defined in 2012. This was the first step of the implementation of the Estonian Marine Strategy. These targets and their associated measures are presented in the program of measures of the Estonian Marine Strategy 2016–2020.

As regards the potential impacts from the NSP2 project, most of the targets and indicators are relevant. Qualitative descriptors and current environmental status according to Estonian Marine Strategy Program of Measures are presented in Table 9-4.

Table 9-4. Qualitative descriptors of good environmental status (Lips 2016).

Qualitative descriptor	Environmental status GES
1. Biodiversity	Not approached
2. Non-indigenous species	Not approached
3. Commercial fish	Not approached
4. Food webs	Not assessed
5. Eutrophication	Not approached
6. Seabed integrity	Good
7. Hydrographical conditions	Not assessed
8. Contaminants	Good
9. Contaminants in fish	Good
10. Marine litter	Not assessed
11. Introduction of energy and underwater noise	Not assessed

9.4.2 Bathymetry, water quality and sediments

The seabed on the Estonian side is generally smoother compared to the seabed topography on the Finnish side and water depths are slightly higher. The bathymetry of the Gulf of Finland is presented in Appendix 12, Map BA-01-F.

Oxygen conditions in the sea water near the seabed have fluctuated, depending on location, sampling season and year, from anoxic to satisfactory or good. The oxygen conditions recorded at the turn of the year 2015/2016, near the seabed, in the middle of the mouth of Gulf of Finland, are presented in Subchapter 7.6.4. Experience from the NSP showed that the temporary turbidity increase due to rock placement was assessed to be short-term (16–60 hours) and the extent of turbidity plumes occurred at a maximum of 600 m from the activity *(Ramboll 2011b)*. The impacted distance from the rock placement site, taken as the 10 mg/l contour, was less than 1 km *(Ramboll 2013b)*. The Estonian EEZ is located an average of 3 km from the pipelines.

The seabed at the entrance of Tallinn is mostly composed of sand, while the sediments in offshore areas of western parts of Estonia are mainly composed of mud (Appendix 12, Map GE-01-F).

During the construction phase of the Nord Stream pipelines in 2009–2012 in the Finnish EEZ, sediment quality was monitored in the Estonian EEZ near the Finnish - Estonian border to identify whether the construction works had caused any transboundary impacts through sediment and contaminant dispersion (Figure 9-6). Samples were taken from three monitoring stations before and after the construction activities. Each station consisted of three sampling locations (1-3). At each station, sediment results for location 2 are presented in Table 9-5.

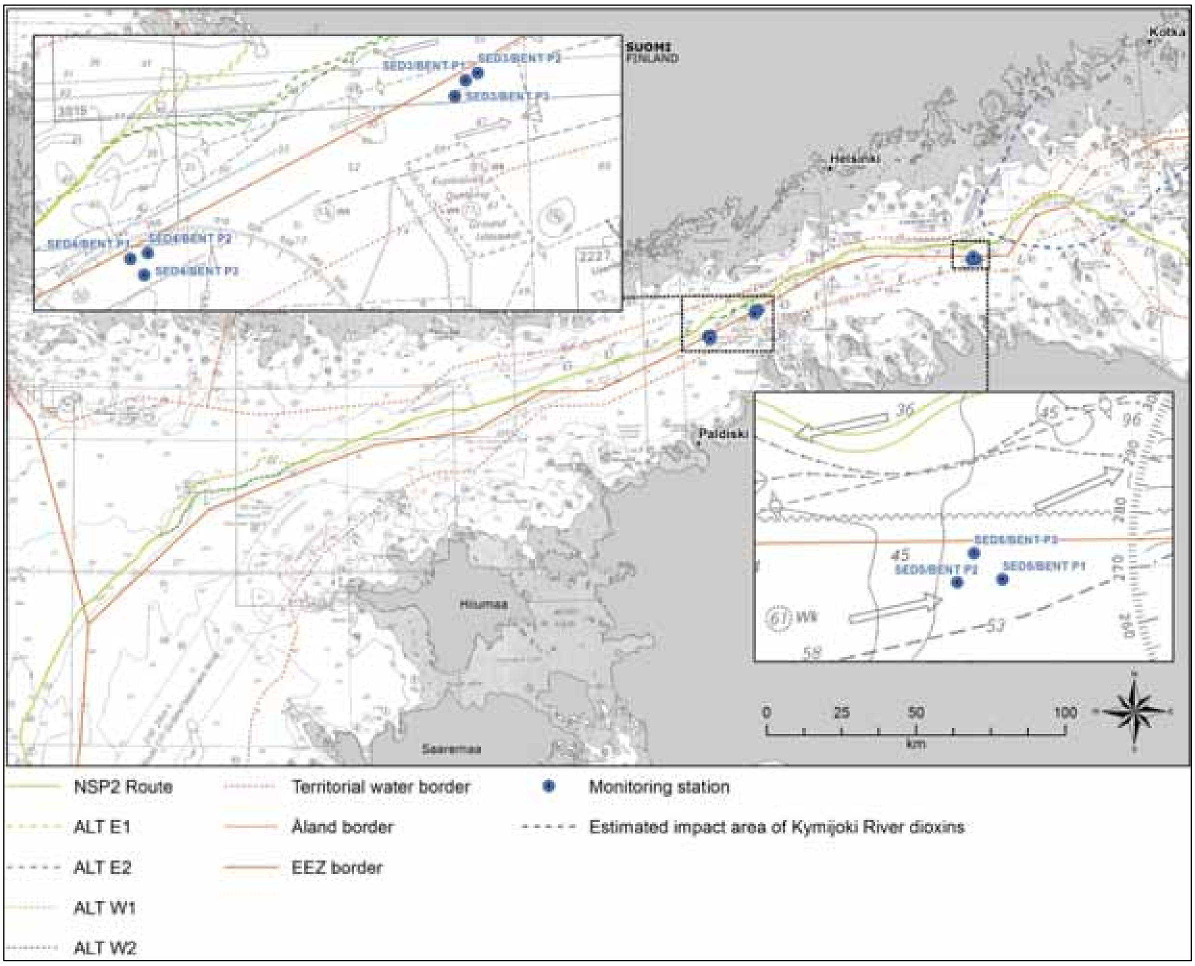

Figure 9-6. Monitoring stations for transboundary impacts (sediment quality, benthos) in Estonian waters during the Nord Stream Project in the Finnish EEZ.

Table 9-5. **Normalised concentrations of metals (mg/kg), tributyltin (µg/kg) and dioxin/furans (ng/kg) in the uppermost seabed surface (0-2 cm) in the Estonian EEZ before (in 2010) and after (in 2012) construction of the Nord Stream pipelines (Figure 9-6). Finnish guideline values for dredged materials are also presented in the table for comparison.**

Compound	Normalised concentration, 0–2 cm						MoE 1/2015[8]	
	SED3 (Est)/2		SED4 (Est)/2		SED5 (Est)/2		Lower guideline value (concentration level 1)* normalised	Higher guideline value (concentration level 2) normalised
	1)	2)	1)	2)	1)	2)		
Arsenic	8.0	7.1	3.3	7.7	N/A	117	15	70
Mercury	<0.10	0.1	<0.10	<0.07	N/A	<0.07	0.1	1
Cadmium	0.9	0.6	<0.4	0.4	N/A	1.8	0.5	2.5
Chromium	42	33	88	32	N/A	19	65	270
Copper	33	27	15	26	N/A	34	35	90
Lead	21	15	13	18	N/A	16	40	200
Nickel	27	22	75	22	N/A	50	45	60
Zinc	110	88	69	83	N/A	229	170	500
Tributyltin (TBT)	2.4	10	15	64	N/A	27	5	150
Dioxins/ furans	4.5	5.3	4.4	8.3	N/A	4.4	5	60

1) Before rock placement

2) After completion of both pipelines

N/A = Not available due to the presence of hard aggregates in sample

* Naturally occurring background level for metals.

Normally, the metal concentrations in the uppermost layer were lower than the lower guideline values in Table 9-5. However, cadmium and zinc concentrations as well as concentrations of TBT and dioxins/furans could have exceeded that threshold value, also prior to the activities.

The results indicate that the seabed in Estonian waters is characterised by small-scale heterogenity. Natural variability in the seabed properties explains the measured differences in contaminant concentrations between sampling campaigns *(Ramboll 2013b)*. In particular, concentrations of an organotin compound, TBT, showed relatively significant variability between sampling locations and different sampling campaigns.

Sediment analysis from the Finnish and Estonian EEZ showed that the changes in the concentrations of harmful substances between the background sampling performed prior to rock placement and upon completion of the NSP pipelines did not indicate any statistically significant trend. Based on monitoring results, the construction activities did not cause any significant relocation of surface sediments and contaminants attached to particles. *(Ramboll 2013b)*

[8] Environmental Administration Guidelines 1/2015. Guidelines for dredging and depositing dredged materials. Ministry of the Environment.

9.4.3 Underwater noise

The baseline data regarding underwater noise is based on the EU LIFE programme supported BIAS Project established in September 2012 *(BIAS 2015)*. More detailed information regarding underwater noise is given in Subchapter 7.7.3.

9.4.4 Benthos

The abundance of zoobenthos in the Gulf of Finland based on the Estonian monitoring results is highly dependent on the oxygen conditions in the near bottom layer. If the oxygen concentration remains below 1.5 mg/l, zoobenthos will perish *(Martin et al. 2016)*.

During environmental monitoring of the construction of the NSP pipelines, benthos samples were taken in 2010 and during 2013–2015 from the same locations as sediment samples (Figure 7-35). Water depth at the sites varied between 63–74 m. The number of macrozoobenthic individuals found in the open Gulf of Finland was small and the frequencies were low. The number of taxa varied between 1 and 5 *(Fish and Water Research Ltd 2016)*. Typically, the dominating taxon in these areas was the non-native polychaeta *Marenzelleria* spp., which can tolerate poor oxygen conditions in its living environment. For some years, the bivalvia *Macoma balthica* has also been observed in the macrozoofauna on soft sediment types. Monitoring results showed that nutrients, metals, organotins and dioxins displaced from the seabed due to the activities did not have any actual impact on aquatic life. *(Ramboll 2013b)*

9.4.5 Fish

As on the Finnish side of the border, the fish community is dominated by European sprat (*Sprattus sprattus L.*) and Baltic herring (*Clupea harengus L.*) and during the winter period, also by the three-spined stickleback (*Gasterosteus aculeatus*). Sprat is the only local fish species that uses offshore waters as a spawning site. Estonian waters near the Finnish border are, however, very marginal for the breeding success of the European sprat (Subchapter 7.10).

9.4.6 Marine mammals

Both ringed seals and grey seals are found in the Estonian waters in the Gulf of Finland. Natura 2000 areas in Estonian waters with grey and ringed seal as part of their selection criteria and situated within 100 km of the NSP2 route are presented in the Table 9-6.

Table 9-6. Natura 2000 areas in Estonian waters with the objective to protect the ringed and/or grey seals.

Sitecode	Site name	Protected species	Min. distance from NSP2 (km)
EE0060220	Uhtju	Ringed and grey seal	38
EE0010171	Kolga lahe	Grey seal	34
EE0010154	Krassi	Grey seal	31
EE0040001	Väinamere	Ringed and grey seal	44
EE0040002	Väinamere	Ringed and grey seal	44
EE0040141	Klaasrahu	Grey seal	66
EE0040476	Tagamõisa	Grey seal	82
EE0040499	Raudrahu	Grey seal	86
EE0040496	Vilsandi	Grey seal	92

The coastline in Estonia does not offer as many suitable resting areas for seals as the coastline of Finland does. Most of the grey seals and ringed seals in Estonia are breeding in the western part of the Gulf of Finland. In Estonian territorial waters, there are seal sanctuaries near Uhtja Island, Kolga Bay, Krassi Island and Väinameri (Appendix 12, Map MA-04-F, Keskonnaamet 2015).

The Estonian ringed seal population is concentrated around Väinameri with hundreds of individuals, and there are only few individuals in the eastern part near the Russian border *(Keskonnaamet 2015)*. There has been discussion on whether the western and eastern ringed seal populations in the Gulf of Finland are actually two separate subpopulations, as satellite tracking data seems to show. The closest distance from the Nord Stream 2 project area in the Finnish EEZ to these areas is approximately 30 km.

According to opportunistic visual sightings (Finnish Ministry of the Environment), very low densities of porpoises is likely present all year in Estonian waters.

9.4.7 Birds

Every year millions of birds follow the eastern coastline area of the Baltic Sea when travelling to and from breeding sites in northern Russia and Siberia. The Gulf of Finland is an important part of this flyway and the majority of birds migrate in the offshore area of the Gulf, with the Estonian parts of the Gulf having higher value than the Finnish parts. As a wintering area, the Gulf of Finland accommodates especially several waterfowl species. Indeed, the majority of the waterfowl species wintering in the Baltic Sea use primarily shallow habitats less than 15 m deep.

The open sea areas in the Estonian EEZ close to the NSP2 pipeline route have value as feeding or stop-over areas for migrating birds but more so for wintering bird species. The most important areas for many seabird species wintering in the EEZ is located in the western part, north from Hiiumaa Island. Near the NSP2 pipeline route, the sea is deeper and these areas are not very attractive for waterfowl species.

9.4.8 Protected areas

There are no protected areas in the Estonian EEZ. Natura 2000 sites with grey seals and ringed seals as part of their protection criteria have been presented in Table 9-6 and Figure 9-7.

9.4.9 Existing infrastructure or other targets

There are six long-term monitoring stations governed by Estonia that are located less than 13 km from the nearest Nord Stream 2 pipeline (Figure 7-35, Table 7-28). Of these, H1 and 25 are located in the Finnish EEZ, and therefore, are presented in Subchapter 7.922. The other four stations (F1, F3, 14, H2) are situated in the Estonian EEZ at a distance of between about 3-13 km from the pipeline route (Table 9-7). In addition, station LL6 is located in Estonian waters and is governed by SYKE.

Two wrecks, named Stella Maris and Virsaitis, and one undefined object of cultural value are located near the NSP2 pipeline route (Figure 9-7).

There are also known cables near the Finnish EEZ border (Appendix 12, Maps: IN-01-F and IN-02-F). The planned Balticconnector pipeline route (Figure 9-7) between Estonia and Finland crosses the NSP2 pipeline route in the Finnish EEZ approximately 3.1 km from the Estonian EEZ border. Further information concerning the crossing of cables and pipelines is given in Subchapter 7.21. The closest planned off-shore wind park areas (max 1,100 MW and 160 wind turbines; 4Energia AS webpage 2016) in Estonia are approximately 23 km from the Nord Stream pipeline route (Figure 9-7).

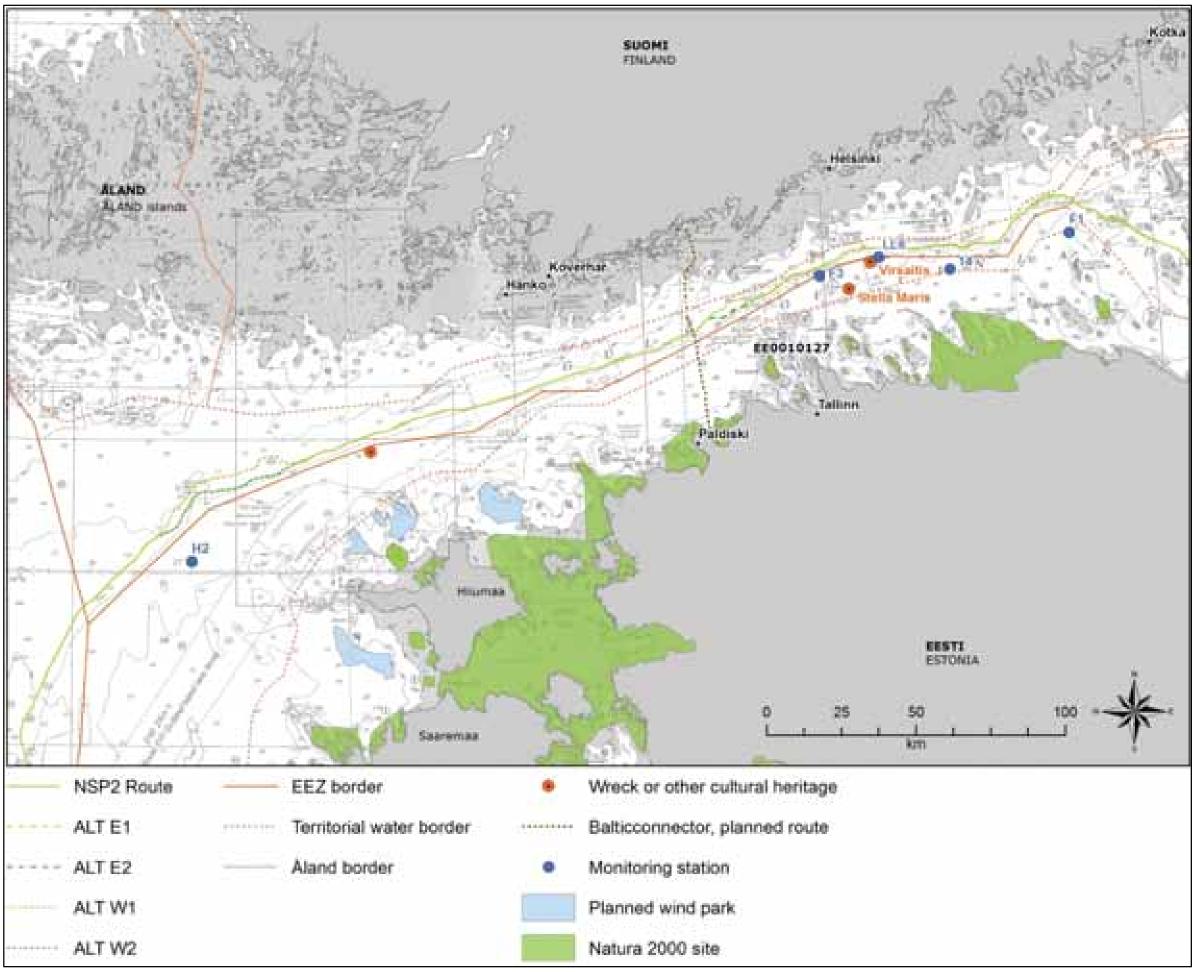

Figure 9-7. Natura 2000 sites, long-term monitoring stations, known wrecks and objects of cultural value in the Estonian EEZ. The figure also presents the installation route for the gas pipeline, Balticconnector.

Table 9-7. Closest objects to the NSP2 route in the Estonian EEZ.

Target		Distance to NSP2 Route (line B), km
Cultural heritage	Wreck Virsaitis (Reg no 30209)	4.4
	Wreck Stella Maris (Reg no 27881)	10.7
	Unknown object of cultural value	5.3
Wind park		23.5
Monitoring stations*	14	8.0
	F1	11.0
	F3	2.8
	H2	12.5

** At each monitoring station, water quality and zoobenthos are monitored.*

9.4.10 Ship traffic

Ship traffic in the Gulf of Finland and in the Northern Baltic Proper is described in Subchapter 7.16

9.4.11 Fishery

According to trawl fishery data from 2013 and 2014 received from the Estonian Ministry of Rural Affairs, the main target species in the Gulf of Finland and in the Northern Baltic Proper (ICES subdivisions 29 and 32 (Figure 7-12 in Subchapter 7.17) were European sprat and Baltic herring. The gear used in the offshore fishery was mid-water trawls towed by either a single vessel or pair of vessels. Bottom trawls were also used on a small-scale in the far end of the Gulf of Finland near the Estonian and Russian borders and outside of the City of Tallinn. When bottom trawling in the eastern Gulf of Finland, the catch consisted of Baltic herring, sprat and small quantities of smelt (*Osmerus eperlanus*). Outside of Tallinn, the catch was insignificant (6 kg of cod).

Measured in weight, in 2014, over 99 % of the Estonian commercial fish catch from the Baltic Sea was caught by mid-water trawl gear. Three fourths (74 %) of the catch by bottom trawl gear consisted of cod and flounder caught from the southern Baltic Sea (ICES 25 and 26; Figure 7-52). The rest (26 %) of the bottom trawl catch was caught from the eastern Gulf of Finland and consisted mostly (95 %) of Baltic herring.

In the EIA Espoo Report for NSP, the Estonian fishery situation before construction of NSP was described as the following: *For the Baltic vessels operating from Estonia, the important species are herring, cod, sprat and salmon. Fishing gear in the Baltic and in the high seas fleet are mostly trawls, mainly targeting herring and sprat. In 2005, 800 tonnes of cod was reported to be taken in sub-square 25, mostly by cod gill netters. Estonia's fishing fleet consists mainly of open boats operating in the coastal waters with gillnets, traps and seines. In coastal fisheries, the most important species by value is herring, followed by perch, pikeperch and flounder.*

9.4.12 People and society

Population

In general, Estonia is relatively sparsely populated. In the beginning of year 2016, the total population was 1.3 million. According to the Statistics Estonia database, the population of Ida-Viru, Lääne-Viru, Harju, Lääne, Saare and Hiiu Counties in January 2016 was as follows: 146,506 (Ida-Viru), 59,467 (Lääne-Viru), 576,265 (Harju), 24,580 (Lääne), 33,481 (Saare) and 9,348 (Hiiu). The population density is greater in the counties of Harju and Ida-Viru.

General environmental awareness

For the assessment of transboundary social impacts to Estonia, a citizen survey was conducted in Estonia (Subchapter 13.1.2.3). According to the survey results, half of the respondents (50 %) see their lifestyle as very environmentally friendly and 46 % consider their lifestyle as somewhat environmentally friendly. The respondents also find that the balance of nature is very delicate and easily upset (93 % of respondents) and when humans interfere with nature, it often produces disastrous consequences (89 %). The survey results indicated that people are concerned about the human impact on the Baltic Sea environment – about half of the respondents (51 %) are somewhat concerned and 40 % of the respondents are very concerned.

Awareness of the Nord Stream and Nord Stream 2 Projects

Most of the respondents of the citizen survey (85 %) have heard something about the Nord Stream Project. The percentage of people who have heard about the Nord Stream 2 Project is somewhat smaller (65 % of the respondents). This can be explained by the fact that during the Nord Stream Project, the media coverage was quite extensive. Due to the fact that the media coverage during the Nord Stream 2 Project has been quite small, the percentage of those who know of the Nord Stream 2 Project is actually relatively high.

The majority of respondents who have heard about these two projects gained their information from television or radio. Websites, newspapers and magazines are also rather relevant information sources. Merely 23 % of the respondents would like to have more information about Nord Stream and only every third would like to have more information about the Nord Stream 2 Project. In Lääne County, the percentage of people who have heard about the Nord Stream 2 Project is considerably higher than in the other coastline counties (Figure 9-8).

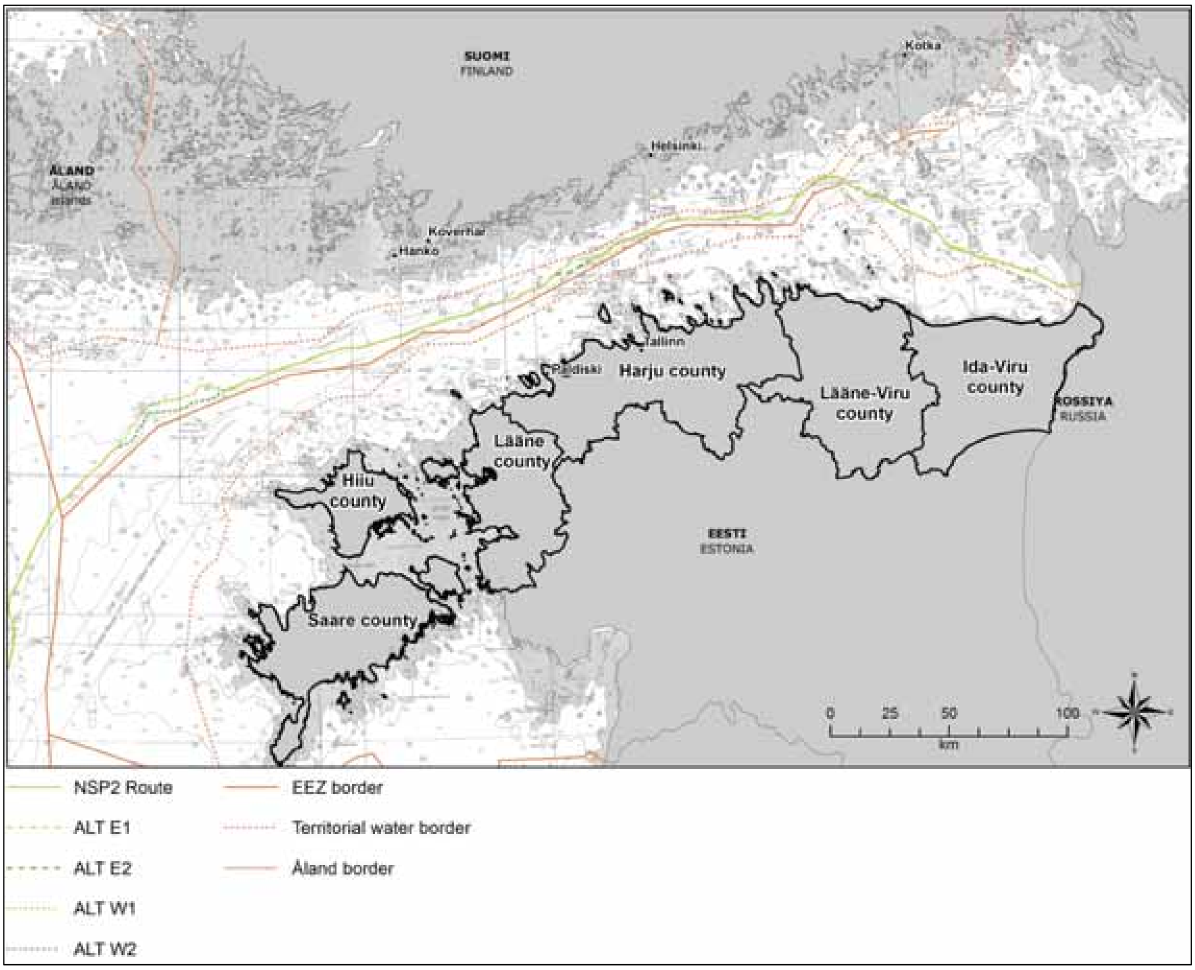

Figure 9-8. **Counties of Estonia along the northern coastline.**

Tourism and recreation

Sea-related summer activities such as sailing, surfing and kitesurfing are popular along the Estonian coast. The coastline has several beaches that attract visitors. The most active harbours are Tallinn Vanasadama Jahisadam (Tallinn Old City Marina), Naissaare Harbour (Harju County) and Kuivastu Harbour (Saare County). Several marinas have plans to increase in capacity. Some are concentrating on international connections and some on leisure boats and yachts.

Local economy

The Estonian economy is currently growing. In general, the Estonian economy is dependent on its neighbours and their economic actions. The most important economic partners to Estonia are Finland and Sweden. The Estonian economy is diverse with industry and transport, as well as commerce and different branches of services being equally important. Due to the available natural resources, the Estonian economy largely relies on sectors related to forestry.

9.5 Sweden

In this subchapter, the transboundary baseline for the most relevant targets of transboundary impacts from the NSP2 Project are presented. Baseline surveys in Swedish waters were carried out during late autumn 2015 by DHI (2016a, 2016b). The northernmost stations in the northern part of the Swedish route (S-ES-05 – S-ES-01) represent the prevailing conditions in the offshore areas near the Finnish EEZ and were used in determining the overall transboundary baseline.

9.5.1 Marine strategic planning: Sweden

The Marine Strategy Framework Directive was incorporated into Swedish law in 2010 as part of the Marine Environmental Regulation (Havsmiljöförordningen), which complies with the directive *(Swedish Agency for Marine and Water Management 2012)*. In Sweden, the biodiversity, commercial fish, eutrophication and contaminants in fish have been assessed to be at an inadequate level (HELCOM 2013c). The main pressures to the Baltic marine environment were found to be biological disturbance, physical disturbance and the loading of nutrients and contaminants.

Qualitative descriptors and current environmental status in Sweden are presented in Table 9-8.

Table 9-8. Qualitative descriptors of good environmental status (HELCOM 2013c).

Qualitative descriptor	Environmental status
1. Biodiversity	Not approached
2. Non-indigenous species	Status not known
3. Commercial fish	Not approached
4. Food webs	No information of the status presented/available
5. Eutrophication	Not approached
6. Seabed integrity	No information of the status presented/available
7. Hydrographical conditions	Good
8. Contaminants	No information of the status presented/available
9. Contaminants in fish	Not approached
10. Marine litter	Status not known
11. Introduction of energy and underwater noise	Status not known

9.5.2 Bathymetry, hydrography and seabed sediments

The environmental conditions in the Northern Baltic Proper, near the Finnish-Swedish EEZ border (<10 km, Figure 7-58), are comparable to the conditions on the Finnish side. The offshore areas in the western Gulf of Finland and northern Baltic Proper are fairly deep (Figure 9-9). In the Baltic Proper (incl. Northern Baltic Proper), the difference between surface and deep water salinity is at present greater compared to in the 1990s, which hinders vertical mixing that could otherwise have oxygenated at least some of the seabed *(HELCOM 2016b)*. Because of the permanent halocline, the waters near the seabed suffer from oxygen deficit (Figure 7-11). This stagnation was clearly visible during the environmental baseline survey in 2015, and dissolved oxygen concentrations near the seabed at the stations nearest to the Finnish EEZ border were extremely low, ca. 0.2 mg/l (Figure 9-10, DHI 2016b).

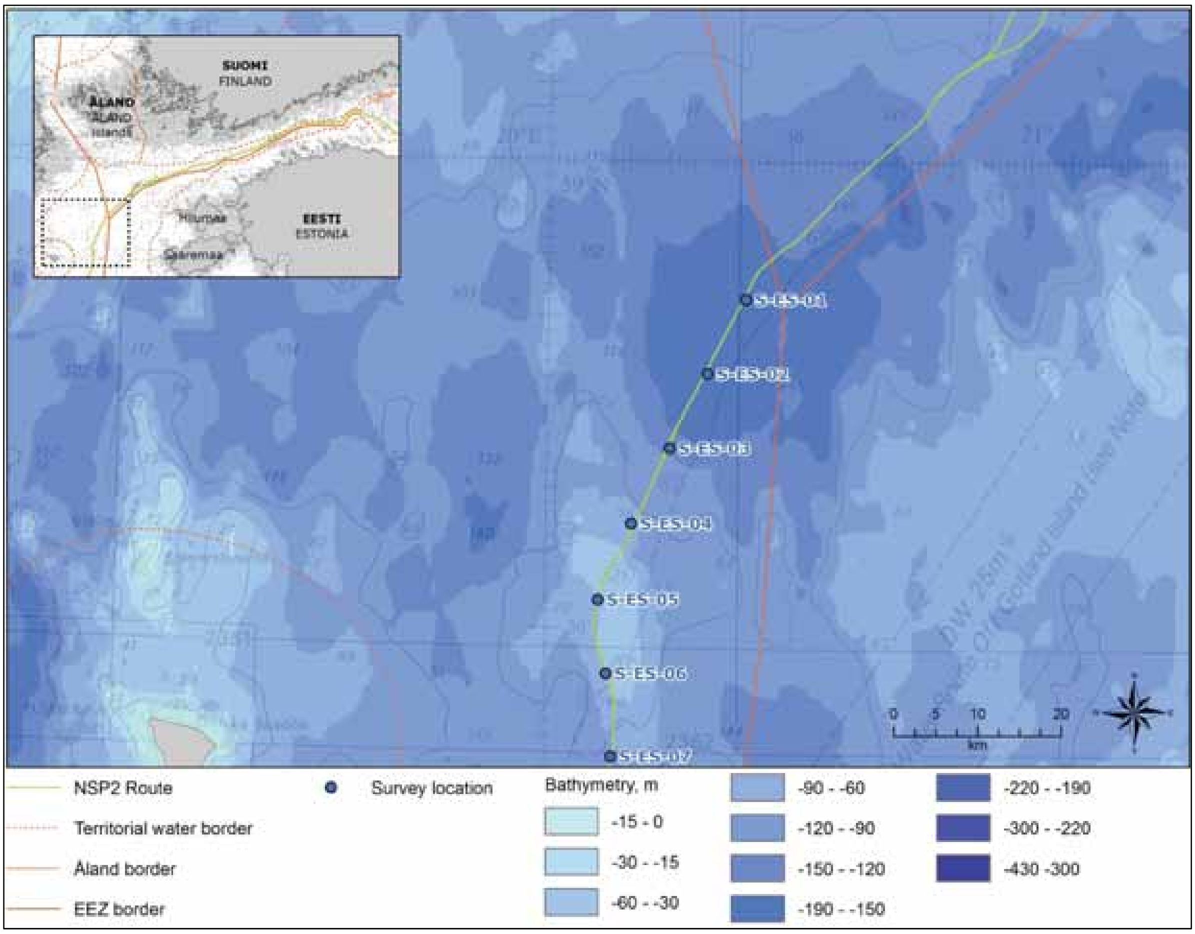

Figure 9-9. Bathymetry of the Baltic Proper and survey corridor in the Swedish EEZ.

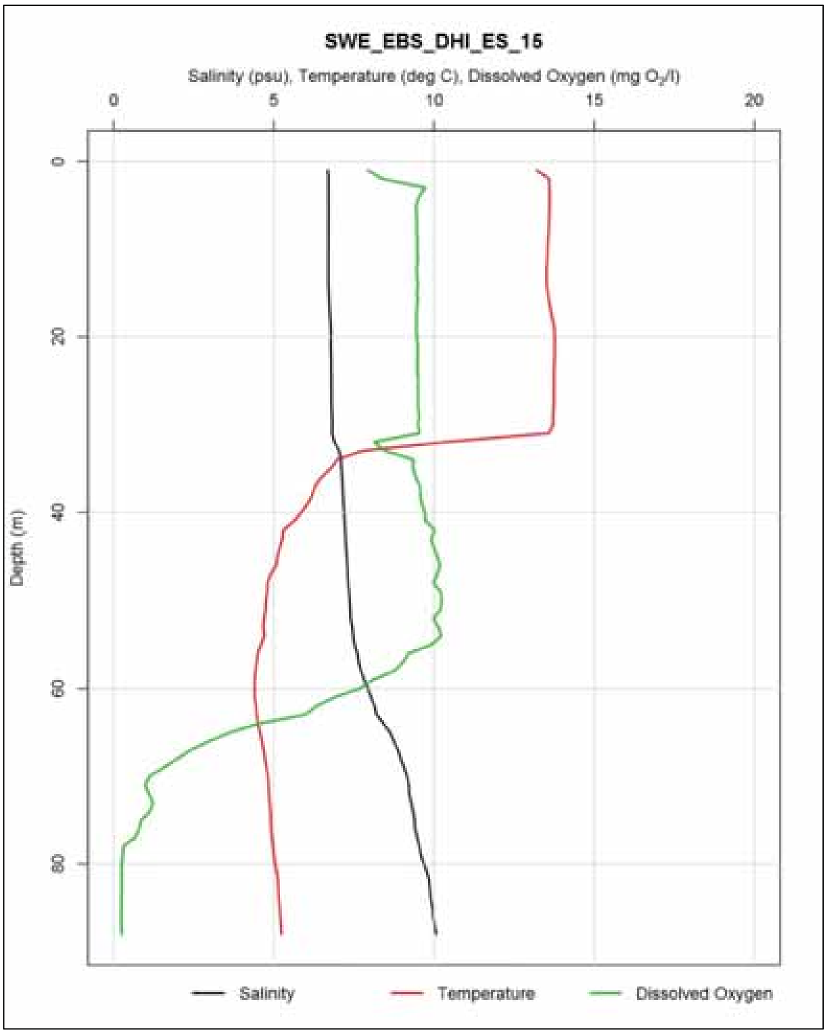

Figure 9-10. **Example of the salinity (psu), temperature (°C) and oxygen (mg O_2/l) profiles in October 2015 in Swedish waters (Station S-ES-01, DHI 2016b).**

According to survey results, surface sediments consist of soft clay, silt and fine sand *(DHI 2016b)*. The content of organic material is relatively high. This refers to conditions on the seabed where accumulation of particles takes place (sedimentation basin).

Figure 9-11. **Surface sediment quality in the northern part of the survey corridor in Swedish waters during the environmental baseline survey in October 2015 (left image: depth 168 m and right image: depth 205 m; DHI 2016b).**

The analysed heavy metal concentrations near the Finnish EEZ in the surface sediments in 2015 are presented in Table 9-9. In general, the survey showed that elevated concentrations of heavy metals and organic contaminants are found at accumulation areas in the northern part of the route. According to Swedish EPA classification *(Naturvårdsverket 1999)*, cadmium concentrations at the northern part of the route were higher than natural background values. Similarly, the sediments in the northern part of the route were contaminated by PAH compounds (indenol(1,2,3-cd)pyrene and bentzo(ghi)perylene).

Table 9-9. Heavy metal concentrations (DW=dry weight) in the surface sediment (0-2 cm, Figure 9-9) in Swedish waters during the baseline survey in 2015, near the Swedish/Finnish EEZ border (DHI 2016b).

Station	As mg/kg DW	Pb mg/kg DW	Cd mg/kg DW	Cr mg/kg DW	Cu mg/kg DW	Co mg/kg DW	Hg mg/kg DW	Ni mg/kg DW	V mg/kg DW	Zn mg/kg DW
S-ES-01	6.4	35.1	0.9	62.5	47.9	20.9	0.09	42.1	77.4	197
S-ES-02	10,0	31	0.4	65.2	40	27.4	0.04	44.2	81.5	209
S-ES-03	10.2	33	0.4	64.5	43.5	25	0.07	43.1	78	203
S-ES-04	0.8	6.9	0.09	7.4	5.0	2.1	<0.01	<5.0	8.1	19.6
S-ES-05	1.5	9.6	0.2	12.1	8.3	3.5	0.03	8	12.7	32.3
Average	**5.8**	**23.1**	**0.4**	**42.3**	**28.9**	**15.8**	**<0.06**	**<34.4**	**51.6**	**132.2**

9.5.3 Underwater noise

The baseline data regarding underwater noise is based on the EU LIFE programme supported BIAS project established in September 2012 *(BIAS 2015)*. More detailed information regarding underwater noise is given in Subchapter 7.7.3.

9.5.4 Benthos

Due to the anoxic conditions, the seabed is lifeless in the deep areas near the Finnish-Swedish EEZ border and no life was found on the seabed during the environmental baseline survey *(DHI 2016a)*.

9.5.5 Fish

As in the Finnish side of the border, the fish community is dominated by European sprat (*Sprattus sprattus L.*) and Baltic herring (*Clupea harengus L.*) and during the winter period, also by three-spined stickleback (*Gasterosteus aculeatus*). Sprat is the only local fish species that uses offshore waters as a spawning site. The Swedish waters near Finnish border are however very marginal for the breeding success of the European sprat (Subchapter 7.10).

9.5.6 Marine mammals

Ringed seal, harbour seal and harbour porpoise are all rare in the easternmost part of the Swedish EEZ. Grey seals in turn are common. The distance from the Finnish project area to nearest islands in Sweden is about 100 km. There are grey seals in the Svenska Björn and Svenska Högarna Natura 2000 sites, located in the Stockholm Archipelago. The Gotska Sandön National Park and Natura 2000 site is more to the south and is located even further from the Finnish border.

9.5.7 Birds

There are no important bird areas, important wintering areas or migratory sto-p-over sites in the vicinity of the survey corridor near the Finnish-Swedish EEZ border.

9.5.8 Protected areas

There are no HELCOM Marine Protected Areas (MPA) or any other conservation sites in the vicinity of the survey corridor near the Finnish-Swedish EEZ border.

9.5.9 Existing infrastructure or other targets

Two known cables (UPT, Sea Lion) and two existing Nord Stream pipelines run from Finnish waters to the Swedish EEZ. The nearest monitoring stations (BY29, LL19) are located approximately at a distance of 8 km from the Finnish EEZ border (Figure 9-12). The LL19 monitoring station (165 m) is used for water quality and benthos measurements and the BY29 monitoring station (170 m) is used for water quality measurements.

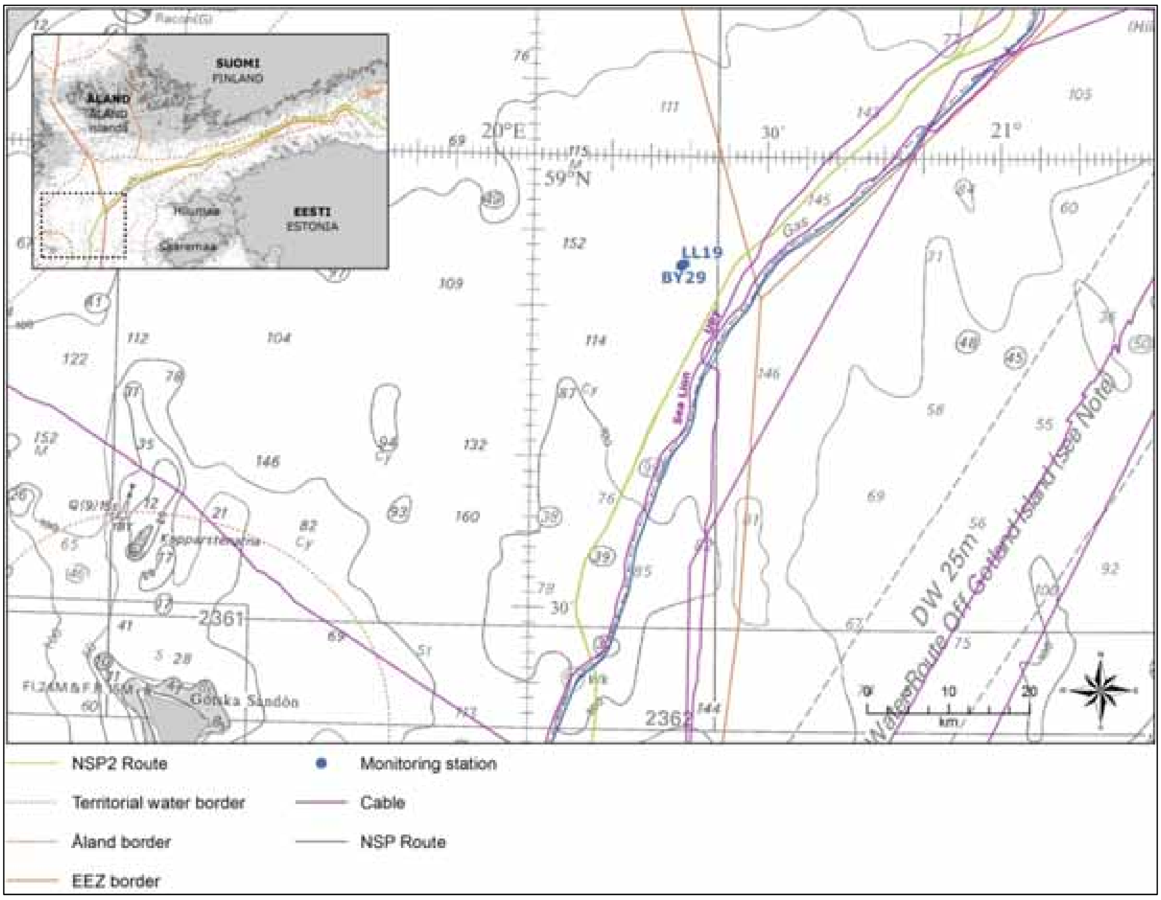

Figure 9-12. **Known cables, the Nord Stream pipeline and long-term monitoring stations in the vicinity of the pipeline route.**

9.5.10 Commercial fishery

According to trawl fishery data from 2010 and 2014 received from the Swedish fishing authorities, the main target species in the Gulf of Finland and in the Northern Baltic Proper (ICES subdivisions 29 and 32 (Figure 7-51 in Subchapter 7.17)) were European sprat and Baltic herring. The gear used in the offshore fishery was mid-water trawls towed by either a single vessel or pair of vessels. The total mean yearly value of the Swedish fishing in the ICES rectangles in the Finnish EEZ was 3,7 M€ by 2010–2014. However, it has to bear in mind that ICES rectangles stretch over jurisdictions of also other countries.

9.5.11 Ship traffic

Ship traffic in the Gulf of Finland and in the Northern Baltic Proper is described in Chapter 7.16

9.6 Other countries

Water quality or noise related impacts originating from the Finnish EEZ are not able to reach other countries jurisdictions. However, EU fishing vessels from other countries are allowed to practice fishing also in the Finnish EEZ outside the Gulf of Finland. According to official catch statistics (2010–2014) Denmark, Germany, Latvia, Lithuania and Poland have registered fish catches from the ICES rectangles which are atleast partly in the Finnish EEZ (Atlas map FC-07-F). The catches caught from these northern ICES rectangles form only a small fraction of the total value of the fish catches by these other countries in the context of the whole Baltic sea (Figure 9-13).

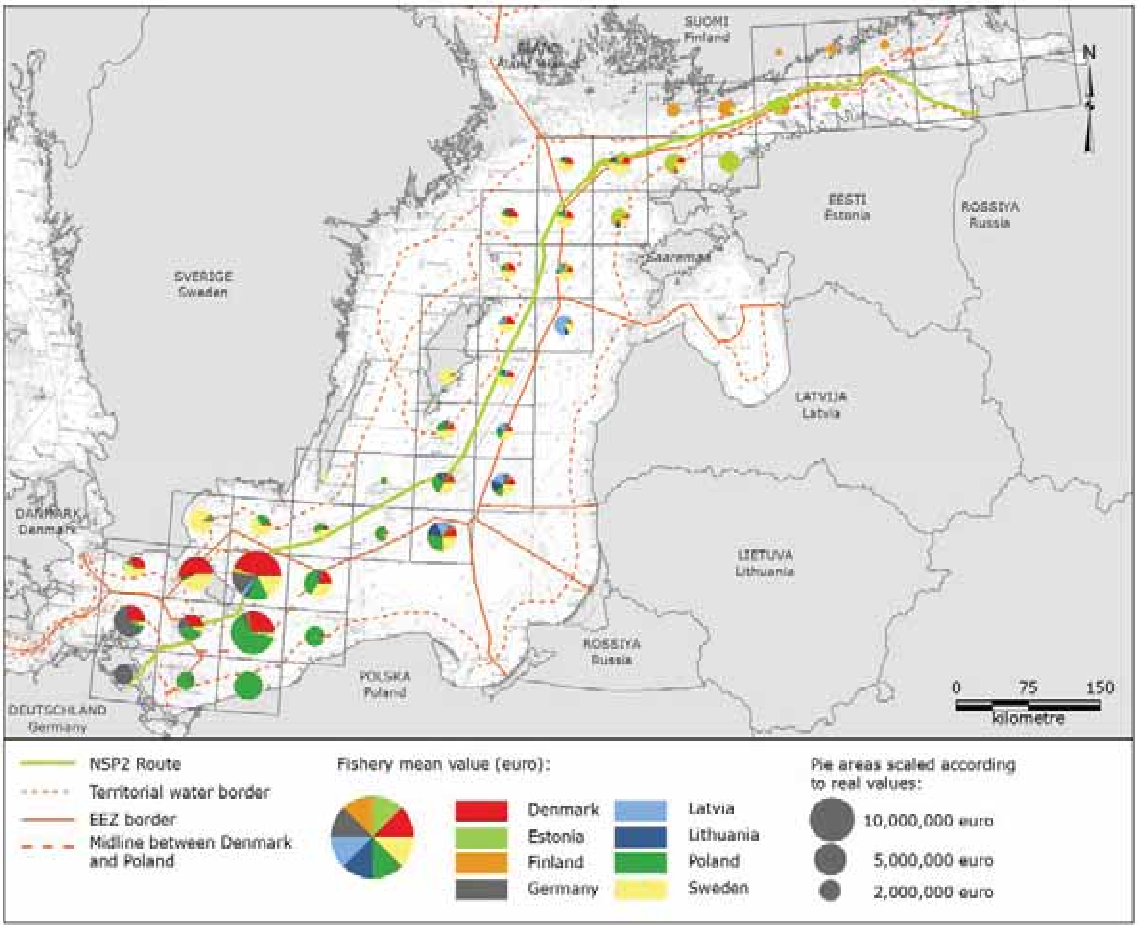

Figure 9-13. Ratio of the mean annual distribution of the value of fishery by country in the ICES rectangles that follow or are adjacent the NSP2 pipeline transect for the period 2010-2014 (*Poland 2009-2013). Source: derived from data obtained from fishery authorities in each country.

10. ASSESSMENT SCOPE AND METHODOLOGY

A systematic approach has been used for the NSP2 Project and is applied in this EIA Report to identify and evaluate the potential impacts that the Project may have on the physical-chemical, biotic and socio-economic environments and to describe mitigation measures to avoid, minimise or reduce these impacts. The overall methods and concepts as well as the relevant terminology used in assessing impacts are described in this chapter. The methodology is to a large extent based on the experiences gained during the assessments for NSP, and is similar to, and a refinement of the methodologies and the principles of IMPERIA assessment methodology *(Mustajoki 2015)* based on multiple-criteria decision analysis.

The method is developed to ensure that all impacts, including direct and indirect, secondary, cumulative and transboundary, are assessed as part of the EIA.

10.1 Scope of assessment and impacts studied

10.1.1 Scope of assessment

Nord Stream 2 AG has determined the scope of this EIA pursuant to the Finnish EIA legislation and the EIA Directive and as instructed by the Finnish Authorities. In addition, the precedents of the ECJ and Finnish Supreme Administrative Court, as well as guidance documents published by the Commission and the Finnish authorities, and the guidance received on the EIA programme from authorities, stakeholders and NGOs, have been used in order to determine the scope for this EIA and the level of assessment for the associated/ancillary works. Furthermore when defining the scope of this EIA, Nord Stream 2 AG has applied the centre of gravity test developed by the Commission in relation to the first Nord Stream project.

When determining the scope and applying the centre of gravity test, Nord Stream 2 AG has considered whether the activities are central or peripheral to the project. Associated/ancillary activities that are peripheral to the project may be permitted and start independently of the main project, but the EIA for the project will still need to address likely significant effects of these peripheral activities.

The following factors are taken into account when evaluating whether the associated/ancillary activities conducted in Finland are either peripheral or central, inextricably linked, to the main project:

- Whether ancillary activities predetermine the location of the main project intervention;
- Whether ancillary activities represent a location-specific part of the construction phase of the main project intervention;
- Whether ancillary activities are exclusively and entirely intended to serve the main project intervention;
- Whether the ancillary activities are likely to predetermine the result of the EIA process for the main works.

The activities numbered in figure 10-1 and table 10-1 below are divided into three main activity streams being:

- Supply chain: Pipe manufacturing and transport thereof (not ancillary/associated works)
- Ancillary activities: Pipe coating including receipt, coating, storage, transhipment
- Ancillary activities: Rock quarrying, transport and storage

Supply chain activities include pipe manufacturing and rail transportation to the coating plant in Kotka (performed by an external supplier using existing pipe mills in Russia and rail network), and material (iron ore, cement, wire) supply to the coating plant in Kotka. As these (Activities 1 - 3 Table 10-1) are a part of the supply chain and not ancillary activities/associated works, they have not been assessed in this EIA.

Concrete weight coating is performed by a supplier using an existing coating plant. Transhipment of the coated pipes uses existing transport routes and the storage areas are within existing harbour facilities. These activities (Activity 4 to 7, Table 10-1) are considered peripheral and not inextricably linked to the main project as:

- The coating plant is an existing facility, used during the Nord Stream Project, and not exclusively and entirely intended to serve Nord Stream 2 AG. Whilst Nord Stream 2 AG is the sole client for the duration of coating for project, the coating plant may be used for other clients in the future. The coating plant is operated by independent supplier.
- Transport of materials by vessel, rail and road use existing routes and the traffic volume increase compared with existing traffic volumes is not significant.
- Storage areas are within the existing harbour areas, they have been used for other purposes and clients in the past and likely to be used by others in the future.
- The location of the project within the Finnish EEZ is not dependent on the location of the coating plant, transportation routes or storage areas.
- The ancillary activities do not change the assessment results of the main project.

Quarrying of rock material is performed by a supplier using existing quarries. Transport of rock material from the quarry to the harbour uses existing roads. Storage areas are within existing harbour facilities. These activities (Activity 8 to 10, Table 10-1) are considered peripheral and not inextricably linked to the main project as:

- The quarries are existing facilities and not exclusively and entirely intended to serve Nord Stream 2 AG. Rock extraction for Nord Stream 2 AG will use only a part of the volume of the quarry. The quarries will be used for other projects during and following the NSP2 project.
- Transport of materials by road uses existing routes.
- Storage areas are within the existing harbour areas, they have been used for other purposes and clients in the past and likely to be used by others in the future.
- The location of the project within the Finnish EEZ is not dependent on the location of the quarries, transportation routes or storage areas.

The overall conclusion when applying the centre of the gravity test for the concreate weight coating plant and the quarrying of rock material i.e. the above listed ancillary activities is that these activities are not considered to be central and inextricably linked to the main project. The activities do not need to be performed in a location pre-determined by the project, they are not a location specific part of the construction nor do they entirely serve the main project. The environmental effects of these ancillary activities are nevertheless assessed in this EIA.

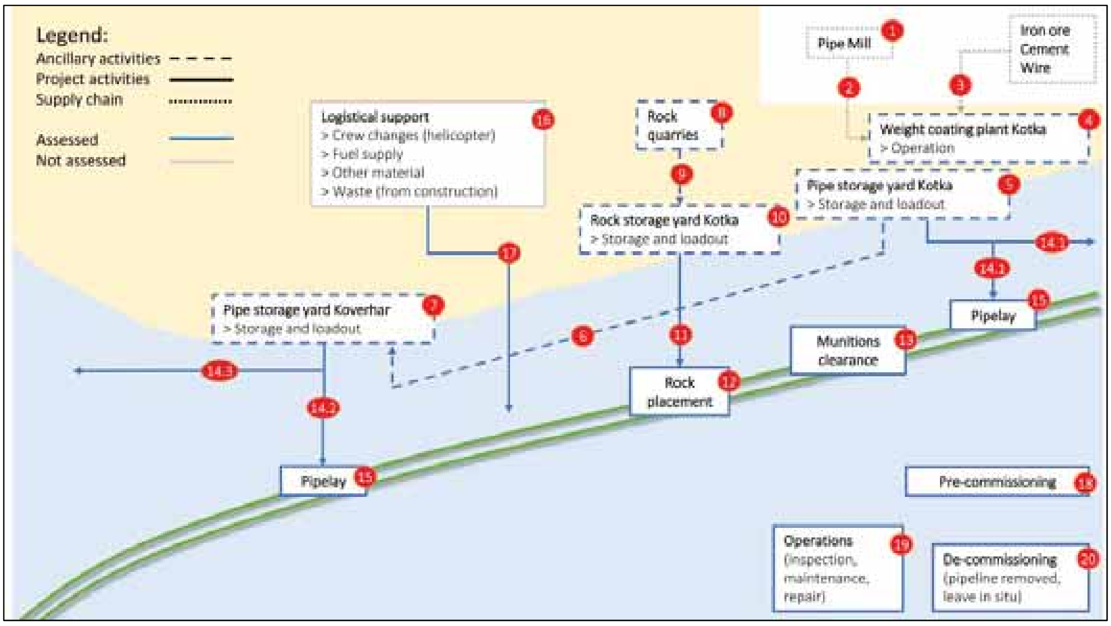

Figure 10-1. Schematic presentation of the scope for the Nord Stream 2 EIA (see definitions of the red legends in Table 10-1).

Table 10-1. Definitions and classifications of activities.

No.	Activity	Classification	Assessment level	Justification / Comments
1	Pipe manufacture at pipe mill	Commodity supplier	Not assessed	Nord Stream 2 AG is one of several Clients for the pipe mills and uses only a part of the capacity at the pipe mills. The pipe mills are not exclusively and entirely intended to serve Nord Stream 2 AG.
2	Transport from mills to Kotka	Commodity supplier	Not assessed	Rail transport uses the existing network and the traffic volume increase due to pipe transport from Russian pipe mills to Kotka compared with existing traffic volume is not significant
3	Transport of materials to Coating plant in Kotka	Commodity supplier	Not assessed	Transport of materials uses existing roads and shipping lanes. Traffic volume increase is not significant when taking into account the existing traffic volume into the Kotka area.
4	Concrete weight coating (CWC) plant in Kotka	Ancillary facility	Assessed	The CWC plant located in the Kotka port area was also used by Nord Stream AG. The facility is owned and operated by a service provider. The plant is assessed on a general level in line with the Finnish EIA coordinating authority statement on the EIA programme.
5	Kotka storage yard	Ancillary activity	Assessed	Uncoated and coated pipes are stored onshore within the existing Kotka port area. The existing quays are used for pipe load-out.
6	Trans-shipment of pipe	Ancillary activity	Assessed	Coated pipes are trans-shipped by freighters using established shipping routes to storage yard in Hanko Koverhar.
7	Koverhar storage yard	Ancillary activity	Assessed	Receipt of coated pipe, pipe storage on land within the existing Koverhar port area. Existing quays are used for pipe load-in and load-out.
8	Extraction of rock material at quarries in Kotka region	Ancillary activity	Assessed	Source of rock is not known at the time of EIA Report preparation. Key assumptions are: • Extraction of rock from existing permitted quarries • Extraction volumes do not exceed maximum permitted annual extraction rates.
9	Transport of rock from quarry to port	Ancillary activity	Assessed	Source of rock not know at time of EIA Report preparation. Key assumptions: • Assessment of transport from quarries via highway to port. Quarries assumed same as in Nord Stream.
10	Storage of rock in Kotka and load-out	Ancillary activity	Assessed	Rock will be stored at the existing quay within Kotka harbour area. Load-out of rock onto rock placement vessels will be at the existing quay within Kotka harbour area.
11	Transport of rock to placement location	Project activity	Assessed	Rock material is transported by the rock placement vessels using established shipping routes to the placement locations. - approximately 160 shipments to the pipeline route in Finnish EEZ - approximately 60 shipments to the pipeline route in Russia
12	Rock placement	Project activity	Assessed	Pre- and post-surveys as part of rock placement activity. Controlled placement of rock using a dedicated dynamically positioned fall pipe vessel.
13	Munitions clearance	Project activity	Assessed	Impact assessment is based on Nord Stream experience regarding type and extent of munitions and applied mitigation.
14	Pipe Supply	Project activity	Assessed	Coated pipe joints are transported by pipe supply vessel to the pipe-lay vessel using established shipping routes. In total 62,000 pipes to Finnish EEZ estimate following frequency of shipments: • 14.1: 49,000 pipes to pipelay barge from Kotka harbour to: Finnish EEZ (30,000 pipes) and Russian TW (19,000 pipes) • 14.2: 32,000 pipes to pipelay barge from Koverhar harbour to Finnish EEZ • 14.3: 30,000 pipes from Koverhar to Sweden
15	Pipelay	Project activity	Assessed	Pre- and post pipelay surveys as part of pipelay activity. Pipelay from anchored and dynamically positioned vessels
16	Pipelay support logistics	Project activity	Not assessed	Logistics base within established harbour. Port services are not exclusively utilised for the project. Airport services from established airport. Airport services are not exclusively utilised for the project.Waste disposal facilities are not exclusively utilised for the project.
17	Pipelay support logistics	Project activity	Assessed	Ship transport (supply fuel, food and consumables, waste). Helicopter flights from Helsinki (Malmi) or Turku.
18	Pre-commissioning	Project activity	Assessed	Two pre-commissioning options (wet and dry) assessed
19	Operation	Project activity	Assessed	External and internal inspection surveys. Rock placement as maintenance. Repair scenarios assessed as unplanned events.
20	Decommissioning	Project activity	Assessed on a general level	Two options (leave in-situ and recovery) described. Environmental considerations of decommissioning included in the EIA Report.

The next step undertaken in the EIA has been to identify the scope of the assessment, i.e. to identify the range of environmental and socio-economic components (receptors) to be studied, the geographical area to be covered and the time frames over which the project will be carried out.

The project description (Chapter 4) forms the foundation for the impact assessments. It defines the technical components of the project (the pipeline system) and describes all pertinent activities associated with the pipelines, such as construction activities, logistical support and ancillary activities as well as pipeline decommissioning.

Project activities as well as ancillary activities assessed in the Nord Stream 2 Finnish EIA are presented in Figure 10-1 and Table 10-1. For information purposes supply chain activities (1–3) are presented in the aforementioned figure and table.

10.1.2 Receptors susceptible to impacts

The relevant environmental and socio-economic receptors which the project may impact are summarised in Table 10-2 and presented in detail as part of the baseline description in Chapters 7 and 8. The potential impacts upon each component are assessed in Chapters 11 and 12.

Table 10-2. Receptors susceptible to impacts associated with the NSP2 Project.

	Environment	Receptor
Offshore	Physical and chemical environment	Climate and air quality
		Seabed morphology and sediments
		Hydrography and water quality
		Underwater and airborne noise
	Biotic environment	Benthic flora and fauna
		Fish
		Marine mammals
		Birds
		Protected areas
		Non-indigenous species
		Biodiversity
	Socio-economic environment	Ship traffic
		Commercial fishery
		Military areas
		Existing and planned infrastructure and utilization of natural resources
		Scientific heritage
		Cultural heritage
		Social impacts
		Compliance to Marine Strategy Framework Directive
Onshore	Environment Kotka region and Koverhar, Hanko	Land use
		Air quality
		Airborne noise
		Road traffic and safety
		Social impacts
		Protected areas

10.1.3 Area definitions

Offshore impacts of the NSP2 Project in the Gulf of Finland will mainly occur in the EEZ waters or in territorial waters of Russia close to the Finnish EEZ. Onshore impacts caused by the ancillary activities in the Kotka region will primarily take place in the vicinity of potential quarries, in Mussalo Harbour/Palaslahti industrial site and along the rock transportation route. Impacts associated with the storage yard of pipes at Koverhar, Hanko, will occur within the Koverhar harbour area. Construction vessels will have specified temporary safety zone (third party exclusion zone). Depending on the on-going activity, the radius of the safety zone will vary from 0.5 km to 2–3 km.

Definitions of the different kinds of areas used in this EIA Report are presented in Table 10-3.

Table 10-3. Type of areas.

Type of area	Definition of area
Survey area	Area where baseline environmental, geotechnical and geophysical surveys were carried out in the Finnish EEZ. The width of the survey area varied from 1.2 km to 5.2 km along the pipeline route corridor.
Project area	The area of physical activity or disturbance related to the project. The broadest physical extent of the project's influence on the environment. Also the area where adverse impacts are anticipated and subsequently investigated and assessed. Typically the main impacts are limited near the construction activities, with an impact radius of up to a few hundreds meters.
Impact area	Area were impacts on the surrounding environment are finally assessed to appear (based on e.g. modelling results). The extent of the impact area can vary according to the construction activity. The largest impact areas will be created by munitions clearance (underwater noise). The definitions of areas related to different receptors are presented in Chapters 11 to 14 as a result of the assessment work.

10.1.4 Impact identification

Potential impacts have been identified by considering the various project and ancillary activities (Chapters 11 and 12) and how the project may interact with its environmental and socio-economic resources and receptors. This has required detailed understanding of the various activities and baseline conditions. Furthermore, the evaluations performed during planning, construction and operation of NSP have served as important input to the identification of potential impacts for NSP2.

The identification of potential impacts of the project included consideration of the following:

- Scope of assessment – the scope of assessment highlights the potential environmental and socio-economic resources and receptors that may be impacted during a certain time frame and over a certain distance.
- Project description – a thorough evaluation of the project design, project phases and activities and the processes involved, leading to an identification of project activities causing potential environmental and socio-economic impacts.
- Stakeholder input – the input of stakeholders has been considered in identifying the potential impacts that are of concern to those parties that may be impacted by the project.
- Expert knowledge – expert knowledge from scientists and regulators familiar with the Baltic Sea as well as the prior experience of pipeline engineers and EIA specialists with experience from similar marine pipeline projects has contributed to the identification of impacts.

Potential impacts from project and ancillary activities that have been assessed are summarised in their respective impact assessment sections.

10.2 Approach and methodology to impact assessment

During the EIA procedure, the direct and indirect environmental impacts that may arise from the natural gas pipeline project have been systematically identified and assessed. An impact is defined as a change in the environment. The magnitude of this change has been evaluated against the current state and sensitivity of the environment.

One of the main aims of the assessment work has been to identify the impacts that are evaluated as being most significant, either alone or together with other impacts and, thus, are taken into consideration in the project design.

Appropriate measures are presented on how to prevent, mitigate or reduce recognised negative environmental impacts.

The impact assessment methodology takes into consideration the nature, type and degree of reversibility of the impact, the magnitude of change, and the current state and sensitivity of resource/receptor in order to make an overall significance rating for the impact (Figure 10-2).

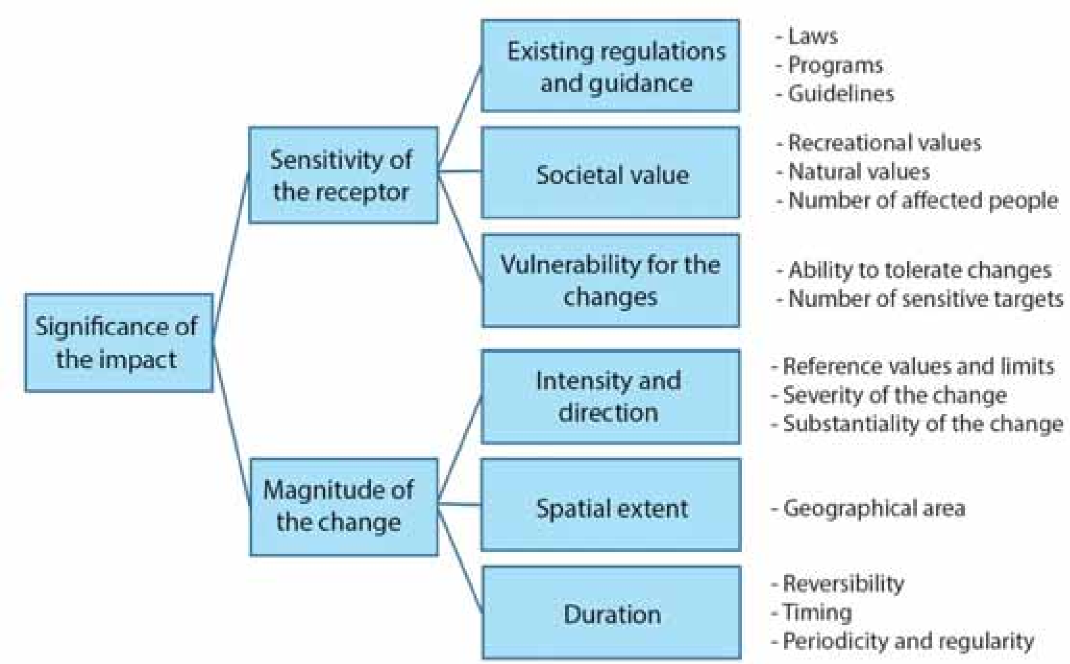

Figure 10-2. Framework for assessing the significance of an impact (Mustajoki 2015).

10.2.1 Nature, type and reversibility of potential impacts

Impacts are classified according to their nature as causing either negative or positive changes to the physical-chemical, biotic or socio-economic environment. Type refers to whether an impact is direct, indirect or cumulative. The degree of reversibility refers to the capacity of returning an impacted resource/receptor to its pre-impact state. Such characteristics are relevant to the EIA process, in particular in developing the mitigation or enhancement measures that can be applied and evaluating the degree to which the predicted impacts can be managed by such measures. Nature, type and reversibility of the impact are further discussed in Table 10-4.

Table 10-4. Classification of change in the environment.

Nature of impact
Negative: an impact that is considered to represent an adverse change from the baseline or to introduce a new, undesirable factor.
Positive: in certain cases an impact can be an improvement to the baseline or introduce a new, desirable factor.

Type of impact
Direct: impacts that result from a direct interaction between a project or an ancillary activity and the receiving environment (e.g. the loss of a habitat during pipeline installation).
Indirect: impacts that result from other activities that happen as a consequence of the project (e.g. an increase in fishery activity along the pipeline route due to the creation of an artificial habitat favourable to certain target species).
Transboundary: direct or indirect impacts that result from activities in one country and may result in the occurrence of significant impacts in neighbouring countries (e.g. the dispersion of resuspended sediment in the water column, or propogation of noise across national borders).
Cumulative: impacts that act together with other impacts (including those from previous, 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 similar projects in the Gulf of Finland).

Degree of reversibility
Reversible: impacts on resources/receptors that cease to be evident, either immediately or following an acceptable period of time, after termination of a project activity (e.g. turbidity levels in the water column will return to normal levels shortly after the construction works in an area are finalised).
Irreversible: impacts on resources/receptors that are evident following termination of a project activity and which remain for an extended period of time. Impacts cannot be reversed by implementation of mitigation measures (e.g. the occupation of seabed by the pipelines).

While highly unlikely to occur, impacts from unplanned or non-routine events (e.g. a fuel/oil spill during construction) could have substantial consequences and therefore also require consideration. The risks and their environmental consequences in the construction and operation phases has been undertaken as part of the risk assessment reported in Chapter 13.

10.2.2 Sensitivity of a receptor

Sensitivity of a receptor (e.g. organism, site, area) describes its susceptibility to any change caused by project or ancillary activities. Expert judgement and stakeholder consultation ensure a reasonable degree of consensus on the intrinsic value of a receptor. Various criteria are used to determine the sensitivity including resistance to change, adaptability, rarity, diversity, value to other resources/receptors, naturalness, fragility and whether a receptor is actually present during the active phase of the project, among other criteria. The criteria for the biological environment are applied with taking into account e.g. seasonal variation and lifecycle stages of different species. For example, birds are typically most sensitive to the impacts during breeding season, but for some species, also migratory or moulting periods can be sensitive. The assessment of value/sensitivity of a habitat is a combination of the variables applicable to both the physical-chemical and biotic environment.

Aspects arising from legislative steering and the specific societal significance of the area or issue have been taken into account in the evaluation process. For every receptor, the sensitivity of the target has been classified into subclasses *High*, *Medium* or *Low* (see criteria tables in relevant subchapter). An example of a sensitivity classification is presented in Table 10-5.

Table 10-5. Example of sensitivity classification of the receptor (fish).

Low	There are neither threatened fish species nor important fish spawning areas in the vicinity of the project area. The status of the exploitable fish stocks in the project area are well above sustainable level.
Medium	Threatened fish species may occur in the project area and nearby areas but there are no important spawning areas. The status of the exploitable fish stocks in the project area are on sustainable level.
High	Threatened fish species and important spawning areas occur in the vicinity of the project area. The status of the exploitable fish stocks in the project area are below sustainable level. There are underwater Natura 2000 habitat types or nature reserves that could support diverse and healthy fish communities in the area.

10.2.3 Magnitude of change

Magnitude of change is a measure of intensity, direction, spatial extent and duration of the change in the baseline conditions caused by the project.

In general, the spatial extent of the particular impact can be ranged as local, regional, national or transboundary. The duration of the impact can be categorized as temporary, short-term or long-term. The parameters of change have been defined individually for each receptor (see criteria tables in relevant subchapter).

The magnitude of change has been attempted to be expressed in quantifiable terms, where possible. Otherwise, the impact has been assessed qualitatively based on expert opinion. Expert judgment and prior experience of the EIA team in the environment in question (e.g. Nord Stream project) have ensured a reasonable degree of consensus on the value placed on an impact variable. An example of the magnitude of change classification is presented in Table 10-6.

Table 10-6. Example of classification of magnitude of change (fish).

Negligible	No detectable impacts on fish species, their living conditions or breeding areas.
Low	Temporary (months) increase of suspended solids concentration <10 mg SS/l (threshold for escape of fish), limited in space (<0.5 km from the source). Concentration of contaminants in suspension is low. Temporary reduction in the size of breeding areas. Underwater noise level from activity is lower than 203 dB SEL.
Medium	Short-term (under two growth seasons) increase of suspended solids concentration >10 mg SS/l, limited in space (0.5–2 km from the source) or concentration of contaminants in suspension is moderate. Reduction in size of breeding areas. Underwater noise level from activity is over 203 dB SEL but less than 207 dB SEL.
High	Long-lasting (many growth seasons) increase of suspended solids concentration >10 mg SS/l, in large impact area (>2 km form the source) or concentration of contaminants in suspension is high. Destruction or deterioration of breeding areas. Underwater noise level from activity is 207 dB SEL or higher.

Various methods have been employed in determining the value of the variables that compromise the magnitude of change. These include:

- The use of sophisticated modelling techniques to determine the extent of interaction between a project activity and the receiving environment
- The use of Geographical Information Systems (GIS) to plot receptors in relation to the pipeline route and the sphere of influence of an impact (determined by modelling, previous studies and available literature)
- Statistical evaluation
- The results of desk studies and field surveys of the presence and sensitivity of receptors

At the end of each impact assessment subchapter, the magnitude of the change for a particular examined impact has been assessed into subclasses *High*, *Medium*, *Low or Negligible*.

10.2.4 Significance of an impact

Virtually all human activity imposes some disturbance (negative impact) to components of the environment due to physical impacts on natural systems or interactions with other human activities and human systems. Often such impacts are slight or transitory and have an impact that may be regarded as neglibigle.

There is no statutory definition of *significance* and the determination of significance is, therefore, subjective by default. For the purposes of the EIA, the following definition of significance has been adopted:

- An impact, either in isolation or in combination with other impacts, assessed to be significant by the EIA specialists, should be accounted for in the decision-making process together with the necessary mitigation measures (from the project) and consenting conditions (from regulators and stakeholders).

Criteria for the assessment of the *significance* of an impact stem from the following key elements:

- The *sensitivity* of the receptor: The sensitivity of the receptor is determined to allow the assessment of the sensitivity of the receptor to change (impact). Various criteria are used to determine value/sensitivity including rarity, diversity, natural occurrence, fragility and whether a receptor is actually present during a project activity, among other criteria. Regulations and social values should also be used to determine sensitivity.
- The *magnitude* of change: The magnitude (in terms of the spatial extent, duration and intensity of the impact) of the change to the physical-chemical, biotic and socio-economic environment is expressed, wherever practicable, in quantitative terms. For social/socio-economic impacts, the magnitude is viewed from the perspective of those affected, by taking into account the likely perceived importance of the impact and the ability of people to manage and adapt to the change.

In determining significance, the status of compliance of each impact is also considered in terms of its conformity with relevant government legislation, standards and limits, its degree of alignment with applicable policies and plans and whether any guidelines, environmental standards and company/industry policies are pertinent to the potential impact.

Significance of an impact has been assessed on the basis of a framework formed by the sensitivity of the receptor to changes and the magnitude of change caused by the project or ancillary activities.

Table 10-7 presents the cross tabulation of the aforementioned sensitivity and magnitude parameters. The result is the significance of the impact to the assessed receptor.

Table 10-7. Indicative table of the methodology to evaluate overall significance of an impact.

Impact significance		Magnitude of change						
		High	Medium	Low	Negligible	Low	Medium	High
Sensitivity of receptor	Low	Moderate	Minor	Minor	Negligible	Minor	Minor	Moderate
	Medium	Major	Moderate	Minor	Negligible	Minor	Moderate	Major
	High	Major	Moderate	Moderate	Negligible	Moderate	Moderate	Major

The method described above was applied to the following receptors:

- Seabed morphology and sediments
- Hydrography and water quality
- Benthic flora and fauna
- Fish
- Marine mammals
- Birds
- Protected areas
- Ship traffic
- Commercial fishery
- Existing and planned infrastructure and utilization of natural resources
- Scientific heritage
- Cultural heritage
- Social impacts offshore
- Onshore – Land use
- Onshore – Air quality
- Onshore – Noise
- Onshore – Protected areas
- Onshore – Road traffic and safety
- Onshore – Social impacts

For every receptor the following summary table is presented at the end of each relevant impact assessment subchapter:

Table 10-8. Example of the significance of the impacts on fish.

Impacts on fish	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Impacts on fish due to munition clearance	Medium	Negligible	Negligible
Avoidance reactions due to spreading of sediments	Medium	Negligible	Negligible
Effects on fish eggs and larvae	Medium	Negligible	Negligible
Effects on fish due to release of contaminants	Medium	Negligible	Negligible
Operation phase			
Forming of an artificial sanctuary for fish	Medium	Negligible	Negligible

10.2.5 Approach to mitigation

A key objective during the planning and design of NSP2 has been to identify means of reducing adverse impacts of the project on the receiving environment. To achieve this, mitigation measures have continually been developed and integrated into the various phases of the project. These mitigation measures have been established on the basis of legal requirements, best practice industry standards, experience from the existing NSP pipelines or input from environmental specialists.

In developing mitigation measures, the first focus has been on measures that will prevent or minimise impacts through the design and management of the project rather than on reinstatement and compensation measures.

In this EIA, the significance of an impact upon the receiving environment is assessed on the present project design, by taking into account the implementation of mitigation measures that have been designed into the project. Impacts assessed to be "major" or "moderate" after the application of the intended mitigation measures will be subject to further mitigation measures development and on-going management and monitoring during the subsequent project phases. Mitigation measures are suggested in this EIA where applicable and are summarised in Chapter 16.

10.2.6 Impact management

Once potential impacts have been identified and assessed and the necessary mitigation measures associated with an impact have been agreed within Nord Stream 2 AG and approved in the permitting process, mitigation measures are integrated into the project.

In order for this to be successful, a plan detailing responsibility, timing and reporting requirements associated with each measure or set of measures is compiled. Various forms of monitoring are developed to ensure that the functionality and success of each mitigation measure is assessed to ensure that impacts are at an acceptable level by best practical means throughout the project and to highlight possible areas that require improvement. The above information is most effectively captured within an Environmental and Social Management System (ESMS).

An ESMS seeks to manage all interaction between the various project activities and the receiving environment during the project lifecycle. Information on the project's approach to environmental management and monitoring is presented in Chapter 19 and Chapter 18, respectively.

10.2.7 Transboundary impacts

The key objective of an EIA in a transboundary context is the rigorous assessment and succinct communication of anticipated transboundary impacts. The Espoo Convention defines a transboundary impact as:

"…any impact, not exclusively of a global nature, within an area under the jurisdiction of a Party caused by a proposed activity the physical origin of which is situated wholly or in part within the area under the jurisdiction of another Party."

The assessment of transboundary impacts relies on the prior identification of all potential impacts associated with the project and for these to have been assessed rigorously and consistently in accordance with the methodology described in the sections above. Assessments of transboundary impacts are included in Chapter 13. Evaluation of the significance of these impacts is based on the same framework as has been used in the Finnish EEZ. Both the magnitude of change and the current status and sensitivity of those transboundary waters where the impact will be targeted form the basis for the assessment.

10.2.8 Cumulative impacts

While the assessment of the NSP2 Project will account for the presence and impacts of other existing development in its vicinity, there is also a need to consider the interaction between the impacts arising from NSP2 with those of other foreseeable developments which are not yet in existence but are likely to be under construction or to have been completed by the time NSP2 is constructed or operational. Such cumulative impacts have been considered through identification of future planned development within the area of influence of NSP2 and a predominately qualitative assessment of the potential inter-project effects with NSP2. This is addressed in Chapter 14.

10.3 Assessment methods and assumptions for sediment dispersion, contaminants and nutrients

Hydrodynamic modelling was carried out to predict the sediment dispersion during construction works, related to munitions clearance and rock placement. Also, during the construction works, re-suspended sediments are potentially mobilizing some of the contaminants into water, with a potential to cause ecotoxicological effects on biotic environment. In this section the assumptions and the basis of numerical modelling of the sediment spill is described. The methodological assumptions are presented more detailed in Ramboll 2016a.

The main parameter describing sediment particles in suspension is the settling velocity. It determines how far each particle travels in the water column. Only fine-grained sediment particles will remain in suspension for a longer period of time. Coarser sand or gravel particles suspended in the water column due to rock placement and munitions clearance will settle within a short period of time and are not considered part of the actual sediment spill. Sediment particle grain size and corresponding settling velocity is presented in Table 10-9.

Table 10-9. Grain size range and corresponding settling velocity (Ramboll 2016b).

Sediment spill class	Lower grain size limit (mm)	Upper grain size limit (mm)	Settling velocity (m/s)
Very fine sand	0.06	0.13	0.0032
Coarse silt	0.03	0.06	0.00089
Medium silt	0.015	0.03	0.0004
Fine silt	0.008	0.016	0.00025
Very fine silt	0.004	0.008	0.00013
Clay	-	0.004	0.000069

Seabed type along the pipeline route varies from soft sediments to hard bottom complexes (Figure 10-3).

10.3.1 Locations for the modelling sites

For *munitions clearance*, modelling of the sediment spill from the disturbed seabed surface considers generic scenarios of the impacts of different charge weights at four selected locations along the pipeline route (Figure 10-3 and Figure 10-4). Modelling was based on a scenario where the most sensitive areas and/or areas with known high density of munitions along the pipeline route were selected as the modelling sites (Table 10-10).

Table 10-10. The criteria for munitions clearance modelling locations.

Location	Criteria for munitions clearance modelling locations
SED1	Closest to Russian border (transboundary impacts)
SED2	Closest to Natura 2000 site (sea area south of Sandkallan; protection is based on Habitats directive (reefs)).
SED3	Known high density of munitions on the seabed, proximity to seal sanctuary (Kallbådan) and proximity to potentially valuable habitats (potential reef areas).
SED4	Closest to Estonian border. Relatively high density of munitions on the seabed.

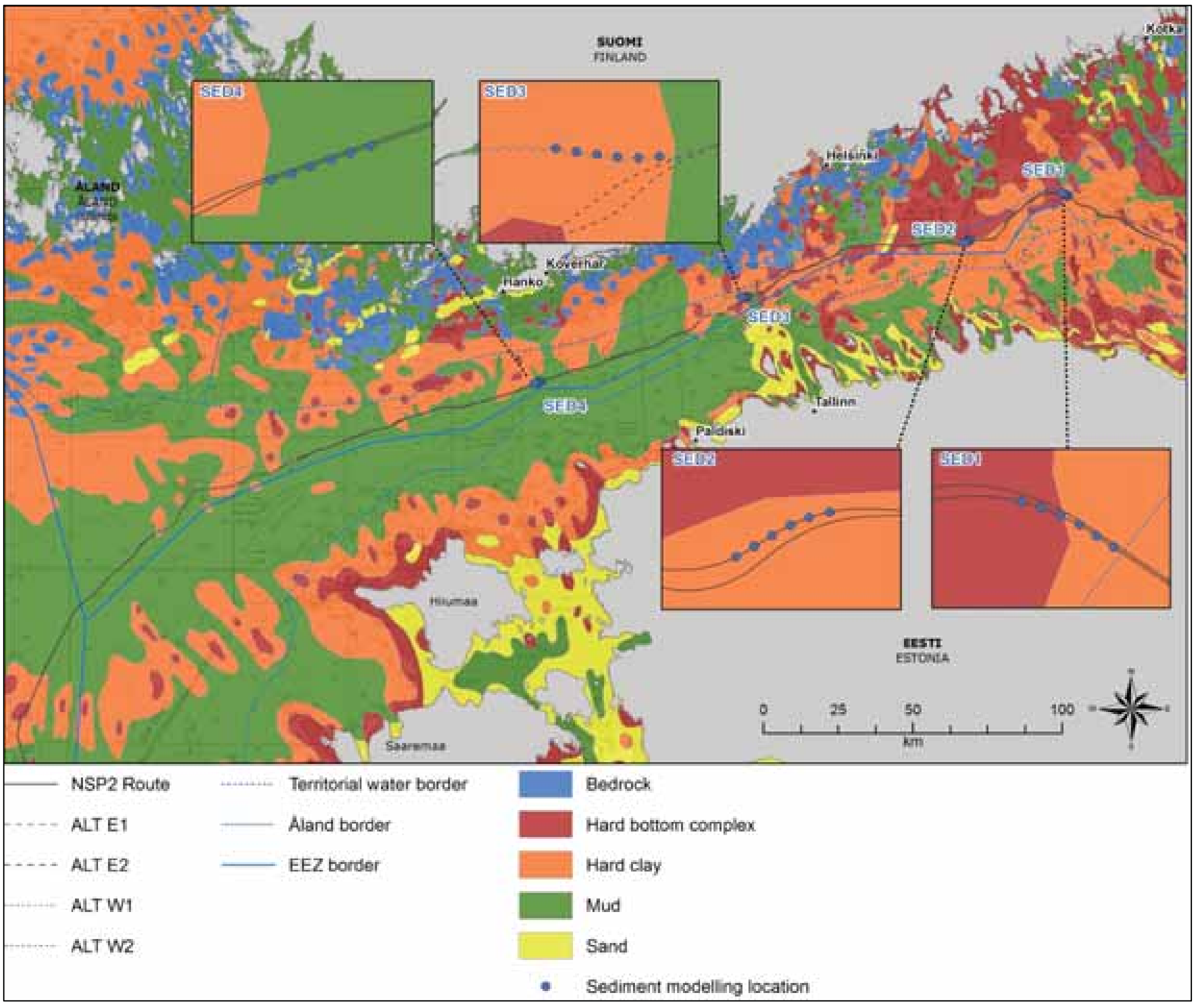

Figure 10-3. Locations for munitions clearance (six spots in each location). Sediment classification is based on data from the Geological Survey of Finland.

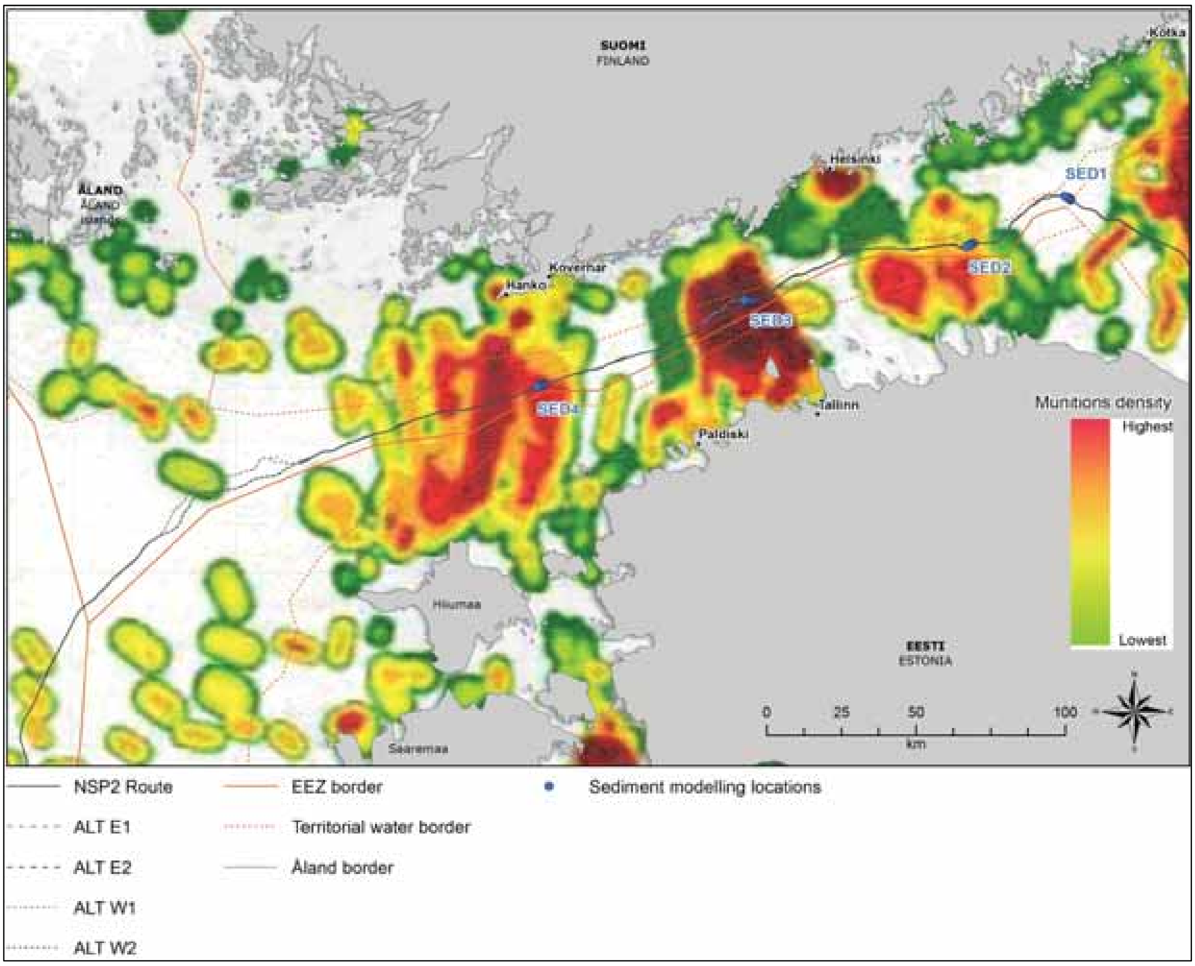

Figure 10-4. Locations of the modelling sites for munitions clearance. The contour in the map shows the relative density of munitions (dark red high, yellow low, not in absolute scale). (After HELCOM 2014b).

Based on the project design, locations for *rock placement* are presented in Figure 10-5. Locations for the pre-lay and post-lay rock placement works are presented in the Atlas maps (Appendix 12, Maps PR-03-F and PR-04-F).

Modelling of sediment spills is carried out for one of the two planned pipelines (northern line A, including sub-alternatives ALT E1 + ALT W1) and the results refer only to this pipeline. This line was selected in part because it is located closer to the nearest sensitive site, the Sandkallan Natura 2000 area.

Because both pipelines will be constructed near each other it has been assumed that the impacts from seabed intervention works for both pipelines would be comparable. For line A, the alternative route (line A – Alternative[9]) was also modelled.

[9] line A, including southern sub-alternatives ALT E2 + ALT W2, Chapter 4

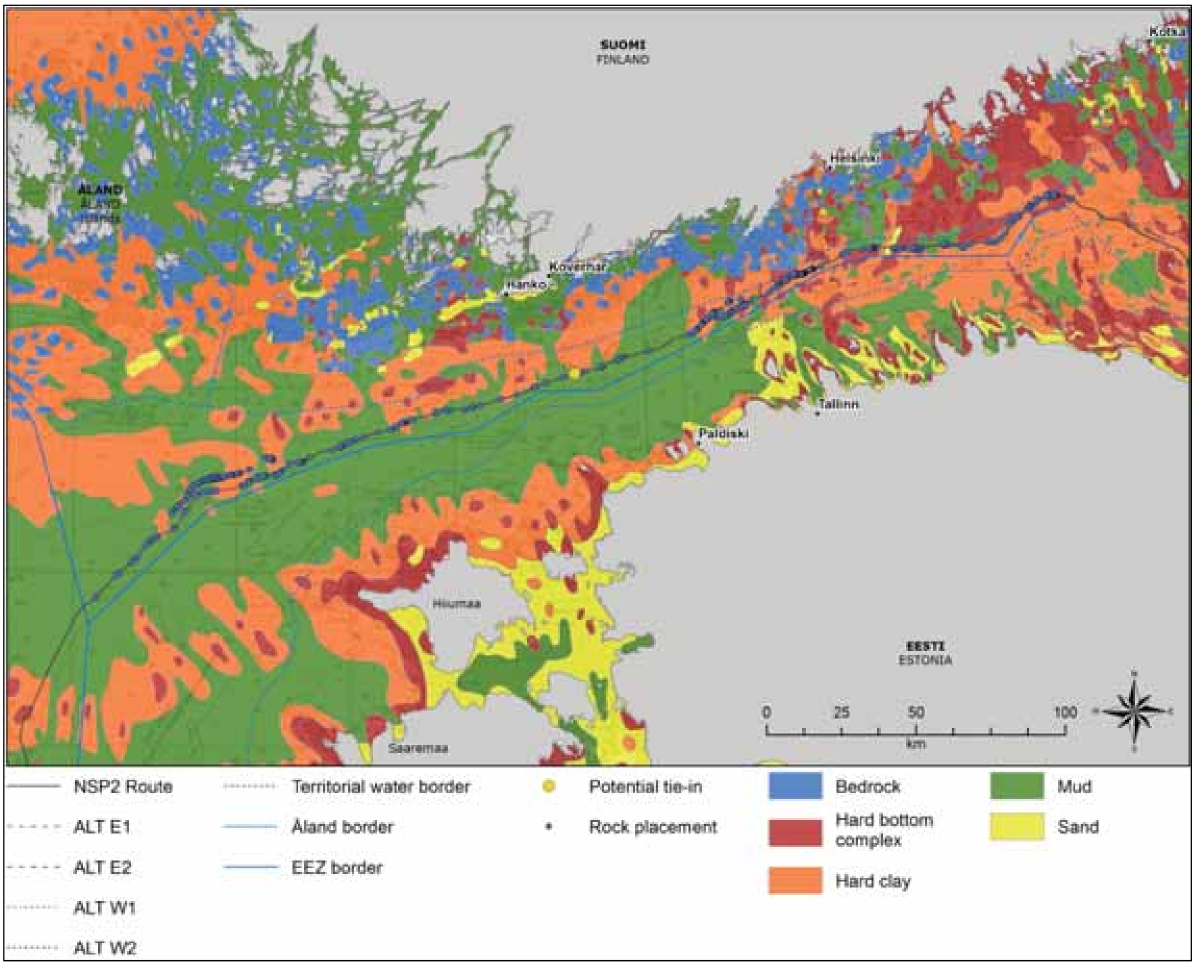

Figure 10-5. **Locations for rock placement along the pipeline route including sub-alternative sections based on the project design (Saipem 2016a). Sediment classification is based on data from the Geological Survey of Finland.**

10.3.2 Description of the MIKE model used

Hydrodynamic modelling was used to describe the hydrographic characteristics of the Gulf of Finland, including bathymetry, water levels and current fields, which are essential for three-dimensional modelling of the transport of suspended sediment, contaminants and spilled oil. The model is based on the modelling software MIKE 3 FM (version 2014) developed by DHI (2014). The MIKE 3 hydrodynamic (HD) model set-up is dedicated to the NSP2 Project. The model covers the entire Baltic Sea (for further information see Ramboll 2016a). To enhance this model, a study was performed in cooperation with SYKE and FMI *(DHI 2016d)*. The purpose was to calibrate the model by using the NSP current monitoring data and the HELCOM long-term monitoring water quality data and to validate the model by using NSP2 environmental baseline data.

The model set-up used a flexible mesh size (Figure 10-6). In large parts of the Gulf of Finland, the horizontal model resolution was in the order of 500–1,000 m so that it was possible to resolve the complicated bathymetry in this sea area. Elsewhere in the Baltic Sea, the resolution varied depending on the distance from the pipeline corridor. The resolution was approximately 800–1,600 m within a 10 km band along the planned pipeline corridor. Further away from the corridor, the resolution decreased gradually until it reached 3–5 km (Figure 10-7).

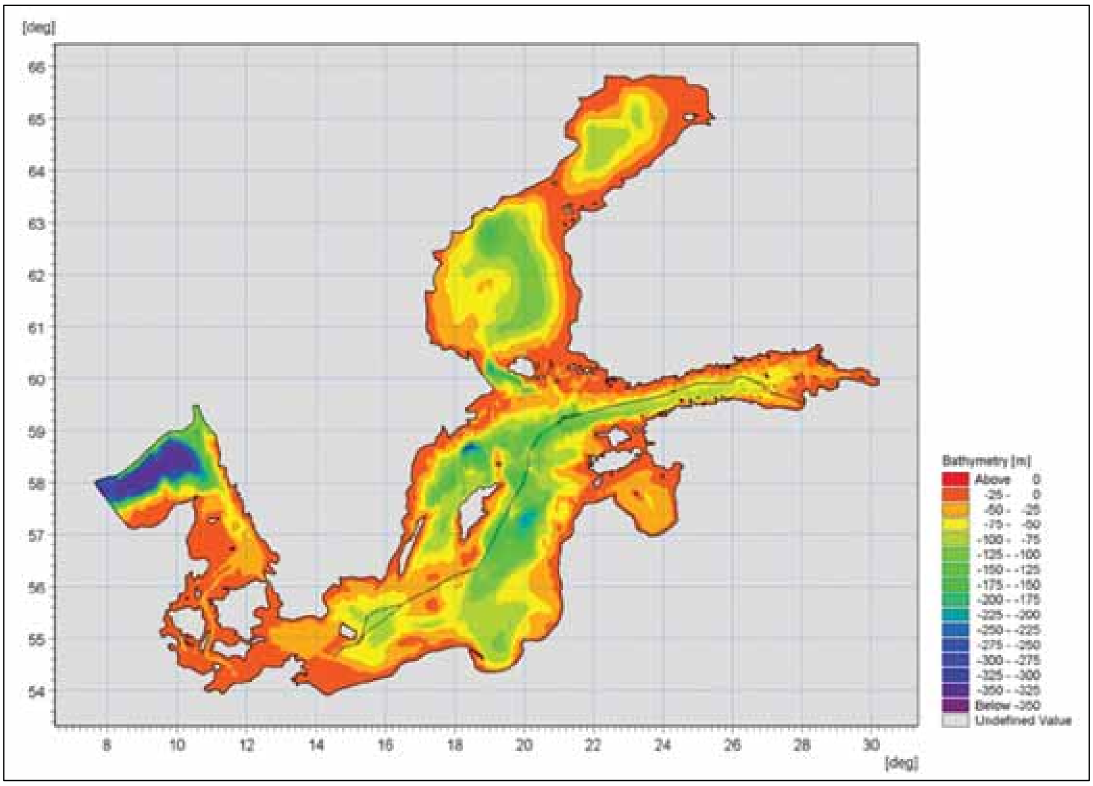

Figure 10-6. Hydrodynamic model domain and bathymetry (DHI 2016d).

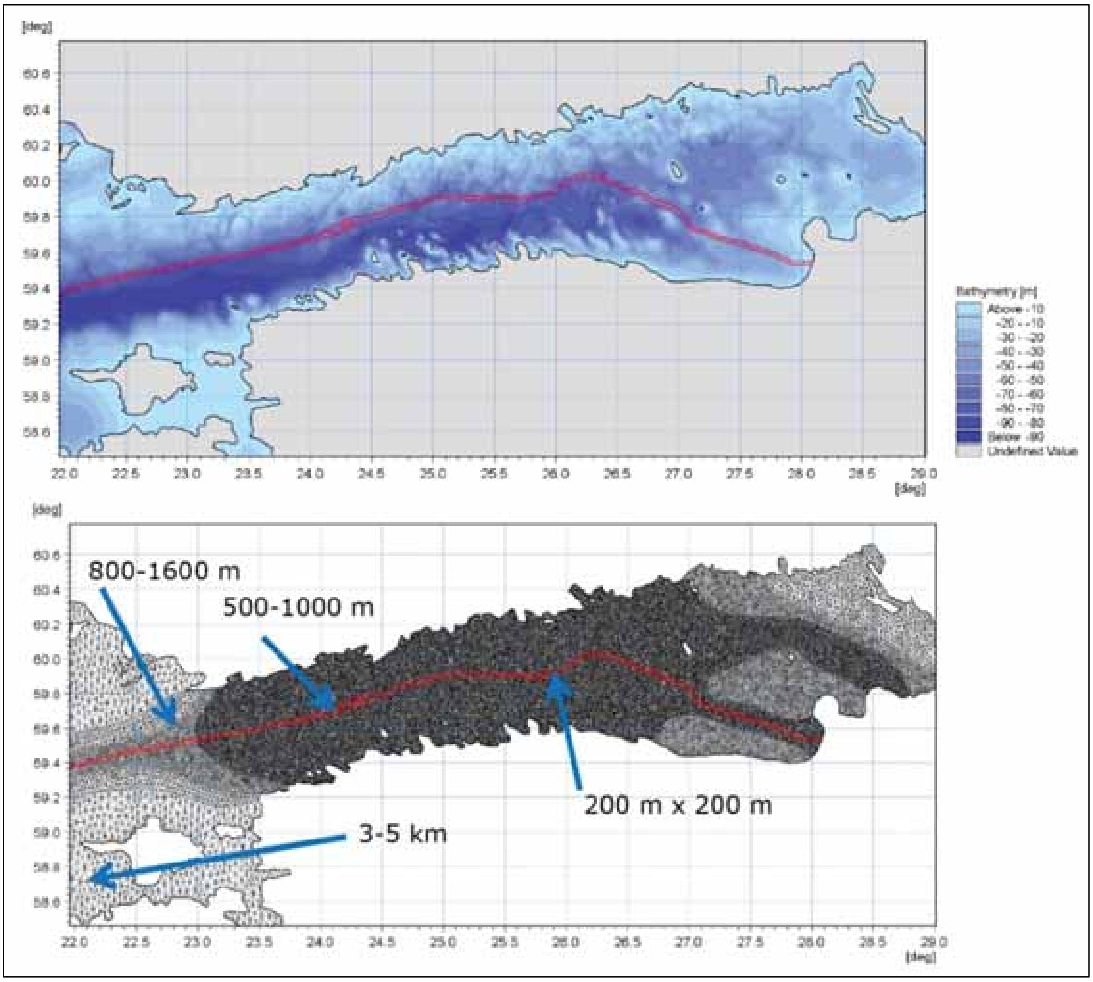

Figure 10-7. Bathymetry (upper image) and mesh size (lower image) used in the hydrodynamic model in the Gulf of Finland (DHI 2016d).

The model bathymetry was interpolated into the model mesh on the basis of three different data sets. A general data set of gridded data in 500 m × 500 m resolution was used in the majority of the Baltic Sea. In the Gulf of Finland from 21°E and eastward, the model bathymetry was based on 500 m × 500 m gridded data from the Baltic Sea Hydrographic Commission from 2013 *(DHI 2016d)*. In Finnish waters, a high-resolution (5 m × 5 m) bathymetric data set, provided by the Finnish Transport Agency (FTA) was used due to the high bathymetric variation in the area. Before it was applied, this data was reduced to 200 m × 200 m resolution for the pipeline corridor (Figure 10-7). The hydrodynamic model is forced by the hydrodynamic conditions at the open boundary (North Sea) and by the meteorological conditions provided by StormGEO *(DHI 2016c)*. For more information, see Ramboll 2016a.

For modelling of sediment and contaminant transportation, the numerical *particle tracking model* MIKE 3 PT was used. This model requires that the current velocities and water level are defined in time and space in a computational mesh covering the model domain. This information is provided by the previously described MIKE 3 HD model. In this EIA, sediment dispersion and selected contaminants were modelled using a Lagrangian-type approach. The method is described in more detail in Ramboll 2016a.

10.3.3 Scenarios for munitions clearance and rock placement

Modelling was done using actual hindcasted hydrographic scenarios for the year 2010 (Ramboll 2016b). Three simulation scenarios were chosen to represent different hydrographical conditions in relation to different current magnitude and stratification conditions in the water column and resulting particle transport capacity:

- Normal conditions; April 2010 (average currents and stratification, average particle transport capacity)
- Calm conditions; June 2010 (weak currents and high stratification, low particle transport capacity)
- Rough conditions; November 2010 (strong currents and low stratification, high particle transport capacity)

Justifications for choosing these hydrographic scenarios are presented in Ramboll 2016a.

Due to the location of the release and because sediment settles through the water column, the highest sediment concentrations are found near the seabed. For rock placement, results related to suspended sediment are based on an average of the lower 10 m of the water column and modelling is done 2 m above the seabed. For munitions clearance, elevated sediment concentrations are found over the interval of 10–20 m above the seabed. For modelling, release 15 m above the seabed was used. The modelling depth for rock placement and munitions clearance, 2 m and 15 m, respectively, was based on the fact that rock material is placed on the seabed with a fall-pipe but detonations will occur freely and the release of sediment spill is assumed to happen further away from the seabed.

For munitions clearance, the assumption is that at each location, six munitions with a distance of 1 km are cleared one at a time with 24 hours between each clearance. The six munitions cleared at each location shift between medium and large sized munition with crater volumes of 20 m^3 and 42 m^3, respectively. The amount of sediment spill corresponds to the dry matter content of the crater volume caused by blasting. Crater volumes are based on the monitoring results from the NSP project. The crater volumes and number of munitions are shown in Table 10-11. Based on previous experience, there is a weak correlation between charge size and sediment release rate (Figure 10-8).

For medium and large charges, spill rates are based on following parameters:

- Medium charge: primary charge[10] is 10–100 kg, observed (NSP) primary charge[11] 30–64 kg and sediment release 20 m^3
- Large charge: primary charge 100–1,000 kg, observed primary charge 100–340 kg and sediment release 42 m^3

For both group of charge sizes, the 95th percentiles of the release quantities were estimated to yield conservative release quantities.

More accurate definitions are presented in Ramboll 2016b.

Table 10-11. The crater volumes and number of munitions.

ID number[1]	Charge sizes	Number of munitions	Crater volume [m^3]
SED1	Large	3	42
	Medium	3	20
SED2	Large	3	42
	Medium	3	20
SED3	Large	3	42
	Medium	3	20
SED4	Large	3	42
	Medium	3	20

[1]ID refers the numbering in Figure 10-3.

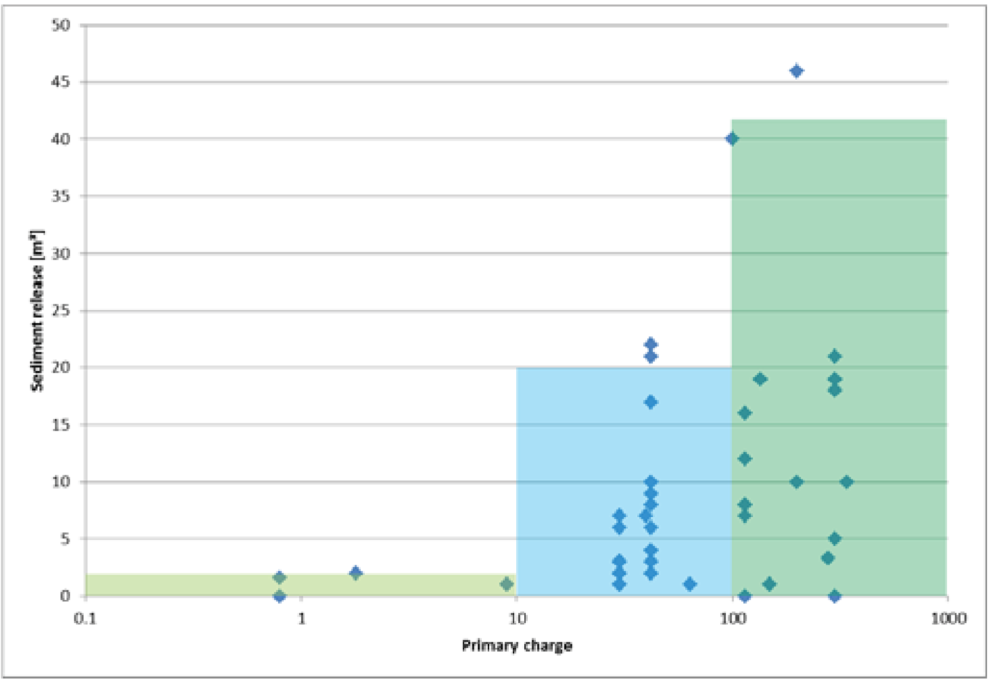

Figure 10-8. Monitoring results from NSP for sediment release rate and charge size during munitions clearance. The columns indicate the 95th percentiles of a spill (Ramboll 2016a).

[10] Explosive that is extremely sensitive to stimuli
[11] Munition found on seabed

The following assumptions have been made for the modelling of sediment dispersion caused by *rock placement* (Ramboll 2016a). The amount of suspension is assumed to be proportional to the placed rock volume, while the suspension rate is assumed to be proportional to the placement rate. Rock placement is assumed to be carried out with a speed of 20,000 tonnes/day. For line A, operations would last about 93 days, presuming that all placements are done by one vessel. For modelling purposes, three vessels have been assumed to be working at the same time (enabling a simulation period of about one month). This approach will be conservative compared to a working period of 93 days (as this approach would result in higher sediment concentrations). For line A – Alternative route (Chapter 5), the working period is increased by approximately 9 days due to an increase of the total rock volume to be handled (three days' increase when 3 vessels are working simultaneously).

Spill rates have been calculated according to CIRIA, CUR and CETMEF (2007) assuming that:

- 30% of the rock volume contributes to the spilling (Only part of the rock material will impact sediment suspension. After the first cover of the seabed with this material, spill rate is greatly reduced when the finest sediment particles are buried and will not suspend into seawater.)
- The velocity of the falling rock inside a fall-pipe (Subchapter 4.1.5.1) of 1.44 m/s
- 10% of the total energy will cause resuspension of sediments

The total calculated sediment spill from rock placement operations for line A and line A - Alternative route is 2,592 t and 2,850 t, respectively (Ramboll 2016b).

10.3.4 Assumptions considering contaminants and nutrients

Chemical compounds have been deposited on the seabed over several centuries. During construction activities, surface sediments can be re-suspended, thereby mobilizing some of these chemical compounds, with the potential to pose a risk to biota if they enter the food web. This is expected especially if the compounds are in dissolved form and thus bioavailable for biota. Normally these compounds (especially the so called POP-compounds, which include many pesticides, PCBs and dioxins/furans) are adsorbed to different inorganic/organic particles in suspension.

Similarly, phosphorus and nitrogen, if in dissolved form, can contribute to the growth of algae, assuming that these nutrients reach the uppermost photic water layer where primary production takes place during summer time.

The amount and behaviour of contaminants and nutrients that will suspend into the water phase have been assessed based on the assumptions of the sediment dispersion model presented in Subchapter 10.3.3 (Ramboll 2016b). However, for contaminants, only the dissolved and bioactive fraction was modelled. This is because compounds in dissolved form or in a chemical form that can be taken up by organisms and/or interact with receptors can pose a risk to organisms or accumulate in food web. This affinity can be described by desorption and bioactivity factors that are summarized in Table 10-132 and discussed in Ramboll 2016a. As in dissolved form, the contaminants are not settling and for precautionary reasons, no decay is assumed in modelling.

The content of contaminants in the surface sediment has been estimated based on samples from the Gulf of Finland collected during the NSP2 environmental baseline survey. The results are presented as the 95th percentile of the series of samples and are shown in Table 10-12. The most critical compounds from a toxicity standpoint were selected for modelling. For this purpose and also for presenting the modelling results, the following method was used:

(1) Predicted environmental concentration (PEC), which is the concentration of dissolved/bioactive contaminant and denotes for estimated exposure the concentration of the specific contaminant in the water body

(2) Predicted no-effect concentrations (PNEC) were compiled (Ramboll 2016a, which estimates the lower limit of the concentration range in the water body known to cause effects. The relevant PNEC values are presented in Table 10-12.

(3) Based on PEC and PNEC values, relative toxicities were estimated. The relative toxicity is quantified as the ratio between the PNEC and PEC values. The relative toxicities are given in Table 10-12. It is seen that the relatively most toxic substances are assumed to be benzo(a)pyrene (PAH), WHO (2005) PCDD/F TEQ upper (dioxins/furans) and zinc, in descending order.

Table 10-12. Observed concentration of contaminants based on sediment samples from the Gulf of Finland collected during NSP2. The results are presented as the 95th percentile of the samples. Relative toxicity is expressed as the volume of water required to dilute the contaminant to PNEC level due to the release of one kilogram of dry matter (DW). Red indicates the most critical compound, yellow the second most critical and green the third most critical compound (Ramboll 2016b).

Chemical compound	Desorption	Bioactivity	Concentration in sediment	Concentration of desorbed /bioactive	PNEC (in excess to background)	Relative toxicity
				mg/kg DW	mg/m³	m³/kg DW
Metal						
Arsenic, As	50%	25%	35.8	4.48	0.6	7.5
Cadmium, Cd	50%	25%	1.80	0.225	2	-
Mercury, Hg	50%	25%	0.070	0.00875	0.05	-
Zinc, Zn	50%	25%	224	28.0	3.4	8.2
Lead, Pb	50%	25%	42.7	5.34	0.83	6.4
Copper, Cu	50%	25%	49.4	6.18	0.9	6.9
Nickel, Ni	50%	25%	55.1	6.89	8.6	-
Organotin						
Tributyltin, TBT	10%	100%	0.0767	0.00767	0.0015	5.1
PAH						
Benzo(a)pyrene	10%	100%	0.170	0.017	0.00017	100
Dioxin/Furans						
WHO (2005) PCDD/F TEQ upper	10%	100%	20.3E-06	2.03E-06	1.00E-07	20.3

The full description of the methodology and assumptions used for modelling are presented in Ramboll 2016a.

10.3.5 Interpretation of results

10.3.5.1 Sediment dispersion

The highest sediment concentrations in suspension are found near the seabed. The results are based on:

- Average of the lowermost 10 m water layer – rock placement and munitions clearance
- Maximum concentrations over the interval 10–20 m – munitions clearance

The results presented for munitions clearance and rock placement include:

- Maximum concentrations of suspended solids over the entire simulation period
- Maximum concentration of suspended solids at specific distances from the activity
- Areas with concentration exceeding 2, 10 and 15 mg/l of suspended solids
- Duration (h) of exceedance of 2, 10 and 15 mg/l of suspended solids concentration
- Maximum sedimentation rate
- Extent of areas with different sedimentation rates

Figure 10-9 is an example of modelling results.

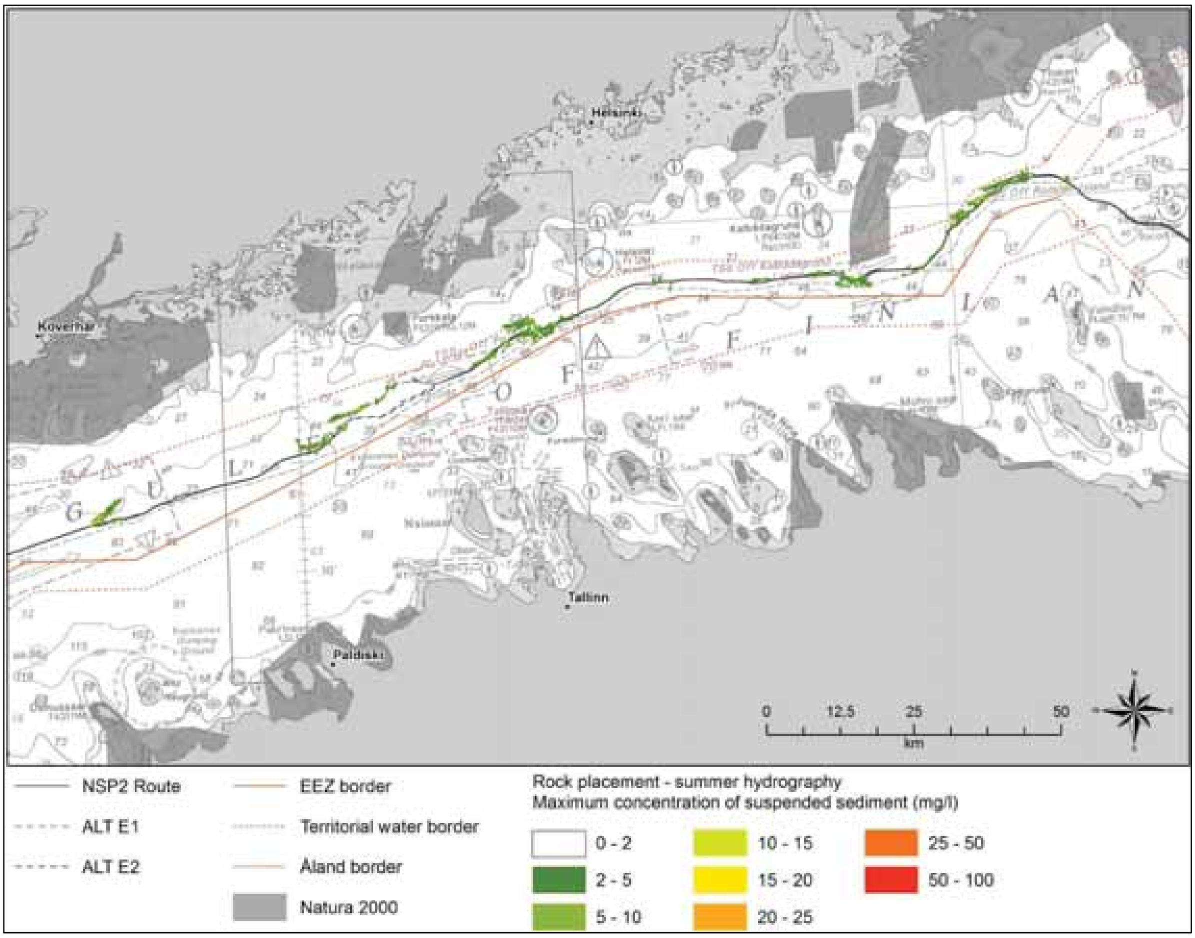

Figure 10-9. Example of sediment modelling results.

10.3.5.2 Contaminants

According to their respective relative toxicities, benzo(a)pyrene, which is a toxic congener of PAHs, dioxins/furans and zinc were found to be the contaminants of most concern in the project area. These compounds could also be used as examples of different types of contaminants and their behaviour during a sediment spill.

For contaminants, the results are presented for:

- Maximum concentration of contaminant (benzo(a)pyrene, dioxins/furans, zinc) occurring during the entire simulation period
- Duration of exceedance of PNEC for PAH, dioxins/furans and zinc (accumulated period of time in hours during which the concentration of the contaminant exceeds the PNEC value during rock placement and munitions clearance).

10.4 Underwater noise modelling

Attention has been raised by the EU on the topic of underwater noise and its effects on marine life. Descriptor 11 of the European Commission decision on the good environmental status of marine waters (2010/477/EU) states: "Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment”.

Munitions clearence and rock placement are identified as potentially significant underwater noise sources in this project. In this subchapter the assumptions and the basis of modelling of the underwater noise is described. The methodological assumptions are presented in more detail in Ramboll 2016d.

10.4.1 Underwater noise modelling method

In this EIA, underwater noise propagation is modelled using dBSEA's acoustic propagation model. It makes use of the parabolic equation method, a versatile and robust method of marching the sound field out in range from the sound source. This method is one of the most widely used in the underwater acoustics community.

The program uses site-specific acoustic parameters, including the expected water column sound speed profile, the bathymetry, and the bottom geo-acoustic properties. Noise source levels are modelled by frequency in octave bands. For this study, modelling is done for octave frequency bands between 10 and 3,000 Hz. Because the sources of underwater noise considered in this study are predominantly low-frequency sources, this frequency range is sufficient to capture essentially all of the energy output.

Output of the modelling is a noise contour map, showing noise distribution of equal noise levels. Noise level is calculated in all depths from surface to the bottom, and highest level at any depth is chosen to represent noise at that location. Noise contours are then showing the maximum distances of predicted noise values.

Modelling has been performed for both winter and summer conditions, which each have different underwater sound propagation characteristics.

10.4.2 Noise indicators

Modeling can be done for many different noise indicators depending on purpose. Sound Exposure Level (SEL) is chosen (based on scientific literature) in this study to quantify impacts on marine life. SEL is a decibel measure for describing how much sound energy a receptor (e.g. a marine mammal or fish) has received from an event and is normalised to an interval of one second (quoted in dB re 1 μPa^2 s).

Cumulative Sound Exposure Level (SEL(cum)) represents cumulative sound energy, when several events occur during a defined time frame (normally 24 h). In general terms, every doubling in the number of similar noise events or doubling of time when the noise occurs corresponds to 3 dB increase in SEL(cum) level. One noise event results in the same value of SEL and SEL(cum).

SEL and SEL(cum) values are both used and compared to applicable threshold values of SEL.

For rock placement, SEL(cum) for two-hour time is calculated. It is assumed, that receiving organism (mammal, fish) stays at it's position for two hours time.

For munitions clearance, SEL for one event (one clearance) is calculated.

10.4.3 Modeling activities and positions in Finland

For rock placement, two locations were chosen for modelling, they are presented in Table 10-13, and Figure 10-10.

Table 10-13. Reasons for the chosen locations for noise modelling for rock placement.

Locations	Description
RP1 $_{Finland}$	Large rock berm for pipeline crossing; close to Russian and Estonian border: potential transboundary impacts; Baltic ringed seal populations in eastern Gulf of Finland.
RP2 $_{Finland}$	Potential large rock berm for tie-in at around KP 300.

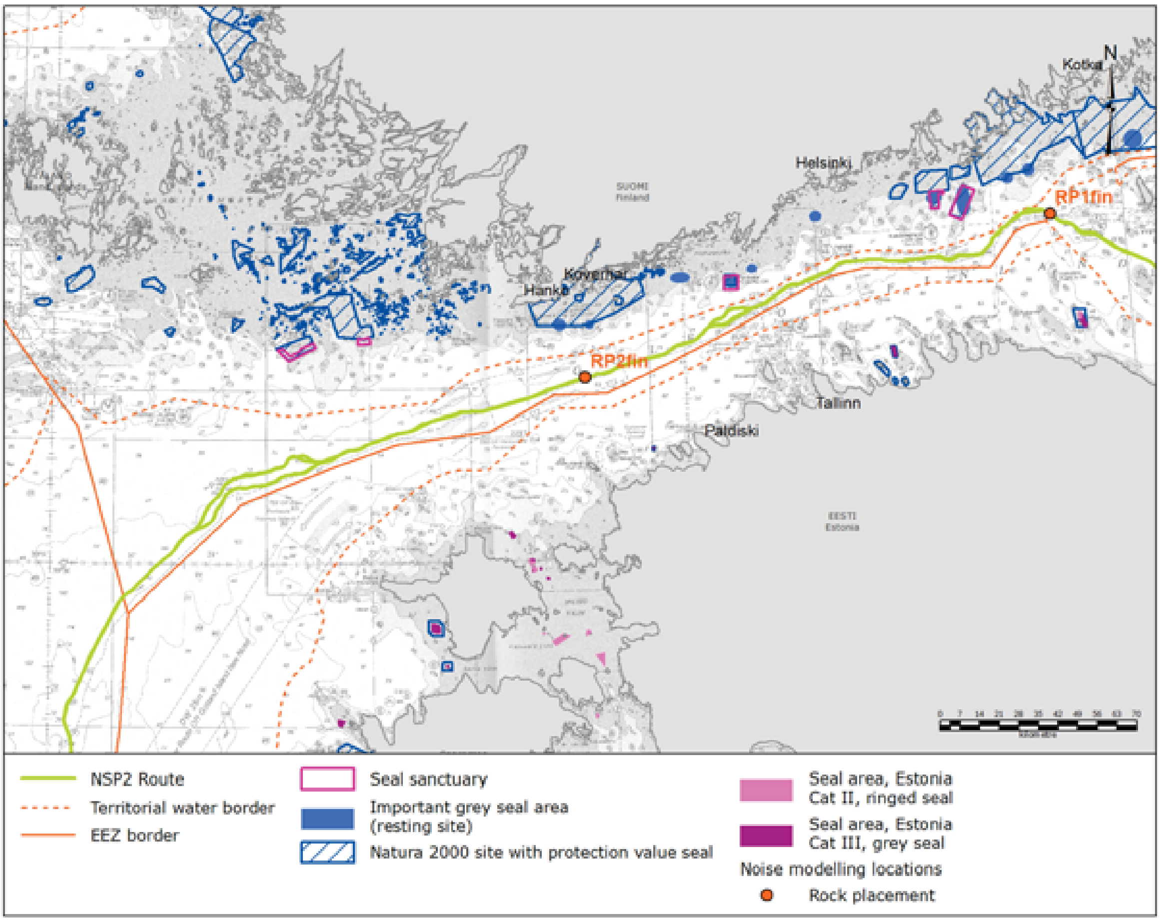

Figure 10-10. Locations for noise modelling for rock placement (RP).

For munitions clearance, four positions were chosen for modelling; they are presented in Table 10-14 and Figure 10-11.

Table 10-14. Reasons for the chosen locations for noise modelling for munitions clearance.

Locations	Description (east to west)
$M1_{Finland}$	Vicinity to Russia and Estonia to assess potential transboundary impacts, Baltic ringed seal populations in eastern Gulf of Finland; shallow areas and important grey seal areas to the north
$M2_{Finland}$	High munitions density; south of Sandkallan Natura 2000 and seal sanctuary area
$M3_{Finland}$	High munitions density; closest to seal sanctuary and Natura 2000 area
$M4_{Finland}$	High munitions density; ringed seal observations

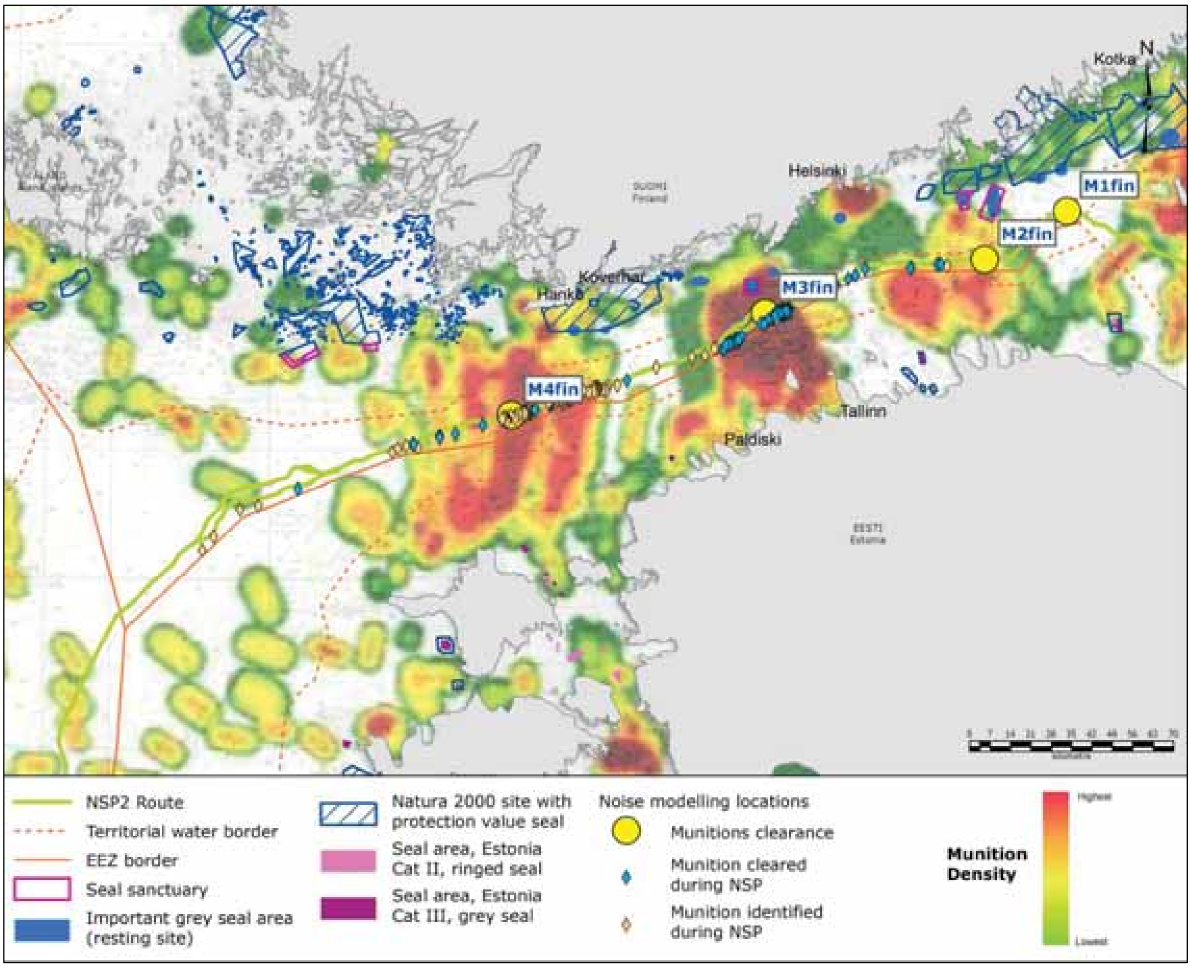

Figure 10-11. Locations for noise modelling for munitions clearance (M1-M4). The density of munitions and munitions identified and cleared during NSP are shown since these have been part of choosing the 4 modelled locations (M1-M4).

10.4.4 Impact thresholds for mammals and fish

Table 10-15 summarises the threshold values of temporary threshold shifts (TTS) and permanent threshold shifts (PTS) for assessing impacts on marine mammals. TTS is temporary reduction in hearing sensitivity, and PTS is an irreversible reduction in hearing sensitivity.

Threshold values for inflicting impact on mammals have been determined based on an assessment of available values from the most recent scientific literature *(Institute for Bioscience 2016)*.

Table 10-15. Marine mammal threshold values for onset of TTS and PTS, as recommended by the project's marine biologists. All levels are unweighted SEL.

Noise Source	Species	TTS (dB re 1 $\mu Pa^2 s$ SEL cum)	PTS (dB re 1 $\mu Pa^2 s$ SEL cum)
Rock placement	Grey seal and harbour seal	188*	200 *
Rock placement	Harbour porpoise	188*	203*
Munitions clearance	Grey seal and harbour seal	164**	179**
Munitions clearance	Harbour porpoise	164**	179**

* Cumulative SEL (two-hour rock placement)
** Cumulative SEL (one event)

For fish, threshold values for mortality (or mortal injury) and injury are set in Table 10-16, based on Popper et al. 2014.

Table 10-16. Threshold values for fish as recommended by the project's marine biologists (based on Popper et al. 2014).

Effect	Munitions Clearance	Rock placement
	Threshold value SEL(Cum*) dB re 1μPa^2 s	Threshold value SEL(Cum*) dB re 1μPa^2 s
Mortality (mortal injury)	207	207
Injury	203	203

* Cumulative SEL (one event)

10.4.5 Model input data

Sound source level is defined as sound levels at 1 m from the source. For munition clearance, source levels are based on actual maximum and average measured peak pressure data collected during munitions clearance for the first Nord Stream pipeline *(Nord Stream AG 2011a)*. Source levels are shown in Table 10-17.

Table 10-17. Munitions clearance overall sound source levels (dB SEL, @ 1 meter).

Position/area	Charge weight	Sound Source SEL, dB re. 1μPa^2 s @ 1 meter
$M1_{Finland}$	Max.	238
$M1_{Finland}$	Ave.	238
$M2_{Finland}$	Max.	243
$M2_{Finland}$	Ave.	238
$M3_{Finland}$	Max.	255
$M3_{Finland}$	Ave.	241
$M4_{Finland}$	Max.	252
$M4_{Finland}$	Ave	246

For rock placement, SEL(cum) 226 dB re. 1μPa2 s @ 1 meter (Cumulative 2 hr) was used in modelling (Wyatt 2008).

10.4.6 Modeling results

The maximum distances from the rock placement and munitions clearance activity to the applicable underwater noise threshold levels are presented in Table 10-18 and Table 10-19.

For rock placement, PTS is 0 meters for all species and TTS 80 m for porpoises and seals (Noise level contour map, Figure 8-4 in Appendix 7).

Table 10-18. Rock placement assessment, distances to the impact thresholds.

Marine group	Rock placement Effect	Assessment levels SEL(Cum*) dB re 1μPa²s	RP1 Finland Threshold distances SEL(Cum*) dB re 1μPa²s	RP2 Finland Threshold distances SEL(Cum*) dB re 1μPa²s
Seals	PTS	200 dB	0 meters	0 meters
	TTS	188 dB	80 meters	80 meters
Porpoises	PTS	203 dB	0 meters	0 meters
	TTS	188 dB	80 meters	80 meters
Fish	Mortality (mortal injury)	207 dB	0 meters	0 meters
	Injury	203 dB	0 meters	0 meters

* Cumulative SEL (two-hour rock placement)

The munitions clearance threshold maximum distances varies, depending on location, from 15,000 to 44,000 meters for TTS in porpoises and seals. PTS ranges from 3,500 to 15,000 meters. For fish, mortality ranges from 50 to 500 meters, and injury from 100 to 1,500 meters (Table 10-19)

Table 10-19. Munitions clearance (maximum) distances to the impact thresholds.

Marine group	Munitions Clearance (Max) Effect	Assessment levels SEL(Cum*) dB re 1μPa²-s	$M1_{Fin, max}$ Threshold distances, max SEL(Cum*) dB re 1μPa²s	$M2_{Fin, max}$ Threshold distances, max SEL(Cum*) dB re 1μPa²s	$M3_{Fin,max}$ Threshold distances, max SEL(Cum*) dB re 1μPa²s	$M4_{Fin,max}$ Threshold distances, max SEL(Cum*) dB re 1μPa²s
Seals	PTS	179 dB	3,500 m	8,000 m	15,000 m	9,000 m
	TTS	164 dB	15,000 m	38,000 m	44,000 m	32,000 m
Porpoise	PTS	179 dB	3,500 m	8,000 m	15,000 m	9,000 m
	TTS	164 dB	15,000 m	38,000 m	44,000 m	32,000 m
Fish	Mortality (mortal injury)	207 dB (229–234 dB peak)	50 m	200 m	500 m	400 m
	Injury	203 dB	100 m	300 m	1,500 m	800 m

* Cumulative SEL (one event)

The munitions clearance threshold average distances varies, depending on location, from 15,000 to 26,000 meters for TTS in porpoises and seals. PTS ranges from 3,500 to 5,000 meters. For fish, mortality ranges from 50 to 500 meters, and injury from 100 to 400 meters (Table 10-20).

Table 10-20. Munitions clearance (average) distances to the assessment level limit thresholds.

Marine group	Munitions Clearance (Average) Effect	Assessment levels SEL(Cum*) dB re $1\mu Pa^2s$	$M1_{Fin, Average}$ Threshold distances, max SEL(Cum*) dB re $1\mu Pa^2s$	$M2_{Fin, Average}$ Threshold distances, max SEL(Cum*) dB re $1\mu Pa^2s$	$M3_{Fin, Average}$ Threshold distances, max SEL(Cum*) dB re $1\mu Pa^2s$	$M4_{Fin, Average}$ Threshold distance, max SEL(Cum*) dB re $1\mu Pa^2s$
Seals	PTS	179 dB	3,500 m	3,500 m	3,500 m	5,000 m
	TTS	164 dB	15,000 m	26,000 m	19,000 m	22,000 m
Porpoises	PTS	179 dB	3,500 m	3,500 m	3,500 m	5,000 m
	TTS	164 dB	15,000 m	26,000 m	19,000 m	22,000 m
Fish	Mortality (mortal injury)	207 dB (229–234 dB peak)	50 m	50 m	200 m	300 m
	Injury	203 dB	100 m	100 m	300 m	400 m
* Cumulative SEL (1 event)						

Noise level contour plots for munitions clearance are presented in Appendix 12, Map MO-01-F and MO-02-F for both winter (winter/spring) and summer (summer/autumn) water column conditions. Here, this kind of contour map is presented as an example in Figure 10-12.

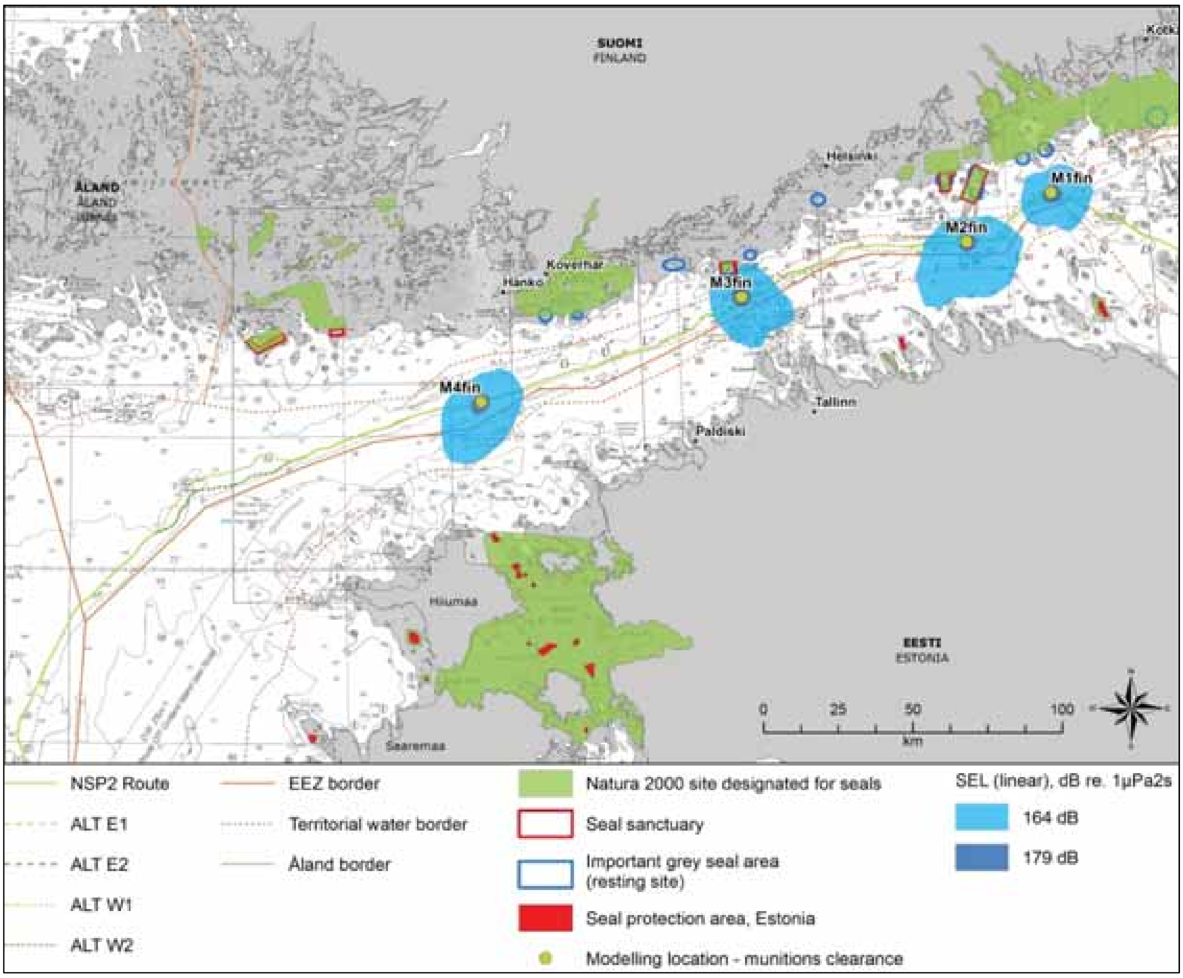

Figure 10-12. Munitions clearance (average) underwater sound exposure levels contour plots SEL (1 event), dB re. $1\mu Pa^2s$ (summer).

11. OFFSHORE IMPACT ASSESSMENT

11.1 Climate and air quality

The purpose of this chapter is to assess the climate and air quality impacts in Finland arising from the offshore activities of the project. Only direct impacts in Finland from the activities included in the project scope have been assessed. Indirect impacts from the entire supply chain of the pipeline life cycle, e.g. the production of materials, have not been included in the assessment.

The climate impact was assessed in terms of CO_2 (carbon dioxide) emissions. CO_2 is the most important of the climate gases which contribute to the greenhouse effect.

The air quality impacts were assessed in terms of nitrogen oxides (NO_x), sulphur dioxide (SO_2) and particulates (PM).

In this subchapter, the impact on climate and air quality is assessed for offshore project activities. The impact from ancillary onshore activities on local air quality and climate in Kotka and Hanko is assessed in Subchapters 12.1.3 (for machinery, vessels, coating plant and rock transport in the Kotka region) and 12.2.2 (for machinery and vessels at the Koverhar Harbour).

In Finland, the direct impacts from the following offshore activities on climate and air quality will be assessed:

- Munitions clearance
- Transport of rock material from Mussalo harbour, Kotka to the NSP2 route (only sailing time within the Finnish EEZ has been included in the calculation)
- Rock placement
- Crossing installations
- Pipelay
  - Only using DP lay barge
  - Using DP lay barge and anchored lay barge
- Surveys performed during construction
- Fuel supply, crew change, other materials
- Pre-commissioning (including hyberbaric tie-in)
- Operation (inspection, maintenance, surveys and freespan correction)

Summary of impact assessment on the climate and air quality	
Lessons learned from the Nord Stream Project in 2009-2012	Climate and air quality impacts were not included in the NSP monitoring programme. Information about the vessel types in NSP and the annual emissions of the coating plant were utilised in this assessment
Main results of the assessment	The total air emissions generated during the offshore construction in the Finnish EEZ are as follows (rounded): 357,000 tonnes of carbon dioxide (CO_2), 7,000 tonnes of NO_X, 230 tonnes of SO_2 and 210 tonnes of particulates (PM) using only DP vessel. These emissions are generated during approximately 1.5 years of construction period in the Finnish EEZ. Total emissions from the vessel traffic in the Gulf of Finland in 2014 were 2,206,000 tonnes of CO_2, 47,500 tonnes of NO_X, 10,900 tonnes of SO_X and 2,300 tonnes of PM. That is to say, the total CO_2 and NO_X emissions of the annual offshore construction activities in the Finnish EEZ (using DP vessel only) are approximately 15%, SO_2 emission approximately 2% and particulates approximately 9% of total emission occurring annually from the vessel traffic in the Gulf of Finland. Regarding impacts on climate and air quality, there are no substantial differences between sub-alternatives and between construction alternatives.

11.1.1 Impact mechanism

Preparation, construction and operation of the Nord Stream 2 pipeline will result in air emissions due to the use of machinery, vessels and other equipment that combust fuel while in operation.

Table 11-1. Possible impacts of the project and ancillary activities on climate and air quality.

Receptor	Project phase	Project activity	Impact
Climate and air quality	Construction	Ship traffic during • Munitions clearance • Rock placement • Pipelay with DP lay barge or DP and anchor lay barge • Crossing installations • Fuel supply, crew change, other materials • Pre-commissioning (including hyberbaric tie-in)	Emissions to air from exhaust gases of vessel engines
	Operation	Inspection Maintenance Surveys Repair	Emissions to air from exhaust gases of vessel engines

Activities not included

The following activities are *not* included in the air quality and climate impact assessment:

Transport of coating materials by ship

There may be transportation of coating materials, such as iron ore and aggregate, in one or two vessels a month, during the construction period. This has not been included as it is considered to have a negligible impact compared to rock and pipe shipping.

Surveys

Geotechnical, geophysical and environmental surveys prior to the actual pipe installation work have not been included in emissions calculations. Also, surveys required by authorities, e.g. monitoring of environmental impacts during construction, have not been included.

Repairs

In the operation phase, the pipeline will be regularly inspected. While emissions arising from planned survey activities have been included, repair work has not been included. Repair works could be required due to unplanned events and based on the risk assessments, the probability of such events occurring is very low.

11.1.2 Methods and data used

Methods and used data in climate and air quality emissions calculations are described in detail in a separate report *(Ramboll 2017a)*. This chapter summarises the methods and used data.

11.1.2.1 Emissions compounds

The combustion of fuel during the operation of vessels, construction machinery and other equipment for Nord Stream 2 Project will result in emissions of a number of air pollutants, i.e. carbon dioxide, nitrogen oxides, sulphur dioxide, particulates, carbon monoxide and hydrocarbons. The vast majority of engines use fuel oil and the emissions take place offshore and in less populated areas onshore. Emissions of compounds such as carbon monoxide (CO) and hydrocarbons (HC) that mainly cause local impacts are assessed to be of less importance compared to carbon dioxide, nitrogen oxides, sulphur dioxide and particulates.

The following pollutants are included in the air emissions calculations:

- Carbon dioxide (CO_2)
- Nitrogen oxides (NO_X)
- Sulphur dioxide (SO_2)
- Particulate matter (PM)

11.1.2.2 Emissions from trucks, machinery, vessels and transport

Emissions from vessels are calculated according to the working time of the individual type of equipment during construction or operation.

In the calculation, the time slice factor includes the assumption that the engine may not be in operation during the entire period that the equipment is available for the project. For example, a pipe lay vessel is expected to be in operation (nearly) 100 % of the time available during construction, whereas a support vessel may be in operation only part (e.g. 25 %) of the time available during pre-commissioning.

The expected time slice for each type of equipment has been defined from the time slice available for similar operations in Nord Stream Project, together with information on the days of operation/availability of each kind of machinery. Whenever possible, the operational time has been deduced from the current project description and the reasons for assumptions etc. have been stated in the respective sections for the different activities.
The individual equipment, machinery etc. may use different fuel types, e.g.:

- Heavy fuel oil (HFO)
- Medium fuel oil (MFO)
- Intermediate fuel oil (IFO)
- Light marine distillates (further divided into marine diesel oil (MDO) and marine gas oil (MGO)

However, the variation in emissions factors between the various fuels is assessed to be negligible and, thus, the same emissions factors are applied in all cases. For CO_2-emissions, HFO is used.

Fuel consumption for machinery depends on the type and age of the engine. In the calculations, a fuel consumption rate of 195 g/kWh has been assumed for all engines *(Shipping Efficiency, 2013)*.

In cases where a sailing distance (or flying distance, in case of helicopter support) is needed to calculate emissions, a maximum distance of 100 nautical miles (185 km) has been used.

For pipelay, the DP lay barge will be used from the Russian border to about KP 350 and either a DP lay barge or an anchored lay barge from KP 350 to the Swedish border.

Table 11-2. Emission factors for vessels used in calculation.

Emission compound	Emission factors used in calculations Vessels
Nitrogen oxides, NO_x	12 g/kWh*
Sulphur dioxide, SO_2	0.001 mass-% **
Particulates, PM	0.0018 tons/ton of fuel*
Hydrocarbons HC	n.a.
Carbon dioxide, CO_2	3.1 tons/ton of fuel***

*) Aarhus University 2015

**) IMO 2008

***) Shipping efficiency 2013

11.1.3 Impact assessment

The total emissions from offshore activities in Finland are shown in Table 11-3.

Table 11-3. Summary of emissions loads from offshore activities in Finland during construction and operation of the NSP2 Project.

Activity	Estimated emissions loads (tonnes)			
	CO_2	NO_X	SO_2	Particulates
Shipping from weight-coating plant	46,362	920	29.9	26.9
Munitions clearance	14,624	290	9.4	8.5
Crossing installations	4,421	88	2.8	2.6
Pipe supply	68,858	1,367	44.4	40.0
Pipelay using DP vessel for whole distance (378 km) (1 year duration)	157,950	3,135	101.8	91.7
Pipelay using anchored vessel incl. anchor handling tugs from KP350 to SWE border	127,171	2,524	82.0	73.8
Survey vessel during pipelay	31,546	626	20.3	18.3
Rock placement	29,963	595	19.3	17.4
Rock transportation from Kotka to the Russian EEZ	538	11	0.3	0.3
Fuel supply, crew exchange etc.	1,295	21	1.3	0.6
Pre-commissioning	1,826	36	1.2	1.1
Total for the construction period using only DP vessel	**357,385**	**7,090**	**231**	**208**
Total for the construction period using both lay vessels	**326,606**	**6,479**	**211**	**190**
Total for the operation period, surveys and freespan correction (estimated to be during 50 years)	**90,074**	**1,788**	**58.0**	**52.3**

Offshore activities are assessed to cause approximately 97–99 % of the whole project's emissions and only a small percentage of the emissions would derive from onshore activities. The emissions to air from *onshore activities* are assessed to constitute only 1 % of the offshore emissions and are assessed in details in Subchapters 12.1.3 (for machinery, vessels, coating plant and rock transport in the Kotka region) and 12.2.2 (for machinery and vessels at the Hanko Koverhar harbour).

11.1.4 Prevention and mitigation of adverse impacts

The tendering procedure for selecting the contractor offers opportunities to prevent air emissions and climate impacts. Nord Stream 2 will periodically audit its Contractors to ensure that their vehicles comply with applicable legal provisions[F-010]. Using clean technologies in vessels, equipment and transportation, keeping transport distances as short as possible and conducting activities effectively can prevent air emissions from construction of the project.

11.1.5 Lack of information and uncertainties

The air emissions calculations are associated with uncertainties, e.g. related to engine type, number of engines, working load of the engines and the exact fuel type. Despite the data limitations and uncertainties, the emissions calculated here are in the order of the correct magnitude.

11.1.6 Significance of the impacts

The total air emissions generated during the offshore construction in the Finnish EEZ are as follows (rounded): 357,000 tonnes of carbon dioxide (CO_2), 7,000 tonnes of NO_X, 230 tonnes of SO_2 and 210 tonnes of particulates (PM) using only DP vessel. Same emissions using both lay vessels are 430,000 tonnes of carbon dioxide (CO_2), 6,500 tonnes of NO_X, 210 tonnes of SO_2 and

190 tonnes of particulates (PM). These emissions are generated during approximately 1.5 years of construction period in the Finnish EEZ.

Total emissions from vessel traffic in the Gulf of Finland in 2014 were 2,206,000 tonnes of CO_2, 47,500 tonnes of NO_X, 10,900 tonnes of SO_X and 2,300 tonnes of PM. Consequently, the total CO_2 and NO_X emissions of the annual offshore construction activities in the Finnish EEZ (using DP vessel only) are approximately 15 % with SO_2 emissions approximately 2 % and particulate emissions approximately 9 % of total emissions occurring annually from vessel traffic in the Gulf of Finland. The significance of the impact to climate and air quality is therefore considered negligible.

As regards impacts on climate and air quality, there are no substantial differences between sub-alternatives and between construction alternatives.

11.2 Seabed morphology and sediments

Rock material placed on predetermined locations (rock berms) and pipelines on the seabed will permanently alter morphological features of the seabed along the pipeline route. In addition, when the pipeline route is cleared of any munitions, detonations of munitions will cause depressions on the seabed. Also, anchor handling from pipe laying barges may cause small depressions on the seabed.

Seabed sediments vary from hard bottom complexes to soft clay along the pipeline corridor in the Finnish EEZ. These sediment types behave differently when disturbed. The finest particles are easily suspended into the water phase. Particles may also contain contaminants normally attached to them. Suspended particles will finally settle down onto the seabed, thus, inducing relocation of surface sediments and contaminants. The extent of the impact area depends on the prevailing hydrological conditions (magnitude of the currents in the water layer nearest to the seabed) during the construction works.

Experience of the Nord Stream Project

Based on the monitoring results of the impacts from the clearance of 49 munitions during the construction of NSP, the radius of created craters varied between 0-7.6 m (most commonly a few m). The range for the amount of released sediment during the detonations was 0-40 m^3. The highest volume was measured on a soil type of very soft clay when the crater radius was 3.1 m. The crater volume was about 10 % of the assessed volume. The analysis of sediment data did not show statistically significant changes in concentrations of contaminants in sediment that could have been attributed to the munitions clearance operations. The measured variations were due to natural variations in the composition of the seabed *(Witteveen+Bos 2011)*.

Sediment monitoring at the tie-in site, which was the largest constructed rock berm, showed no indication that rock placement would have caused any significant sediment relocation or increases in the concentrations of contaminants *(Ramboll 2011b)*.

The height of the constructed rock berms varied roughly from 1.5 m to 6.0 m. The maximum length and height of freespans in one of the pipelines during the 2013 survey was 129.5 m and 7.2 m, respectively (Figure 11-1). The total number of freespans in the Finnish EEZ was 612 *(Fugro Subsea Services Ltd 2014)*.

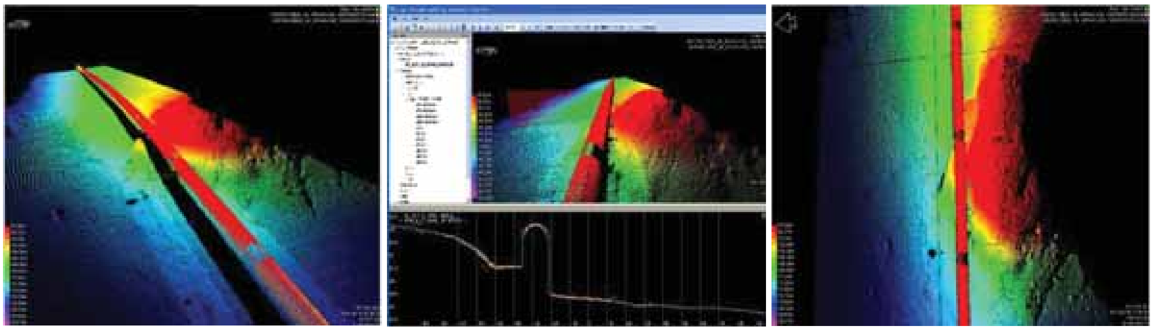

Figure 11-1. Freespan (>100 m) in NSP pipeline; maximum height 2.3 m (Ramboll 2013b).

Summary of the impact assessment on seabed morphology and sediments	
Lessons learned from the Nord Stream Project in 2009–2012	Construction works created localised depressions (munitions clearance, anchor handling) and elevations (rock placement, mattress installation and the pipeline as a feature) on the seabed. The area that was covered by the rock berms and pipelines was small (0.018%) compared to the total seabed area of the Finnish EEZ. Munitions clearance resulted in smaller craters than was assessed and the actual total amount of released sediment was substantially smaller than the assessed volume. The actual craters did not resemble a 'cone' as assumed, but were more like depressions with a more or less even bottom. The water quality monitoring results indicated only minor sediment resuspension during munitions clearance, rock placement and pipelay by the anchored lay barge. Based on this, no significant relocation of surface sediments or increase in concentrations of contaminants on the seabed near the activitiesoccurred. The overall conclusion was that the impacts of the construction works on the seabed were minor.
Main results of the assessment	The total amount of suspended sediments caused by the planned construction works has been modelled to be relatively low. The footprint of the pipeline system covers approximately 0.029% of the seabed area in the Finnish EEZ. The magnitude of change (i.e. new area covered by the pipeline system) has been classified as low. Re-sedimentation (settling down of sediment particles in suspension) has been assessed to be minor, at most a few millimetres and occurring near the working sites. Contaminants and nutrients attached to sediment particles in suspension will finally resettle on the seabed, thus, causing different degrees of relocation of these compounds. Munitions clearance or rock placement near the Natura 2000 site "Sea Area South of Sandkallan" is not assessed to have adverse impacts on the seabed inside the conservation area. Thus, the project is not a threatto the representativeness of those ecological values that serve as the grounds for the conservation of that Natura 2000 site. The modelling results confirm the conclusions that were presented in the Natura assessment screening report. Overall, the significance of the surface sediment movements during construction, in the open Gulf of Finland, has been assessed as negligible when compared with the natural processes that occur over the seabed during storms.

11.2.1 Impact mechanism

Seabed intervention related to the project, especially, during the construction phase can alter the current seabed features along the pipeline route by causing depressions and elevations to the seabed topography (Table 11-4). Depending on the sediment type, disturbance may cause sediment particles and contaminants attached to particles, if any, to suspend and disperse into the overlying seawater and, finally, to settle down onto the seabed surface. Morphological features of the seabed and surface sediment quality in different parts of the project area in the Finnish EEZ are presented in Subchapter 7.4.

During construction of the pipelines, the project activities causing impacts to theseabed are munitions clearance and rock placement, but also, to a lesser extent, pipelay with an anchored lay barge (Table 11-4).

During operation, pipelines and support structures (rock berms, cable etc. crossings) on the seabed, as a new object, cause morphological changes in a limited area.

Table 11-4. Possible impacts of the project activities on seabed morphology and sediments

Receptor	Project phase	Project activity	Impact
Seabed surface	Construction	Munitions clearance Rock placement Pipelay with DP lay barge Pipelay with anchor handling	Creation of depressions/elevations Re-sedimentation of disturbed sediment particles (relocation) Re-sedimentation of contaminants attached to sediment particles (relocation)
	Operation	Pipelines and support structures on the seabed Maintenance rock placement	Morphological change (height and width of structure, freespans) Possible changes in footprint

11.2.2 Methods and data used

The assessment of the impacts of the main construction activities, munitions clearance and rock placement on the seabed morphology and sediment quality is based on modelling of the sediment spills (Subchapter 10.3, *Ramboll 2016b*). Impact assessment of pipelines as objects on the seabed are based on the present project design *(Saipem 2016a)* and experience from the Nord Stream Project *(Ramboll 2013b)*.

Munitions clearance and rock placement will have direct impacts (detonations will create depressions on soft sediments and rock berms will change seabed morphology) and indirect impacts (disturbed particles in suspension will resettle on the seabed – relocation of surface sediments) on the seabed. The extent of increased sedimentation of suspended solids (impacted area) in relation to the pipeline alignment is based on the results of modelling of sediment spills (Subchapter 10.3).

The method used to calculate the footprint of the pipelines and support structures is presented in Subchapter 11.16.2.

Significance of an impact (sensitivity of the receptor and magnitude of change) on seabed morphology and sediments has been assessed according to the principles presented in Chapter 10 and Table 11-5 and Table 11-6.

Table 11-5. Sensitivity of receptor (seabed morphology and sediments).

Low	The seabed along the survey area is homogenous, comprising soft sediments or mixed soil types and is not geologically valuable. Surface sediments contain concentrations of contaminants at average levels that are the same or less than the lowest guideline values 1, 1A and 1B (Environmental Administration Guidelines 1/2015).
Medium	The seabed along the survey area is variable with mixed soil types and has some or potential geological value. Surface sediments contain concentrations of contaminants at average levels that are at guideline level 1C.
High	The seabed along the survey area is variable, with valuable geogenic formations. The area is protected (Natura 2000 or other protection purpose). Surface sediments contain concentrations of contaminants at average levels that exceed the highest guideline level 2.

Table 11-6. Magnitude of change (seabed morphology and sediments)

Negligible	The footprint of the pipelines, rock berms and other support structures on the seabed comprise ca. 0.001% of the seabed surface in the Finnish EEZ. Pipelines and support structures are causing only slight morphological (width, height, elevations) changes in a very limited area. There are no changes in hydrographic and hydrodynamic conditions near the seabed.
Low	The footprint of the pipelines, rock berms and other support structures is ca. 0.01% of the seabed surface in the Finnish EEZ. Pipelines and support structures are causing some morphological (width, height, elevations) changes in a limited area. Only slight and local changes in hydrographic and hydrodynamic conditions near the seabed occur in the vicinity of the pipelines.
Medium	The footprint of the pipelines, rock berms and other support structures is ca. 0.1% of the seabed surface in the Finnish EEZ. Pipelines and support structures are causing moderate morphological (width, height, elevations) changes but change is local. Evident but local changes occur in hydrographic and hydrodynamic conditions near the seabed in the vicinity of the pipelines.
High	The footprint of the pipelines, rock berms and other support structures is ca. 1% of the seabed surface in the Finnish EEZ. Pipelines and support structures are causing major morphological (width, height, elevations) changes in an extensive area. Evident and extensive changes occur in hydrographic and hydrodynamic conditions near the seabed.

11.2.3 Impact assessment

The seabed along the pipeline route has no special geological value. However, in the survey corridor nearest to the Sandkallan Natura 2000 area in the eastern Gulf of Finland there are outcrops of hard bottom complexes on the seabed. These formations may potentially be continuations of the reef-like hard seabed types (bedrock, till, sand, gravel and stony bottoms) that have been subject to inventory inside the Natura 2000 area. Also, at the level of Porkkala, in the open Gulf of Finland, there may be potential seabed types that could be important for the biodiversity of the seabed (Figure 11-30 in Subchapter 11.5).

Hydrographic conditions near the seabed determine to a large extent the seabed properties (accumulation/erosion areas, presence of contaminants). Concentrations of contaminants in the surface sediments are generally low along the whole pipeline route (Subchapter 7.2.4). Where slightly elevated concentrations of organic compounds like dioxins exist on soft seabed, these contaminants are normally strictly attached to the finest sediment particles. Traces of the polluted sediments discharged from the River Kymijoki are still to be seen on the seabed in the easternmost part of the project area (Subchapter 7.4).

According to the assessment criteria (Table 11-5), sensitivity of the seabed along the pipeline route is assessed mainly as *low*. Near Sandkallan and Porkkala area, sensitivity of the seabed has been assessed as *medium*.

11.2.3.1 Impacts during construction

Munitions clearance and rock placement are the main activities that may alter the present seabed morphology and quality of the surface sediments by creating elevations or depressions and relocating suspended sediments. Impacts of these activities are, at least partially, reversible (depending on the seabed type) and irreversible, respectively.

The preliminary schedule for munitions clearance is between April and July 2018 and rock placement from April 2018 till autumn 2019 in the Finnish EEZ.

11.2.3.2 Modelling of sediment spills during munitions clearance and rock placement

<u>Total amount of sediments in suspension</u>

Table 11-7 shows the results for the modelled maximum amounts of sediment released from the seabed during munitions clearance and rock placement. According to the modelling results, the total amount of suspended solids released because of detonations of 24 munitions (Figure 10-8) is assessed to be approximately 1,000 tonnes.

During rock placement, suspension is assessed to be approximately 2,700 tonnes for one pipeline. Modelling includes construction of the hyberbaric tie-in location which is an option at the present design stage of the project.

Table 11-7. Modelling results for the amount of suspended sediments during munition clearance and rock placement for the northern pipeline (Figures 10-2 and 10-4).

Construction works	Total amount of suspended sediments, tonnes
Munitions clearance[1]	1,030
Rock placement – Northern line A[2]	2,590
Rock placement - Alternative route[3]	2,850

[1] For 24 munitions

[2] Including sub-alternatives ALT E1 + ALT W1

[3] Northern line A, including sub-alternatives ALT E2 + ALT W2 (modelled for rough conditions only)

<u>Munitions clearance</u>

In a modelled generic scenario, six munitions were cleared at each selected location. Munition charge sizes varied between medium (charge 30-64 kg - 3 munitions) and large (100-350 kg - 3 munitions) with a crater volume of 20 m^3 and 42 m^3 (95^{th}percentiles), respectively. In defining charge sizes and crater volumes, experience was used from the monitoring of munitions clearance during NSP (Subchapter 10.3). Soil type at the selected munition clearance sites consists of (Figure 10-3):

- Hard clay or hard bottom complex (SED1)
- Hard clay (SED2)
- Hard clay (SED3)
- Mud (SED4)

Table 11-8 shows the extent for the areas of different sedimentation rates. The largest areas represent the lowest sedimentation rate (thickness of relocated material <1 mm). Typically, the largest sedimentation will happen in the vicinity of the munition clearance activity. Sedimentation is not assessed to exceed 179 g/m^2 at any location after detonation. Considering fluffy sediment with a dry matter content of ca. 100 kg/m^3, a thickness of 1 mm corresponds to a sedimentation rate of 100 g/m^2. A higher degree of consolidation (consequently higher sediment density) corresponds to a thinner layer thickness for the same sedimentation rate *(Ramboll 2016b)*.

Table 11-8. Areas where sedimentation of different threshold concentration levels of suspended solids are exceeded during munitions clearance.

Hydrographic scenario (Subchapter 10.3)	Extent of area with different sedimentation rates				
	>200 g/m^2	>150 g/m^2	>100 g/m^2	>50 g/m^2	>10 g/m^2
	km^2	km^2	km^2	km^2	km^2
Calm conditions	0.00	0.00	0.12	1.3	22
Normal conditions	0.00	0.04	0.14	1.5	28
Rough conditions	0.00	0.09	0.10	0.48	13

<u>Rock placement</u>
As with munitions clearance, during rock placement, re-sedimentation of suspended solids is highest closest to the activity (Table 11-9). According to the modelling results, sedimentation does not exceed 400 g/m^2 at any location after rock placement during a calm period or 170 g/m^2 during rough and normal conditions. The corresponding thickness on the seabed surface depends on the density, which in turn is dependent on the consolidation of the material. Maximum sedimentation rates correspond to a thickness of a few millimeters of resettled material on the seabed. The amount of relocation of suspended sediments can be assessed insignificant compared to the natural sedimentation rate of even several kilograms and several millimetres per square metre per year. For example, Vallius (1999) has reported annual natural sedimentation rates 2.5–15 mm in the central part of the Gulf of Finland. This corresponds to annual sedimentation rate of 250–1,550 g/m^2 of fluffy sediment with a dry matter content of ca. 100 kg/m^3, and a higher sedimentation rate in grams/m^{2,} if the degree of consolidation of sediment is higher.

Table 11-9. Areas where sedimentation of different threshold concentrations of suspended solids are exceeded during rock placement.

Hydrographic scenario (Subchapter 10.3)	Extent of area with different sedimentation rates				
	>200 g/m^2	>150 g/m^2	>100 g/m^2	>50 g/m^2	>10 g/m^2
	km^2	km^2	km^2	km^2	km^2
Northern line A, including sub-alternatives ALT E1 + ALT W1					
Calm conditions	0.1	0.2	0.6	3.9	64
Normal conditions	0.0	0.1	0.6	3.6	59
Rough conditions	0.0	0.0	0.04	0.5	22
Alternative route[1]					
Rough conditions	0.0	0.1	0.1	1.0	25

[1] Northern line A, including sub-alternatives ALT E2 + ALT W2 (modelled for rough conditions only)

11.2.3.3 Impacts of munitions clearance and rock placement

Charge size and soil type are the main factors that influence the dimensions of depressions on the seabed created by munitions clearance. On soft sediments, the craters are largest but gradually the seabed will get levelled out. On hard seabed type, the depression may be a more or less permanent feature. Seabed quality along the pipeline route is presented in Subchapter 7.4. Reversible impacts on the quality of seabed sediments are caused by the relocation of suspended particles and the substances attached to these particles. Particles in suspension will finally settle down onto the seabed. Modelling results assess the amounts of sediment spills and re-sedimentation rates of suspended particles in relation to distance from the activity during different hydrographic conditions.

The number of munitions and detonations along the route for both pipelines is not yet known, but based on the munitions clearance during NSP, the number can be estimated to be approximately 50. For 50 munitions detonations (of which 25 medium-size and 25 large-size charges) the total amount of suspended solids released because of detonations would be about approximately 2,150 tonnes. This amount can be considered very conservative, since during NSP the mean observed crater volumes were about one third of the 95th percentile crater volumes presented above.

Munitions clearance will have the greatest impact on seabed when munitions are located on soft soil type. The western areas in the Gulf of Finland best represent these kinds of sediments (Subchapter 7.4). However, the seabed in the Gulf of Finland has a small-scale heterogenic nature along the pipeline route. Overall, the significance of the impacts on the seabed is assessed as minor. The conclusion is the same as during NSP *(Ramboll 2013b)*.

Irreversible but local impacts on the seabed are caused by the coverage of seabed with rock material. Rock berms will permanently change the present seabed bathymetry along the pipeline route. As it is assumed that the impact from seabed intervention works for the other pipeline is similar to the pipeline modelled, considering the assumptions presented above, the total amount of suspended sediments for the northern pipeline during rock placement, if carried out in 30 days, would be about 2,600 tonnes and 5,200 tonnes for two pipelines (Table 11-7). This is a conservative assessment of the amount of sediment particles to be released during the activity. However, rock placement for the pipelines is planned to be spread over a nine-month period. It can be assessed that in this situation, overall impacts on the amount of suspensions and, hence, on the seabed, is locally lower than in the modelled scenario.

For comparison, annual resuspension of seabed sediments (depth range 40 m) in the Gulf of Finland is on average 10 kg/m^2 (10,000 t/km^2). Single storm events may cause resuspension of solids the magnitude of which may arise to 1 kg/m^2 (1,000 t /km^2). These assessments are based on continuous measurements of different water quality parameters over three year periods *(Luode Consulting Ltd 2013c)*.

The amount of suspension is the same as the total volume (about 5,200 tonnes) that was modelled for NSP (Ramboll 2009a). Overall, the significance of the impacts on the seabed is assessed as minor. This is in line with the monitoring results gained during construction of NSP *(Ramboll 2013b)*.

<u>Sub-alternatives</u>

The total amount of suspended sediments for the alternative route option (Northern line A, including sub-alternatives ALT E2 and ALT W2) is approximately 2,900 tonnes, being 260 tonnes larger than what is assessed for the pipeline route including sub-alternatives ALT E1 and ALT W1 (Table 11-7). The extent of sedimentation areas for different concentrations of suspended solids is only slightly larger between different sub-alternatives (Table 11-9). Uncertainty in the result is caused by the fact that the results available are based on simulations of rough conditions only. Based on data presented for the northern pipeline in Table 11-9, it can be assumed that during calm and normal weather conditions the sedimentation rates and corresponding areas are larger than during rough conditions. However, the overall impacted areas in both alternatives are very small.

Minimum water depth is lower in ALT E1 compared to ALT E2 where the footprint is assessed to be larger. Also, the number of large freespans (>100 m) in the pipeline section is supposed to be higher in ALT E2. On the other hand, potentially sensitive areas in the level of Porkkala are nearer to ALT E1. Based on this and the assessed overall lower impacts on seabed sediments and topography, ALT E2 is assessed as a better option for the pipeline route within these sub-alternatives.

Sub-alternatives ALT W1 and ALT W2 are situated in the western section of the pipeline route in the Baltic Proper. The average water depth is greater than in the eastern sub-alternatives. The footprint of the pipelines is assessed to be relatively similar, but based on the design, the number of freespans is considerably greater in ALT W1 and, thus, causing greater changes to seabed morphology. The significance of this impact is assessed as minor when the location of this pipeline route section in the Baltic Sea is taken into consideration. There are no known sensitive areas near the sub-alternatives. Overall, conclusion of the assessed impacts of rock placement on the seabed is that both sub-alternatives are equally feasible.

Release of contaminants and nutrients

Both munitions clearance and rock placement will cause the release of contaminants and nutrients into seawater attached to sediment particles. The amount of these compounds in suspension is dependent on the seabed quality and the impact of the activity on the seabed. Contaminants and nutrients are found in the sedimentation areas on soft seabed type. Based on the modelling results, concentration levels of dissolved compounds in seawater, because of the construction works, are very low and less than the environmental quality standard *(EQS; Ramboll 2016b)*. This supports the view that most of the contaminants are adsorbed by particles when in a water phase.

In the survey corridor in the Finnish EEZ, the general level of heavy metals on the seabed surface is normally less than the lowest guideline value, whereas dioxins/furans and tributyltin (TBT) concentrations are slightly above that threshold value (Subchapter 7.4). In suspension, contaminants and nutrients will drift depending on the prevailing magnitude and direction of currents before settling on the seabed. The impact on the seabed is the possible relocation of these substances because of the construction activities. It can be assessed that the main part of contaminants and nutrients originally adsorbed into sediment particles will finally resettle back on the seabed. The overall significance has been assessed as negligible. The monitoring results from NSP are in line with this conclusion *(Ramboll 2013b)*.

11.2.3.4 Pre-commissioning (option 1 and 2)

In this section, the impacts on seabed of two options for pre-commissioning of the pipelines are briefly assessed. The wet and dry pre-commissioning alternatives have been presented in Sub-chapter 5.2.

For dry pre-commissioning there is no need to construct hyperbaric tie-in in Finnish waters (Table 11-10).

For wet pre-commissioning the construction of a hyperbaric tie-in at approximately KP 300 in the Finnish EEZ is needed. The rock volume (on the average 96,000 m^3) to be used for the rock berm(s) at the tie-in location is estimated to be about 5 % of the total rock volume needed in the Finnish section. The potential tie-in site is located in the mouth of the Gulf of Finland, near the tie-in for NSP, where the water depth is about 80 m. The construction of the tie-in berm will cause local change in seabed morphology. However, based on the survey results, throughout the survey corridor in the section of the planned pipeline route, inside which the tie-in site would locate, there are areas of irregular seabed texture and outcrops of hardground generally less than 400 m wide and up to 10 m high *(Fugro Survey Limited 2016)*. In this environment the amount of rock material to be placed on the seabed for the tie-in is assessed to be *low* and the overall significance as *minor* (Table 11-10).

Table 11-10. Assessed impacts of pre-commissioning on seabed in the Finnish EEZ.

Impact on seabed		
Option	**Dry pre-commissioning**	**Wet pre-commissioning**
Action	No rock placement	Low amount of rock placement
Impact	No impact	Minor and local but irreversible impact on seabed morphology

In conclusion, on the basis of comparison of the two pre-commissioning alternatives, impacts on seabed in the Finnish EEZ are none or minor in significance, depending on which option is chosen.

11.2.3.5 Pipelay

Pipelay with DP lay barge

Water depth along the pipeline route varies from 33 m to 184 m. A dynamically positioned (DP) lay barge will be used in the Gulf of Finland between the Russian-Finnish border and approximately KP 350 to minimise the need for munitions clearance. Whether thruster-jet induced currents from the vessel will erode the seabed, depends on the magnitude of the currents, but especially the seabed type. Based on calculations and the modelling results, erosion and suspension due to vessel positioning with thrusters could potentially occur at water depths of 36–40 m with loose sediment. Instead, no significant erosion of surface sediments due to thrusters wash is expected at water depths greater than 50 m *(Ramboll 2009a)*. Easily erodible soft sediments are not found on the pipeline route at depths of less than 50 m. The seabed consists mainly of hard soil types (bedrock, hardground, glacial till and hard clay; Figure 11-6).

Based on the seabed types along the pipeline route, calculations and the monitoring results (Ramboll 2013b) during the construction works of NSP, the thrusters wash of the DP lay barge in the Gulf of Finland is not assessed to cause any disturbance and relocation of seabed sediments. However, the pipelay, when the pipeline touches the seabed while being installed by the DP barge, may cause some sediment disturbance when laid on soft seabed.

Pipelay with anchored lay barge

Pipelay with an anchored lay barge will be used in the westernmost, deep sea areas (between approximately KP 350 and the Finnish-Swedish EEZ border). In these areas, soft sediment type is common on the seabed. The anchors of the construction vessel (twelve 25-ton anchors) are attached to the vessel with 7.5 cm thick cables. During the EIA of NSP, the lowering of one anchor was estimated to release 100 kg of seabed sediment. When all the anchors are placed according to anchor patterns, the lay barge will be supported by them while moving forward about 500 m. After that, the anchors are raised and moved to a new location. The estimated amount of cut loose material is about 1,600 kg/anchor *(Ramboll 2009a)*.

The main impact of anchors will, on the one hand be localised depressions on the seabed and, on the other hand, relocation of sediments. Based on experience, the impacts on the seabed have been partially reversible, depending on the type of seabed. In the case of soft sediments, the seabed recovery time may last from several weeks to months. On more cohesive or harder (less erodible) seabed areas, the recovery may take several years or the depressions may be permanent *(Nord Stream AG 2009)*.

Anchor wire movement is a slow process and because of the prevailing hydrographical conditions (permanent halocline) in the area where anchors are planned to be used, suspension of particles will stay in the water layer nearest to the seabed and near the pipeline alignment. Depending on the presence and magnitude of bottom close currents, these disturbed sediment particles will stay in a water phase until they finally settle onto the seabed.

During NSP, the anchor handling activities were assessed to cause sedimentation at a rate >1 mm/m^2 in areas less than 0.1 km^2. Based on modelling, the total amount of suspended sediments was assessed to be 2,070 tonnes in a length of 180 km *(Ramboll 2009a)*. The seabed along the pipeline route in these areas, where the anchoring vessel will be used, has no special geological value. The sensitivity of the seabed is assessed as low and the magnitude of change of this activity as low. The overall significance of depressions and relocation of suspended sediments on the seabed that will be created by the anchors and cables is assessed as minor.

11.2.3.6 Impacts during operation

Morphological changes

Seabed morphology will change along the pipeline route when rock berms are constructed to secure the integrity of the pipeline in the long-term. Also, the crossing sites of existing pipelines and cables and possible freespans in the pipelines will create morphological changes on the current seabed profile. Based on experience from NSP, the maximum heights of the constructed berms are around 6 m and the maximum heights of freespans approximately 7-8 m (see later). The design of the NSP2 pipelines is still on-going and the detailed design of the rock berms is not yet known.

The presence of pipelines and support structures (rock berms, cable etc. crossings) on the seabed will irreversibly change the seabed morphology. The footprint of this pipeline system has been roughly calculated and the results show that the percentage of the covered area is about 0.029 % of the seabed in the Finnish EEZ. This assessment includes the possible tie-in berm and the post-lay in-service buckling (ISB) berms. Based on experience from NSP, on soft seabed sediments, gradual embedment is a common feature for the pipeline. In the long run, this and natural sedimentation processes will diminish the morphological anomaly and the footprint effect of the pipeline system.

The total amount of rock material that is planned to be placed on the seabed is approximately 2 million m^3. This is 4-5 times larger than the amount used on the NSP *(Ramboll 2013b)*. As stated earlier in text, the seabed along the pipeline route has normally no special geological values. Possible exceptions are the areas near the Sandkallan Natura 2000 area and the Porkkala region (Subchapter 7.9.2.1). All dimensions of the area in question should be taken into consideration when the impacts and their significance are assessed. As a comparison, the diameter of the fully exposed pipe is about 1.4 m, while the water depth varies from 39 m to 183 m and, especially, in the eastern Gulf of Finland, the seabed relief can be tens of metres.

Elevations that will be produced on the seabed by the project, when proportioned to the scale of the Gulf of Finland, can be assessed as minor in significance. Based on that, and the fact that the footprint of the covered seabed area in the Finnish EEZ is small, the overall impacts on seabed morphology have been assessed as minor in overall significance, though larger than during NSP.

Hydrodynamic changes

Pipelines on the seabed can potentially cause minor local changes in small-scale hydrodynamic conditions and, hence, sediment dynamics. This requires that pipes are exposed (embedment <20 %) on the seabed. On soft seabed, the embedment of pipelines will be high (>20 %). In areas where the pipeline is exposed, small changes in bottom close currents have been found in the vicinity (within a distance of 50 m) of the pipes *(Witteveen+Bos 2012 and Luode Consulting 2012)*.

Based on experience from the monitoring of the impacts of NSP, processes like scouring (erosion) or sedimentation near the pipelines are not expected to occur to a significant amount *(Ramboll 2015b)*. Potentially, local scouring may be caused by the bottom close currents on the soft seabed type in the immediate vicinity (1 m offset) of the pipes. This finding confirmed the modelling based assessments that the impacts of the pipes on sedimentation and erosion patterns will be minor or negligible *(Ramboll 2009a)*.

11.2.4 Prevention and mitigation of adverse impacts

No mitigation measures are needed.

11.2.5 Lack of information and uncertainties

Assessment of the environmental impacts of the construction activities is based on the knowledge of the current state of the environment in the Finnish EEZ where the pipelines are planned to be constructed. For this purpose, a survey programme was compiled where special attention was paid to collect representative samples from the environment where the seabed is known to be heterogenic in nature. As the survey area was very long (about 378 km), and it is generally known that hydrological and physical-chemical conditions in the water environment may vary quite a lot along the east – west axis of the Gulf of Finland, the information received during the baseline sampling inevitably includes some deficiencies and, hence, uncertainties. Uncertainties have been able to be minimised by utilising the experience gained during monitoring of the environmental impacts of the construction works of NSP. That pipeline project was carried out mainly with the same technique and in the same area where the construction activities of this project are planned to occur.

Some uncertainty is related to munitions clearance as the exact number of munitions to be cleared is not known at the EIA phase of the project. Information is available from the NSP surveys of the frequencies and locations of the cleared munitions in the pipeline route. Highest frequencies were found in the western part of the route (mouth of the Gulf and Porkkala region), where soil type is mainly soft mud and clay. The assessments will be updated in the permit application based on the latest project information.

The behaviour of sediment particles after disturbance has been assessed by modelling. Assumptions and certain degrees of uncertainty are typical for all models. Hydrodynamic modelling is based on the sophisticated version of the MIKE 3 model. For example, it uses a fine mesh along the pipeline corridor in the Gulf of Finland, while a coarser mesh is used in other parts of the Baltic Sea. Also, a high-resolution (5 m × 5 m) bathymetric data set was applied in Finnish waters *(Ramboll 2016b)*. Validation of the model was carried out and sensitivity analyses were undertaken to minimise uncertainties and to assess the influence of the assumptions on the modelling results *(DHI 2016d)*.

Modelling was done for the northern pipeline and an assumption made that the suspended solids volume for the southern pipeline is of the same magnitude. Uncertainty associated with the impacts refers to the design plan to construct both pipelines simultaneously. Uncertainty is reduced by the plan to carry out rock placement for the two pipelines during different periods. The preliminary schedule for the whole activity (pre-lay and post-lay rock placement) is over 21 months.

11.2.6 Significance of the impacts

Seabed construction works will cause impacts that are reversible or irreversible, depending on the activity. In NSP monitoring results, the actual crater volumes due to munitions clearance were 10 % of the assessed. These lessons learned have been incorporated in the NSP2 assessments. In general, the assessed amounts of relocation of suspended sediments are assessed insignificant compared to the natural release rate of surface sediments e.g. during storms in the Gulf of Finland.

If seabed construction works (post lay rock placement is planned) are needed close to the Sandkallan Natura 2000 area, the assessment, based on the modelling , is that the project will not have any adverse impacts on the seabed inside the Natura 2000 area. This confirms the conclusions that were already presented in the Natura assessment screening report.

Although the NSP2 twin pipeline system has been assessed to cover a larger seabed area than the NSP pipelines, the overall impact on the total seabed area of the Finnish EEZ is still low (about 0.029 %).

Sub-alternatives
In the section of the pipeline route where sub-alternatives ALT E1/ALT E2 are located, the impact on the seabed is assessed to be larger for ALT E1. The main reason is the closer distance to potential sensitive seabed areas in the Porkkala region.

Another sub-alternative section ALT W1/ALT W2 along the pipeline route is located out of the Gulf of Finland in the Baltic Proper. Near the section there are no known sensitive seabed areas. In terms of impacts on seabed, it is assessed that both sub-alternatives, ALT W1 or ALT W2, are equally good.

Overall conclusion
Based on the assessment results, the sensitivity of the seabed along the pipeline route is assessed mainly as *low*. Near Sandkallan and Porkkala, area sensitivity is assessed as *medium*. The magnitude of change is assessed, depending on the activity, either as *negligible* or *low* (Table 11-5 and Table 11-6). Hence, the overall significance of the impact of the project on the seabed and seabed morphology during the construction works is assessed to be *negligible* or *minor* and during operation as *minor* (Table 11-11).

Table 11-11. Significance of the impacts on seabed morphology and sediments.

Impacts on seabed morphology and sediments	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Munitions clearance	Low/Medium	Low	Minor
Rock placement	Low/Medium	Low	Minor
Pipelay with DP lay barge	Low/Medium	Negligible	Negligible
Pipelay with anchor handling	Low	Low	Minor
Operation phase			
Pipelines and support structures on the seabed	Low/Medium	Low	Minor

11.3 Hydrography and water quality

Impacts during the construction phase of the pipelines are related to temporary sediment spreading causing water quality changes. In suspension there are sediment particles and nutrients and contaminants attached to particles. During disturbance of the surface sediments, dissolved nutrients and some soluble contaminants may be released from the pore water into the overlying sea water. Depending on the quality of changes in the overlying sea water, part of the particulate-bound contaminants and nutrients may also be dissolved in the water column. The duration of increased turbidity in the water column above the seabed and the extent of water quality changes depend on the prevailing hydrographical conditions (the magnitude and direction of bottom-close currents and the stratification of the water column).

During operation of the pipelines, certain hydrographical changes in the area around the pipelines are possible. This depends largely on the seabed type and hence the embedment rate of the pipelines.

Summary of impact assessment on hydrography and water quality	
Lessons learned from the Nord Stream Project in 2009-2012	Monitoring of the environmental impacts of the construction activities confirmed that the actual impacts were of the same order or less than predicted in the EIA. Increased turbidity during the construction works was restricted to the water layer above the seabed (0-10 m) in the vicinity of the activity. During rock placement, resuspension of surface sediments decreased as a function of time when the activity continued and the original seabed was buried by new rock material. Harmful compounds in suspension were mainly attached to particulate matter. The general concentration level in the water near the seabed was low. Because of poor oxygen conditions in the water layers in question, most of the phosphorus was in dissolved form. Dioxins/furans and tributyltin (TBT) are mainly attached to inorganic and organic particles in the seabed sediment. The possible soluble fraction of these contaminants adsorbs rapidly to suspended solids when released in the water column. The monitoring results indicated that hydrodynamical conditions may change a short distance just above the seabed around exposed (embedment rate <20%) pipelines. The changes in sediment and erosion patterns on soft seabed were negligible. The minor, small-scale hydrodynamical impacts (small eddies just above the seabed due to turbulence caused by the presence of the pipelines) were limited to the nearest vicinity of the pipelines. During the first year of operation, the concentration of zinc in sea water near the anodes was low or under the detection limit.
Main results of the assessment	The main construction works (munitions clearance and rock placement) are assessed to cause temporary water quality changes mainly in the water layer closest to the seabed and relatively near the activity. A slight increase in the concentration of suspended solids during munitions clearance may be detected beyond the project area. If munitions clearance is needed near the Natura 2000 site "Sea area south of Sandkallan", minor changes in water quality are possible in that area. However, concentrations in the sea water above the seabed are assessed to be low and the duration of the water quality change is assessed to be short. The concentration of dissolved contaminants in sea water due to the construction works is assessed as low. Although the PNEC value of benzo(a)pyrene is assessed to be exceeded during munitions clearance, the highest modelled concentrations are still lower than the environmental norm (EQS) for that PAH compound. Suspended phosphorus due to the construction works will not have any effects on the eutrophication status of the Gulf of Finland. During operation, minor, limited hydrographical changes near the pipelines are possible in sections where the pipelines are clearly exposed.

11.3.1 Impact mechanism

Depending on seabed type, impacts on water quality will most probably arise during construction works such as munitions clearance and rock placement. Surface sediments will be disturbed and sediment particles will be released into the sea water. Organic, muddy, soft clay and fine silt sediments are the most sensitive in this respect.

During the operation phase, the pipelines on the seabed can alter hydrological conditions such as the pattern and magnitude of the bottom-close currents. Other potential impacts are changes in heavy metal concentrations because of the release of metal from the anodes and changes in temperature because of the difference between the temperature of the gas inside the pipelines and the ambient water temperature.

Table 11-12. Possible impacts of the project activities on hydrography and water quality.

Receptor	Project phase	Project activity	Impact
Water quality	Construction	Munitions clearance Rock placement Pipelay with DP lay barge Pipelay, anchor-handling	Water quality changes caused by sediment particles released into suspension
	Operation	Pipelines on seabed	Release of contaminants from anodes Temperature change in sea water because of temperature of gas in pipelines Changes in current patterns close to pipelines
		Maintenance rock placement	(see above - Impacts of rock placement)

11.3.2 Methods and data used

Impacts on the physical-chemical environment have been assessed by an expert opinion. The assessment of the release and spreading of disturbed sediments and contaminants is based on the modelling results (Subchapter 10.3). Experience gained from the monitoring of the construction works of the Nord Stream Project in 2009-2012 *(Ramboll 2013b)* and later operation of the pipelines has been utilised in the assessment.

The overall significance of an impact (based on assessment of sensitivity of receptor and magnitude of change) on hydrography and water quality is assessed according to the principles presented in Subchapter 10.3 and Table 11-13 and Table 11-14.
.

Table 11-13. Sensitivity of receptor (hydrography and water quality).

Low	Sea water near the project area does not belong to any protected area. Characterized by low oxygen level and poor living conditions for organisms 1 m above the seabed due to high water depth.
Medium	Sea water near the project area forms part of a protected area. During turnover times, favourable oxygen level and for most of the time moderate living conditions for organisms 1 m above the seabed.
High	Sea water near the project area belongs to a protected area. Permanently favourable oxygen level and good living conditions for organisms 1 m above the seabed.

Table 11-14. Magnitude of change (hydrography and water quality).

Negligible	No detectable impacts on water quality caused by the construction works or the operation of the pipelines on the seabed.
Low	Duration of increased* (>10 mg/l) suspended solid concentrations in water above the seabed less than one week. Concentrations of dissolved contaminants may temporarily (<one week) exceed the PNEC[12] values.
Medium	Duration of increased (>10 mg/l) suspended solid concentrations in water above the seabed more than one week but less than one month. Concentrations of dissolved contaminants exceed the PNEC values for more than one week but less than one month.
High	Duration of increased (>10 mg/l) suspended solid concentrations in water above the seabed for prolonged period (>one month). Concentrations of dissolved contaminants exceed the PNEC values for prolonged period (>one month).

* The background concentration of suspended solids is approximately 2 mg/l. Impacts of only clearly increased values from the background have been assessed.

11.3.3 Impact assessment

Stratification conditions in the water column vary in different parts of the pipeline route in the Finnish EEZ. Therefore the water quality properties in the lowermost water layer, where the main impacts of the construction works concentrate, vary accordingly. In the western and middle section of the pipeline route, the sensitivity of the sea water ecosystem near the seabed is assessed as *low* and in the eastern section as *medium* (Table 11-13). Classification of sensitivity is based on the oxygen level and living conditions differences only.

11.3.3.1 Construction phase

Munitions clearance

Modelling results of sediment spills during munitions clearance

Modelling results cover the clearance of 24 munitions objects, half of which used a medium charge and half of which used a large charge (Subchapter 10.3). The total sediment volume released during the modelled clearance activity is 744 m^3 (corresponding to 1,030 tonnes of sediment). The estimated total number of munitions for the full length of both pipelines in the Finnish EEZ is discussed later.

During munitions clearance, sediment is released 15 m above the seabed. Although the detonations will mix sediment through the whole water column, the majority of the sediment volume will disperse in the bottom-close waters less than 15 m above the seabed. This is in line with the monitoring results of the activity during NSP, which indicated elevated turbidity in the water mass located maximum 10-15 m above the seabed *(Witteveen+Bos 2011)*.

Table 11-15 presents the maximum concentrations of suspended solids in relation to the distance from the detonation locations. The highest concentration (100 mg/l) at a distance of 1 km is found during calm (summer) conditions.

[12] Predicted No Effect Concentration

Table 11-15. Maximum concentration of suspended solids at specific distances from the detonation locations.

Water layer	Concentration (mg/l) in relation to distance								
	200 m			500 m			1,000 m		
	Normal	Calm	Rough	Normal	Calm	Rough	Normal	Calm	Rough
0–10 m	69	106	96	68	100	82	53	100	82
10–20 m	108	90	90	108	83	85	68	75	54

Table 11-16 shows the areas where the threshold concentrations of suspended solids are exceeded. The largest impact area for suspended solid concentrations >2 mg/l[13] is in the layer 0–10 m above the seabed during rough weather conditions. When bottom-close currents are strong, spreading but also dilution of particles is most effective. In the layer 10-20 m above the seabed, the maximum impact area is about a third of the lower layer. The maximum impact areas for increased concentrations of suspended solids (>10 mg/l) are found during calm conditions when current magnitudes are low and dilution is weaker than during rough conditions. Differences between the impact areas during different hydrographical conditions are small.

Table 11-16. Areas of suspended solids exceeding different threshold concentrations during munitions clearance and during different hydrographical conditions. The shaded area represents increased concentrations of suspended solids.

Water layer	Area (km^2) with concentration exceeding the threshold value								
	>2 mg/l			>10 mg/l			>15 mg/l		
	Normal	Calm	Rough	Normal	Calm	Rough	Normal	Calm	Rough
0–10 m	129	155	258	35	46	33	19	28	16
10–20 m	33	35	78	20	20	31	17	16	22

The duration of exceedance of the 10 mg/l threshold is presented in Table 11-17. The duration varies between 5 and 13 hours. The differences between the modelled hydrographical scenarios are small.

Table 11-17. Duration of suspended solids above the threshold concentrations during munitions clearance and during different hydrographical conditions. The shaded area represents increased concentrations of suspended solids.

Water layer	Maximum duration (hours) of concentration								
	>2 mg/l			>10 mg/l			>15 mg/l		
	Normal	Calm	Rough	Normal	Calm	Rough	Normal	Calm	Rough
0–10 m	24	23	20	13	9	7	10	8	5
10–20 m	21	15	12	12	6	9	11	6	5

Figure 11-2 and Figure 11-3 show the maximum concentrations of suspended solids in two different water layers for calm hydrographical conditions. Summer conditions were chosen to be presented because these conditions had the largest impact area of increased suspended solids concentrations (>10 mg/l) in modelling. This is also the period when munitions clearance will be carried out. The highest concentrations at different sites are seen in the lowermost water layer above the seabed.

[13] Background level is assumed to be around 2 mg/l.

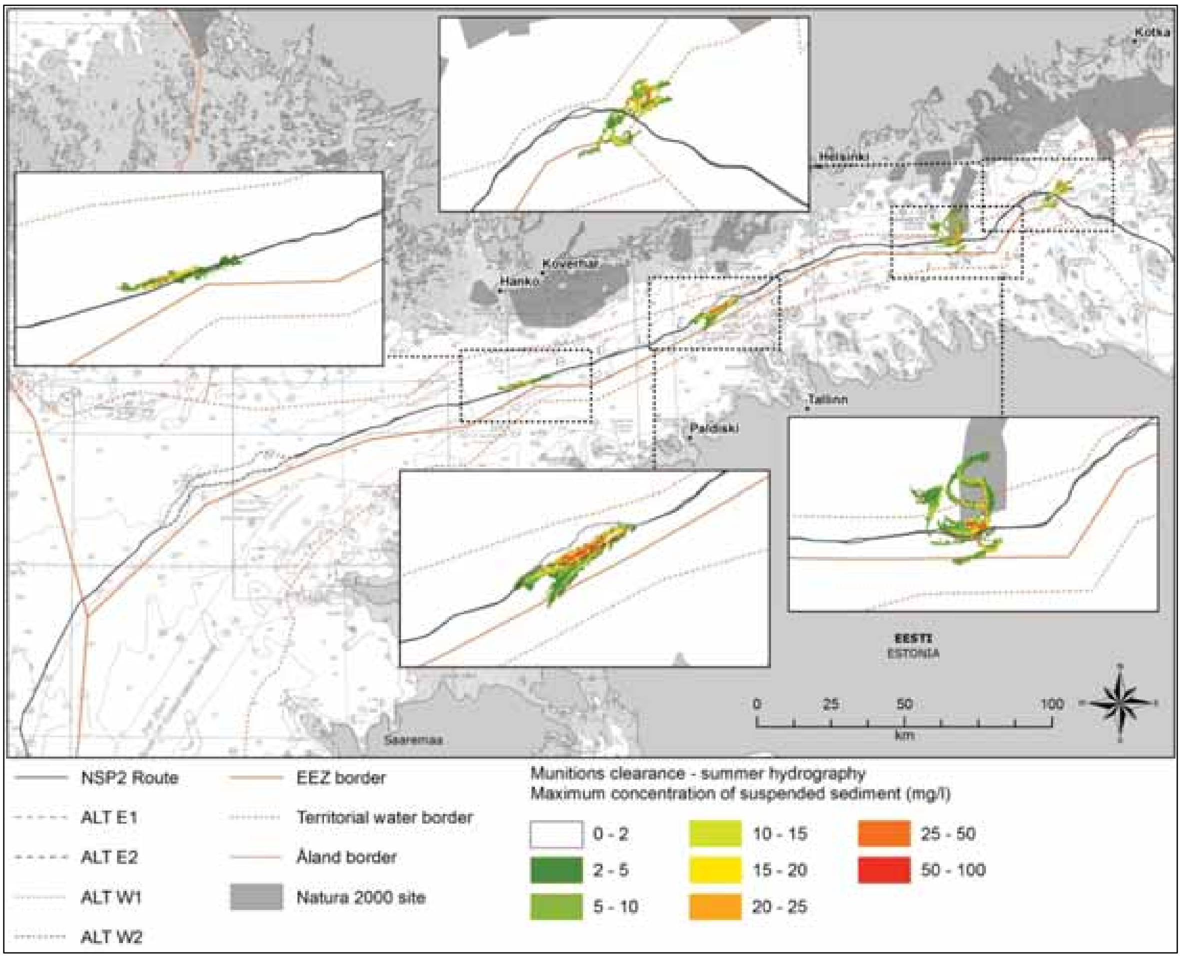

Figure 11-2. Maximum concentration of suspended solids (mg/l) during munitions clearance along the eastern and central pipeline route, 0-10 m above seabed. Modelling results for calm hydrographical conditions.

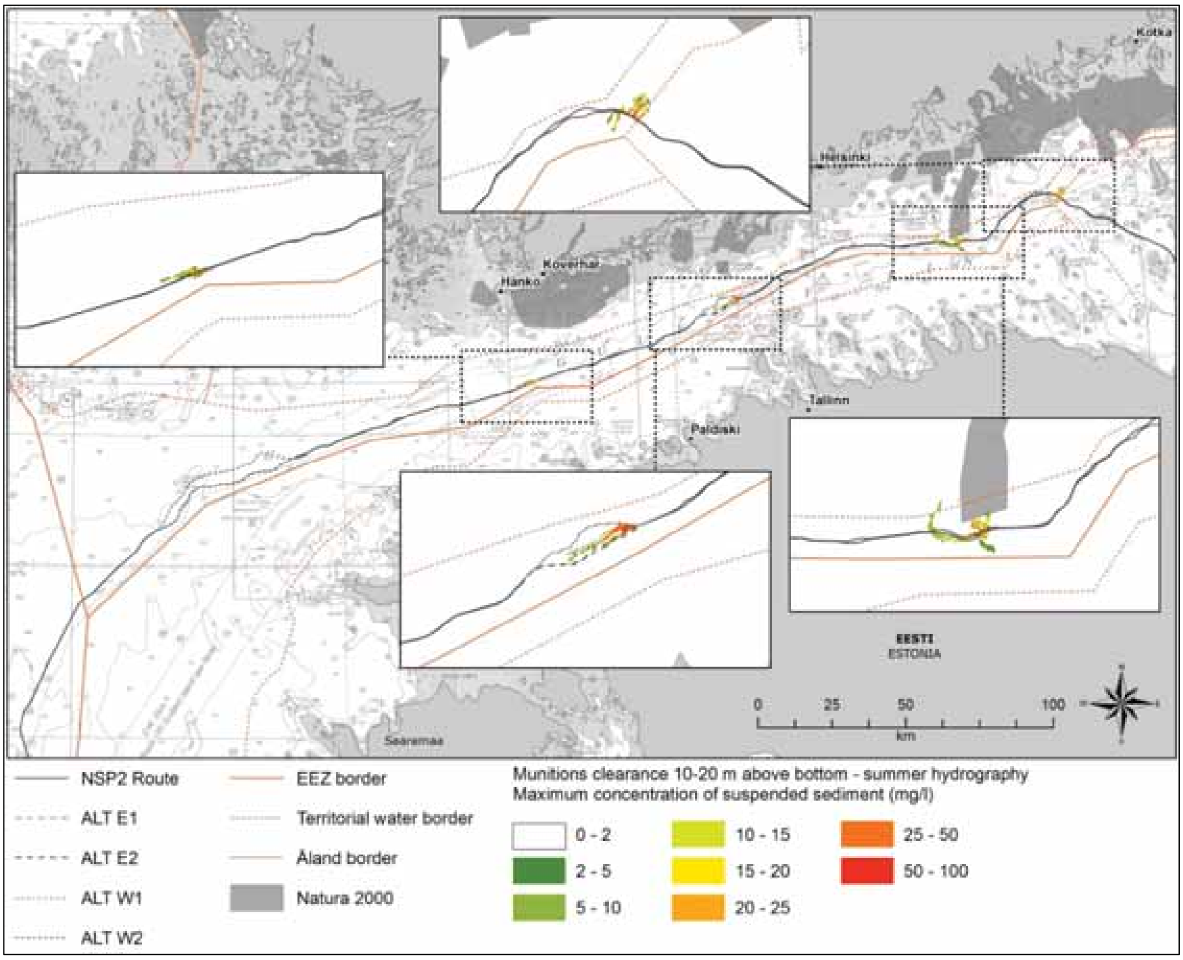

Figure 11-3. Maximum concentration of suspended solids (mg/l) during munitions clearance along the eastern and central pipeline route, 10-20 m above seabed. Modelling results for calm hydrographical conditions.

Assessed impacts of munitions clearance

The total number of munitions to be cleared inside the pipeline route was not known at the time when the EIA report was written. In modelling, a generic scenario was used where the impacts of 24 munitions were assessed. During NSP, a total of 49 munitions objects were cleared *(Ramboll 2013b)*. It can be assessed that the total number of munitions to be detonated for this project is approximately 50. Although the total amount of suspended sediments during munitions clearance cannot be assessed, the modelling results represent the worst case scenario of impacts caused by the modelled munitions at the studied locations (e.g. area with concentration exceeding the threshold value and maximum duration of suspended solids in a water phase). Due to careful selection of the modelling sites (sensitive areas nearby) and the modelling constraints (number and distance of munitions, charge sizes, 24 h between clearances; Subchapter 10.3), it is assessed that the results give a good basis for the assessment of impacts on water quality near the detonation locations, both spatially and over the munitions clearance time.

The main factor affecting the spreading and dilution of suspended matter after detonations is the bottom-close currents. During calm conditions when the current magnitudes are normally low, the highest concentrations of suspended solids near the seabed are near the detonation locations (Figure 11-2). The impact area is most often limited in the direction of the pipeline route to the surrounding environment. It is possible that if munitions clearance is needed to be carried out in the project area, an increased concentration of suspended solids will temporarily be detectable in the southern part of the Sandkallan Natura 200 area. However, concentrations in sea water above the seabed are assessed to be low and the duration of the water quality change short.

In conclusion, munitions clearance in the project area is assessed to cause short-term impacts on sea water quality near the seabed. Water quality changes will reach their maximum values nearest to the clearance sites, but increased concentrations of suspended solids can be found even at a distance of 1,000 m from the detonation locations. The duration of increased concentrations of suspended solids has been selected as the main criteria for the magnitude of change. It is assessed, based on the modelling results for 24 munitions, that the local duration of concentrations >10 mg/l will not last longer than one day, even if approximately 50 munitions are cleared.

Rock placement

Modelling results of sediment spills during rock placement

Sediment spills during rock placement have been modelled for one pipeline (Northern line A) and for the alternative route of the same pipeline (Subchapter 10.3.1). Modelling includes construction of the hyberbaric tie-in location, which is an option at the present design stage. It has been assessed that the impacts of the construction works for the other pipeline are similar to the modelled pipeline.

The highest suspended solid concentrations were found in the lowermost 10 m water layer above the seabed. This is in line with the monitoring results of increased turbidity in this layer during construction of the NSP pipelines *(Ramboll 2013b)*.

Table 11-18 presents concentrations of suspended solids in relation to distance from the pipeline route. Concentrations less than 20 mg/l are assessed to occur within a distance of 1,000 m from the route. The highest concentrations are assessed to occur close to the activity. During rough conditions, there is no difference in concentrations between the main route and the alternative route. The general concentration level of suspended solids in sea water as a result of rock placement is low.

Table 11-18. Maximum concentrations of suspended solids at specific distances from the rock placement sites.

Rock placement	Concentration (mg/l) in relation to distance								
	200 m			500 m			1,000 m		
	Normal	Calm	Rough	Normal	Calm	Rough	Normal	Calm	Rough
Northern line A[1]	20	21	14	20	20	10	17	17	10
Alternative route[2]	nd	nd	14	nd	nd	10	nd	nd	10

[1] Including sub-alternatives ALT E1 and ALT W1.
[2] Northern line A, including sub-alternatives ALT E2 and ALT W2 (modelled for rough conditions only).
nd = not determined

Impact areas of increased concentrations of suspended solids (>10 mg/l) are very small in size during all hydrographical conditions (Table 11-19).

Table 11-19. Areas of suspended solids exceeding different threshold concentrations during rock placement and during different hydrographical conditions. The shaded area represents increased concentrations of suspended solids.

Rock placement	Area (km²) with concentration exceeding the threshold value								
	>2 mg/l			>10 mg/l			>15 mg/l		
	Normal	Calm	Rough	Normal	Calm	Rough	Normal	Calm	Rough
Northern line A[1]	191	121	267	6	4	4.5	0.6	1.2	1.7
Alternative route[2]	nd	nd	353	nd	nd	9.5	nd	nd	3

[1] Including sub-alternatives ALT E1 and ALT W1.

[2] Northern line A, including sub-alternatives ALT E2 and ALT W2 (modelled for rough conditions only).

nd = not determined

The duration of suspended solids in sea water near the seabed is presented in Table 11-20. Increased (>10 mg/l) concentrations are assessed to occur for between 2 and 19 hours, depending on hydrographical conditions.

Table 11-20. Duration of suspended solids above the threshold concentrations during rock placement and during different hydrographical conditions. The shaded area represents increased concentrations of suspended solids.

Rock placement	Max duration (hours) with concentration								
	>2 mg/l			>10 mg/l			>15 mg/l		
	Normal	Calm	Rough	Normal	Calm	Rough	Normal	Calm	Rough
Northern line A[1]	43	165	24	7	19	7	1.5	8	3
Alternative route[2]	nd	nd	32	nd	nd	7	nd	nd	2

[1] Including sub-alternatives ALT E1 and ALT W1.

[2] Northern line A, including sub-alternatives ALT E2 and ALT W2 (modelled for rough conditions only).

nd = not determined

Alternative route

Along the sub-alternative route sections (Northern line A, including southern sub-alternatives ALT E2 and ALT W2) sediment release and impacts on water quality were modelled for rough weather conditions, when the spreading of particles is theoretically greatest. In conditions when currents near the seabed are strong, the impact area of increased (>10 mg/l) concentrations of suspended solids is approximately double the size of the area of Northern line A (Table 11-19).

Figure 11-4 and Figure 11-5 show the maximum concentration of suspended solids during rock placement during calm (summer) hydrographical conditions. Concentrations are low and limited to the vicinity of the activity.

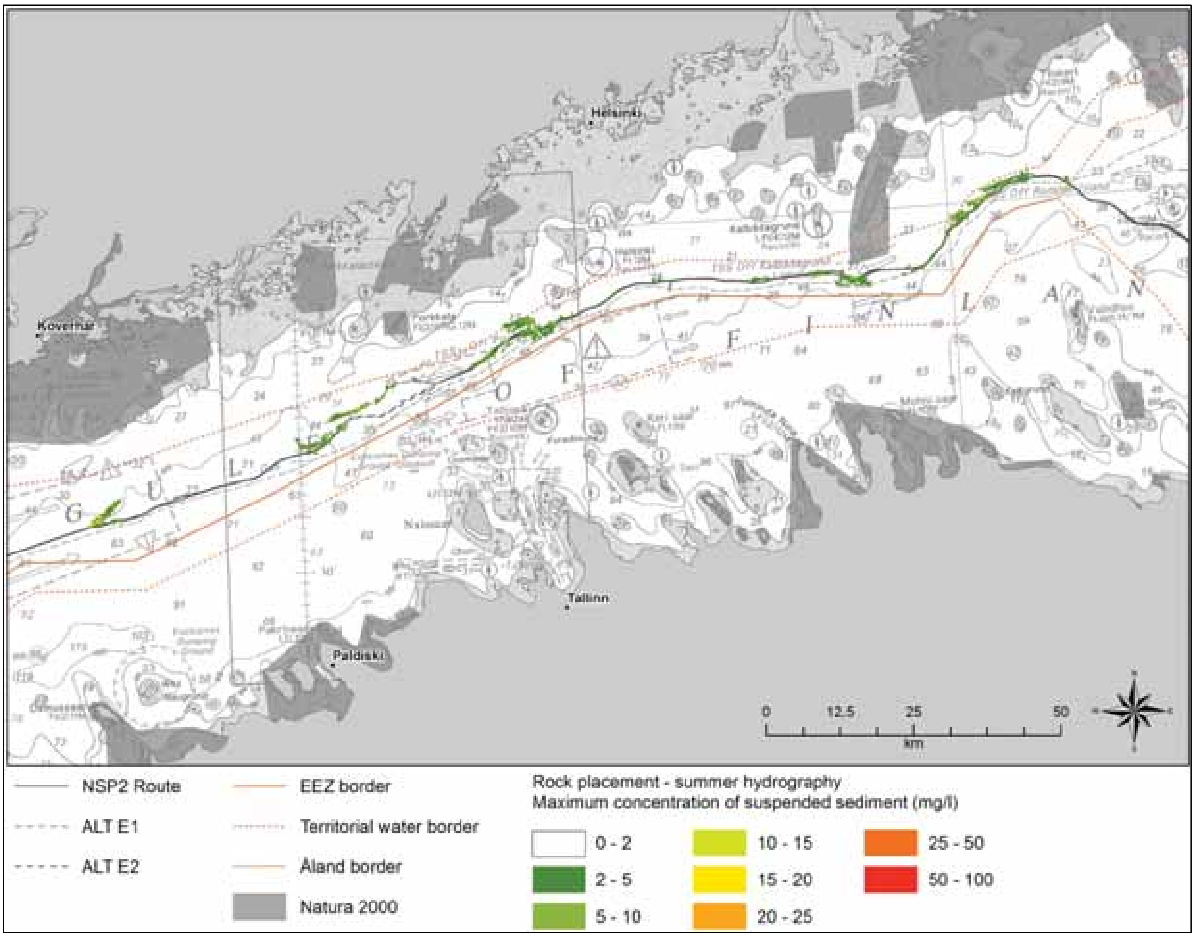

Figure 11-4. Maximum concentration of suspended solids (mg/l) during rock placement along the eastern and central pipeline route. Modelling results for calm hydrographical conditions.

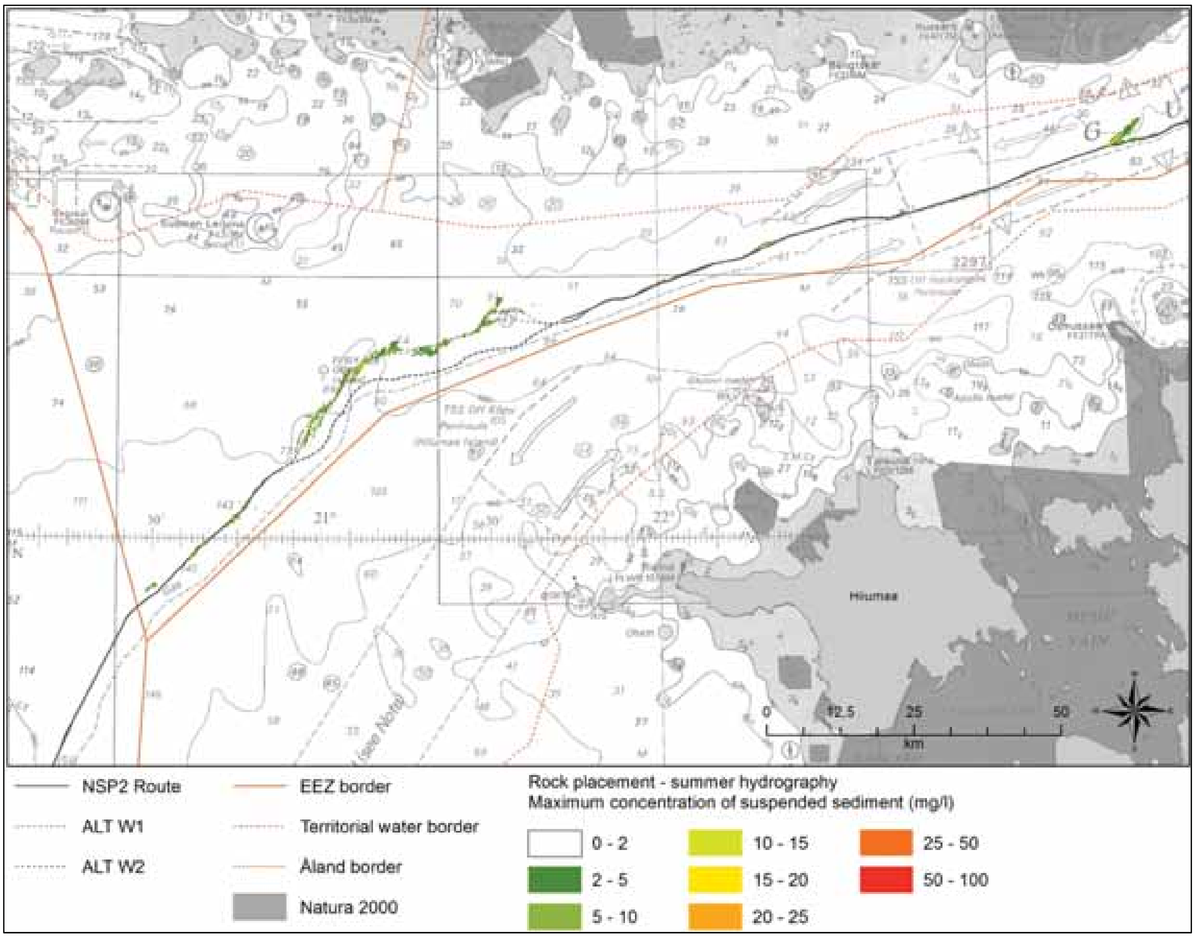

Figure 11-5. Maximum concentration of suspended solids (mg/l) during rock placement along the western pipeline route. Modelling results for calm hydrographical conditions.

Assessed impacts of rock placement

Modelling of the total amount of suspended sediments during rock placement was carried out for the northern pipeline that is nearest to the sensitive areas in Finnish waters. When overall impacts on water quality are assessed, both pipelines have been taken into consideration. Although construction works for both pipelines are planned to commence simultaneously, seabed intervention works will start from different ends of the pipeline route and occur during different periods for each pipeline in the Finnish EEZ. This will minimize the local impacts on water quality. On this basis, the values presented in Table 11-18, Table 11-19 and Table 11-20 are assessed to indicate the worst-case scenario for rock placement along the route, both regionally and over time.

Rock placement is planned to be carried out with the same method as was used during NSP. This method, in which rock material will be placed on the seabed through a fall-pipe, guarantees that the suspension of finest sediment particles will be minimised (Subchapter 4.1.5.1).

Low concentrations of suspended solids in sea water near the activity indicate that impacts on water quality are limited relatively near the working sites. For the NSP2 route alternatives, the impact area of increased concentrations (>10 mg/l) varies from <1 km^2 to about 10 km^2 (Table 11-19). This is assessed to be evidence of the local character of the impacts.

The monitoring results during construction of the Nord Stream pipelines confirm this assessment. When the largest rock berm at the tie-in site was constructed, the highest measured turbidity in sea waterwas 54 NTU (approximately 54 mg/l of suspended solids; Rasmus et al. 2015). The total duration of increased turbidity lasted from 16 to 60 hours. The extent of turbidity plumes was at its maximum 600 m from the activity *(Ramboll 2011b)*.

Sub-alternatives

The amount of rock material needed for the southern sub-alternatives ALT E2 and ALT W2 is about 22 % higher than for the northern sub-alternatives ALT E1 and ALT W1 (Figure 5-1). Still, short-term quality changes in the water layer near the seabed are assessed to be on the same level. Although in certain conditions the impact area is assessed to be larger for the southern sub-alternatives, the modelling results indicate that the overall difference between the alternatives is small.

In conclusion, it is assessed that either the northern or the southern sub-alternatives can be chosen. However, the southern alternative route sections pass nearer to the Finnish/Estonian EEZ border. Hence the possibility of transboundary impacts on water quality is higher. Transboundary impacts are assessed in Chapter 13.

Impacts of dissolved contaminants and nutrients

Modelling results for the release of contaminants into sea water

Based on their relative toxicity, the behaviour of three contaminants found in the seabed along the pipeline route was selected for modelling. The values presented in Table 11-21 and Table 11-22 are the overall maximum values covering normal, calm and rough conditions (Subchapter 10.3.3).

Table 11-21. Maximum areas where selected contaminants exceed PNEC values during construction works.

Construction activity	Area with concentration exceeding PNEC value		
	PAH	Dioxins/furans	Zinc
	km^2	km^2	km^2
Munitions clearance	118	21	3
Rock placement	10	<0.02	<0.02

The extent of the areas where the concentrations of the three modelled contaminants exceed the PNEC value varies significantly. The largest area is for the PAH compound bentzo(a)pyrene during munitions clearance. Dioxin/furans and zinc are expected to exceed the PNEC values only during munitions clearance.

The duration of exceedance of the PNEC values in sea water varies from a few hours to about 20 hours (Table 11-22).

Table 11-22. Maximum duration of exceedance of PNEC values during construction works.

Construction activity	Maximum duration with concentration exceeding PNEC value		
	PAH	Dioxins/furans	Zinc
	hours	hours	hours
Rock placement	22	0	0
Munitions clearance	19	7	3

Dissolved contaminants

Particles released from soft seabed during the construction works may contain contaminants that are mainly attached to these particles. In addition, pore water in the surface seabed contains dissolved forms of contaminants. In suspension, these compounds have different kinds of chemical reactions and usually have a strong tendency to attach to organic and inorganic particles. However, part of the dissolved forms of contaminants may stay in the water column at concentration levels that exceed the PNEC values for biota.

Dioxins/furans are typical persistent organic compounds (POP) that are generally strictly bound to sediment particles and when in suspension, if dissolved, they will eagerly adsorb to organic or inorganic particles that are always present in sea water. Therefore dissolved concentrations in water will decrease rapidly. Similarly, inorganic *zinc* in water will also adsorb to particles. The same is valid for *PAH* compounds. Once incorporated into sediments, they will not easily dissolve into water, and when dissolved they will adsorb rapidly to organic matter *(Mannio et al. 2011)*.

In modelling, the highest dissolved concentrations for *benzo(a)pyrene* in sea water were in the range 0.0017 µg/l. According to the decree of the Council of State 1308/2015, the EQS concentration for benzo(a)pyrene in the sea environment is 0.027 µg/l. Hence, the modelled maximum concentration is considerably below the environmental norm.

Release of nutrients into sea water

Rock placement will cause resuspension of sediment particles from the soft seabed along the proposed pipeline route. Construction works will not increase the total nutrient load into the Gulf of Finland. Instead, the release of surface sediment particles during construction will cause local, short-term and temporary increase in the internal load of phosphorus and nitrogen. The pore water in the sediment-water interface may contain high concentrations of dissolved phosphorus that will be released to the overlying water column.

The modelled amount of released sediment is approximately 2,700 tonnes per pipeline. It is estimated that the amount for both pipelines is about the same. During the baseline survey in 2015, the median concentration of total phosphorus and nitrogen in the seabed surface (0–30 cm) of the survey corridor was 710 mg P/kg dry weight and 3,000 mg N/kg dry weight, respectively *(Luode Consulting Ltd 2016a)*. To be on a conservative side it was then assumed that the dry weight of sediment is 82 % of the wet weight (highest measured value in the sediment data). On the basis of these figures, the total amount of released phosphorus for rock placement for the two pipelines is 3.1 tonnes, and the total amount of released nitrogen is 13.3 tonnes. The corresponding values for approximately 50 munitions detonations (released amount of sediment about 2,150 tonnes) are 1.3 tonnes of phosphorus and 5.3 tonnes of nitrogen.

According to Lehtoranta (2003), most of the phosphorus in sediment in anoxic conditions is in dissolved or highly soluble form and only 15% is attached to iron ligands. Both nitrogen and phosphorus are important for primary production and limiting nutrient for algal growth may vary between area and time. Dissolved forms of phosphorus are essential for primary production and an increase in dissolved phosphorus potentially increases primary production.

To evaluate the potential eutrophication effects, calculations were made for the worst-case scenario in which 85 % of the total released phosphorus was dissolved and evenly mixed in the water column due to mixing conditions. A 2 km wide area over the length of pipelines (ca. 380 km) in the Finnish EEZ and a mean depth of 70 m for both pipelines were used as a mixing zone. A theoretical increase of 0.048 µg/l P was calculated for rock placement and 0.021 µg/l P was calculated for munitions clearance. Normally, phosphorus content in the euphotic zone is approximately 25 µg/l. As a worst-case scenario, the calculated increase in phosphorus concentration can be considered so low that it will not have any observable effect on primary production. Theoretically, this type of nutrient mixing may occur only if a turnover[14] is on-going during rock placement or munitions clearance activities.

For comparison, the assessed annual waterborne total load of nutrients to the Gulf of Finland in 2006 was 5,000 tonnes for phosphorus and 130,000 tonnes for nitrogen *(HELCOM 2012a)*. In 2015, point-source loading of nutrients from wastewater treatment plants in the Helsinki area to the Gulf of Finland was 35 tonnes of phosphorus and 984 tonnes of nitrogen *(Helsingin seudun ympäristöpalvelut HSY -kuntayhtymä 2016)*.

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[14] Rapid breakdown of stratification in a body of water by natural forces, often induced by winds.

In comparison with these amounts, the calculated amounts of released phosphorus and nitrogen are small. In suspension, the dissolved form of phosphorus eagerly adsorbs to organic matter or clay particles. During the stratified periods (summer), the waters nearest to the seabed are prevented from mixing with the photic zone where primary production occurs. A permanent halocline is normally found at a depth of 60–80 m in the western and in the middle part of the Gulf of Finland. In these conditions, resuspended nutrients will stay in the lowermost water layer without having any impacts on the biotic environment. In the eastern section, the released nutrients could have a slight impact on the growth of algae if a release occurs during the spring turnover times. In this part of the pipeline route, the soft sediment type is not as common as in the western pipeline section.

In conclusion, resuspension of nutrients during the construction works of NSP2 is not assessed to have any impacts on the eutrophication status of the Gulf of Finland. This opinion is supported by the monitoring results of NSP *(Ramboll 2011b)*. The fact that the total amount of munitions to be cleared inside the pipeline route was not known during the EIA phase does not change this conclusion.

Pre-commissioning (option 1 and 2)

In this section, the environmental impacts of two options for pre-commissioning of the pipelines are briefly assessed. The wet and dry pre-commissioning alternatives have been presented in Subchapter 5.2.

During dry pre-commissioning, only cleaning and gauging of the pipelines using dry air will be considered. The pipelines will not be water-filled and, consequently, no dewatering will be required. For this option there is no need for hyperbaric tie-ins, which means that about 5 % less rock material will be needed compared with the total rock volume needed in the Finnish EEZ.

For wet pre-commissioning, 1.3 million m^3 of pressure test water, taken from the tie-in sites at KP 300 and KP 675 and treated with an oxygen scavenger, will be discharged in Russian territorial waters. These impacts are not assessed in the Finnish EIA report. During wet pre-commissioning operations, a limited discharge from the pipelines is expected at the hyperbaric tie-in location in the Finnish EEZ. This water will not be treated with any additives.

Environmental impacts can be assessed based on experience from NSP. In April 2011, the total amount of water taken from the Finnish EEZ at KP 297 (tie-in site) was 340,000 m^3 and the total amount of water discharged at this same site was approximately 11,900 m^3. All of the water discharged was untreated and filtered. Only a few debris items were found on the sealing discs after discharge (~0.1 kg to <2 kg, depending on the pipeline inspection gauge (so called pig; Ramboll 2012b). On this basis, no adverse impacts are assessed to be caused in the Finnish EEZ if the wet pre-commissioning option is chosen (Table 11-23). The water depth at the potential tie-in site KP 300 is more than 60 m, meaning that the water column is more or less permanently stratified because of the presence of a halocline. Therefore possible resuspension of soft surface sediments during moderate water discharge would remain in the deepest water layer and not spread into the upper photic layer.

Construction of the tie-in site has been included in the modelling of sediment spills *(Ramboll 2016b)*. Based on the modelling results, no increase of suspended sediments during rock placement is anticipated near the potential tie-in site at KP 300 (Appendix 12, Map MO-03-F).

Table 11-23. Assessed impacts of pre-commissioning on seawater in the Finnish EEZ.

Impact on water environment				
Option	**Dry pre-commissioning**		**Wet pre-commissioning**	
Action	No rock placement	No discharge of untreated water in the Finnish EEZ	Rock placement	Discharge of moderate amount of untreated water in the Finnish EEZ
Impact	No impact	No impact	Minor and local temporary impact on water turbidity	No noteworthy impact

In conclusion, on the basis of the comparison of the two pre-commissioning alternatives, impacts in the Finnish EEZ are negligible in significance, regardless of which option is chosen.

Pipelay

Pipelay with DP lay barge

As presented in Subchapter 11.2.4, pipelay with a DP lay barge in the Gulf of Finland is not assessed to cause disturbance of soft seabed sediments. Experience from NSP confirms this conclusion because no turbidity increase was observed during the activity. This indicated that neither the thruster wash nor the pipeline touchdown had caused measurable resuspension of sediments from the seabed *(Ramboll 2013b)*.

It has been assessed that no erosion of surface sediments takes place during pipelay at water depths greater than 50 m in the Finnish EEZ *(Ramboll 2009a)*. In places where the depth is less than 50 m, the seabed consists mainly of hard bottom types (Figure 11-6).

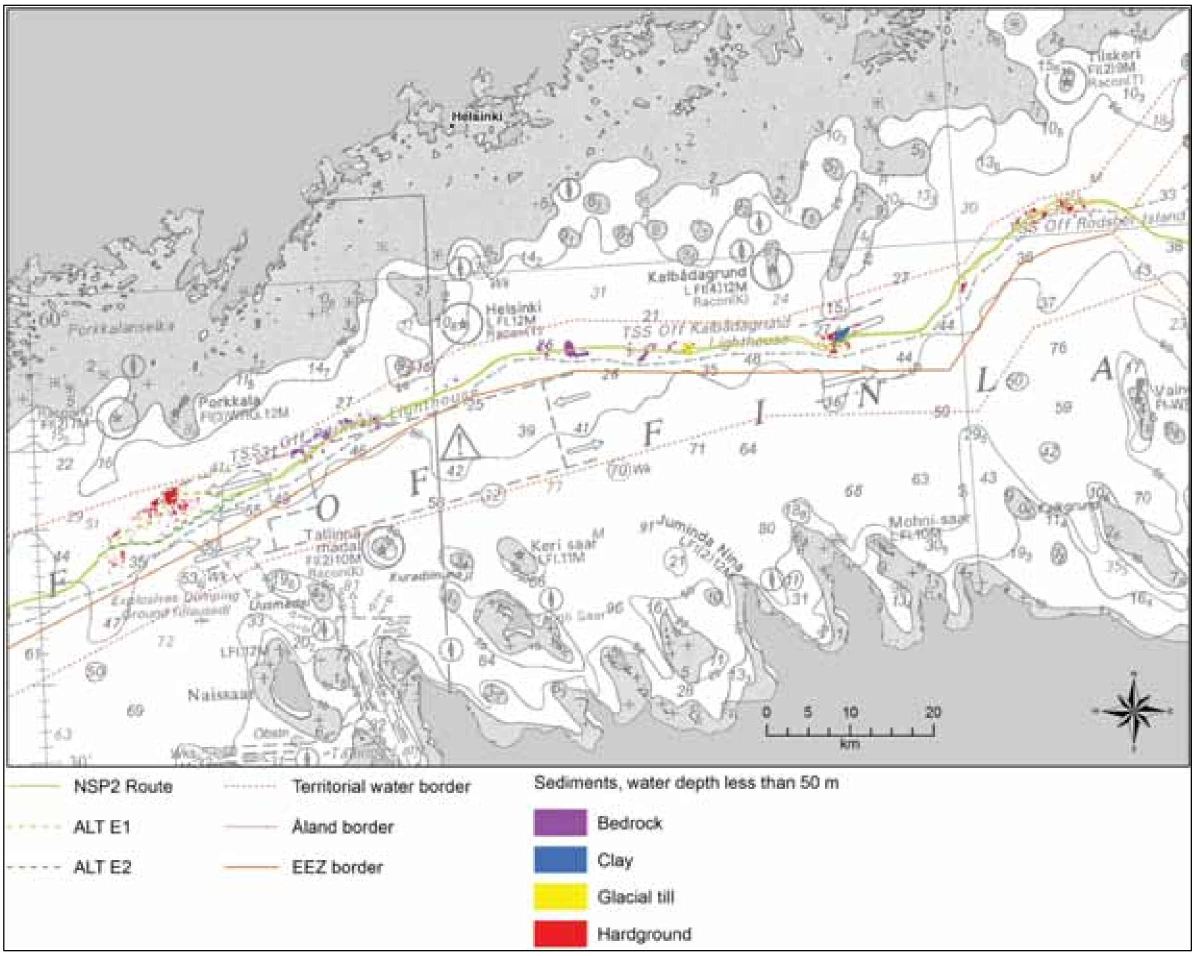

Figure 11-6. Seabed type at depths below 50 m along the NSP2 pipeline route.

<u>Pipelay with anchored lay barge</u>

In the section of the pipelines where pipelay is planned to be carried out by an anchored lay barge (from KP 350 to KP 492), the activity is assessed to cause low, temporary adverse impacts on sea water quality (increase of turbidity) near the seabed. In these deep sea areas, a permanent halocline is present in the water column, thus limiting suspended solids to the lowermost water layer.

The assessment is based on the experience from NSP. During pipelay the anchor-handling process on soft sediment type indicated only low impacts on water turbidity above (1.5–2 m) the seabed near the pipeline alignment (within 50 m). The observed low turbidity increase 1–4 NTU *(Ramboll 2013b)* corresponds to a suspended solids concentration of approximately 1–4 mg/l.

11.3.3.2 Operation phase

<u>Hydrographical changes near the pipelines</u>

A potential impact during operation of the pipelines is the change in current fields near the soft seabed surface. This in turn may impact on the prevailing scour and sedimentation patterns. On soft seabed, minor changes in hydrographical conditions are assessed to occur near the pipelines. The degree of these impacts is assessed to diminish concurrently to the embedment rate of the pipes. However, local changes in bottom-near currents and sedimentation conditions can be greater if several high rock berms will be constructed close to each other on soft seabed. At such sites, the accumulation of solid substances may occur on the leeward site of these structures. Rock placement on clearly soft bottom type in the Finnish EEZ is planned on sections in the Northern Baltic Proper and near the potential tie-in site at the mouth of the Gulf of Finland (Appendix 12, Maps PR-03-F and PR-04-F). On the other hand, on the basis of surveys it has been concluded that the NSP pipelines on the seabed in the Finnish EEZ are located in areas where currents near the seabed are normally low *(Ramboll 2015b)*. The planned NSP2 route runs near the NSP pipelines (Subchapter 4.1.1). Based on these facts, it has been concluded that the NSP2 pipelines on the seabed will not have an impact on the overall bottom-near current patterns in the Gulf of Finland, even though the amount of rock placement material will be clearly more than that used for NSP

This assessment is supported by the monitoring results from NSP, which indicated that minor current changes are possible at a short distance from the pipeline in sections where the pipeline is clearly exposed. The impact of the pipelines at distances over 50 m was negligible *(Witteveen+Bos 2012 and Luode Consulting 2012)*. However, in soft seabed areas where changes in sedimentation and erosion patterns could be possible, the pipelines were normally embedded deeper into the sediments than was predicted. Monitored minor impacts were too small to cause significant scouring *(Ramboll 2013b)*. Local erosion, if any, may happen quite near the pipelines, depending on the degree of exposure of the pipes. As a result, coarser sediments may accumulate on the leeward side of the pipes *(Ramboll 2015b)*.

Release of metals from the anodes

During operation of the pipelines, anodes will protect the pipelines from corrosion. In the Gulf of Finland, the main metal in the anodes is zinc, but there is also aluminium (Subchapter 4.1.2.2, Figure 11-7).

Figure 11-7. Anode around the pipeline on the seabed seabed to protect from external corrosion. ©Nord Stream

During the first year of operation of NSP, the impacts of zinc anodes on sea water quality were monitored by water sampling. Samples were taken from both sides of the pipeline at a 1–2 m distance from the anode and 1 m above the seabed. At the monitoring sites the pipeline and the anode were almost fully exposed (embedment <50 %) on the seabed. Concentrations of heavy metals near the anode were low (<1 µg/l) or under the detection limit. The general level of metal concentration was of the same order of magnitude between these sampling points and the reference area. A few micrograms of zinc were measured at both sites *(Ramboll 2013b)*. During external inspections of the NSP pipelines in 2015, the surveyed anodes exhibited low levels of metal depletion *(DeepOcean 2016)*.

The release rate of zinc ions from the anodes depends on the total amount of anode material to be installed, the current induced in the anodes and whether there is any damage to the pipeline coating, resulting in exposure of bare pipeline steel *(Ramboll 2009c)*. The release rate of certain metals from the anodes will increase over the years. When taking into account that dilution of zinc (main component) and other metals is very effective and quick, elevated concentrations in seawater are assessed to be limited to the very proximity of the anodes (about 3 m). Based on advection-dispersion calculations the distance from the zinc anodes where elevated zinc concentrations (PEC>PNEC) may be found depends on the anode type (Figure 11-8).

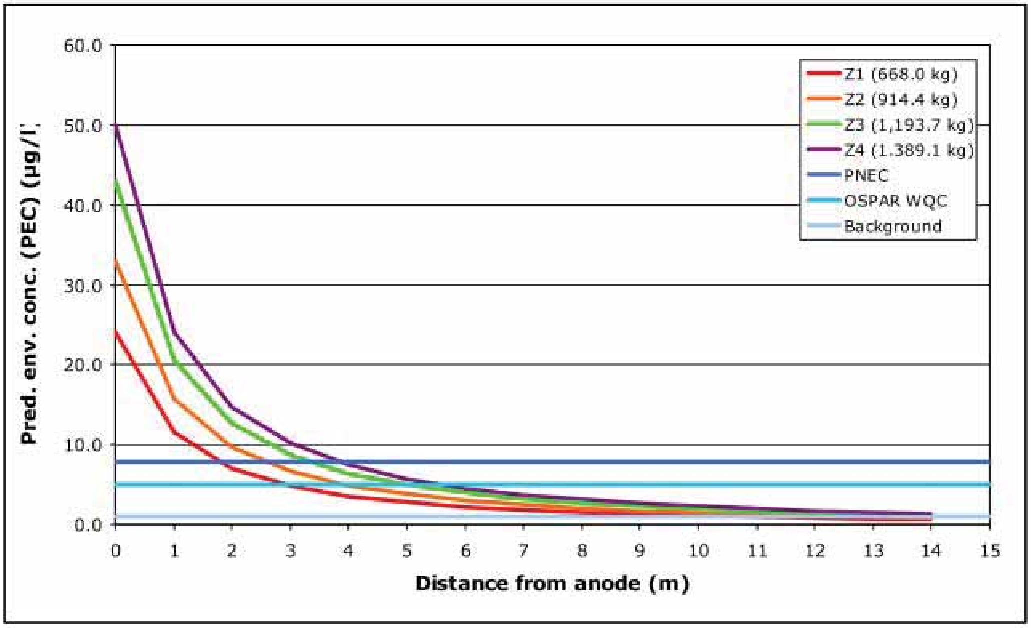

Figure 11-8. **Relatonship between PEC and PNEC for zinc released from the didderent types of zinc anodes (Ramboll 2009c). Anode type Z1 and Z2 are used in the Gulf of Finland.**

Where the pipelines are fully embedded into the seabed, no release of zinc directly to the water column will occur. Released inorganic zinc will mostly adsorb to sediment particles. If the conditions in sediment are anaerobic, as they usually are, formation of zinc sulphide (ZnS) is common *(Ramboll 2009c)*. This will effectively limit the mobility of released zinc.

<u>Heating effect of gas flowing in the pipelines</u>

During the EIA of NSP, modelling (computational fluid dynamics, CFD) showed that the water temperature at the surface of an unburied section of pipeline could be up to 0.5°C higher than the temperature of the surrounding water in a case when the temperature gradient was estimated to be approximately 60°C (close to the Russian landfall; Figure 11-9, *Ramboll 2009b*). Modelling also showed that in this situation mixing will ensure that the water temperatures reach equilibrium with the surrounding water temperatures at a distance of 0.5–1 m from the pipelines.

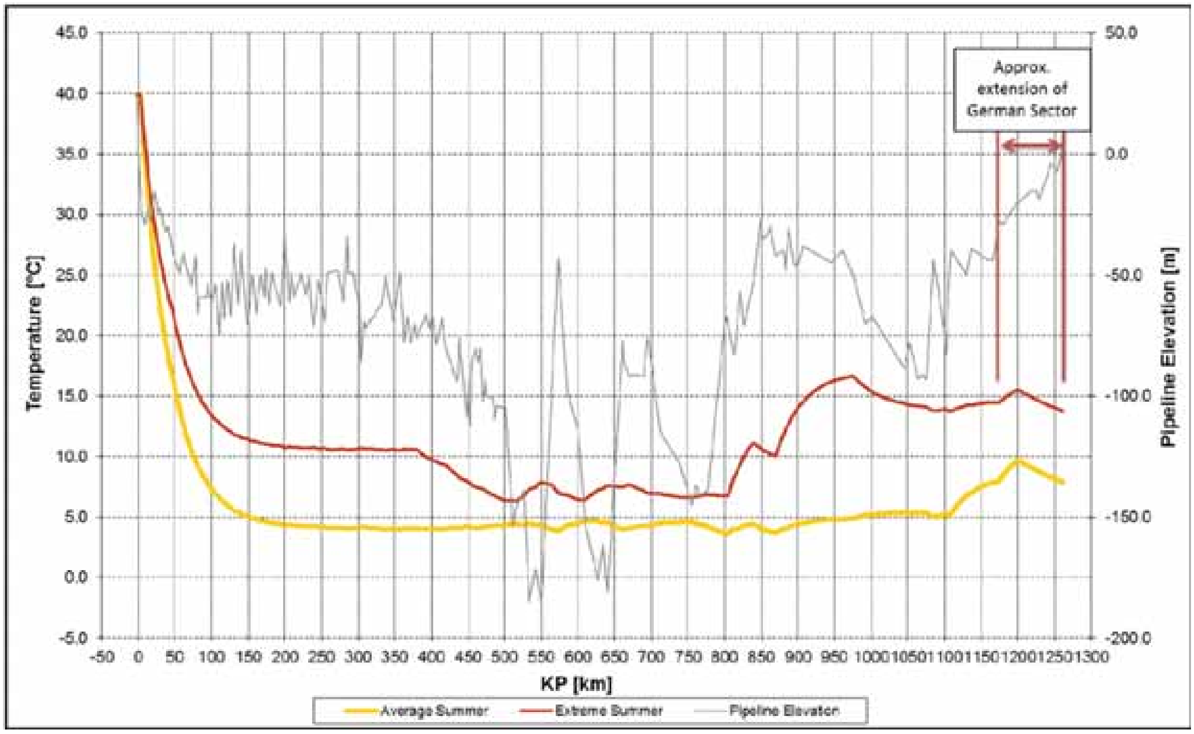

Figure 11-9. Sensitivity of inlet temperature of gas compared with environmental temperature. Summer temperature profiles. The Finnish sector of the pipelines lies between KP 114 and KP 492 (Saipem 2016a).

Gas temperature in the Finnish EZZ is estimated to vary from 5°C to 10°C *(Saipem 2016a)*. In the same area, the temperature of sea water near the seabed has been measured to vary from 2°C to 10°C (Subchapter 7.5 Figure 7-15 and Figure 7-16). The temperature gradient between the gas inside the pipelines and the sea water in the Finnish EEZ is therefore much smaller than in the modelled situation, and heat transfer from gas to sea water is consequently estimated to be *low* as a whole. *Low* temperature difference will be equalized by 'heat' dissipation by the surrounding sediment and water, meaning there will be no impact on the surrounding waters.

11.3.4 Prevention and mitigation of adverse impacts

Overall impacts on hydrography and water quality are assessed as negligible or low and therefore no mitigation measures are suggested. Based on the results of environmental monitoring during the construction activities, necessary corrective measures will be taken.

Rock placement will be a controlled operation utilizing a fall pipe and instrumented discharge head located near the seabed to ensure precise placement of rock material.[FIN-OSP-007]

11.3.5 Lack of information and uncertainties

The design of the project with regard to the construction works had not yet been completed during the writing of the EIA Report. Accurate information on the locations and amounts of rock material needed along the pipeline route were not available, nor were the results of the munitions survey. Therefore modelling of the impacts of munitions clearance has been based on a generic scenario using the knowledge gained during the NSP project. Uncertainty was reduced by the methods selected for the modelling.

A certain degree of uncertainty is included in the decision that modelling of the sediment spreading during rock placement was carried out for one pipeline only. Uncertainties related to the basis for the modelling of sediment spills have been discussed in Subchapter 11.2.5.

11.3.6 Significance of the impacts

The main turbidity increase in sea water resulting from the construction works is assessed to occur in the lowermost water layer above the seabed, relatively near the activities. During rough conditions, slight increases of concentrations of suspended solids are possible further away from the project area. Contaminants in suspended sediments are assessed to be mainly adsorbed to sediment particles, and if dissolved, the adsorbtion reactions to organic or inorganic particles are assessed to be very rapid. Nitrogen and phosphorus release from the seabed during the construction works is assessed to have no impacts on the current eutrophication level of the Gulf of Finland.

Both of the sub-alternative route sections, northern (ALT E1 and ALT W1) or southern (ALT E2 and ALT W2) along line A, are assessed as equal in terms of impacts on water quality.

Table 11-24. Significance of the impacts on hydrography and water quality

Impacts on hydrography and water quality	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Spreading of sediments caused by munitions clearance	Low / medium	Low	Minor
Spreading of sediments caused by rock placement	Low / medium	Low	Minor
Release of dissolved contaminants and nutrients	Major	Negligible	Negligible
Spreading of sediments caused by pipelay with DP lay barge	Low / medium	Negligible	Negligible
Spreading of sediments caused by pipelay with anchor-handling	Low	Low	Minor
Operation phase			
Hydrographical changes near the pipelines and support structures on the seabed	Low	Negligible or low (locally)	Negligible or minor (locally)
Release of metals from the anodes	Low / medium	Low	Minor
Heating effect of gas flowing in the pipelines	Low / medium	Negligible	Negligible

11.4 Underwater and airborne noise

The purpose of this section is to evaluate the impacts of airborne and underwater noise with respect to the physical environment (e.g. sources, propagation, levels, duration), caused by NSP2 offshore construction and operation. The assessment of the potential effect of noise on the different receptors, i.e. nature conservation areas, marine mammals, fish and birds is addressed in their specific subchapters.

However, in order to be compliant with the Marine Strategy Framework Directive (MSFD, see Table 6-1 in Chapter 6 and Subchapter 7.2) we have assessed underwater noise impacts as the degree of impulsive and continuing noise caused by human activities. The above mentioned regulation defines that the degree of impulsive and continuing noise is not increasing and is at a level that does not exceed natural noise levels nor cause harmful effect on the ecosystem and does not cause economic harm to the coastal and marine industry. Therefore, the assessment of underwater noise impacts are inevitabely linked to the biotic receptors (e.g. marine mammals, birds and fish).

The most noisy of the construction activities is considered to be pipe-laying with respect to airborne noise and munitions clearance with respect to underwater noise.

The total duration of construction activities within Finnish EEZ will be approximately 17 months (Figure 4-18). Munitions clearance activities will be carried out during 3-month period (necessary detonations are momentary events), pre-lay rock placement will take about 3 months, pipe-laying about 9 months (speed of the pipelay vessel is 2–3 km per day) and post-lay rock placement will be carried out during 6 months. Consequently, noise generation will be temporary.

The methodology for the modelling and the results gained for underwater noise are described in Chapter 10.

During operation, gas pipe can act as continuous underwater noise source. Gas flow in the pipe can be turbulent and part of turbulent energy is converted into noise. Gas pumping compressors generates noise and emits it into the pipe. Both gas flow and compressor noise can then radiate through the pipe wall to the sea.

For airborne noise assessment, the general noise level guidelines have been used as below (Table 11-28).

Summary of noise impact assessment	
Lessons learned from the Nord Stream Project in 2009–2012	Underwater noise from munitions clearance was measured during the construction of NSP. Results were used to estimate the actual source levels for underwater noise modelling. Airborne noise from the pipe-laying vessels during construction activities was modelled for the existing Nord Stream pipelines (NSP). This was considered relevant to assess noise levels in air for Nord Stream 2.
Main results of the assessment	Munitions clearance produces high underwater noise peaks which exceed the natural noise levels of the sea environment and, may cause some harmful effects to marine fauna. Other activities generate much less underwater noise. Rock placement and pipe-laying produce underwater noise that is slightly more noisy compared to regular ship traffic. Biotic impacts of underwater noise are assessed in Subchapters 11.6–11.8 (Mammals, Fish and Birds). Pipe-laying is assessed to be the most noisy activity generating airborne noise. Airborne noise levels are assessed to be below applicable guidelines in the nearest sensitive area. Noise from pipe (gas flow) operation is assessed to be negligible because measurements near the NSP pipeline gave no indication of noise emissions from the pipe in the Finnish EEZ.

11.4.1 Impact mechanism

Noise is physical energy in the form of sound waves in air or water. Different activities associated with the NSP2 project generate either airborne or underwater noise or both. Generated sound propagates through the medium, causing sound levels that decrease with distance from the source.

Table 11-25. Impacts of the project activities on underwater noise.

Receptor	Project phase	Project activity	Impact
Underwater	Construction	Rock placement Pipelaying Munitions clearance	Increase in noise levels near the activities. Munitions clearance creates high single noise peaks.
	Operation	Pipeline (gas flow and compressor noise) Maintenance inspections	Potential pipeline noise would be a permanent impact. Increase in noise levels along the pipeline due to vessel activities.

Table11-26. Impacts of the project activities on airborne noise.

Receptor	Project phase	Project activity	Impact
Air	Construction	Rock supply Rock placement Pipelaying	Increase in noise levels along the pipeline due to vessel activities.
	Operation	Maintenance inspections	Increase in noise levels along the pipeline due to vessel activities.

11.4.2 Methods and data used

11.4.2.1 Underwater noise

Underwater noise propagation and noise level contours are modelled for the construction activities (rock placement, munitions clearance). Noise from pipelaying activities was estimated on the basis of NSP experience. Noise during operation is assessed for pipe gas pumping and flow using a modelling report from NSP and available measurement results. Underwater noise modelling is presented in Subchapter 10.4.

In compliance with the Marine Strategy Framework Directive (MSFD, see Table 6-1 in Chapter 6 and Subchapter 7.2) underwater noise impacts have been assessed as the degree of impulsive and continuing noise caused by human activities. In this chapter, we assess whether the underwater noise levels are higher than the ambient noise levels. For this reason, IMPERIA criteria (Chapter 11) have not been used for the assessment of underwater noise. For criteria and impacts of underwater noise to marine fauna, please see Subchapters 11.6–11.8.

Background underwater noise levels were measured between December 2015 and May 2016 (as described in the baseline chapter) and varied from 85 to 142 dB (broadband LAeq 5 min), averaging 110 to 115 dB (Luode Consulting Ltd 2016a). Available results from the BIAS project indicates that underwater noise levels (exceeding 50 % of time) at octave frequency 125 Hz varies mostly between 90 and 105 dB within the Gulf of Finland (Subchapter 7.7.3; BIAS 2015).

Pipe-laying itself causes underwater noise. To assess the noise originating from pipelaying we used data from NSP. During the construction of NSP, monitoring of underwater noise from construction activities was performed in Sweden as a joint project with FOI *(Johansson and Andersson 2012)* and was used in this assessment.

Noise during operation is assessed based on modelling results from NSP (gas flow and compressor noise emissions from the pipe, ØDS 2008) and measurement results available from the Environmental Baseline Survey *(Luode Consulting Ltd 2016a)*.

11.4.2.2 Airborne noise

The airborne noise levels from construction activities during the installation of NSP2 are assumed to be the same as during the installation of NSP. Airborne noise from the pipe-laying vessels during construction activities was modelled for the existing NSP pipelines. This was considered relevant to assess noise levels in air for Nord Stream 2.

Noise of a typical anchor handled pipe-laying vessel such as the Castoro Sei together with four supporting tugs and a supply vessel has been used as the source of noise (Table 11-27).

Table 11-27. 'A'-frequency weighted* sound power level L_{WA} [dB, re 10^{-12} W] for representative vessel sound power level.

		L_{WA} at octave centre frequency (Hz)						
	Total, L_{WA}	63	125	250	500	1,000	2,000	4,000
Pipe-laying vessel	113	103	108	105	108	103	94	82
Supply vessel	110	100	105	102	105	100	91	79
Tugboat	105	95	100	98	100	95	86	74

**'A'-weighting is standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.*

Airborne noise from vessels is generated from the main and auxiliary engines and from ventilation fans. The noise level from a noise source diminishes over increasing distance. This is due to the fact that the noise spreads over an expanding area as the distance increases. Theoretically, the level will be reduced by 6 dB for each doubling of the distance (geometrical attenuation).

Normally, noise-prediction calculations are carried out for situations that will result in the highest typical noise levels. In practical terms: downwind and a moderate negative temperature gradient (lower temperature near the ground). This situation can be estimated using the General Prediction Model *(Kragh 1982)*. This method anticipates 6 dB reduction for each doubling of the distance.

<u>Impact criteria</u>

The Council of State Decision (993/1992) provides the following (Table 11-28) noise level guidelines for *outdoors*. Values are average A-weighted noise levels L_{Aeq} during daytime (7.00 am–10 pm) and nighttime (10.00 pm–7.00 am).

Table 11-28. Noise level guidelines 993/92 outdoors.

	$L_{Aeq(7.00\ am–10.00\ pm)}$	$L_{Aeq(10.00\ pm–7.00\ am)}$
Residential areas	55 dB	50 dB (45 in new areas)
Recreation areas in conglomerations and areas in their proximity	55 dB	50 dB
Areas serving nursing or educational institutions	55 dB	50 dB
New residential and recreation areas and areas serving institutions	55 dB	45 dB
Holiday settlements (summer cottages, camping sites, etc.) and nature conservation areas	45 dB	40 dB

Table 11-29. Sensitivity of receptor (airborne noise).

Low	There is a lot of noise generating activities in the area or the area is otherwise affected by the noise. Noise levels exceed the limit values. There are no sensitive receptors, such as residential areas, holiday homes, schools, day-care centres or protected areas and the area is not used for recreation.
Medium	The area has some noise generating activities or is otherwise affected by the noise. There are some sensitive receptors nearby, such as residential areas, holiday homes, schools, day-care centres or protected areas, and the area is not used for recreation.
High	There are only small amounts of noise generating activities in the area and the area is not affected by the noise coming from elsewhere. There are noise sensitive receptors, such as residential areas, holiday homes, schools, day-care centres or protected areas, and the area may be used for recreation.

Table 11-30. Magnitude of change (airborne noise).

Negligible	No changes to the noise level. The noise level increases by 0–1 dB.
Low	The change in noise level caused by the project is small or non-existent. The project will not cause exceedance of the noise level guideline values. The noise level increases by 1–4 dB.
Medium	The change in noise level caused by the project is medium. The project causes no or only a slight exceedance of the noise level guideline values. The noise level increases by 4–7 dB.
High	The change in the noise level caused by the project is high. The project will result in exceedances of noise guideline values. The noise level increases by >7 dB.

11.4.3 Impact assessment

11.4.3.1 Underwater noise

Impacts during construction

Munitions clearance causes a high, single, sound pulse which travels far from the source. A single pulse Sound Exposure Level SEL 164 dB extends up to 44 km from the place of clearance when a maximum charge is cleared (definition of SEL, see Subchapter 10.4.2). This type of noise is not normally present in the marine environment. For impact to marine fauna, please, refer to Subchapters 11.6–11.8.

Rock placement noise is assessed to be SEL 188 dB (cumulative 2 hours exposure) at 80 m from the source. This equals to a 149 dB constant sound pressure level (Leq, 2 hr). This is slightly higher than the highest measured background noise level, where a 5 min average noise level was around 142 dB.

According to a study by Johansson and Andersson (2012), an average noise level of 130.5 dB re 1 µPa was measured during NSP pipe-laying activities near Norra Midsjöbanken, approximately 1.5 km from the activity (measuring time was 2,183 minutes and recorded between January 27–29, 2012). At this location, the pipe-lay fleet consisted of nine vessels of different characteristics. The average background noise level measured between March 2–6, 2012 was 110,9 dB re 1 µPa. The increase in noise level caused by pipe-lay was then 20 dB.

Measurements at another point located 24 km from the pipe-laying activity resulted in an average noise level of 120 dB re 1 µPa and a background noise level of 115.5 dB re 1 µPa. The increase in noise level caused by pipe-lay was at this point 4.5 dB.

All underwater noise originating from the construction activities is of a temporary nature.

Impacts during operation

Noise during operation consists mainly of noise emissions from the pipe (gas flow noise) during the lifetime of the pipeline system.

Noise levels close to the existing NSP pipelines were measured during an environmental baseline survey in the Finnish EEZ (Subchapter 7.7.3). Noise was measured at two locations at a 10 m distance from the pipe. Noise caused by pipeline operation could not be identified. Noise was at the level of regular background noise which is mostly due to shipping activities.

Noise from the gas pipe as modelled during NSP is presented in Table 11-31. The table shows that the noise is below the Baltic Sea background broadband noise level of 110–115 dB.

Table 11-31. Modeled gas pipe noise levels at 10–1,000 m distance, NSP.

	Sound pressure level at varying distances from pipeline, dB re 1 µPa		
Location - KP, km	10 m	100 m	1,000 m
125 (Finland)	90	80	70
493 (Finland)	56	46	36

Based on the above figures, there is no reason to believe that NSP2 pipelines would act in a different way. No significant underwater noise emissions from the pipeline operation is, thus, expected.

11.4.3.2 Airborne noise

Airborne noise is caused mostly during construction and pipe-laying is considered the most noisy activity. Supply, rock placement and maintenance inspection vessels are considered to be equal to regular ship traffic. Noise propagation from pipe-laying activities was modelled during the existing pipeline project Nord Stream. At a distance of 4.1 km from the pipe-laying, the noise level was predicted to be 33 dB. Noise level contours are shown in Figure 11-10. The Figure presents the situation when pipe-laying activity is passing the Natura 2000 site of Kallbådans Islets and Waters (seal sanctuary).

The magnitude of noise change is low because of the short duration of activities (e.g. pipe-lay lasts for max 2–3 days in the vicinity of the site) and low noise levels. Thus, the significance of the airborne noise impact is negligible.

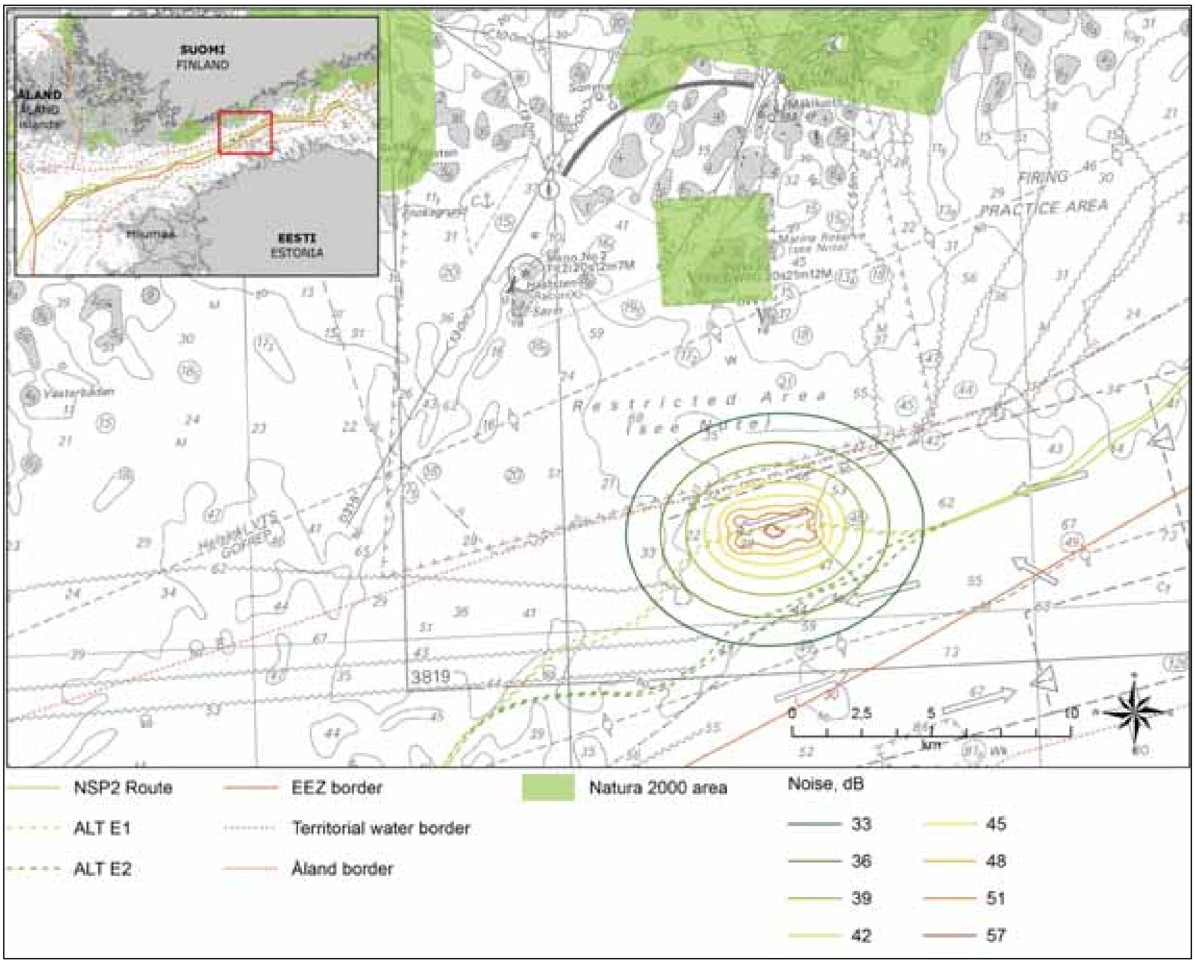

Figure 11-10. Airborne noise level contours LAeq from pipe laying activity.

11.4.4 Prevention and mitigation of adverse impacts

The most sensitive species to adverse effects of underwater noise are marine mammals. Munition clearance is identified as a potential source of adverse effects. Other activities produce noise that is tolerable, and no mitigation is needed.

In addition to the munitions clearance methods and mitigation techniques successfully implemented for Nord Stream Project, Nord Stream 2 is performing an assessment of alternative clearance methods and mitigation techniques to reduce the impact associated with underwater noise from in situ detonation. For the permit application, a detailed noise and Natura assessment will be carried out based on the latest munitions survey data and on the study of mitigation measures applicable to clearance activities.

11.4.5 Lack of information and uncertainties

The available baseline data is considered sufficient for the assessment. However, at this stage detailed information regarding munitions distribution along the pipeline route is not available. Additional uncertainties related to underwater noise modelling are discussed in Subchapter 10.4 and Appendix 7.

11.4.6 Significance of the impacts

The different route alternatives do not make a remarkable difference from the point of view of noise.

Underwater noise

In general during the construction, the project does not produce underwater noise that would largerly or permanently change the background noise level. An exception to this would be munitions clearance as that would cause temporary underwater noise levels which are not found naturally in the marine environment. Impacts on marine life (mammals, birds, fish) are assessed in their specific subchapters. NSP2 is currently investigating alternative methods that would allow to reduce the emitted noise.

During operation, noise emissions from the pipeline are considered *negligible* based on available measurement results.

Airborne noise
The significance of airborne noise during construction is considered *negligible* compared to noise level guidelines applicable at closest area, namely nature conservaton area, Table 11-28.

The significance of airborne noise during operations is assessed to be *negligible*, because vessel traffic caused by the maintenance inspection is comparable to regular traffic in the Baltic Sea.

Table 11-32. Significance of the impacts on airborne noise

Impacts of airborne noise	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Noise level in the nearest sensitive area caused by pipe laying	Medium	Negligible	Negligible
Operation phase			
Noise level in the nearest sensitive area caused by maintenance inspections	Medium	Negligible	Negligible

11.5 Benthic flora and fauna

This chapter describes impacts on benthic fauna in the offshore areas in the vicinity of the pipeline route. The assessment is focused on benthic fauna, since there are no benthic flora in the project area. The pipelines will be constructed offshore, mainly in deeper waters. Benthic communities in these areas are typically composed of opportunistic species that can cope with high oxygen fluctuations and even oxygen deficiency. In depths over 80 m, there is essentially no life at the seabed.

The pipeline and its support structures on the seabed have effects on benthic communities by occupying the seabed. During construction, munitions clearance, rock placement, anchor-handling and pipe-laying cause physical disturbance on the seabed that interferes with biota or results in defaunation in the impacted area. This impact can be irreversible (caused by the permanent structures on the seabed) or reversible (caused by temporary changes in living conditions on the seabed, i.e. sediment resuspension and resettling).

The state of the benthic communities along the pipeline route has been described in relation to different depth zones. The impacts have been assessed as an expert opinion. The assessment is based on calculations of the spreading of sediment and contaminants, the technical description of the project, the existing conditions for benthos along the pipeline route and previous experience from a similar project.

Summary of impact assessment on benthos	
Lessons learned from the Nord Stream Project in 2009-2012	The impacts during the construction and operation phases of the Nord Stream pipelines have been monitored near the tie-in site and near the HELCOM long-term stations situated in the vicinity of the pipelines. The main conclusions of these studies were that the high oxygen fluctuations near the seabed are the main controlling factor of macrozoobenthos and that unsatisfactory living conditions have superseded the possible effect of the pipelines as a hindrance of dispersion of benthic fauna.
Main results of the assessment	In the offshore areas of the Gulf of Finland, the oxygen level above the seabed is the major controlling factor of benthos. Communities in the area are dominated by a few opportunistic species that can tolerate low oxygen levels, and diversity is typically low. As a result of permanent anoxic conditions, there is virtually no life on the seabed in the western parts of the pipeline route. Construction activities (mainly munitions clearance and to a lesser extent anchor-handling) cause physical disturbance, leading to defaunation or interference with benthic communities. These impacts are negative but local in nature, and the time-scale is rather short. The impacts are reversible, and the communities are able to recover. Construction activities also cause sediment dispersion, which could harm benthic fauna by interfering with feeding (while in suspension) and by causing interference due to increased sedimentation. The magnitude of change was assessed as negligible. The pipelines and support structures occupy approximately 0.02% of the seabed at depths under 60 m in the Finnish EEZ. Benthos underneath these structures will be destroyed permanently. This impact is negative and irreversible. The magnitude, however, is considered to be low.

11.5.1 Impact mechanism

The assessed impacts on benthos (Table 11-33) have been identified by considering the various project activities during the construction and operation phases and their impacts on benthic communities.

Project activities have either direct or indirect impacts on benthos, and these impacts can be reversible or permanent. The impacts and their relevance during construction and operation are discussed further in Subchapter 11.5.3, and the identified potential impacts are described in Table 11-33.

<u>Direct impacts:</u>

- Detonation of munitions as a part of munitions clearance generates a shock wave that will create craters. Benthic fauna will be completely destroyed at these sites. This impact is regarded as reversible because of the subsequent resedimentation and recolonisation processes.
- During pipelay, anchors that are used to maintain the position of the lay barge cause a direct mechanical disturbance of the seabed and benthic life. This impact is regarded as reversible and is limited to a very restricted area.
- Benthic communities underneath the pipelines and support structures will be lost. This impact is long-term (irreversible), as the planned operational lifetime of the pipelines is at least 50 years.
- During operation, maintenance rock placement would cause loss of benthos in limited areas.

<u>Indirect impacts:</u>

- Most of the construction activities cause sediment resuspension and resedimentation, with corresponding release of contaminants that may adversely affect benthos (acute impacts or accumulation of contaminants). Typically, these impacts are rather short-lived and occur in a specific area as the construction process moves forward along the pipeline route. Therefore these impacts are regarded as reversible.

- During operation, the pipelines may cause minor changes in sedimentation and erosion patterns in the close vicinity of the pipelines leading to minor changes in the living environment or dispersal of benthic animals.
- During operation, the pipelines will change the benthic habitats by offering a hard substrate for benthic species to settle upon. This would have relevance only in shallow areas.

Additionally, the pipelines as an object on the seabed (possibly together with the existing infrastructure) may prevent or hinder benthic species from spreading and colonising new areas.

Table 11-33. Possible impacts of the project activities on benthos.

Receptor	Project phase	Project activity	Impact
Benthos	Construction	Munitions clearance	Direct impact on benthos due to the physical disturbance of the seabed or the loss of habitats on the seabed. Impacts may be irreversible or reversible.
		Rock placement	
		Offshore pipe-laying	
		Anchor-handling	
		Munitions clearance	Changes or loss of benthos due to sediment spreading (sediment resuspension) and the release of contaminants. Impacts are mainly reversible.
		Rock placement	
		Offshore pipe-laying	
		Anchor-handling	
	Operation	Pipeline and support structures on seabed	The pipeline and its support structures on the seabed (footprint) cause loss of habitats underneath the pipelines and change habitats. Impact is irreversible.
		Maintenance rock placement	Similar impacts (footprint) as above, but in a more restricted area.
		Metals from anodes	Release of contaminants from anodes and possible acute/chronic or accumulation effects.

11.5.2 Methods and data used

The significance of impacts (sensitivity of receptor and magnitude of change) on benthos has been assessed according to the methods presented in Subchapter 10.2.

The impacts have been assessed as an expert opinion. The assessment is based on the technical description of the project, the existing conditions in the area, hydrodynamic modelling of the sediment and contaminant dispersion and information that has been collected during the monitoring of NSP.

In order to assess what kind of impacts (occupation of the seabed, habitat change) pipelines as a new object on the seabed may have, the footprint of pipelines was calculated. The footprint was calculated for the pipeline section in the Gulf of Finland where water depth is less than 60 m and where the living conditions for benthic species are generally better than in deeper areas.

The footprint of the project and its impact assessment is based on:

- Surface area covered by the pipelines and rock berms in a section in the Finnish EEZ where water depth is less than 60 m;
- Current state of biotic environment in the pipeline corridor.

Table 11-34. Sensitivity of receptor (benthos).

Low	The seabed in the project area is composed of soft sediments. Living conditions for benthos are highly unfavourable with prevailing anoxic/hypoxic conditions, therefore life at the seabed is virtually absent or only the most competitive opportunistic species survive in the area. In the event of disturbance, the recovery of the species and populations would be rapid. This is based on the high migratory capacity of mobile and opportunistic species that are typical for harsh environments.
Medium	The majority of the project area is composed of soft sediments, although hard seabed types also occur, thus making the area more diverse. Living conditions near the seabed could be variable but most of the time oxygen conditions are satisfactory for benthic communities, which are vital and typical for the area in question. In the event of disturbance, the recovery of the species and populations is moderate and there could be a risk that species with high migratory capacity may cause changes in the original composition of the community.
High	The seabed in the project area is spatially variable and supports diverse habitats with soft and hard substrates as well as valuable benthic underwater habitat types such as reefs, sandy bottoms, etc. Rich, vital benthos communities exist in the area. In the event of disturbance, the species composition may change easily and the recovery of the original communities is either hindered or progress is slow.

Table 11-35. Magnitude of change (benthos).

Negligible	No detectable impacts on the seabed or overlying sea water that could have impacts on benthos. Footprint of the pipelines, rock berms and other support structures on the seabed comprise the order of 0.001% of the seabed surface in areas where water depth is less than 60 m in the Finnish EEZ in the Gulf of Finland and the Northern Baltic Proper.
Low	Adverse impacts (e.g. due to sediment dispersion) are of low intensity and limited to small area. Duration of impacts is short (hours). Impacts are reversible. Footprint of the pipelines, rock berms and other support structures is in the order of 0.01% of the seabed surface in areas where water depth is less than 60 m in the Finnish EEZ in the Gulf of Finland and the Northern Baltic Proper.
Medium	Adverse impacts (e.g. due to sediment dispersion) are of medium intensity, spatial extent is limited and duration is from days to weeks. Impacts are reversible. Footprint of the pipelines, rock berms and other support structures is in the order of 0.1% of the seabed surface in areas where water depth is less than 60 m in the Finnish EEZ in the Gulf of Finland and the Northern Baltic Proper.
High	Adverse impacts (e.g. due to sediment dispersion) are of high intensity, spatial extent is large and duration is long (months). Impacts are irreversible. Footprint of the pipelines, rock berms and other support structures is in the order of 1% of the seabed surface in areas where water depth is less than 60 m in the Finnish EEZ in the Gulf of Finland and the Northern Baltic Proper.

11.5.3 Impact assessment

11.5.3.1 Sensitivity

The sensitivity of the benthos along the pipeline corridor is assessed on the basis of existing data. The sensitivity is considered mainly to be *low* because: (1) the majority of the seabed is composed of soft sediments and there are no threatened or otherwise notable species; (2) the diversity of the benthic fauna is low (which is typical for deep parts of the Gulf of Finland, where oxygen conditions near the seabed are highly variable); (3) the most abundant species are opportunistic with high migration potential; and (4) some parts of the seabed are lifeless due to severe oxygen depletion and the formation of hydrogen sulphide.

There are specific areas with potential occurrence of reef formations. These are the Sandkallan Natura 2000 site and adjacent areas as well as the pipeline section (ALT E1/E2) at the entrance of the Porkkala cape (Subchapter 7.9.2 and Figure 7-37). The sensitivity of these areas is considered *medium*.

11.5.3.2 General factors affecting benthic recovery after disturbance

Certain general factors can affect benthic recovery after direct disturbance (these have been studied, e.g., in relation to many dredging projects or projects involving the disposal of dredged material) (e.g. *Wilber and Clarke 2007*). Some benthic organisms, such as burrowing polychaetes, can survive newly deposited sediments through vertical migration in sediment with vertical migration capacity around 20–30 cm. For these animals, recovery rates can therefore be quicker in comparison with the lateral migration of juveniles and adults from adjacent areas or with larval settlement. Vertical migration can be an important recovery mechanism in areas where sediment spreads and resettles after construction activities, such as rock placement.

Benthic habitats that frequently experience disturbances are typically inhabited by low-diversity, r-selected (opportunistic) benthic assemblages. These communities are able to recover more rapidly than communities in more stable environments. Rapid recolonisation is also associated with fine-grained sediments such as mud, where typical recovery time could be approximately 6-8 months *(Newell et al. 1998)*. It has been also suggested that recovery time is dependent on the spatial scale of the disturbed area (e.g. *Zajac et al. 1998*); therefore recovery is faster after small-scale disturbances (areas under 1,000 m^2).

11.5.3.3 Construction phase

Construction activities (munitions clearance and rock placement as well as pipe-laying and anchor-handling) cause either direct or indirect impacts on benthos. The relevance of each activity is assessed by taking account of the existing information from environmental impact monitoring during pipeline construction *(Ramboll 2011a, Ramboll 2012b)* and the modelling results of sediment dispersion (Subchapter 11.3 and references therein).

<u>Physical disturbance on seabed</u>

Munitions clearance and to a lesser extent anchor-handling during pipe-laying cause a *physical disturbance* on benthos. This may lead to total or partial defaunation in an impacted area. During pipe-laying and rock placement, benthos underneath the pipelines and support structures will be permanently destroyed. The impacts due to *the occupation of the seabed and the habitat change* are addressed below in Subchapter 11.5.3.4, Operation phase.

The impacts caused by munitions clearance are most pronounced in the areas with the highest density of munitions (Subchapter 7.18). During the NSP project, a total of 49 munitions objects were cleared, and the highest number of munitions was found in the central Gulf of Finland (entrance of Porkkala cape). Thus, munitions clearance is likely during construction work for NSP2. The size and shape of craters resulting from detonations or depressions resulting from anchor-handling were studied during the construction of NSP *(Ramboll 2011a, Ramboll 2012b)*. The actual radius of the craters was generally smaller, and they were also less deep than predicted *(Ramboll 2011a, Ramboll 2012b)*. According to worst-case estimates, the radius of each impacted area was approximately 10-15 m and the depth was approximately 5-7 m *(Nord Stream AG 2009)*, whereas according to monitoring results for the NSP project, the average radius of the craters was 3.9 m (median 3 m, range 0–21 m) *(Witteveen+Bos 2011)*. Thus the areas where benthic fauna were totally destroyed by detonations were quite small (approximately 251 m^2/detonation).

Based on monitoring results, the impact area of one munitions clearance would be fairly small. Resedimentation that will eventually fill up craters and parallel recolonisation will begin after detonation. Benthic recovery should be fairly rapid but is dependent on the seabed type (rapid recovery in soft seabed and slower recovery in hard bottoms). The small spatial scales of the impacted areas and the high migration capacity of the opportunistic benthic species typical for the deeper areas of the Gulf of Finland support this conclusion.

An anchored lay barge is planned to be used in deep areas where there are no macrozoobenthos on the seabed as a result of poor oxygen conditions. Thus expected impacts are negligible.

The loss of benthos due to disturbance of the seabed is a negative and direct impact. The impact from detonations or even smaller-scale disturbance from anchors is reversible and very limited in space, and it is assumed that recolonisation will progress rapidly. The magnitude of change is thus considered as *negligible*. The sensitivity of the benthic communities in the area is *low* due to a high relative proportion of soft sediment types and the dominance of opportunistic species or *medium* (less deep areas with possible reef formations). The overall significance of the impact is assessed as *negligible.*

<u>Sediment resuspension and sedimentation</u>

The process in which sediment is resuspended into the water column near the seabed due to construction activities and thereafter resedimented after a given time may negatively affect benthos. Munitions clearance and rock placement have been identified to be the most significant activities causing sediment dispersion during construction work, while pipe-laying and anchor-handling have, based on monitoring, only minor impact and thus are not assessed here.

Changes in water quality during construction activities were monitored during the NSP project *(Ramboll 2012b)*, and the main results are presented in Subchapter 11.3. According to the baseline study undertaken in December 2015 – May 2016 for this EIA, natural turbidity fluctuations near the seabed are approximately at the same level or even higher than those caused by construction activities *(Luode Consulting Ltd 2016a, Appendix 4)*.

According to modelling results, the highest turbidity caused by detonations is concentrated in water layers near the seabed (water layers 0–10 m and 10–20 m above seabed) (Subchapter 11.3). The highest modelled concentrations were in the range of 50–100 mg SS/l. Concentrations over 10 mg SS/l persisted for approximately 6–12 hours. During calm and rough hydrographical scenarios, the maximum suspended solid concentrations decrease faster (in hours), even nearest to the seabed.

Solid substances suspended in the water near the seabed can harm filtering benthic organisms by clogging their feeding and respiratory apparatuses *(Newell et al. 1998)*. However, benthos studies undertaken in the project area suggest that the most abundant species, *Marenzelleria* spp. and *Macoma balthica*, are well adapted to occasionally high and variable concentrations of suspended matter near the seabed. Therefore turbidity fluctuations are assessed to have no probable detrimental effect on the benthic community. According to the monitoring results of NSP, it is assumed that impairment of benthos is possible only in the immediate proximity of the individual rock placement and munitions clearance sites *(Ramboll 2012b)*.

The monitoring results from NSP *(Ramboll 2012b)* suggest there has not been any significant relocation of surface sediments on the seabed near the activities. Similarly, modelling of sediment dispersion suggests that the sedimentation near the construction activities would be at most a few millimetres (Subchapter 11.3) and no increase in sedimentation in the Sandkallan Natura 2000 area is expected. Most species in the impact area are able to cope with conditions of substantial cover, hence they can actively move upward in the sediment. *Marenzelleria* spp. lives quite deep in the sediment at 10–40 cm and is able to dig its way upward even under substantial cover of several centimetres. *M. balthica* is also able to survive sediment accretion up to 7 cm per month *(Turk and Risk 1981)*. Therefore the impact of sediment dispersion and sedimentation will be *negligible* and the overall significance for the benthic communities and ecological conditions in the area is *negligible*.

Contaminants suspended in the water column
In the Gulf of Finland, the seabed sediments are known to be contaminated by chemicals and metals (Subchapter 7.4). During sediment dispersion, some of these contaminants may be released (in dissolved form) into the surrounding water and become bioavailable. This mechanism may potentially cause chronic and/or acute effects on benthic fauna and/or bioaccumulation so that contaminants can transfer to higher trophic levels via the food web. Contaminants that are easily dissolved in water and have high bioactivity are the most critical with regard to harmful effects on biota. According to relative toxicity, PAH (bentzo(a)pyrene), dioxins/furans and zinc were identified as the most critical compounds and were chosen for modelling (further information, *Ramboll 2016a*).

Modelling results suggested (Ramboll 2016b, Appendix 6) that PNEC values were exceeded during munitions clearance for all three chemicals but the duration of exceedance was very short (19 hours maximum). The impact area is largest for PAH. For rock placement, only PAH showed concentrations above the PNEC value. Similarly, the duration of exceedance was assessed to be very short (5 hours maximum) and the impact area was small. In addition, environmental monitoring results before and after construction activities for NSP revealed that there was no significant increase of contaminants in the sediments surrounding the construction activity sites *(Ramboll 2012b)*. The overall conclusion was that the slight variations could be attributed to natural variations in sediment composition and natural processes influencing the surface sediments *(Ramboll 2012b)*. Considering the short time scale of the elevated values of contaminants in the water, it can be assumed that contaminants suspended in water do not constitute a threat to benthic fauna. The findings of this EIA and the monitoring results from NSP *(Ramboll 2012b)* suggest that the risk of chronic and/or acute effects or bioaccumulation is *negligible*.

11.5.3.4 Operation phase

Occupation of the seabed
The pipelines and support structures (constructed rock berms, other support structures and maintenance rock placement) will cause reduction of habitat due to the occupation of the seabed. Installed pipelines as a new object on the seabed could act as an obstacle or delaying factor for the free movement of bottom-dwelling animals in areas where biota exist and where the pipes are partly or fully exposed on soft seabed.

Based on the project design and experience from NSP, it has been roughly calculated that the footprint of the pipeline system in the Finnish EEZ where the water depth is less than 60 m comprises about 0.46 km^2. This is is about 0.018 % of that seabed area in the Finnish EEZ.

The reduction of habitat due to occupation of the seabed is a negative, direct and permanent impact, as it will last the entire operational lifetime of the gas pipelines, which is at least 50 years. The magnitude of the permanent change is assessed to be *low*: the footprint of the pipelines is small, higher fauna is absent on a large portion of the route, and generally the benthic communities are in very poor condition due to high variations in environmental conditions. The extent of the impact is small and local, but the duration is permanent. The overall significance of the impact on benthos due to the permanent occupation of the seabed is assessed as *minor*.

<u>Change of habitat</u>

The pipelines on the seabed and their support structures can offer a settlement substrate for hard-bottom benthic fauna. The majority (approximately 75 %) of the pipeline will be situated in deep (>60 m) soft bottoms that permit no or hardly any benthic colonisation owing to permanent or recurring oxygen deficiency.

Areas where the depth is less than 60 m comprise approximately 25 % of the pipeline route, and only 0.01% of the route runs through areas where the water depth is less than 30 m. In these depth ranges, changes of species composition and a subsequent increase in biodiversity is possible if the pipelines are on soft seabed. On the contrary, fairly large areas of natural hard bottoms (boulders, hard clay) can be found in the eastern part of the route (especially near Kalbådagrund). The pipelines in these areas would not measurably enlarge the amount of available hard-bottom substrate. Moreover, external inspections of the NSP pipelines in the Finnish sector have shown the plain surface of the pipes, indicating no formation of epifauna or reef structure (e.g. *DeepOcean 2015*). Comparing the footprint of the pipelines with hard-substrate areas with good oxygen conditions, it is assessed that the impact significance is *no or negligible.*

<u>Change of sedimentation and erosion patterns</u>

The effect of the pipelines on sedimentation and erosion patterns and potential impacts on benthic communities has been studied by the Finnish Environment Institute (2015d) and during the environmental monitoring of NSP *(Ramboll 2016c)*. The overall conclusion is that no scouring effects have been observed in the proximity of sections located nearest to the monitored HELCOM stations. Also, hydrographical changes (water currents) were limited to 50 m from the pipelines (Subchapter 11.3.3.2). Based on these studies, it was concluded that possible small impacts cannot be separated from natural fluctuations *(Finnish Environment Institute 2015d, Ramboll 2016c)* and the impact significance is *negligible*.

<u>Release of metals from anodes</u>

The impacts of contaminants from the anodes have been assessed in Subchapter 11.3. The release of contaminants (Zn, Cu, Cd) from pipeline materials is small (Ramboll 2013b). The impact significance is assessed as *negligible*.

11.5.4 Prevention and mitigation of adverse impacts

The most important measures are related to commitments that minimise the impacts by munitions clearance and footprint of the pipelines. To minimise munitions clearance, a dynamically positioned lay barge will be used in the heavily mined areas of the Gulf of Finland. In order to decrease sediment dispersion and footprint of the pipeline, rock placement will be a controlled operation utilizing a fall pipe and instrumented discharge head located near the seabed to ensure precise placement of rock material. Where vessels using fall pipes are used, the rock placement process will be monitored and final geometry will be controlled through surveys.

11.5.5 Lack of information and uncertainties

Environmental impacts, including impacts on benthic communities, have been studied as part of the Nord Stream monitoring programme. Yearly monitoring has increased the knowledge of the impacts associated with this type of large offshore construction project. Nevertheless, there are some uncertainties in the assessment of the magnitude of change on benthic fauna and the time scales of recovery, which are related to year-to-year changes in living conditions (e.g. oxygen fluctuations) in the seabed areas adjacent to the pipeline route. However, due to the long-term monitoring data of the authorities, studies to investigate the recovery of benthos after the construction of NSP and a literature survey, the overall data and knowledge basis for the impact assessment is good.

11.5.6 Significance of the impacts

The alternative routes are mainly situated in rather deep areas. The depth range of ALT E1 and E2 is approximately 30-60 m and the depth range of ALT W1 and W2 is approximately 30-90 m. Benthic fauna at these depths are typically adapted to soft bottoms and fluctuating oxygen conditions. Opportunistic species are mostly dominating these assemblages. The alternative routes are more or less identical with regard to bathymetry and the difference in seabed morphology is also rather small. The proportion of hard bottom (hard clay) is slightly higher in ALT W1 than in ALT W2.

In light of these fairly small differences and the knowledge that oxygen fluctuations are the major factor that regulates soft-bottom fauna in these areas, it is plausible that there are no measurable differences in impacts on benthic communities. For that reason there are no differences between sub-alternatives. This also applies to construction alternatives.

The overall significance of the impacts during construction and operation on benthic fauna varies between *negligible* and *minor*.

Table 11-36. Significance of the impacts on benthos.

Impacts on benthos	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Direct mechanical disturbance on seabed	Low/Medium	Negligible	Negligible
Sediment resuspension and changes in net sedimentation	Low/Medium	Negligible	Negligible
Contaminants in the water column	Low/Medium	Negligible	Negligible
Operation phase			
Occupation of the seabed	Low/Medium	Low	Minor
Change of habitat	Low/Medium	Negligible	Negligible
Change of sedimentation and erosion patterns	Low/Medium	Negligible	Negligible
Release of metals from anodes	Low/Medium	Negligible	Negligible

11.6 Fish

The purpose of the assessment of impacts on fish is to determine whether the pipeline project may have impacts on fish in the Finnish project area. The assessed impacts on fish have been identified by considering the various project activities during construction and operation and how these activities may interact with the environmental target, fish. Interaction between fish and the planned project activities during construction relates principally to underwater noise and sediment spreading resulting from different construction activities.

The objective was to identify potential fish species and spawning grounds that may be affected by construction activities. Results of the water quality assessment have been utilised as a basis for this assessment. Experience and results from the NSP has been fully exploited. This assessment has been performed as an expert opinion.

Summary of impact assessment on fish	
Lessons learned from the Nord Stream Project in 2009-2012	Fish populations have not been monitored according to the environmental monitoring programme of Finland in relation to the Nord Stream pipelines. In Sweden, where the pipelines cross important fishing and fish nursery grounds, fish populations have been monitored. In the report on monitoring in Sweden in 2010-2014 (Ramboll 2015c) it was concluded that the abundance of fish along the pipeline route has not decreased since the establishment of the pipelines on the seabed. There was evidence of an effect on the composition of demersal fish, and indications that cod may feed in close vicinity to the pipelines, resulting in an improved condition for these individuals. These effects can be attributed to the presence of the pipelines on the seabed. Echo-sounder measurements of fish abundance near the pipelines indicated only natural variations between the years 2010, 2011, 2012, 2013 and 2014.
Main results of the assessment	Fish mortality resulting from munitions clearance is assessed to be direct and negative, as it kills or injures individual fish. However, on the fish stock level the impact is assessed to be negligible. Avoidance reactions of fish in relation to construction activities are assessed to be temporary and short in duration and there will be no long term impact on fish communities. The impacts of suspended sediments and released contaminants on sprat eggs and larvae are assessed to be negligible considering the low value of individual sprat eggs in the context of sprat stock. During operation in the Finnish EEZ the pipelines on the seabed are assessed to have no impacts on fish.

11.6.1 Impact mechanism

The assessed impacts on fish have been identified by considering the various project activities during construction and operation and how these activities may interact with the environmental target, fish. Interaction between fish and the planned project activities during construction relates principally to noise and sediment spreading resulting from different construction activities.

Planned construction activities consist of munitions clearance, rock placement and offshore pipe-laying including anchor-handling. For all activities, interaction between fish and the planned construction works relates principally to sediment plumes and the release of contaminants, which cause changes in water quality. Munitions clearance may also physically injure fish. Sediment spreading affects fish by causing adult pelagic fish (sprat and herring) to avoid the construction area *(Moore 1977)*. Sprat eggs and larva in the project area during the summer months may also be affected by suspended sediment if suspended matter adheres to their surface, causing them to sink towards the bottom *(Westerberg et al. 1996)*, where there is a risk of oxygen depletion.

During the operation phase of the pipeline system, fish may be affected by sediment spreading resulting from maintenance rock placement. Increased vessel traffic for pipeline maintenance purposes may also affect fish. The pipelines on the seabed will form an artificial sanctuary for fish species, making it harder to catch demersal fish species around the pipelines.

Table 11-37. Possible impacts of the project activities on fish.

Receptor	Project phase	Project activity	Impact
Fish	Construction	Munitions clearance	Fish mortality due to munitions clearance
		Munitions clearance	Avoidance reactions due to spreading of sediments
		Rock placement	
		Offshore pipe-laying	
		Munitions clearance	Effects on fish eggs and larvae due to spreading of sediments and sedimentation
		Rock placement	
		Offshore pipe-laying	
		Munitions clearance	Effects on fish due to release of contaminants
		Rock placement	
		Offshore pipe-laying	
	Operation	Maintenance rock placement as required	Disturbance due to spreading of sediments and release of contaminants, underwater noise from maintenance activities
		Pipelines on the seabed	Creation of artificial sanctuary around pipelines for fish

11.6.2 Methods and data used

This assessment is based on the planned construction activities and their impacts on water quality and underwater noise levels (Subchapters 11.3 and 11.4). The identified magnitude and geographical extent of impacts during construction and operation is considered against existing information on fish stocks, the distribution of fish species and the assumed and known spawning sites of fish populations gathered from literature and other sources.

When possible, information has been compared with known threshold values and impacts caused when these values are exceeded. Experience from NSP water quality monitoring was also taken into consideration to evaluate impacts on local fish and fish stocks. This assessment of impacts on fish focuses on Baltic herring and sprat, the prevailing species in the open sea communities along the pipeline corridor, but also takes into account threatened fish species in the project area.

The significance of impacts (sensitivity of receptor and magnitude of change) on fish has been assessed based on the methods and categories presented in Chapter 10 and and Table 11-38 and Table 11-39.

Table 11-38. Sensitivity of receptor (fish).

Low	There are no threatened fish species or important fish spawning areas in the vicinity of the project area. The status of the exploitable fish stocks in the project area is well above sustainable level.
Medium	Threatened fish species may occur in the project area and nearby areas but there are no important spawning areas. The status of the exploitable fish stocks in the project area is at sustainable level.
High	Threatened fish species and important spawning areas occur in the vicinity of the project area. The status of the exploitable fish stocks in the project area is below sustainable level. There are underwater Natura 2000 habitat types or nature reserves that could support diverse and healthy fish communities in the area.

Table 11-39. Magnitude of change (fish).

Negligible	No detectable impacts on fish species, their living conditions or breeding areas.
Low	Temporary (months) increase of suspended solids concentration <10 mg SS/l (threshold for escape of fish), limited in space (<0.5 km from the source). Concentration of contaminants in suspension is low. Temporary reduction in the size of breeding areas. Underwater noise level from activity is lower than 203 dB SEL.
Medium	Short-term (under two growth seasons) increase of suspended solids concentration >10 mg SS/l, limited in space (0.5-2 km from the source) or concentration of contaminants in suspension is moderate. Reduction in size of breeding areas. Underwater noise level from activity is over 203 dB SEL but less than 207 dB SEL.
High	Long-lasting (many growth seasons) increase of suspended solids concentration >10 mg SS/l, in large impact area (>2 km form the source) or concentration of contaminants in suspension is high. Destruction or deterioration of breeding areas. Underwater noise level from activity is 207 dB SEL or higher.

11.6.3 Impact assessment

11.6.3.1 Construction phase

<u>Impacts on fish due to munitions clearance</u>
Fish behaviour in response to underwater noise is not well understood. Sound pressure levels that may deter some species may attract others. There are relatively few studies conducted through out the world that address noise-related impacts on fish, and the existing studies often show varying results. Popper et al. (2014) have summarised the latest research on the matter, which is used in this assessment.

Mortal injuries can result from exposure to very high amplitude sounds. Species with a swim bladder and other gas chambers have a greater potential to suffer physiological trauma (baro-trauma) than those without gas chambers. Sudden pressure changes, particularly from impulsive sounds such as from an explosion, can cause rapid motion of the walls of these cavities and tear them apart or damage surrounding tissue. Fish species lacking a gas-filled cavity primarily detect particle motion and do not detect sound pressure *(Popper et al. 2014)*. The majority of the fish species in the Finnish NSP2 project area have a swim bladder and therefore are susceptible to barotrauma.

Hearing loss due to noise exposure can be permanent or temporary. For fish, physical damage to the hearing apparatus rarely leads to permanent changes in the sound detection threshold as the sensory epithelium will regenerate over time. However, temporary hearing loss (TTS, temporary threshold shift) may occur *(Popper et al. 2014)*. Various threshold criteria for effects on fish are presented in Table 11-40.

Table 11-40. Threshold criteria for effects on fish (Popper et al. 2014).

Marine group	Munitions clearance Effect	Assessment levels SEL(Cum*) dB re 1µPa2-s
Fish	Mortality (mortal injury)	207 dB (229-234 dB peak)
	Injury	203 dB

* Cumulative SEL (1 event).

According to the results of the report on munitions clearance for NSP in the Finnish EEZ *(Nord Stream AG 2011)*, relatively small numbers of fish, mainly Baltic herring or sprat, were killed during clearance operations. Prior to detonations, a vessel searched the area with a fish finder, and no fish shoals were detected during clearance activities. Prior to each detonation a small charge was fired to frighten fish away from the area. Based on these findings it can be assessed that no major fish mortality will occur during the munitions clearance operations for NSP2.

The old minefields identified along the pipeline route in the Gulf of Finland are not in close vicinity to any important spawning or nursery areas for fish. It is assessed that noise from munitions clearance will have an impact on fish and that fish in close proximity to the detonations will sustain lethal injuries. According to the report on underwater noise modelling related to munitions clearance in the Gulf of Finland *(Ramboll 2016d)*, the longest lethal distance for fish around maximal detonated munition is 500 m.

The impact on fish due to munitions clearance would be direct and negative, as clearance operations kill or injure individual fish. However, on a fish stock level, the impact is assessed as negligible. The overall impact significance on fish and fish stocks is assessed as *negligible.*

<u>Avoidance reactions due to spreading of sediments</u>

Spreading of sediments and further sedimentation will occur during various construction activities e.g. during munitions clearance, rock placement and anchor-handling of the pipe-laying vessel. At the construction site, sediment suspension in excess of certain threshold values will cause avoidance reactions in fish.

Increased levels of suspended sediments may damage adult and juvenile fish. Particles may accumulate in their gills, reducing oxygen absorption. Sharp-edged particles may also damage gills. Species that use their vision for feeding can be affected by increased turbidity. The sensitivity of adult fish to suspended particles varies highly between species and during their life stages and depends on sediment composition, concentration and duration of exposure. In general, pelagic fish are more sensitive to suspended sediment than demersal fish *(Moore 1977)*. Pelagic fish are more likely to suffer gill injury as a result of their faster swimming speed and larger gill area. In comparison, demersal fish are more highly adapted to increased concentrations of suspended material in their natural environment.

Baltic herring is a pelagic species and therefore sensitive to increased levels of suspended sediments. According to COWI/VKI (1992), adult herring (*Clupea harengus*) show avoidance responses in 10 mg/l concentrations of suspended sediments in water. The same threshold level is probably also valid for sprat (*Sprattus sprattus*) because it is a close relative of herring. The background concentration of suspended sediments in the Gulf of Finland is about 2 mg/l (Subchapter 11.3.3.1). The modelling of turbidity spreading near construction sites is used to assess the extent of the avoidance reactions of sprat and Baltic herring.

The exposure time is of great importance when it comes to biological effects. It has been shown that sediment concentration (mg/l) and exposure time (h) jointly are significantly correlated to the degree of a biological effect, whereas sediment concentration on its own was not *(Newcombe & MacDonald 1991)*.

According to the water quality assessment (Subchapter 11.3.3), suspended sediments originating from construction activities remain in the water layers near the seabed. The duration of exceedance of 10 mg SS/l in seawater during rock placement near the seabed varies between 7 and 18.5 hours, depending on the conditions (Table 11-20). In NSP monitoring, it was noted that the duration of individual turbidity peaks over 10 mg SS/l varied between 1 and 12 hours. The extent of turbidity plumes was at its maximum 600 m from the activity *(Ramboll 2011a)*. Avoidance reactions of fish are therefore assessed to be temporary and short in duration, and there will be no long-term impact on fish communities. The impact magnitude is assessed to be *negligible*.

<u>Effects on fish eggs and larvae due to release of suspended matter</u>

Pelagic fish eggs, such as sprat eggs, may be affected if suspended matter adheres to the eggs, causing them to sink towards the bottom *(Westerberg et al. 1996)*, where there is a risk of oxygen depletion. As described in Subchapter 7.10, the only commercially important species that theoretically can spawn in the pelagic environment of the Gulf of Finland is sprat. The relevant exposure time as mentioned in the previous paragraph is modelled to last maximum 18.5 hours. This would according to Westerberg et al. (1996) in 10 mg SS/l affect the loss of fish egg buoyancy by 2–3 PSU. Considering the edge of the sprat distribution area within the Finnish project area, this level of buoyancy loss would impact sprat eggs by making them sink towards the seabed.

According to the water quality assessment (Table 11-16 and Table 11-19), the maximum areas where 10 mg/l suspended sediment concentrations are exceeded during munitions clearance and rock placement is 46.1 km^2 and 9.46 km^2 respectively. As an estimate, when comparing the total area suitable to sprat eggs (roughly 10,000 km^2 in the Finnish project area, see Figure 7-42 in Subchapter 7.10) with the area in which sediment concentrations are greater than 10 mg/l, it is assessed that the extent of the impact is local. Furthermore, in the context of the entire Baltic Sea, the importance of sprat reproduction in the Gulf of Finland remains marginal due to limiting environmental conditions, particularly low salinity *(Raateoja and Setälä 2016)*. Considering the low value of individual sprat eggs in the context of sprat stock and the marginal importance of the Gulf of Finland in sprat reproduction, it is assessed that the impact significance on sprat eggs and larvae is *negligible*.

<u>Effects on fish due to release of contaminants</u>

Contaminants released from sediment (Subchapter 11.3.3) can increase the mortality of fish eggs. However, the pipeline construction will be conducted at a great distance from all known herring spawning sites. However, for sprat eggs, contaminants can increase mortality. Still, contaminants will be released near the seabed and within a very limited area compared with the potential sprat spawning area in the upper water layers. When acute toxicity effects are concerned, the impact is irreversible for individual eggs or larvae. However, because only individual fish or eggs are affected and no impact at the species level is expected due to the small impact area, the overall impact is assessed to be reversible. Theoretically, a minor portion of released contaminants may accumulate in food webs and with other exposure sources cause potential adverse effects. This impact would be partly reversible. However, considering the short duration of the contaminants exposure resulting from construction activities, this impact is assessed to be highly unlikely and therefore *negligible*.

Impacts during operation

The pipelines will occupy the seabed and form a new obstacle on the sea floor. Benthos will colonise the surface of the pipes and an artificial reef structure may be formed. However, in the Finnish EEZ the prevailing environmental conditions do not favour this kind of reef formation because of oxygen deficiency. There are also no demersal fish species present at the depths of the pipeline that could benefit from a reef structure. External inspections of the Nord Stream pipelines in the Finnish sector *(DeepOcean 2015)* have shown the plain surface of the pipes, indicating no formation of epifauna or reef structure. This impact is therefore assessed to be negligible. Even though the reef effect is not relevant in the Finnish EEZ, the pipelines will form an artificial sanctuary for fish in relation to fishing. Fish shoals near the pipelines will manage to avoid trawl gear, as trawlers are forced to leave space between their trawl gear and the pipelines in the uneven seabed areas for safety reasons (Subchapter 11.3.3). This impact is relevant for sprat, which form shoals near the seabed in the winter when they seek warmer water layers *(Parmanne et al. 1994)*. However, the significance of this impact for sprat at the population level is negligible, as the area that the pipelines occupy on the seabed is very small compared with the area of the Gulf of Finland.

During pipeline maintenance work, increased vessel traffic and possible post-lay rock placement may disturb fish in the offshore area. However, this impact is assessed to be within the range of normal maritime impacts and therefore its significance is considered to be *negligible*.

11.6.4 Prevention and mitigation of adverse impacts

Impacts on fish will be mitigated by route optimisation and the number of munitions to be cleared. These measures will reduce the amount of suspended sediments and sediment-bound contaminants originating from construction activities. Considering the minor significance of the pipeline project on fish in the Finnish EEZ, no further mitigation measures are found to be necessary.

11.6.5 Lack of information and uncertainties

The available data is considered sufficient for the assessment. Although the exact reaction of fish during construction is uncertain, the assessment suggests that because the sources of impacts are of a temporary nature, fish will return and there will be no permanent impacts on fish stocks.

11.6.6 Significance of the impacts

The route sub-alternatives do not differ from each other with regard to impacts on fish. The sub-alternatives (E1 and E2 in east, as well as W1 and W2 in west) require approximately the same amount of seabed intervention works that will affect water quality. The distances between important fish spawning and nursery areas are at the same level. Therefore no significant difference in relation to fish or fish stocks can be found between the sub-alternatives.

Regarding impacts on fish, there are no substantial differences between construction alternatives.

The impact receptors, in this case fish species inhabiting the Finnish project area (EEZ), are open-sea species, some of which are categorised as threatened. Stocks of salmon and sea trout are in weak condition owing to the shortage of suitable natural spawning and nursery grounds. These species breed in rivers and spend most of their adult period in the sea, which makes them non vulnerable to the activities in the sea area.

Other sensitivity criteria for fish relate to nearby spawning areas affected by project activities. The only fish species spawning in the pelagic offshore areas in the Finnish EEZ is sprat (Subchapter 7.10). Even though the sprat spawning area covers open waters westward of the mouth of the Gulf of Finland, the most important spawning grounds of sprat are situated at the edges of the deep basins of the Baltic Proper *(Parmanne et al. 1994)*. This makes the Finnish project area marginal in relation to the breeding success of the Baltic sprat stock. The status of both of the main target species of Finnish commercial fishing within the NSP2 project area, sprat and Baltic herring, is considered to be at the sustainable level (Subchapter 7.10). The above factors contribute to the sensitivity of the fish receptor, resulting in it being categorised as medium sensitive (Table 11-38). The magnitude of the change in relation to fish is assessed to be negligible because the impact on sprat spawning success or salmon and sea trout feeding grounds is assessed to be negligible. The overall impact significance on fish is assessed to be negligible (Table 11-41).

Table 11-41. Significance of the impacts on fish.

Impacts on fish	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Impacts on fish due to munitions clearance	Medium	Negligible	Negligible
Avoidance reactions due to spreading of sediments	Medium	Negligible	Negligible
Effects on fish eggs and larvae due to release of suspended matter	Medium	Negligible	Negligible
Effects on fish due to release of contaminants	Medium	Negligible	Negligible
Operation phase			
Impacts on fish due to forming of an artificial sanctuary	Medium	Negligible	Negligible

11.7 Marine mammals

Possible impacts on marine mammals can roughly be divided to two main categories: physical impacts on individuals and factors, which may lead to impaired breeding, feeding or haul-out areas, and lead to changes in populations.

Main tasks were to assess the possible direct impacts to individuals caused by project activities, such as munitions clearance and rock placement. Secondly, possible direct or indirect impacts on breeding, feeding or haul-out areas were assessed with comparison of known populations and projects activity areas.

The assessment takes into consideration the mitigation measures described in the project description (Subchapter 4.2.5) and in Subchapter 11.7.7 Prevention and mitigation of adverse impacts.

Impacts on Natura 2000 sites with conservation base as seals and other important seal areas have been assessed in Subchapter 11.9 Protected areas.

NSP2 is investigating alternative munition clearance methods to further reduce the impacts of munition clearances.

Summary of impact assessment on marine mammals	
Lessons learned from the Nord Stream Project in 2009–2012	In the Nord Stream Project only one seal was observed by on-board observers during munition clearance operations. No negative effects on seal populations were seen. A special seal survey was conducted during late winter-spring, and it showed that grey seals are abundant and, depending on ice conditions, can be found in different parts of the Gulf of Finland. It's clear, that observing seals outside haul out areas is very difficult. After the Nord Stream Project, the underwater noise and its possible impacts on marine mammals has become a topic of growing concern, and a lot of new information on that subject has been published during recent years.
Main results of the assessment	Main conclusions are that, even with mitigation measures, munitions clearance can lead to blast injuries or hearing thresholds shift to ringed seals and grey seals with impacts at individual and population level. The permanent threshold shift impact area can extent several kilometres from the detonation site. Impacts on breeding, feeding and haul-out areas are not so critical. Additional mitigation measures can further reduce the impacts.

11.7.1 Impact mechanism

The environmental impacts on marine mammals concerns mainly two species in Finland, the grey seal and the ringed seal, but also harbour porpoises are occasionally present *(Sveegaard et al. 2017, Appendix 8B)*. The potential pressures that are related to the construction, pre-commissioning, commissioning and operation phases of the gas pipeline are described in Appendix 8B.

The impacts arise from the project activities that are introduced below (Table 11-42). Detailed description is presented in Appendix 8B. Noise modelling results and assumptions regarding noise are presented in Subchapters 10.4 and 11.4 in this EIA Report.

The key question in the context of the NSP2 project and marine mammals is whether the construction and operation of the pipeline are likely to have an impact (positive or negative) either at individual level or at population level (e.g. on abundance and distribution).

Assessing the impact at the population level is challenging unless all factors related to the population structure and abundance of the animals, as well as all other factors affecting their survival in relation to direct and indirect impacts are known. Information on the animals using the impact areas and the status of the populations are not well known and hence associated with uncertainty.

Table 11-42. Possible impacts of the project activities on marine mammals.

Receptor	Project phase	Project activity	Impact
Marine mammals	Construction	Munitions clearance	Deleterious effects or disturbance due to underwater noise Disturbance due to waterborne noise from vessels
		Rock placement	
		Pipe supply	
		Munitions clearance	Visual impact from increased vessel activity Visual impairment due to sediment dispersion
		Rock placement	
		Pipe supply	
		Pipe laying	
		Munitions clearance	Behavioural disturbance due to sediment dispersion Health effects caused by contaminants
		Rock placement	
	Operation	Monitoring and surveying	Disturbance due to noise and visual impact from increased vessel movement
		Maintenance rock placement as required	

The impact assessment is carried out by considering mitigation measures that were applied during munitions clearance of NSP and that NSP2 commits to (Subchapter 4.1.4 for detailed description of these methods). These measures have been primarily implemented to reduce impacts on marine mammals and fish (Subchapter 4.2.5 and Figure 4-22).

Visual observations will be performed one hour before the detonation and one hour after by seal observer, stationed on munition clearance vessels (Subchapter 4.2.5). Also a passive acoustic monitor will be deployed into the water column to record any vocalization by marine mammals prior detonation. This gives information on the presence of marine mammals in the area.

In addition to monitoring methods, deterring measures will be used prior to detonation to scare seals and harbour porpoises away. For this purpose, acoustic deterrent devices (seal scrammers) for seals and harbour porpoises will be deployed prior to detonations to drive animals away from detonation zone. Several ADDs in appropriate arrays will be used if required to increase the area of the avoidance zone.

Mitigation measures are summarized in Subchapter 11.7.7.

11.7.1.1 Underwater noise

Modelling results of propagation of underwater noise from munition clearance and rock placement during construction of NSP2 are presented in Subchapter 10.4 and 11.4.

<u>Munitions clearance</u>

Underwater detonations generate very large sound pressures with an extremely steep onset (shock wave). The frequency spectrum of noise pulses from explosions is dominated by energy at low frequencies. Compared to other noise sources, munitions clearance is by far the loudest activity.

Under optimal conditions the noise from an explosion can be transmitted over distances of hundreds of kilometres. Actual transmission range depends, as with other types of sound, on the bathymetry, hydrography and sediment types around the detonation site. Transmission of noise from explosives is greatly reduced in shallow waters (tens of meters or shallower) due to the poor propagation of low frequencies in shallow water (Urick 1983).

The duration of a single detonation is less than a second, which means that for single detonations the main concern relates to the risk of causing immediate damage to tissue and hearing, whereas effects on for example behaviour is limited. Repeated detonations in the same area can change this and the cumulative effect of damage and behavioural disturbances must be considered in those situations.

Rock placement

Noise measurement data indicate that the dominating underwater noise from rock placement activity is from the surface activities (ship motors, thrusters, conveyors, rock pouring) rather than the noise from the actual placement of the rock on the seabed.

Source noise levels for vessels depend on the vessel size and speed as well as propeller design and other factors. There can be considerable variation in noise magnitude and character between vessels even within the same class.

Pipe-lay, anchor handling

The noise emitted from pipe-laying and anchor handling during construction is expected to be lower than that from rock placement and therefore noise from rock placement is used as worst case proxy for impacts on marine mammals from pipelaying and anchor handling activities.

Ship noise

Ship noise during construction and operation phases originates though several mechanisms. Large amounts of low frequency noise can be generated by the engine and propeller shaft, transmitted through the hull into the water. At higher frequencies the dominating source is cavitation around propellers, which can be very loud in case of high speed propellers on smaller vessels and damaged propeller blades. Additional sources of noise can be ancillary machinery, such as generators, hydraulic pumps, winches and ventilation systems.

In general there is a monotonic relationship between ship speed and noise level: higher noise levels are generated at higher speed. There can however be exceptions for this general relationship. Also ships equipped with dynamic positioning systems can be very noisy at slow speed or while maintaining constant position, due to the rapidly changing speed of the powerful ducted propellers.

Underwater noise from gas pipeline

During operation phase, gas that flows through the pipeline will generate low levels of noise at low frequencies. Based on noise recordings at the vicinity of the Nord Stream pipeline and noise modelling (Subchapter 7.7 and 11.4.3.1), the noise levels in Finnish waters are expected to be well below natural ambient and dominated by ship noise as pipeline runs close to the major shipping route in the Gulf of Finland. Thus *impacts due to pipeline noise are not assessed further*.

11.7.1.2 Sediment spill

Modelling results of sediment spill during NSP2 are presented in Subchapter 11.3.

Seabed disturbance during construction can result in increased turbidity and the creation of sediment plumes. Sediment plumes have the ability to extend the impact of seabed disturbance over larger areas that would otherwise remain unaffected physically. It has been shown that effects are generally short lived, lasting a maximum of two to three days and are confined mainly to an area of a few hundred metres from the point of discharge.

The main impacts on marine mammals from sediment spill are visual impairment, behavioural impacts such as avoidance of sediment plumes and health deterioration caused by mobilization of contaminants from the sediment in to the food chain.

11.7.1.3 Increased vessel movement

Increased vessel movement during construction and to a lesser extent during operation can cause visual disturbance (although the underwater noise is the most important source of disturbance) to seals at the vicinity of the project area. The Gulf of Finland is major ship route to Finland, Estonia and Russia and the area therefore is characterized by high volumes of ship traffic (Subchapter 11.12). Construction vessels or inspection/service vessels are not assessed to change the ship traffic conditions (Subchapter 11.12) in the whole area therefore it is unlikely that seals, which are already accustomed to a densely trafficked area, would be impacted by relatively small increases in ship traffic. Therefore additional visual disturbance to marine mammals will be *negligible and is not assessed further*.

11.7.1.4 Ice breaking

A potential impact from the increased marine traffic e.g. by service vessels is the breaking of ice in the Gulf of Finland. Grey seal and ringed seal use the ice for breeding, resting and socializing and may thus be present and affected by the breaking of ice. The impact may range from disturbance of natural behaviour (short-term and low magnitude) to the potential collision and death of seals pups by hypothermia The reason for this is that their fur coat is not waterproof for the first months of their life, when they are restricted to stay on the ice (long-term and high magnitude).

Due to the potential impacts, NSP2 has committed to restrictions regarding ice breaking.

The general content of these restrictions is that construction activities such as pipe lay and rock placement are not foreseen in the winter ice conditions. If these activities are performed in `marginal` winter ice, the necessary safety measures will be implemented in conjunction with the maritime authorities. Moreover, if there is a potential impact on breeding seals, the coordinating environmental authority shall be notified with supporting impact assessment and mitigation measures. Mitigation measures are summarized in Subchapter 11.7.7.

This means that if ice breaking at some point is deemed necessary, a new impact assessment will be performed. Consequently, *ice breaking is not assessed further*.

11.7.1.5 Potential impacts from other activities

<u>Pre-commissioning</u>
After installation of the pipelines, pre-commissioning (and possibly tie-ins) will be performed before the pipeline system can enter into operation. The pre-commissioning activities can include: flooding, cleaning and gauging of the pipelines, a system pressure test, and dewatering and drying of the pipelines. These activities are described in Subchapter 4.2.10.

None of the activities during the pre-commisioning phase are assessed to have a significant impact on marine mammals and are thus *not further assessed*.

<u>Commissioning</u>
Commissioning comprises all activities that take place after the pre-commissioning and until the pipelines are ready for gas filling and transport. These activities are described in Subchapter 4.1.11.

None of the activities during the commisioning phase are assessed to have a significant impact on marine mammals and are thus *not further assessed*.

<u>Operation: Changes in the habitat</u>

The introduction of hard bottom substrates in form of the gas pipeline on the bottom represent a change in the habitat and may potentially have an indirect long-term effect by creating shelter for fish or by being colonised by algae and filter feeding epifauna. This means that the species composition around the pipeline may be altered and the number of individuals increased. Depending on the species, this may lead to an increase in the food available to marine mammals.

However, in the Finnish EEZ the prevailing environmental conditions do not favour this kind of reef formation because of oxygen deficiency. There are also no demersal fish species present at the depths of the pipeline that could benefit from a reef structure. External inspections of the Nord Stream pipelines in the Finnish sector *(DeepOcean 2015)* have shown the plain surface of the pipes indicating no formation of epifauna or reef structure. The impact significance is assessed as *negligible* and is *not further assessed*.

11.7.1.6 Unplanned events

The impacts by unplanned events are assessed in Chapter 16.

The event of an oil-spill caused by a collision or accident during construction work may impact marine mammals as would any other oil discharge at sea. The impact depends on the size of the oil spill, type of oil, weather conditions, etc. The chemical constituents of spilled oil are poisonous and exposure to oil through ingestion or inhalation or from external exposure through skin and eye irritation, may thus harm marine mammals. Oil can also smother the fur of seals and thereby reduce their ability to maintain body temperatures.

During operation of the pipeline, there are a number of low risks which may result in pipeline failure and lead to subsea gas release such as corrosion, natural hazards, and external interference related to ship traffic such as dragged and dropped anchors. In the event of gas release, marine mammals within the gas plume or the subsequent gas cloud may die if positioned directly in the plume or flee from the influenced area and thereby causing a behavioural effect.

11.7.2 Methods and data used

The assessment methodology is described in Subchapter 10.2. In this chapter, this methodology is interpreted in relation to marine mammals.

11.7.2.1 Data used

The following sources were used for the assessment:

- Received information and studies conducted during the Environmental Impact Assessments for marine mammals from Nord Stream (NSP)
- Modelling results of sediment dispersion and underwater noise in Finnish waters performed by Ramboll (Appendix 6 and 7)
- Baseline report of marine mammals in the Baltic Sea *(Teilmann & Sveegaard 2017, Appendix 8A)*
- A more detailed impact assessment is presented in Sveegaard et al 2017, Appendix 8B while in this EIA we present the methodology used for the assessment and the summary of the results.
- Relevant literature. No new fieldwork was conducted.

11.7.2.2 Criteria for sensitivity and magnitude of change of marine mammals

<u>Sensitivity</u>

When assessing sensitivity of marine mammals in relation to the impact type, the main focus has been on population status (declining/stabile/increasing), abundance, distribution (their presence during the impact), protection status (national and international), vulnerable periods (e.g. breeding or moulting season) and biology (physiological impact). The assessment criteria of sensitivity have been summarized in Table 11-41.

The information on population status, abundance, distribution and protection status are given in Appendix 8A and in Subchapter 7.11.

Table 11-43. Assessment categories and methodology of sensitivity for marine mammal populations. All marine mammals in the Baltic are internationally and nationally protected, so this is identical for all sensitivity categories.

Low	The population is stable and the abundance is increasing. The impact area does not include nationally or regionally important areas (used for breeding, feeding or migration). Marine mammals only occur in low density. The marine mammal species is not sensitive to environmental changes i.e. their biology (physiology or behaviour) is not or is only temporarily affected by the impact.
Medium	The population is stable. The impact area includes parts of nationally or regionally important areas (used for breeding, feeding or migration). Marine mammals only occur regularly (= medium density). The biology of the marine mammal species are moderately affected by the impact.
High	The population is decreasing and/or the abundance is low. The impact area includes nationally or regionally important areas (used for breeding, feeding or migration). Marine mammals occur in high densities within the impact area. The marine mammal species is highly sensitive to environmental changes i.e. their biology (physiology or behaviour) is severely affected or damaged by the impact.

Sensitivity and magnitude of change should be assessed independently. For some inputs to sensitivity, however, this is impossible. The assessment of animal presence during the impact (especially munition clearance) requires input of spatial extend of the impact (the impact area). The spatial extend should, however, be assessed on a more general scale than for example the extent of the models of noise and sediment spill.

Consequently, the Finnish part of the NSP2 route was divided into four zones according to the population status and general distribution of especially ringed seals, paying attention to the density of munitions and munitions identified and cleared during NSP (Figure 11-11). Each zone, except for the western part of the Gulf of Finland, thus contains at least one position where sound exposure from munitions clearance was modelled (locations M1-M4). The four zones identified were:

1) The inner Gulf of Finland (M1-2 area, including eastern GoF)
2) The central Gulf of Finland (M3)
3) The outer Gulf of Finland (M4, mouth area of the GoF)
4) The western Finnish waters

Number of ordnances found and detonated, respectively, in the four areas are listed in Table 11-44.

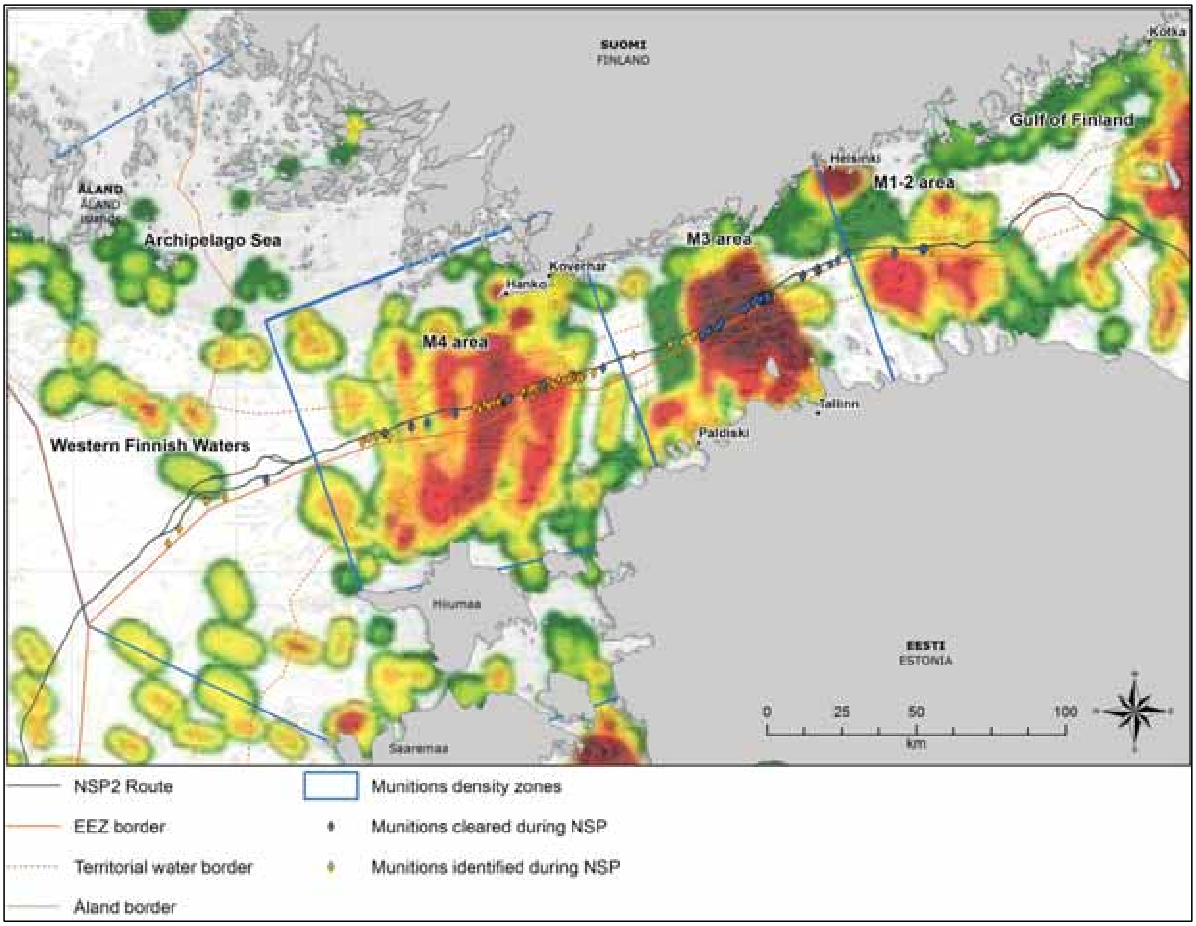

Figure 11-11. Sensitivity assessment zones in the Finnish part of the NSP2 route 1) M1-2 area (the inner Gulf of Finland), 2) M3 area (the central Gulf of Finland), 3) M4 area (the outer Gulf of Finland) and 4) the western Finnish waters. Zones are divided according to the density of munitions and munitions identified and cleared during NSP. (Appendix 6)

Table 11-44. Number of identified and cleared unexploded ordances in the four different areas shown in Figure 11-11.

Munition	Outside	M4	M3	M1-2
Cleared	1	7	42	6
Identified	5	139	181	7

In relation to munition clearance, the western Finnish waters, due to a low density of munitions and sensitive targets, is considered of low importance until it has been further clarified whether munitions are located along the NSP2 route and munition clearance noise models have been produced accordingly. In contrast, for the three other areas, it is clear that munition clearance will be performed. Buffer zones were calculated based on the maximum extent of the TTS (temporary threshold shift) and PTS (permanent threshold shift) zones for detonations at the four Finnish positions M1 through M4 (Ramboll 2016d and Table 10-19 and Table 10-20) (Figure 11-12).

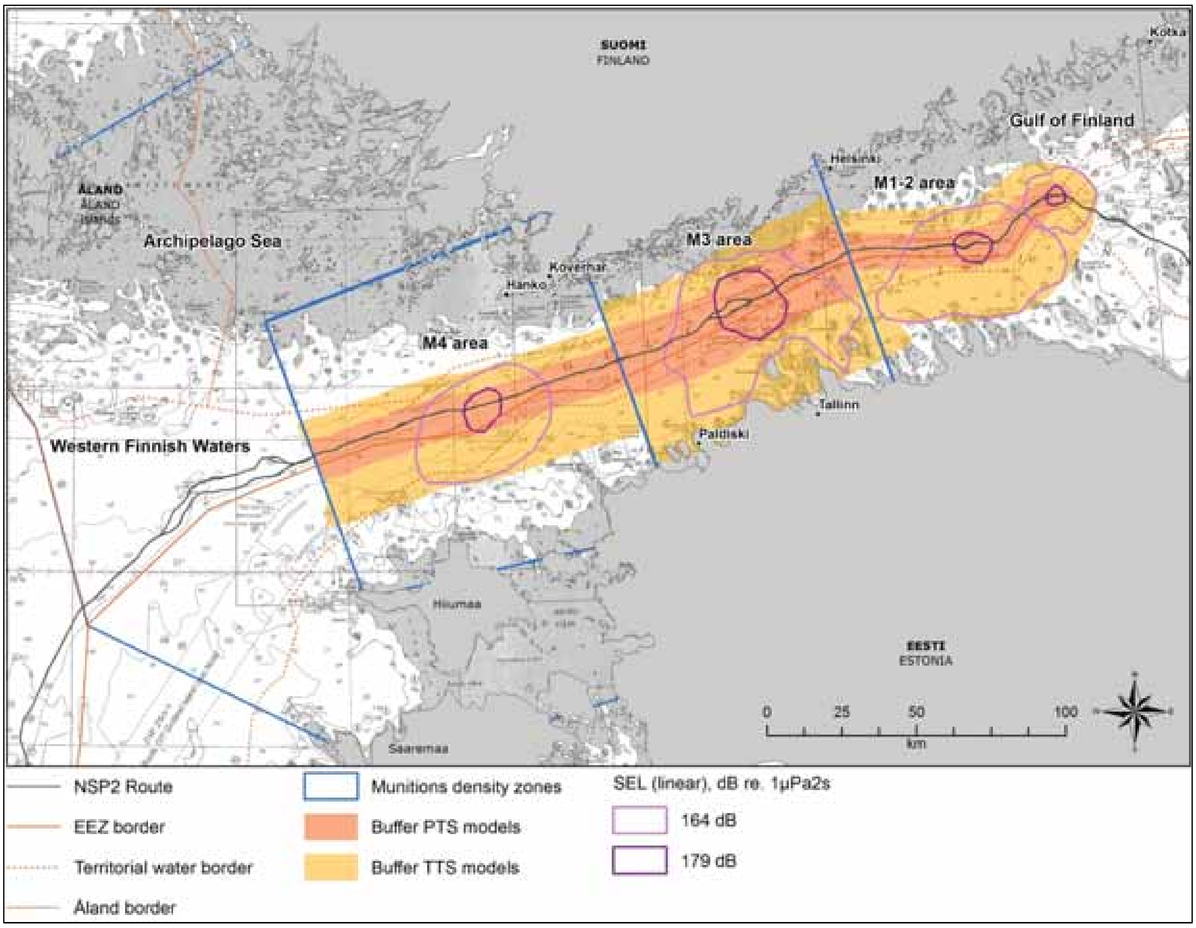

Figure 11-12. The buffer zones based on the maximum and mean extent of the TTS and PTS for detonations at the four Finnish positions M1 through M4 (from Appendix 6 and Table 8-1).

Sensitivity within each areas based on buffer zones along the NSP2 route is assessed in Appendix 8B and in this report we summarize the results described in the appendix. In this EIA, Sensitivity for each species is considered as the worst case sensitivity identified for the species among all areas in question. Sensitivity of the different species to different type of impacts is assessed in Subchapter 11.7.3.

Magnitude of change

The spatial extend of the magnitude of change varies from local extend where only the near waters in or in the near vicinity of the pipeline are affected to large scale impacts affecting several hundred square kilometres. The general method for assessing the magnitude of change are described in Subchapter 10.2.3 and criterias for the magnitude of change are summarized in Table 11-45.

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Table 11-45. The categories of magnitude of change.

Negligible	No detectable impacts on marine mammals.
Low	Impacts are of low intensity, the spatial extent is small and/or the duration is short (hours). Impacts are reversible and do not lead to any permanent change.
Medium	Moderate impacts on marine mammal species. Impact time is from days to weeks. Limited spatial extent. Some impacts may be irreversible.
High	Significant long-lasting (months) or permanent impacts on marine mammals (i.e. high intensity). Large geographical extent. Most impacts are irreversible.

11.7.2.3 Assessment levels

For the two seal species the impacts of munition clearance are assessed on two two levels:

1) Significance at the individual level: potential impact occurring to individual seals may not have repercussions at the population level but assessment is necessary because injuries to marine mammals may have other type of implications (e.g. ethical implications).
2) Significance at the population level in relation to seal distribution and abundance.

Cumulative impact from repeated exposures to detonations is assessed both at the level of individuals (of particular importance for TTS/PTS and behavioural reactions) and at population level. Cumulative impact at the population level arises because each additional detonation will add a risk that one or more animals are injured by the noise and thus even if a single detonation is assessed to have insignificant impact on the population, the cumulated risk will at some point become so large that the impact must be considered above insignificant. The method is illustrated more detailed in Appendix 8B.

11.7.3 Assessing sensitivity of marine mammals

11.7.3.1 Noise induced injuries and hearing losses

Underwater noise impacts on marine mammals comes with the form of injury, hearing threshold shift and disturbance, which are briefly summarized here and explained detailed in Appendix 8B. In terms of severity, there is a gradual transition from TTS over PTS (see below) to more detrimental damages such as tissue damages and in the worst case also lethal injuries (Figure 11-13).

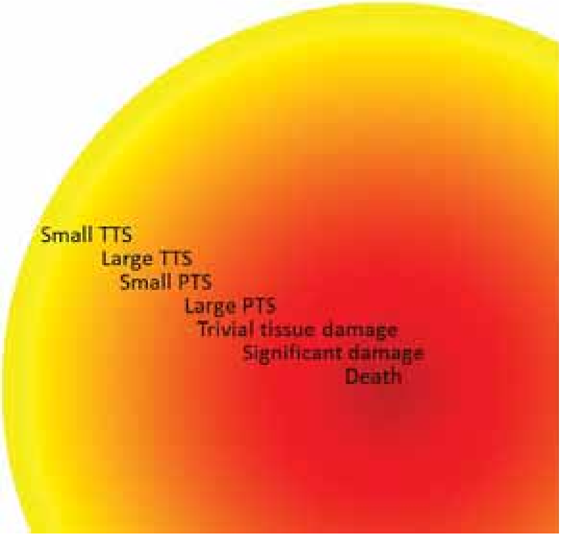

Figure 11-13. Schematic severity scale. The exact distribution of transitions away from the center depends critically on the type of sound involvedand is not to scale.

Blast injury caused by munitions clearance

The noise sources that are of most concern are those that generate short powerful pulses of noise such as blast (acoustic impulse). At a close range, the shock wave from an explosion can cause tissue damage. These damages can range from insignificant small bleedings (that would heal over time) through permanent damage (that does not naturally heal over time) to lethal injury. The severity of injury is related to acoustic impulse (overpressure and pulse duration, which is defined as the integral of pressure over time.

These kind of high peaks tend to cause damage to the structures that contain air (e.g. lungs) and are due to the rapid compression and subsequent overexpansion. The injury is also dependent to differential acceleration of tissues with different density.

Yelverton et al. (1973) determined blast injury thresholds for mammals through a series of experiments with live sheeps and dog submerged in a lake (Table 11-46). These thresholds can be transferred to small marine mammals as the lung volume appears to be the most significant scaling factor.

Table 11-46. Blast injury thresholds for mammals (Yelverton et al. 1973). Note that harbour porpoises, as all cetaceans, have no functional ear drum.

Acoustic impulse[1]	Description
280 Pa·s	No mortalities, but frequent incidence of moderately severe blast injuries, including ear drum rupture. Animals considered capable of recovering on their own.
140 Pa·s	High incidence of slight blast injuries, including ear drum rupture.
70 Pa·s	Low incidence of trivial blast injuries. No ear drum rupture.
35 Pa·s	Safe level

Figure 11-14 shows an example of estimation of a blast injury zone around a 300 kg mine detonated at 40 m depth, illustrating that the blast injury zone can extend many kilometres out from the blast site.

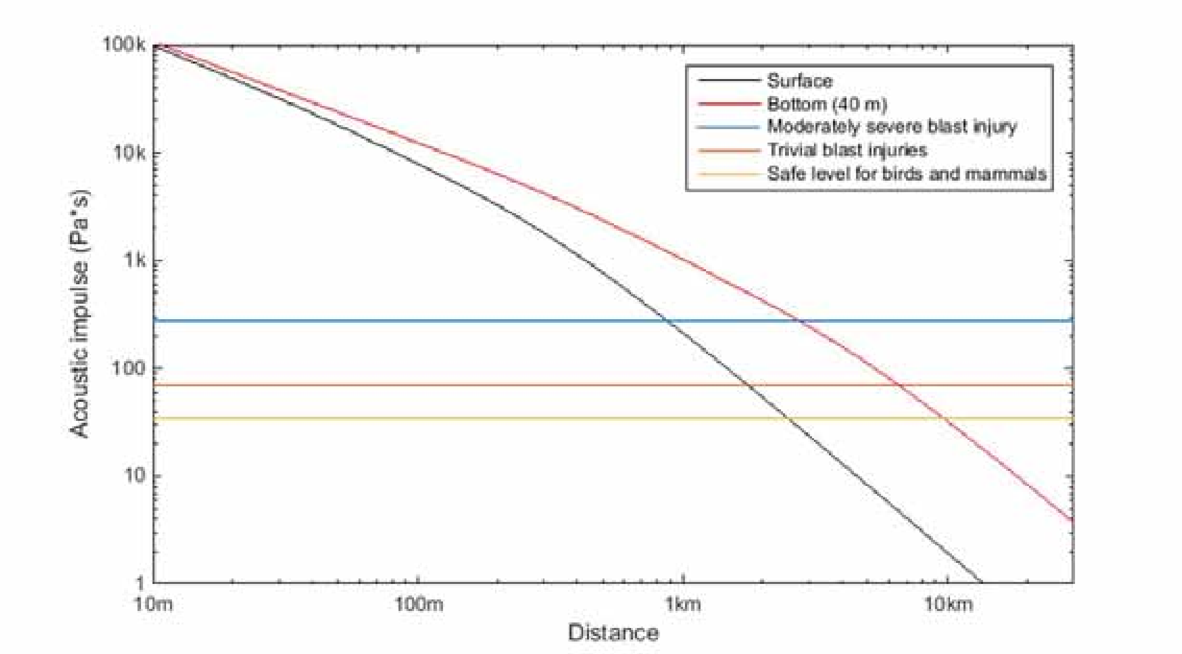

Figure 11-14. Example of estimated acoustic impulse with range for a 300 kg detonation (mine + donor charge) at the bottom at a depth of 40 m. Black line is for animals at the surface, red line close to the bottom. Three horizontal lines indicate the injury thresholds defined by Yelverton et al. (1973). A worst case scenario is assumed in which the total charge explodes together with the donor charge and that the explosion is with access to open water (directly on the seabed). Predictions and injury thresholds from Yelverton et al. (1973)

Based on calculations in Appendix 8B, the potential impact of the shock wave may extend several kilometres. The safe level, where no risk of blast injury is expected, is about 2.5 km for animals in the surface and ca. 10 km for animals at the bottom. Threshold distance for risk of "moderately severe blast injuries" is less than 1 km and about 2.5 km for animals in the surface and at the bottom (40 m depth), respectively. This category covers non-trivial, but survivable injuries, where animals are considered to be able to recover on their own. It is however possible that the injuries will decrease the fitness for a period of time or even cause reproduction failure (miscarriages) for a season. Consequently, the impact of moderately severe injuries may have an effect on very small threatened populations such as the Baltic harbour porpoise or the Gulf of Finland ringed seal population.

Without mitigation, tThe sensitivity of both seal species in the impact area to blast injury is assessed as *high* at the individual level because of the risk of fatal injuries and the high likelihood of seals being present in the area. At population level the sensitivity for blast injuries is identical to the sensitivity of PTS (Subchapter 11.7.5).

Sensitivity of harbour porpoises to blast injury is assessed as *low* for both individual and population level due to the very low density in the Gulf of Finland

Sensitivities are further discussed in the Appendix 8B.

<u>Hearing threshold shift (TTS/PTS)</u>

The auditory system of marine mammals is the most sensitive organ to acoustic injury. The risk of incurring into temporary or permanent hearing loss occurs at lower noise levels compared to levels needed for tissue damages (see e.g. *Southall et al. 2007*). Noise induced threshold shifts are temporary reductions in hearing sensitivity following exposure to loud noise (commonly experienced by humans as reduced hearing following e.g. rock concerts). Furthermore, noise induced threshold shifts are likewise accepted as precautionary proxies for more widespread injuries to the auditory system.

Temporary threshold shift (TTS) disappears with time, depending the severity of the impact. The amount of TTS immediately after end of the noise exposure is referred as initial TTS, which denotes for the amount by which the hearing threshold is elevated and is measured in dB. The larger the initial TTS, the longer the recovery period.

At higher levels of noise exposure the hearing threshold does not recover fully, but leaves a smaller or larger amount of permanent threshold shift (PTS). This is resulted by damage to the sensory cells in the innear ear *(Kujawa and Liberman 2009)*. An initial TTS of 50 dB or higher is generally considered to constitute increased risk of generating a PTS *(Ketten 2012)*. Further information for example of long-term effects of PTS, see Appendix 8B.

Lower levels of TTS can, if repeatedly induced, may also lead to PTS *(Kujawa and Liberman 2009)*, which is also well known in humans. This effect has, however, not been included in the assessment, as there is no experimental evidence from marine mammals that can help quantify this effect.

In order to assess the impacts, thresholds for TTS and PTS were established (Table 11-47). These thresholds are intended to be the thresholds above which there is the onset of a risk of causing either temporary (TTS) or permanent (PTS) hearing losses. There are no general thresholds and deriving these kind of thresholds is not a straightforward task. TTS and PTS thresholds were determined for seals and harbour porpoise using existing empirical data and literature. The methods are further explained in Appendix 8B.

Table 11-47. Estimated threshold levels for inducing temporary threshold shift (TTS) or permanent threshold shift (PTS) from single detonations and continuous noise from rock placement. See Appendix 8B for justification and references to experiments underlying these thresholds.

	Munitions Clearance		Rock placement	
	TTS	**PTS**	**TTS**	**PTS**
Harbour porpoise	164 dB SEL	179 dB SEL	188 dB SEL	203 dB SEL
Seals	164 dB SEL	179 dB SEL	188 dB SEL	200 dB SEL

The sensitivity of both seals species to PTS is assessed to be *high* at individual level because of the potential detrimental effect and the possibility that an individual will be present near detonation site.

At population level, sensitivity of grey seals is assessed to be *low*, because the population abundance is increasing and population has good environmental status.

On the basis of the present knowledge on ringed seals distribution in the Baltic Sea, there are two separate ringed seal populations occurring along the Finnish section of the NSP2 pipeline: the Gulf of Finland population and the Gulf of Riga population (Subchapter 7.11.3). The small and isolated Gulf of Finland sub-population is sensitive to any kind of disturbances that may decrease the population size. Therefore for this population, at population level, the sensitivity to PTS would be *high*. In contrast, on the basis of abundance and distribution, the Gulf of Riga sub-population is presently in good status and is not so vulnerable to disturbances (mainly area M4). Thus the sensitivity to PTS at population level would be *low*.

The sensitivity of harbour porpoises to PTS is assessed to be *low* both at individual level and population level due to very low densities of these animals in the impact area.

The sensitivity of both seal species and harbour porpoises to risk of TTS is assessed to be *low* on both individual and population level due to the reversible and temporary nature of the impact.

<u>Noise induced disturbance of behaviour</u>

Noise levels higher than ambient levels may alter the behaviour of animals. Behavioural changes may occur already at noise levels below the TTS. If a sufficiently high proportion of the population is affected for a sufficiently long period, there could be implications for long-term survival and reproductive success of animals due to behavioural changes *(NRC 2003)*. These may include panic or fleeing or separation of calves from mothers. More common responses are probably the less severe effects where animals may be displaced or their foraging or mating behaviour may be altered due to noise. Seals are generally considered less sensitive to displacement by noise, but this conclusion is largely without experimental evidence (for further information see Appendix 8B. Example of noise source that may result in disturbance and behavioural changes such as avoidance in relation to the NSP2 pipeline, is increased vessel traffic.

The sensitivity to noise induced behavioural changes or disturbances are assessed to be *medium* for seals and *low* for harbour porpoises due to the low density in the impact area.

Based on calculations in Appendix 8B, the noise induced disturbance of behaviour is considered covered by the TTS-zone (*see hearing threshold shift for TTS/PTS*) and is thus assessed together with TTS.

<u>Masking</u>

Sounds with longer duration, such as from rock placement or ship noise, may cause masking. Masking noise is strong enough to interfere with the detection of other sounds, such as communication signals or echolocation clicks. The zone for audibility can be used as a very precautionary indicator to the possible extent of the masking impact. The zone of audibility is defined as the area within which the animal is able to detect the sound. Noises that mask important sounds, such as calls, may have an indirect impact on marine mammals by postponing reactions to calls. Although there are many indications that marine mammals might have the ability to change their natural sound in order to counteract the masking effect, confirming studies are scarce. For further information see Appendix 8B.

The sensitivity to noise induced masking is assessed to be *medium* for seals and *low* for harbour porpoises due to the low density in the study area.

Based on calculations in Appendix 8B, the masking is considered covered by the TTS-zone (*see hearing threshold shift for TTS/PTS*) and is thus assessed together with TTS.

11.7.3.2 Sediment dispersion

Possible impairment of marine mammals might occur due to changes in the physical and chemical environment during construction and/or operation of the pipelines. Disturbance due to sediment spreading may take place especially during construction.

<u>Visual disturbance</u>

The potential of increased turbidity to cause visual disturbance is assessed to be low based on existing studies, which are summarized in Appendix 8B. For example harbour porpoise use echolocation for orientation and can hunt in complete darkness. Also seals are able to forage in conditions of poor light although their visual acuity decreases with increasing turbidity.

For these reasons marine mammals are not considered sensitive to turbidity and thus the sensitivity of seals and harbour porpoise is assessed as *low*.

<u>Behavioural impacts</u>

Behavioural impacts caused by increased turbidity are difficult to evaluate. Potential behavioural impacts ranges from strong reactions, such as panic or fleeing to more moderate reactions where animal may for example move slowly away. Also other aspects, such as season, sex and age may correspond to behavioural changes. The impact at a population scale is probably dependent on the duration and extent of the impact and marine mammals that are found in Finnish waters may be relatively unaffected by short-term avoidance behaviour.

The sensitivity of seals to changes in behaviour is assessed to be *medium*. For harbour porpoises it is *low* due to the low density.

Health effects caused by contaminants
Marine mammals are generally sensitive to hazardous substances. Many of the substances that are of anthropogenic origin are highly persistent, bioaccumulative and toxic. Marine mammals make up the highest trophic levels and have large lipid storages, and therefore persistent organic pollutants and heavy metals are biomagnified in their tissues. High contaminant levels have been linked to immune system depression, diseases, reproductive alterations, developmental effects and endocrine disruption. See Vos et al. (2003) for a review of the toxins. The magnitude of change is dependent on the levels and types of contaminants and the length of exposure. However, linking remobilization of contaminants from sediment spill will be impossible as marine mammals are mobile and exposed to contaminants throughout their entire life.

The sensitivity of seals to contaminants in general (without including information on duration, type and level of contaminant exposure) is assessed to be *high*. For harbour porpoises it is *low* due to the low density of porpoises in the study area.

11.7.3.3 Seasonal sensitivity

The most vulnerable periods for seals in the Baltic Sea are primarily during their moulting, breeding and lactation periods (ca. from January to May/June). Harbour porpoises are also vulnerable in the breeding period, but the calves are dependent on their mother for at least 10 months and may be vulnerable throughout the first year and especially in the first period after leaving their mother.

The actual sensitivity for a given activity is found as the combination of the sensitivity to the activity itself and the sensitivity related to the period.

11.7.4 Assessing magnitude of change

Determining the magnitude of each potential impact is important in order to assess the overall significance of the impact on marine mammals.

Considering munitions clearance, the magnitude of change is presented both without mitigation measures and with mitigation measures in place.

11.7.4.1 Noise induced injuries and hearing loss

In the assessment, blast injuries and PTS are assessed separately and disturbance (avoidance, masking) together with TTS.

Effect of seal scarer
With respect to effect on marine mammals, the use of seal scarers is likely to have the largest mitigation effect and will thus reduce the risk of fatal injuries (i.e. the risk that marine mammals occur in the impact area during detonation – effects on sensitivity – and therefore that they are subjected to injuries – effects on magnitude). This mitigation measure is effective especially regarding the most severe impacts, such as blast injuries. As have been mentioned earlier (Subchapter 11.7.2.2), sensitivity and magnitude of change are closely related regarding animal densities in the impact area. For the purpose of this assessment, the effect of mitigation measures are introduced in magnitude of change (Appendix 8B).

Porpoises are known to react strongly to seal scarers by evasion (e.g. *Johnston 2002, Olesiuk et al. 2002, Brandt et al. 2012*). Deterrence ranges differ between studies, but appears to be at least 350 m for total deterrence and somewhere between 1 and 2 km for almost complete deterrence (see review by *Hermannsen et al. 2015*). Effects up to 8 km has been observed in a single study *(Brandt et al. 2012)*. The most effective seal scarer appears to be the Lofitech, which is same model as used for NSP.

In contrast, seals react differently to seal scarers compared to porpoises *(Götz and Janic 2014)*. The response has been found to be strongly context dependent. The primary use of seal scarers is to deter seals from aquaculture facilities and fishing gear. Seal scarers have been reported to have very variable ability for deterrence in these situations, ranging from some deterrence to active attraction (so-called "dinner-bell" effect) (*Königson et al. 2007 and Mikkelsen et al. 2015* for reviews). When these devices are used as mitigation for loud underwater noise, the context is different and the seals are not rewarded for ignoring the loud sound by a food source (the fishing gear or net pen). There is thus several studies supporting that seals are deterred at the vicinity of the seal scarers when used without food reinforcement. The Lofitech device is considered effective in deterring harbour and grey seals out to a distance of at least some hundred meters *(Mikkelsen et al. 2015)*. At further distances, out to around 1 km, the seals may not be deterred, but will change their behaviour and spend more time in the surface *(Gordon et al. 2015)*, which will also function as a mitigation measures since seals that are outside of the water will not be impacted by PTS/TTS.

Blast injuries

Based on calculations in Appendix 8B, the impact of the shock wave for a 300 kg detonation (Subchapter 11.7.3.2) may extend several kilometres. The safe level, where no blast injury is expected, is about 2.5 km for animals in the surface and ca. 10 km for animals at the bottom. Threshold distance for "moderately severe blast injuries" is less than 1 km and about 2.5 km for animals in the surface and at the bottom (40 m depth), respectively. This category covers non-trivial, but survivable injuries, where animals are considered to be able to recover on their own.

The magnitude of change of risk of blast injury without mitigation is assessed as *high* for all marine mammal species for both the individual and the population level, due to the large geographical extent, the irreversible and cumulative nature and high intensity of the impact.

The seal scarers will provide considerable protection for the seals for up to 1300 m from the detonation. The use of seal scarers reduce the magnitude of change to individual grey and ringed seals to *medium*, as the likelihood of killing or permanently disabling seals due to blast injuries is considered to be small. The magnitude of change at population level will be reduced to *low/medium* depending on the species and location (Appendix 8B).

Seal scarers are very effective in deterring porpoises out to distances of at least 1-2 km and since the density of porpoises in the Gulf of Finland is already very low, the magnitude of change will be reduced to *low* (Appendix 8B).

TTS and PTS due to munition clearances

The extent of the TTS and PTS zones are similar across the species, because of the identical PTS and TTS thresholds established (Table 11-48) for detonations. There are only minor differences between summer and winter, which are not separated in the assessment.

Estimated maximum impact ranges and mean expected impact ranges are given in Table 11-48. It is evident that the extent of the TTS and PTS impact zones are considerable for both seals and porpoises and extend into both Estonian and Russian waters. The extent of the impact (when assessed by the buffer zones in Subchapter 11.7.2.2. (Figure 11-11) covers large parts of the Gulf of Finland and at several locations it is transboundary.

Table 11-48. Maximum and mean extent of the TTS and PTS zones for explosions at the four Finnish positions M1 through M4 (Ramboll 2016d). Indicated are both maximum and mean values (based on maximum and mean sound pressure, respectively, encountered during construction of Nord Stream).

Animal group	Effect	Threshold distances (km)							
		M1 (max)	M1 (mean)	M2 (max)	M2 (mean)	M3 (max)	M3 (mean)	M4 (max)	M4 (mean)
Seals	PTS	3.5	3.5	8	3.5	15	3.5	9	3.5
	TTS	15	15	38	26	44	19	32	22
Porpoises	PTS	3.5	3.5	8	3.5	15	3.5	9	3.5
	TTS	15	15	38	26	44	19	32	22

Effects are either *temporary and reversible* (TTS) or *permanent and irreversible* (PTS, by definition). Permanent and irreversible applies only to the individual animal affected by PTS and the effect will thus disappear from the population whenever the affected animals eventually die. For the population the effect is thus *long-term*, but *reversible*.

For the TTS/avoidance zone (164 dB) it is assessed that without mitigation the magnitude of change is *low* both at the individual and population level for all species due to the short duration of the impacts and the low intensity of the impacts. The risk of inflicting TTS on marine mammals is largely unaffected by the use of seal scarers as mitigation measure, since seals scarers are not effective at considerable distance from the detonation site (Appendix 8B).

For the PTS zone (179 dB), it is assessed that the magnitude of change without mitigation is varying between *low* (porpoises) and *medium* (seals) both at the individual and population level, due to the irreversible (or long-term) and cumulative nature and high intensity of the impact. Deterrence of marine mammals prior to detonations will also have substantial effects on the number of animals likely to suffer PTS but only in a relative small area compared to maximum extent of the PTS zones. Consequently, the suggested mitigation measure is considered not to reduce the assessed magnitude of change. It should be however noted that these measures will significantly reduce the number of animals, which would acquire severe PTS (Appendix 8B).

Both PTS and TTS due to munition clearance cover large areas (for PTS more than 10 km from the detonation) with potential for transboundary impacts (i.e. not confined to Finnish waters).

<u>TTS and PTS: Rock placement</u>
Modelled noise levels from rock placement were low. Estimated extent of TTS and PTS zones under a very conservative assumption that animals would remain stationary at the same distance from the rock placement for 2 hours, are given in Table 11-49. Modelled noise levels were not sufficiently high to induce PTS, even if the receiving animal is right next to the rock placement, whereas TTS could hypothetically be induced if a seal or a porpoises lingered within a distance of 80 m from the rock placement ship for a period of 2 hours or more.

Table 11-49. Maximum extent of the TTS and PTS zones for rock placement at the Finnish positions (RP1 and RP2) where modelling was performed (Ramboll 2016d).

Animal group	Effect	RP1	RP2
		Threshold distances, max	Threshold distances, max
Seals	PTS	0 m	0 m
	TTS	80 m	80 m
Porpoises	PTS	0 m	0 m
	TTS	80 m	80 m

Impacts from rock placement and other vessel-based activity are very small. Effects are temporary and reversible, as PTS is considered unlikely to occur. The magnitude of change is assessed to be *low* for all marine mammal species.

11.7.4.2 Sediment dispersion

The extent of sediment dispersion and consequent turbidity blooms are assessed in Subchapter 11.3. Based on assessment, turbidity is short lived and local. Highest turbidities are concentrated the water layers near the seabed.

The duration of the impact was assessed as temporary and reversible, and the magnitude of change as *negligible* for all marine mammal species.

11.7.5 Impacts during construction

11.7.5.1 Underwater noise due to munitions clearance

The following assessment is carried out considering the effect of munition clearances with mitigation measures (monitoring, seal scarers, Subchapter 4.1.4).

The significance of noise induced impacts were assessed at individual and population level for each species (for definition of the assessment levels, see Subchapter 11.7.2.4).

The assessment is focused on blast injury, PTS and TTS/avoidance zones caused by maximum detonations. The contour curves in Figures 11-15, 11-16, 11-7 and 11-18 represent the worst case situation, as they indicate that maximal extent of a zone where sound exposure level anywhere in the water column exceeds the relevant threshold (TTS or PTS). The available information on population sizes and spatial distribution are not sufficient to quantify the impact in terms of number of affected individual, and therefore it is not possible to quantitatively assess the difference between a medium or a maximum detonation. It should however be noted that in terms of severity, there is a gradual and not discrete transition from TTS to PTS to blast injury: the risk of causing hearing losses increases with the increase of sound exposure levels. The conclusions are based on the expert assessment of the likelihood of an animal being inside the impact area.

Animals closer to the bottom are more severely affected than animals closer to the surface and thus the extent of the impact zone differs with depth of the animals (Subchapters 11.7.3 and 11.7.4. The actual impact of an explosion will depend critically on the number of animals present within the impact area at the time of detonation. The density of seals and porpoises varies with geographical position and time of year. It can be assessed, that safety zone from munition clearance is at least several kilometres.

Cumulative impact from repeated exposures to detonations is assessed both at the level of individuals (of particular importance for TTS/PTS and behavioural reactions) and at population level. Cumulative impact at the population level arises as each additional detonation will increase a risk that one or more animals are injured by the noise. Therefore even if a single detonation may be assessed to have a small impact on the population, the cumulated risk will at some point become so large that the impact will have to be considered above insignificant. Quantifying this relationship is extremely difficult, as it must rely on very accurate knowledge of the risks involved and the behaviour of the animals.

The extent of noise propagation from detonations at the four locations M1 through M4 is presented in Subchapter 10.4 and in Appendix 7. Here the extent of noise impacts are illustrated by plotting PTS and TTS zones (based on noise modelling) against indicative distribution of each species. The extent of area where blast injuries are possible is assumed to fall within PTS zone, with the maximum threshold distance for moderately severe blast injuries being ca. 2.5 km for animals occurring within the area.

Harbour porpoise

Harbour porpoises are occasional visitors in Finnish waters. The waters adjacent to the NSP2 pipeline in Finnish waters holds a very low density of harbour porpoises. During the SAMBAH project no acoustic detections were made in Finnish waters during summer (Figure 11-15) *(SAMBAH 2016)*. During winter, however, detections were made approx. 40 km west of the M4 area (Figure 11-16). Based on confirmed visual sightings, low densities can be found from the Gulf of Finland all year round (Finnish Ministry of Environment). This means that porpoises could potentially be present in impact area during munition clearance, although in very low numbers.

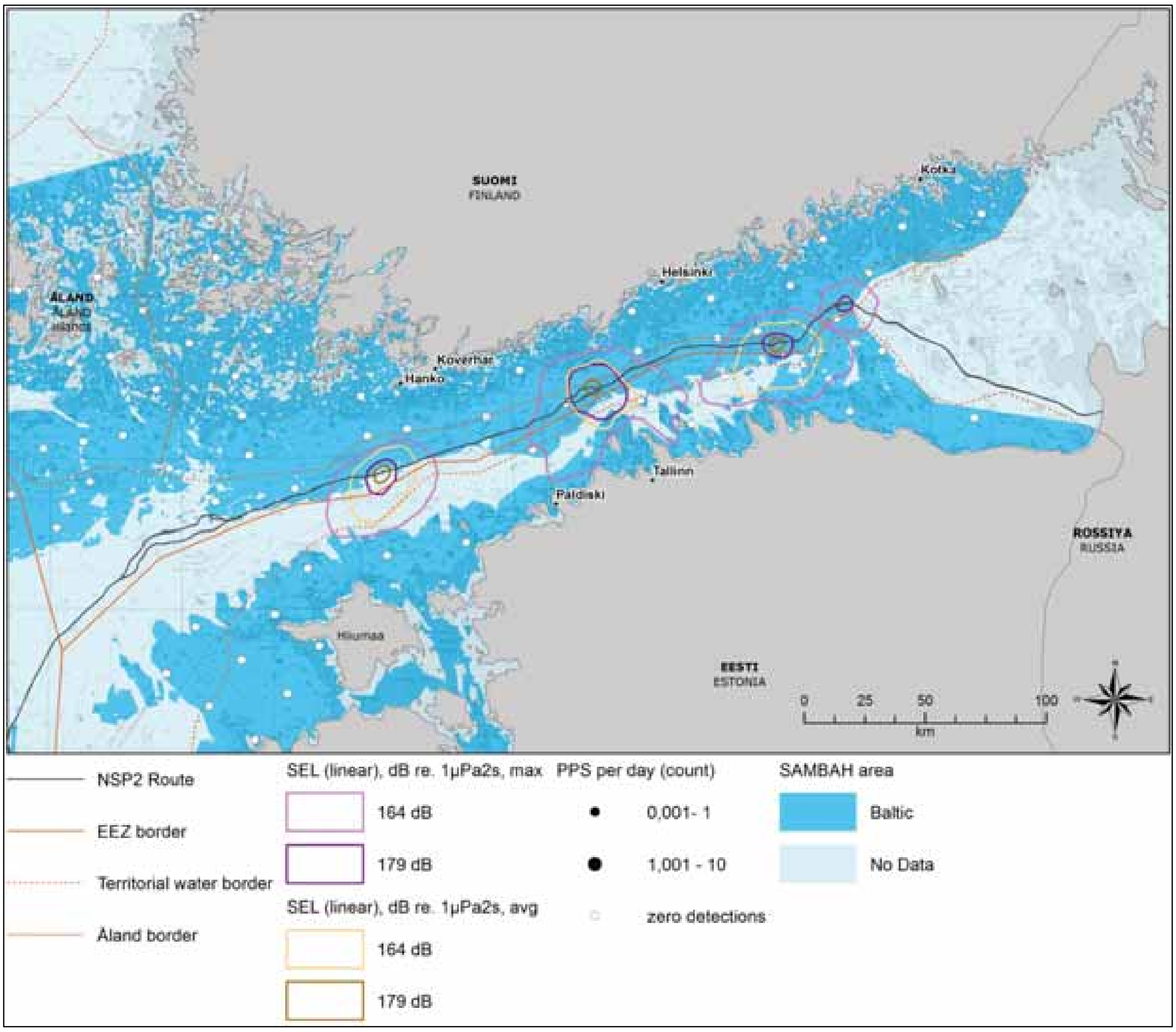

Figure 11-15. Harbour porpoise detections (Porpoise positive seconds per day) during summer (May–Oct) as detected during the SAMBAH project 2011-2013 and the modelled extent of munitions clearance during winter.

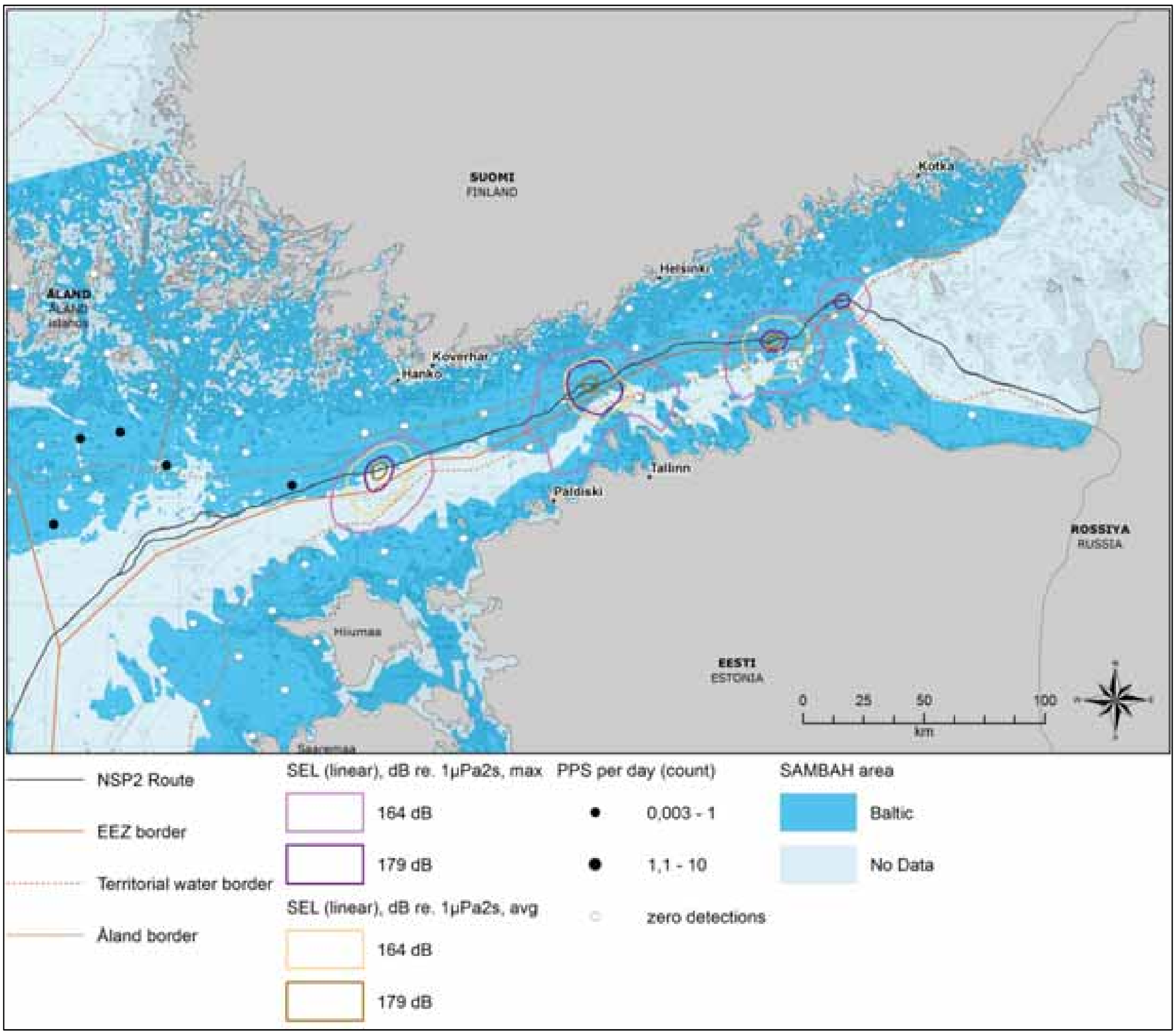

Figure 11-16. Harbour porpoise detections (Porpoise positive seconds per day) during winter (Nov - Apr) as detected during the SAMBAH project 2011–2013 and the modelled extent of munitions clearance during winter.

Blast injury and PTS, individual level and population level

Due to the very low densities of harbour porpoises in the Finnish waters, it has been assessed that harbour porpoises are not very sensitive to blast injuries or PTS.

of large detonation (such as 300 kg TNT-equivalent at a depth of 40 m) the impact of the shock wave extends out to several kilometres (Figure 11-14). However, the use use of seal scarers before detonations, as have been described before, will reduce the risk of fatal injuries to porpoises, and reduce, but not eliminate the risk that the porpoises present within some kilometres from the detonation point could suffer non-lethal blast injuries. The reason for this is that seal scarers are very effective in deterring porpoises out to distances of at least 1-2 km and since the density of porpoises in these areas are very low, it is unlikely that any porpoises will be within this range at time of the explosion. For this large explosion the *"safe level"*, where no blast injury is expected is about 2.5 km for animals in the surface and about 10 km for animals at the bottom. At the same time threshold distances for *"moderately severe blast injuries"* (terminology from Yelverton et al. 1973) is less than 1 km for animals in the surface and about 2.5 km for animals at the bottom (40 m). The category *"moderately severe blast injuries"* covers non-trivial, but survivable injuries, where animals are considered able to recover on their own.

Combining the above information about likely deterrence of porpoises and extend of injuries, it is concluded that use of seals scares before detonations, as described above, will reduce the risk of fatal injuries to porpoises to negligible levels, and reduce, but not eliminate the risk that a porpoise present within some kilometres from the blast site could suffer non-lethal blast injuries. The magnitude of change of blast injuries is thus considered to be *low* at all modelled areas, both at individual and population level and with *low* sensitivity the overall significance is assessed as *minor* at all areas.

Similarly, because the threshold distances for PTS as shown in Table 11-48 are considerably larger than the deterrence ranges expected for porpoises, the risk that one or more individuals acquire PTS cannot be eliminated completely by using seal scarers. However, as the likelihood that porpoises will be present within the 1–2 km from the detonation is extremely low, the likelihood that any porpoises will acquire severe PTS is similarly low. Consequently, with *low* sensitivity and *medium* magnitude of impact, the impact significance of PTS is assessed as *minor* both at individual and population level at all areas.

Cumulative impact on porpoises from several detonations may occur if the same individual happens to be exposed several times from different detonations. Cumulative impacts are assessed to potentially occur only in proximity of M3 (Figure 11-12), since a large number of munitions are likely to be encountered in the area (42 detonations during Nord Stream construction). As the sensitivity is assessed to be *low* and the significance of a single detonation is set to be *minor*, the cumulative risk of impact with increasing number of detonations will also increase and at some level warrant an increase of the impact. Without detailed knowledge about the movement of the porpoises and thus the likelihood that they are present in M3-area it is not possible to quantify this critical number of detonations. Estimation of such a number is further complicated by the fact that the sound exposure from each detonation isn’t known beforehand (as charges likely detonate only partially). Since it is assessed that the number of potential munition clearances in the M3-area is critically high, the overall significance in the M3-area may at some point increase due to the increased cumulative risk.

TTS and disturbance:
The sensitivity of harbour porpoises to TTS and avoidance is assessed to be *low* for both individual and population level, the magnitude of impact is *low* and therefore the overall significance *minor*, as the impacts will be temporary and most likely only affect a small proportion of the population (if any). Because temporary threshold shift can extent at considerable distance from the detonation, i.e. well beyond of the seal scarers. The risk of inflicting TTS on harbour porpoises is largely unaffected by the use of seal scarers and thus mitigation will not change the overall impact significance.

Grey seal

Grey seals can be found everywhere in the Gulf of Finland and western Finnish waters. With the available data it is not possible to estimate the number of individuals in a risk to become affected along the NSP2 pipeline. However, based on the distribution of grey seal haul-outs and the available telemetry data, it is likely that grey seals will be present in all Finnish waters relevant to the construction of NSP2 including the area where blast injuries are possible and PTS zones.

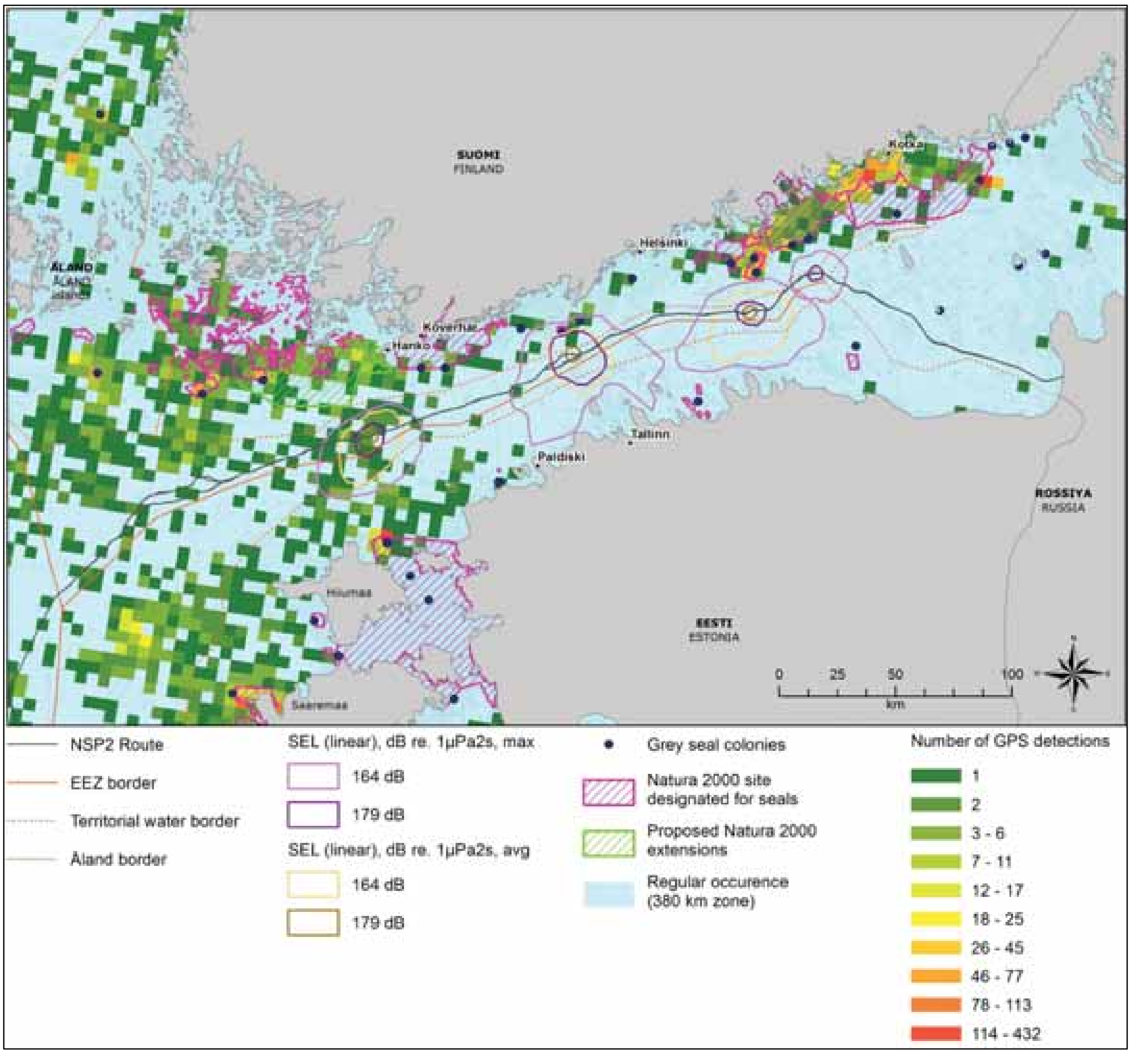

Figure 11-17. Grey seal telemetry data (38 tracked individuals, HELCOM data), locations of colonies, N2000 for grey seals and the modelled extent of munitions clearance during summer and winter. Only Finnish and Estonian Natura 2000 areas within 100 km of the NSP2 route are displayed.

Blast injury, individual level and population level:

The same threshold distances, described for porpoises, apply equally well for grey seals. The deterrence ranges are however smaller compared to that for porpoises and thus the effect of seal scarers differ somewhat from porpoises. These devices are effective for seals approximately at a distance up to 1 300 m from the detonation and seals are reacting to these devices by spending more time in the surface, which provide considerable protection for the grey seals from the explosion. Threshold distance for moderately severe injuries for the 300 kg explosion is about 1 km for animals in the surface and 2.5 km at the bottom (sensu Yelverton et al. 1973), which means that the likelihood that seals are killed or permanently disabled by the explosion is reduced substantially especially at the surface and is considered to be small. With mitigation measures in place, the magnitude of impact at individual level is thus assessed as *medium* and with *high* sensitivity the overall significance of blast injuries to grey seals in all areas is thus *moderate*.

From a population level point of view, it should be noted that the Baltic population of grey seals is abundant and has been increasing over the last decades. Therefore, the sensitivity to blast injuries is considered *low* at the population level and the overall significance is thus assessed to be *minor* in all areas.

PTS, individual level and population level:

Seals are assessed to be very sensitive to PTS and the risk to incur in permanent hearing losses is considered high if seals are in the proximity of detonations. However, the use of seal scarers will reduce this risk. Since seals in the proximity of the detonation (some hundred meters) will be displaced, the risk that seals are exposed to the levels capable of inducing severe hearing loss is effectively reduced and at further distance (ca. 1 km), the seals may not be deterred but, will spend more time in the surface (seals that are in the surface or have their head out of the water at the time of the detonation are effectively protected from hearing loss). Grey seals more than 1-2 km distance from the detonation will likely not be affected by the seal scarer and are thus at risk of suffering hearing loss to the same degree as in unmitigated detonation. As a whole, however, the use of seal scarers will reduce the total number of seals with hearing loss and reduce the average amount of hearing loss. Therefore, the maximum overall impact significance is assessed as *moderate* at individual level and *minor* at population level in all areas.

Cumulative impact from several detonations can occur if the same individual happens to be exposed several times from different detonations. This is likely to occur for some grey seals, as they are numerous, especially in the M3 area, where the largest number of detonations is likely to take place (42 detonations during construction of Nord Stream). Therefore, it is assumed, that the overall significance of the impacts at the individual level for seals occurring in the proximity of the M3-area may at some point increase due to the increased cumulative risk. However, cumulative impact at the population level in area M3, are not likely to change the assessment, since the grey seal population is considered to be in a favourable status.

TTS and disturbance:

The sensitivity to TTS is considered *low*, the magnitude of change is *low* and overall significance *minor*, on both individual as well as population levels as the impacts will be temporary and most likely only affect a small proportion of the population. Because temporary threshold shift can extent at considerable distance from the detonation, i.e. well beyond of the seal scarers. The risk of inflicting TTS on grey seals is largely unaffected by the use of seal scarers and thus mitigation will not change the overall impact significance.

The sensitivity to avoidance and masking is assessed as *low* and the magnitude of change is *low*. The overall significance is assessed to be *minor* due to the temporary nature of the impact.

Ringed seals

On basis of the present knowledge on ringed seals distribution in the Baltic Sea, there are two separate ringed seal populations occurring along the Finnish section of the NSP2 pipeline: the Gulf of Finland population and the Gulf of Riga population (Figure below and Subchapter 7.11.3). Although ringed seals can be potentially found everywhere in Finnish waters, the densities are generally higher near the haul-outs and at foraging sites (Figure 11-18). These foraging sites may alter seasonally and annually and with the current knowledge, it cannot be assessed whether or not significant foraging sites exist in areas relevant to the NSP2 pipeline.

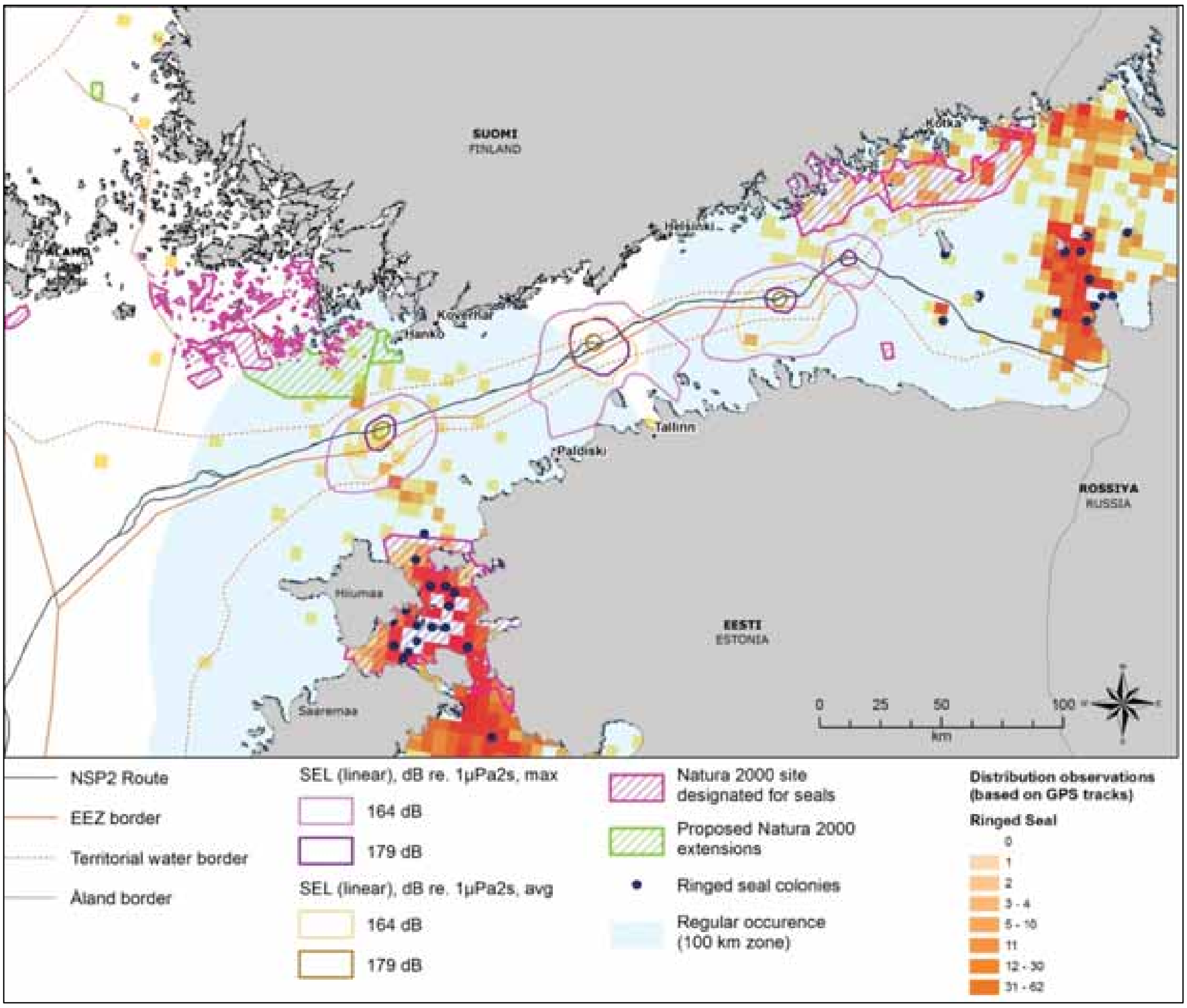

Figure 11-18. Ringed seal observations based on GPS tracks, source: HELCOM, Balsam-project, data accessed 27.1.2017 (http://www.helcom.fi/baltic-sea-trends/data-maps/biodiversity/seals/) (EELIS Estonian Nature Information System, Metsähallitus). Locations of colonies, N2000 for ringed seals and the modelled extent of impact areas due to munitions clearance during summer and winter are also presented. Only Finnish and Estonian Natura 2000 areas within 100 km of the NSP2 reference route are displayed.

<u>Blast injury, individual level and population level:</u>
The same threshold distances described for porpoises and grey seals apply equally well for ringed seals. Similarly, the same deterrence ranges described for grey seals are valid for ringed seals. Therefore, the effectiveness of seals scarers is comparable to what have been presented for grey seal.

Similarly to grey seals, the magnitude of change at individual level is assessed as *medium* and with *high* sensitivity the overall significance of blast injuries to ringed seals at all areas is assessed as *moderate*.

At population level, the three breeding areas of the two populations of ringed seals (Gulf of Finland, Archipelago Sea and Gulf of Riga) are precautionary considered to be reproductively isolated. The impacts are assessed on the basis of the population status and abundances of animals in the two populations.

Gulf of Finland subpopulation: Munitions clearance at the M1-2 area will likely affect ringed seals from the inner Gulf of Finland. The M3 area is relatively distant to any ringed seal haul outs (= colonies/breeding sites) and locations from telemetry data. Nevertheless, low numbers of transient individuals from all the breeding areas, including the threatened Gulf of Finland seals may potentially be present within the area where blast injures are possible at the time of munition clearance. It is unlikely that Gulf of Finland ringed seals would be found in M4.

As the abundance of Gulf of Finland ringed seal subpopulation is very low (probably between 100–300 individuals), every individual is demographically important for this population. Although there is no telemetry data from animals tagged at the most proximate haul-outs, it is unlikely that more than a few individuals will be present within the area where blast injuries are possible at the time of each munition clearance. However, if these e.g. are 2–3 mature females, the impact on the population may be high. Therefore, the ringed seals in the Gulf of Finland are considered very sensitive to blast injuries. However, with the use of mitigation measures, the same considerations presented for grey seals, are valid for ringed seals. Hence, with mitigation measures in place the overall significance in M1-2 and M3 areas are assessed as *moderate* for the ringed seals in the Gulf of Finland.

Cumulative impact from several detonations can have an impact on the ringed seals population of the Gulf of Finland if many munitions clearances were to take place in the M1-M2 area. However, only six detonations were performed during construction of Nord Stream in that area. The potential cumulative impact for area M3 is larger, as a number of munitions are likely to be encountered (42 detonations during Nord Stream construction), but this is also the area with fewest ringed seals. Without detailed knowledge about the movement of the seals and thus the likelihood that ringed seals from the Gulf of Finland population are present in area M3, it is not possible to quantify this critical number of detonations. Therefore, the overall impact to the ringed seals in the Gulf of Finland may at some point increase due to the increased cumulative risk. However, the number of expected munitions in the eastern Gulf of Finland is at the moment low.

Gulf of Riga subpopulation: Munitions clearance at M4 or adjacent areas will potentially affect the Gulf of Riga subpopulation of ringed seals that breed in the Archipelago Sea and in the Gulf of Riga. As described above, transient animals may be also found in the M3 area while it is unlikely that any ringed seals belonging to the gulf of Riga subpopulation would be found in the M1-2 areas. Since the Gulf of Riga subpopulation is in a healthy state, it is unlikely that a demographically significant number of individuals will be present within the area where blast injuries are possible at the time of munition clearance (but note that there is no telemetry data from animals tagged at the most proximate haul-outs for any of the three breeding areas). This is true also if we consider potential cumulative impacts due to multiple munition clearances. In M4 area the expected number of detonations is low (seven detonations during construction of Nord Stream) and in M3, although the number of munitions is significantly higher, not many ringed seals are present.

Therefore, The Gulf of Riga ringed seal population has been assessed to not be very sensitive to blast injuries and the impact significance on Gulf of Riga population is assessed as *minor* with mitigation.

<u>PTS individual and population level</u>:
The same PTS zones that have been presented for grey seals are applicable for ringed seal and mitigation measures will have the same effect on the two subpopulation of ringed seals than those presented for grey seals.

The use of mitigation measures will reduce the risk that seals close to the detonation are exposed to the levels capable of inducing severe hearing loss, although it will not be eliminated entirely. As a whole, however, the use of seal scarers will reduce the total number of seals with hearing loss. Hence, similarly as described for blast injuries, with mitigation measures in place, the overall significance is assessed as *moderate* for the ringed seals in all areas at individual level and as *moderate* for the Gulf of Finland ringed seal population and *minor* for the Gulf of Riga ringed seal population.

<u>TTS and disturbance:</u>
The sensitivity of ringed seals to TTS as well as magnitude of change of TTS is assessed to be *low* and the overall significance is thus *minor* at individual as well as population level since the impacts will be temporary and only affect few individuals. As it is a case with grey seals and porpoises, the risk of inflicting TTS on ringed seals is largely unaffected by the use of seal scarers and thus mitigation will not change the overall impact significance.

The sensitivity of ringed seals to avoidance and masking is assessed as *low* and the magnitude of change is *medium*. The overall significance is assessed to be *minor* due to the temporary nature of the impact.

11.7.5.2 TTS/PTS from rock placement

Even with precautionary assumptions regarding impact of noise from rock placement, the impact is strictly local, temporary and of low intensity (PTS unlikely). The magnitude of change is thus *low*. The sensitvity for seals is *medium*, while it is *low* for porpoises (due to their unlikely occurrence in the project area). The significance of the impact is assessed as *minor* for all species.

11.7.5.3 Behavioural reactions to noise

Noise from the rock placement was used as a proxy for construction related noise from vessels in general, as the rock placement is considered one of the noisiest activities arising from the project (except for munitions clearance).

Behavioural reactions to underwater noise from rock placement and other vessel related activities around the pipeline are expected to occur only in the vicinity of the vessels and remain only for the time when the vessels are present. The duration is thus temporary and impacts are spatially local. Disturbance from activities during construction, pre-commissioning and commissioning is considered of minor importance. Disturbances are likely to be of similar magnitude as disturbance from passing merchant vessels, which are very abundant along the pipeline route (Figure 7-29 and Figure 7-31 in Subchapter 7.7.3). The intensity and magnitude of change from vessel noise and rock placement is therefore rated *low* and the overall significance *minor*.

Seals and porpoises will be able to hear the underwater noise from munition clearance at very large distances from the blast sites and may be expected to react to the sounds, even if the levels are not high enough to cause PTS or TTS. At ranges where the rise time of the shock wave is sufficiently steep the noise is likely to induce a startle reflex, which is an involuntary contraction of the body muscles. This reflex is harmless, but repeated exposures may lead to fear conditioning (Götz and Janik 2011). At further distances from the blast site the animals are likely to react to the shock wave by a brief cessation of current activities, but the resume these afterwards. Behavioural effects of munition clearance are thus considered to be very short and without significant consequences for the animals.

11.7.5.4 Impacts due to sediment dispersion

<u>Visual impairement</u>
Suspended sediment may have a direct effect on marine mammals by either hindering their visual capacity or by affecting their vision since suspended sediment scatters light, degrades the image contrast, limits the visual range and also determines the spectral bandwidth and intensity of light available for vision at certain water depths *(Weiffen et al. 2006)*.

Since the harbour porpoise use echolocation for orientation in the environment as well as prey localisation, the visual impairment caused by sediment plumes, is not assessed to have a significant impact at an individual nor at a population level. Seals does not use echolocation, but like porpoises they are often found in darkness and in turbid waters where prey aggregate and as such, visual impairment are not believed to have a significant negative impact.

The spatial and temporal extend of a sediment spill and hence visual impairment is local and temporary, with low intensity and magnitude of change and consequently the significance on seals and porpoises in Finnish waters is *negligible*.

Behavioural impacts

The duration of behavioural responses caused by sediment spill is temporary and local. This mean that the animals will return or are assumed to behave normally once the activity has ceased. The behavioural impacts are all assessed to be reversible and the intensity and magnitude is *negligible*. The sensititivy is assessed to be *medium* for seals and *low* for porpoises, the overall significance is *negligible* for all species.

Health effects caused by contaminants

In the Gulf of Finland, the seabed sediments are known to be contaminated by chemicals and metals (Subchapter 7.4). During sediment dispersion, some of these contaminants may be released into the surrounding water and become bioavailable. The effects of contaminants on biota have discussed also in Subchapter 11.5.

Considering the short time scale of the elevated values of contaminants in the water, it can be assumed that contaminants suspended in water do not cause health effects to marine mammals. The assessments in this EIA and the monitoring results from NSP *(Ramboll 2012)* suggest that the risk of health effects or bioaccumulation is *negligible.*

11.7.6 Impacts during operation

The potential impacts are either assessed elsewhere (unplanned events – gas release, Subchapter 16.4) or have been assessed to be negligible based on monitoring during NSP or other baseline information (underwater noise from pipeline, changes of habitat). Only impact that is considered to be higher than negligible is noise from service vessels and is assessed here.

11.7.6.1 Underwater noise from service vessels

The level of ship activity in relation to inspection and maintenance of the pipeline is considered to be insignificant in comparison to the general level of shipping activity in the central Baltic (Figure 7-49) and any disturbance from these ships will be local and temporary. The intensity and magnitude is low and the sensitivity is also low. Thus the the overall significance is assessed as minor.

11.7.7 Prevention and mitigation of adverse impacts

There are several relevant measures for mitigation of adverse impacts on marine mammals. As have been discussed earlier, the most important are the measures to deter individuals before detonation. For this purpose, acoustic deterrent devices (seal scrammers) for seals and harbour porpoises will be deployed prior to detonation to drive animals away from the detonation zone. Several ADDs in appropriate arrays will be used if required to increase the area of the avoidance zone. Additionally, marine mammal observers (MMOs) will be stationed on munition clearance vessels to check for the presence of marine mammals and diving seabirds (such as sea-ducks and auks) and detonation will be delayed if they are observed in the area[FIN-UXO-005.02].

Previously mentioned commitment (Construction activities such as pipe lay and rock placement are not foreseen in the winter ice conditions. Should work be performed in `marginal` winter ice then the necessary safety measures shall be implemented in conjunction with the maritime authorities, moreover, should there be a potential impact on breeding seals, the coordinating environmental authority shall be notified with supporting impact assessment and mitigation measures [OSP-016.3].) will help to safeguard breeding seals.

Additionally, NSP2 is further investigating alternative methods of munitions clearance.

11.7.8 Lack of information and uncertainties

The assessment of the magnitude of change on marine mammals includes uncertainties. The most important is incomplete knowledge of species-specific sensitivity of marine mammals to noise and pressure waves. We have used knowledge from for example scientific papers where the impacts of offshore wind farm construction or seabed oil drilling on seals have been studied. The data concerns mainly harbour porpoise and harbour seal. With regard to seals, the data used to derive TTS and PTS for ringed and grey seals was based on experiments based on harbour seals, assuming that these species physiology would not differ largely.

Information on migration patterns and presence of the different species in the offshore areas of the Finnish EEZ is also scarce and there is a lot of uncertainty related to spatial distribution of marine mammals in the study area. Satellite tracking data published by HELCOM to visualize spatial distribution of marked individuals have been used in the assessment. The actual breeding areas cannot be known for sure because they are dependend on ice conditions, which are extremely variable. Due to these variations, the actual number of seal pups born in the area cannot be projected exactly. However, no pipe-laying activities are planned during ice-period.

There is also uncertainty as the type and location of munitions to be cleared is unknown at the moment.

Regardless of this lack of information, the knowledge base for the impact assessment is sufficient.

11.7.9 Significance of the impacts

In the Finnish EEZ, the impacts of both route sub-alternatives on marine mammals are assessed to be very similar. Differences in impacts are mainly due to the route deviation between sub-alternatives. Northern alternative is closer to the seal haul-out areas. Sub-alternative ALT E1 is closer to Kallbådan area and hence impacts (underwater noise) may be slightly higher from ALT E1 than from ALT E2. Further assessment of the impacts will require additional modelling, which is planned to be carried out in permitting phase. There are no differences between sub-alternatives ALT W1 and ALT W2 and between construction alternatives.

Harbour porpoise is very rare visitor in the Finnish EEZ and the impacts of both alternatives are assessed to be the same.

NSP2 is committed to use seal scarers and monitoring in order to reduce impacts. In this EIA we assessed how the identified impacts would be influenced by the application of the mitigation measures. In the summary tables, the overall impact significance is presented by taking account of mitigation measures that NSP2 is committed to use. Also alternative ways to further mitigate impacts from munition clearances are presently investigated by NSP2.

Table 11-50. Significance of the impacts on harbour porpoise with mitigation measures committed by NSP2 (monitoring, seal scarers).

Impacts on seal species	Activity	Impact	Sensitivity	Magnitude of change	Significance of the impact
Construction phase					
Underwater noise	Mun. clearance: individual & population level (M1-M4)	Blast injury and PTS	Low	Medium	Minor
	Mun. clearance: individual & population level	TTS, avoidance masking	Low	Low	Minor
	Rock placement	PTS/TTS, avoidance, masking	Low	Low	Minor
	Construction and support vessel movement	Avoidance	Low	Low	Minor
Impacts due to sediment spill	Mun. clearance, rock placement	Visual impairement	Low	Negligible	Negligible
	Mun. clearance, rock placement	Avoidance, disturbance of natural behaviour	Low	Negligible	Negligible
Release of contami-nants	Mun. clearance, rock placement	Health deterioration	Low	Negligible	Negligible
Operation phase					
Underwa-ter noise	Routine inspection, maintenance, support vessel movement	Avoidance	Low	Low	Minor

Table 11-51. Significance of the impacts on grey seals with mitigation measures committed by NSP2 (monitoring, seal scarers).

Impacts on seal species	Activity	Impact	Sensitivity	Magnitude of change	Significance of the impact
Construction phase					
Underwater noise	Mun. clearance: individual level (M1-M4)	Blast injury and PTS	High	Medium	Moderate
	Mun. clearance: population level (M1-M4)	Blast injury and PTS	Low	Medium	Minor
	Mun. clearance: individual & population level	TTS, avoidance, masking	Low	Low	Minor
	Rock placement	PTS/TTS, avoidance, masking	Medium	Low	Minor
	Construction and support vessel movement	Avoidance	Medium	Low	Minor
Impacts due to sediment spill	Mun. clearance, rock placement	Visual impairement	Low	Negligible	Negligible
		Avoidance, disturbance of natural behaviour	Medium	Negligible	Negligible
Release of contaminants	Mun. clearance, rock placement	Health deterioration	High	Negligible	Negligible
Operation phase					
Underwater noise	Routine inspection, maintenance, support vessel movement	Avoidance	Medium	Low	Minor

Table 11-52. Significance of the impacts on ringed seal with mitigation measures committed by NSP2 (monitoring, seal scarers).

Impacts on seal species	Activity	Impact	Sensitivity	Magnitude of change	Significance of the impact
Construction phase					
Underwater noise	Mun. clearance: individual level (M1-M4)	Blast injury and PTS	High	Medium	Moderate
	Mun. clearance: population level (M1-M2)	Blast injury and PTS	High	Medium	Moderate
	Mun. clearance: population level (M3)	Blast injury and PTS	Medium	Medium	Moderate
	Mun. clearance: population level (M4)	Blast injury and PTS	Low	Medium	Minor
	Mun. clearance: individual & population level	TTS, avoidance	Low	Low	Minor
	Rock placement	PTS/TTS, avoidance, masking	Medium	Low	Minor
	Construction and support vessel movement	Avoidance	Medium	Low	Minor
Impacts due to sediment spill	Mun. clearance, rock placement	Visual impairement	Low	Negligible	Negligible
	Mun. clearance, rock placement	Avoidance, disturbance of natural behaviour	Medium	Negligible	Negligible
Release of contaminants	Mun. clearance, rock placement	Health deterioration	High	Negligible	Negligible
Operation phase					
Underwater noise	Routine inspection, maintenance, support vessel movement	Avoidance	Medium	Low	Minor

11.8 Birds

This subchapter describes impacts on birds in the Finnish project area. The purpose of the assessment is to identify possible impact mechanisms and the magnitude of change during the construction and operation phases of NSP2. The main impact mechanisms are disturbance, noise and impacts on water quality.

Summary of assessment of impacts on bird life	
Lessons learned from the Nord Stream Project in 2009-2012	The environmental monitoring during munitions clearance for NSP 2009–2010 during construction works included bird monitoring. According to monitoring results, munitions clearance had no significant negative impacts on seabirds.
Main results of the assessment	In the offshore areas of the Gulf of Finland, the shallower water areas are regarded as potentially important feeding and resting areas during the breeding, migration and wintering seasons. According to available data, no significant feeding or resting areas have been identified in the vicinity of the planned pipeline. However, monitoring data on the offshore areas of the Gulf of Finland are scarce. Shallow water areas are located mainly more than 5 km from the planned pipeline route, and all important bird areas areas (IBAs, FINIBA´s) are located more than 8 km away from the pipeline route. Hence the impacts on birds are considered to be mainly temporally short and the magnitude of change low.

11.8.1 Impact mechanism

The assessed impacts on seabirds (Table 11-53) have been identified by considering the various project activities during construction and operation and how these activities may interact with the environmental target, birds. Interaction between seabirds and planned project activities during construction relates principally to noise and visual disturbance, as well as to sediment spreading resulting from different construction activities.

The impacts and their relevance during construction and operation are discussed further in Subchapter 11.8.3, and the identified potential impacts are described in Table 11-53.

Direct impacts:

- Detonation of munitions as a part of munitions clearance will cause pressure changes, which may lead to direct physical impacts or even mortality. The physical impacts are regarded as either reversible or irreversible, depending on the severity of the impacts.

Indirect impacts:

- Detonation of munitions as a part of munitions clearance will cause both airborne and underwater noise. The disturbance effect of noise is regarded as reversible.
- Construction and operation phases (e.g. munitions clearance, rock placement, pipe-laying, anchor-handling and maintenance) include vessel traffic, which causes visual and noise disturbances.
- During the construction phase, detonations of munitions, rock placement, pipe-laying and anchor-handling will cause loss of feeding areas (mainly in shallow water areas, less than 30 m). This impact is regarded as partly reversible and very local. During operation, maintenance rock placement has a similar impact.
- Most of the construction activities will cause sediment resuspension and resedimentation leading to increased turbidity and/or contaminant release, which may cause indirect impacts on benthic food resources for seabirds. These impacts are regarded as reversible.

Table 11-53. Possible impacts of the project activities on birds.

Receptor	Project phase	Project activity	Impact
Seabirds	Construction	Munitions clearance	Disturbance due to noise and visual impact from increased vessel activity
		Rock placement	
		Pipe supply	
		Pipe-laying	
		Munitions clearance	Diminished feeding area due to underwater construction and spreading of sediments and possible negative impacts on health of individuals due to release of contaminants
		Rock placement	
		Pipe-laying	
	Operation	Monitoring and surveying	Disturbance due to noise and visual impact from increased vessel movement
		Maintenance rock placement as required	Diminished feeding area due to underwater construction and spreading of sediments and possible negative impacts on health of individuals due to release of contaminants

11.8.2 Methods and data used

This impact assessment is based on available literature and studies on identified impact mechanisms and available monitoring data, mentioned in the subchapter on existing conditions (7.12). Reference data on impacts has also been gathered in the environmental monitoring programme surveys for NSP. The criterion of sensitivity emphasises the occurrence of protected and endangered species and IBAs in the impact area. The criterion of magnitude considers the temporal and spatial aspects of the impact.

Table 11-54. Sensitivity of receptor (birds).

Low	Protected or endangered bird species does not occur regularly in the vicinity of the project area. Important bird areas (IBA's, FINIBA's) are not situated in the vicinity of the project area.
Medium	Protected or endangered bird species occur regularly in the vicinity of the project area. Occuring protected or endangered species are moderately sensitive to environmental changes. Nationally important bird areas (FINIBA) are situated in the vicinity of the project area.
High	Significant numbers of protected or endangered bird species occur regularly in the project area or strictly protected species occur regularly in the project area. Occuring protected or endangered species are highly sensitive to environmental changes. International important bird areas (IBA, Ramsar) are situated in the vicinity of the project area.

Table 11-55. Magnitude of change (birds).

Negligible	No detectable impacts on protected bird species.
Low	Impact area covers a minor part of the total area of the habitats used by protected or endangered species. Impact time is short. All impacts are reversible.
Medium	Moderate impacts on protected or endangered bird species. Impact area covers a relatively large part of the total area of the habitats used by protected or endangered species. Impact time is from days to weeks. Some impacts may be irreversible.
High	Significant impacts on protected or endangered bird species. Impact area covers the majority of the total area of the habitats used by protected or endangered species. Impact time is months or permanent. Most of the impacts are irreversible.

Sensitivity of the receptor is assessed to be *medium* based on uncertainties of the available data and the precautionary principle. According to present knowledge, the project area has *low* importance for breeding species, but the possibility of breeding, migrating or wintering threatened seabird species occurring regularly in the impact area cannot be entirely excluded. All known IBAs and nearly all potentially important areas are situated more than 5 km from the pipeline route alternatives.

11.8.3 Impact assessment

11.8.3.1 Construction phase

The impacts of the construction phase include airborne and underwater noise, visual disturbance, spreading of sediments and the possible release of contaminants.

<u>Disturbance and airborne noise</u>
The pipelines will be constructed and placed on the seabed from a lay barge. Along with the lay barge, the pipe-laying also includes the traffic of the pipe-supply vessels, which transport pipe sections to the lay barge. Seabed intervention works related to construction works such as rock placement, pipe-laying, anchor-handling and increased ship traffic have the potential to disturb resting and foraging seabirds. The increased ship traffic and the presence of construction vessels cause visual disturbance as well as noise emissions.

The potential impacts of temporary noise and visual disturbance are greater in the breeding areas than in the feeding and resting areas of migrating or wintering birds. In the vicinity of breeding sites, disturbance may potentially lead to e.g. abandonment of nests, increased nest predation rates or changes in the breeding sites. These in turn have an effect on the population growth rate and distribution. By contrast, temporary disturbance in the feeding or resting areas during wintering periods is usually less severe, affecting potentially only the energy consumption rate of individuals. In theory, the effects of disturbance on feeding or resting areas could be potentially more severe if suitable feeding or resting areas for target species or populations were very scarce and limited.

In particular, the visual presence of moving vessels, often in combination with airborne noise emissions, may disturb seabirds and cause them to fly off and move away from their resting and/or foraging areas. Concerning visual disturbance, studies have shown that faster moving vessels cause a larger disturbance than slower moving vessels (e.g. *Burger 1998, Ronconi et al. 2002*).

The distance at which birds begin to react to approaching danger differs between species and individuals. It also depends on behavioural activity and life-cycle stage (e.g. foraging vs. resting and migratory season vs. breeding season). Fleeing distances for many bird species are still unknown, but this subject has been studied on a few of the species observed in the offshore areas of the Gulf of Finland.

Among the seabirds in the Baltic Sea, divers, common scoter and velvet scoter have shown high sensitivity to disturbance from ship traffic. Divers may react to moving vessels by flushing (flying away) at a distance over 1 km. The flush distance of the common scoter has been reported to be approximately 800 m, although single flush observations have been made up to 3.2 km from a passing vessel. The flush distance of the velvet scoter is roughly 400 m and that of the long-tailed duck is 300 m. The common eider shows lower sensibility, with an average flush distance of approximately 200 m. It is essential to note that flock size and flush distance correlates positively on seabirds and flushing distance correlates positively also on vessel speed. Furthermore, the tendency to flush seems to depend strongly on the existing disturbance level at the target site: sensitivity to disturbance is lower in shipping lanes than in areas without daily ship traffic *(Garthe and Hüppop 2004, Kaiser et. al. 2006, Schwemmer et. al. 2011, Topping and Petersen 2011)*.

Based on these examples, impacts on birds from airborne noise and visual disturbances from ships involved in the construction phase in general will be limited to a 1-2 km radius around the work area. Foraging and resting birds within this area may be impacted and will fly off. Pipe-laying will be conducted on a 24 hour basis, approximately 2-3 km per day. The temporal disturbance impact for a single resting or feeding area would be relatively short (approximately 2-6 days depending on the total area of the feeding areas, which varies in the Gulf of Finland from less than 1 square kilometre to tens of square kilometres).

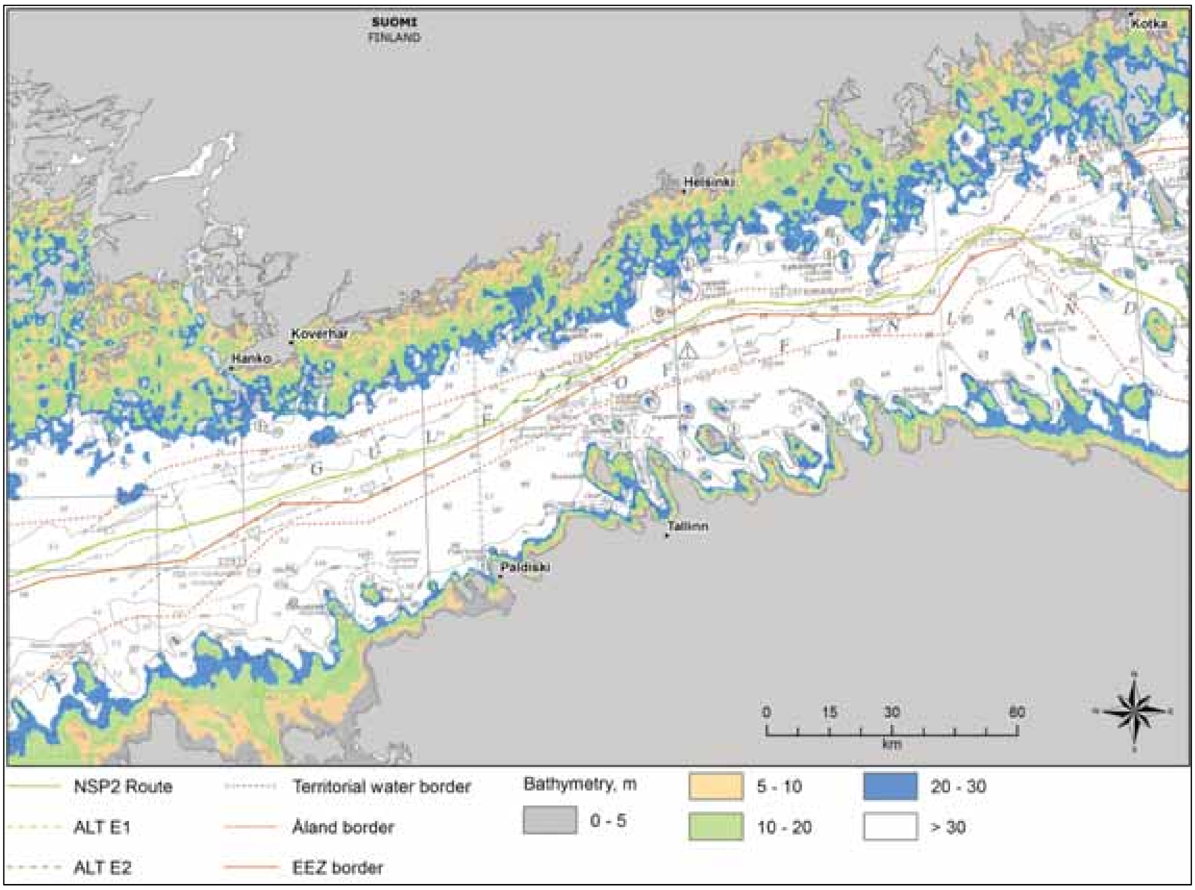

Figure 11-19. Shallow water areas in the Gulf of Finland. Map represents 0-30 m deep sea areas, which are the feeding areas preferred by seabirds. Nearly all shallow water areas are situated more than 5 km from the planned pipelines. The most western parts of the Finnish EEZ offshore areas are not shown on the map. In the excluded Finnish EEZ offshore areas, all <30 m deep areas lie further than 20 km from the pipeline route. Bathymetry is also presented in Appendix 12 (Map BA-01-F).

No important feeding or resting areas are identified in the vicinity of the route alternatives. Furthermore, the distance between the pipeline alternatives and nearly all potentially important shallow water areas (less than 30 m deep) is mainly more than 3 km, which is much farther than the estimated flush distance thresholds for target species. Hence, the magnitude of change of airborne noise and visual disturbance is assessed to be *negligible.*

Based on the above-mentioned literature data, the planned speed of construction and the situation of the important or potentially important bird areas, the impacts of airborne noise and visual disturbance on birds during the construction phase are assessed to be *negligible*, temporally short and reversible.

Munitions clearance and underwater noise

Many of the activities related to construction of the pipelines will generate underwater noise. Underwater noise from munitions clearance is clearly the loudest activity.

Munitions clearance involves underwater detonations, which may have negative impacts on seabirds in the vicinity of the detonation area. Negative impacts include pressure changes in the waterbody and noise. Pressure changes (shock wave of explosion) extend over a larger area in water than in the air. Therefore the safe distances are greater in the water than in the air. This is important for diving seabirds, as pressure changes may theoretically result in severe physical injuries or even death for diving individuals.

Underwater noise and impacts on seabirds are poorly understood phenomena, and little is known about the different threshold limits for diving birds. Yelverton et al. (1973) have determined pressure thresholds for diving birds in a study conducted with *Anas*-species. The results are not directly applicable to seabirds, but they are the only available data when estimating the possible impact areas of munitions clearance. According to study results, the threshold for low probability of trivial lung injuries and no eardrum rupture is 187 SEL, dB re. 1 $\mu Pa^2 s$ (equals 10 psi*msec represented in the original study results) and the mortality threshold (LD_1) for these species is 198 SEL, dB re. 1 $\mu Pa^2 s$ (equals 36 psi*msec). No temporary or permanent threshold shifts in hearing were determined and the study concentrated on physical injuries (e.g. eardrum rupture, injuries in airsack, etc.) and mortality.

Underwater noise modelling for munitions clearance in the Gulf Of Finland has been carried out for Nord Stream 2 Project, but the report does not address the propagation of the noise from the viewpoint of seabirds *(Ramboll 2016d)*. Nevertheless, separate results on underwater noise propagation at 10 m depth was extracted from the model (Figure 11-20). The basis for this procedure lies in the depth zone seabirds dominantly use when foraging and the relation of the water depth to the propagation of the underwater noise. The majority of the seabirds use less than 10 m shallow waters, and underwater noise propagates more efficiently in the deep waters than at the surface. Based on cross section plots of the modelled underwater sound propagation profiles, an average difference between the maximum level over the whole depth of the water column and the levels at approximately 10 m below the surface is estimated to be 10 dB (Figure 11-21).

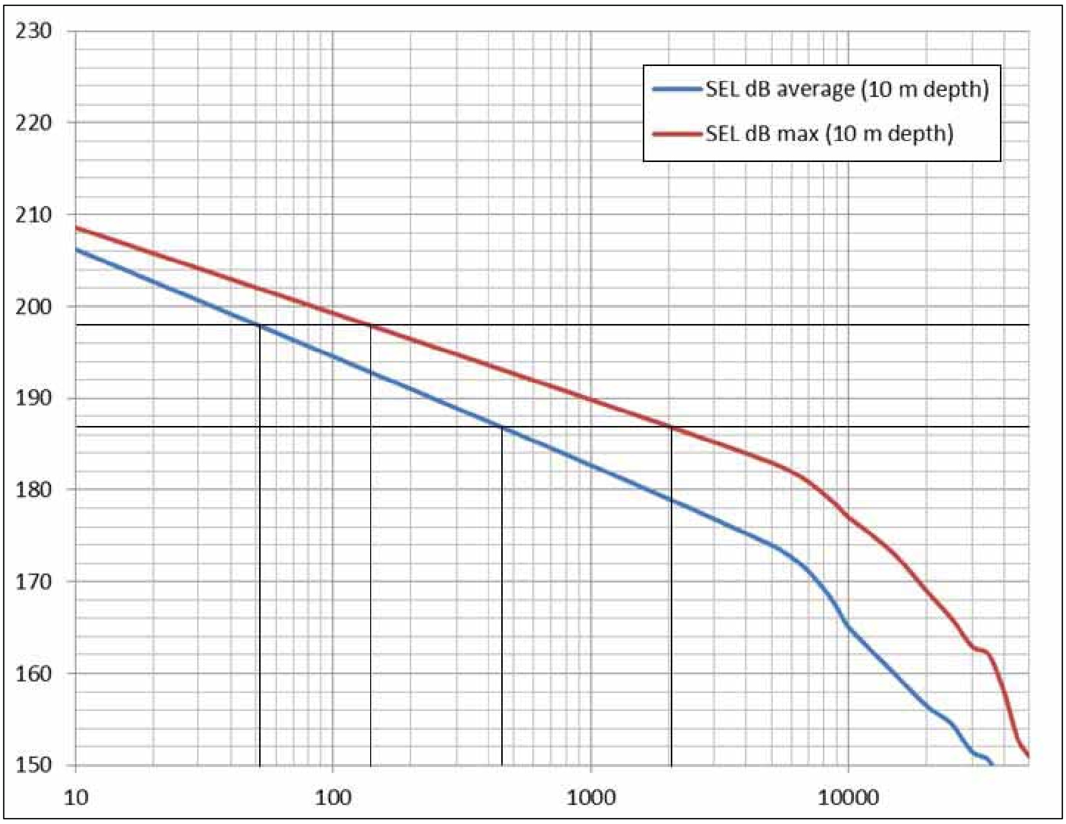

Figure 11-20. Average and maximum propagation of underwater noise at 10 m depth. Results are extracted separately from the underwater noise modelling concerning munitions clearance in the Gulf of Finland (Ramboll 2016d). Horizontal lines indicate the mortality threshold level (198 SEL, dB re. 1 μPa^{2}s) and the threshold for low probability of trivial lung injuries and no eardrum (187 SEL, dB re. 1 μPa^{2}s) defined by Yelverton et. al. 1973. The X-axis represents the distance (m) and the y-axis represents the underwater noise level (SEL, dB re. 1 μPa^{2}s).

Figure 11-21. Explanatory figure showing how underwater noise propagates more efficiently in the deep waters than at the surface. Examples of vertical plot of munitions clearance sound propagation (colour scale) vs. depth (Y axis, 80 m) and distance (X axis, 50 km). Figure taken from underwater noise report (Ramboll 2016d).

According to underwater noise modelling results in 10 m depth, the maximum distance for the 198 SEL, dB re. 1 µPa^{2}s noise level is approximately 150 m and the maximum distance for the 187 SEL, dB re. 1 µPa^{2}s noise level is 2.0 km (average value being 400-500 m). These results indicate that the impact distance for physical injuries would vary between 0.5–2.0 km and mortality would occur only within close range of clearance site. It should be noted that these results are based on only one study. Therefore the impacts and impact distance of underwater noise disturbance is unclear.

The closest known IBAs in relation to the planned pipeline route are in the Kirkkonummi archipelago area. Kirkkonummi archipelago IBA and FINIBA areas are situated 8.2 km from the pipelines. Nearly all other shallow water areas (less than 30 m deep) are situated 3 km or more from the pipeline route. Based on distance from the IBAs and potentially important shallow water areas, significant impacts via physical injuries or mortality are unlikely. According to present knowledge, seabirds use deep water areas very seldom. Only razorbill and common murre are exceptions, since these species are known to regularly forage also in deep water areas (50-100 m) (e.g. *Kuepfer 2012, Piatt and Nettleship 1985*). The impact of disturbance due to underwater noise is considered to be *minor*.

Munitions clearance for NSP included bird monitoring, and no injuries or mortality of seabirds was observed *(Ramboll 2013c)*.

Overall, the impacts of munitions clearance on birds is assessed to be *minor*.

Spreading of sediments

The pre-construction and construction phase involves multiple operations (e.g. munitions clearance, rock placement, pipe-laying and anchor-handling), including underwater work that may lead to the spreading of seabed sediments. Sediment spreading may have multiple impacts on seabird species. First, the resuspension of sediment in the water column makes foraging more difficult because of reduced visibility. Earlier studies imply that water clarity has an effect on the dive durations of seabirds, at least for divers *(Thompson & Price 2006)*. Second, sediment spreading may lead to resedimentation in the feeding areas of seabird species, which in turn leads to changes and possibly losses of prey species (e.g. molluscs, crustaceans, marine invertebrates and fish). Possible impacts also include the release of contaminants and metals from the sediments. In aquatic environments, biomagnification is characteristic for several metals and contaminants. When contaminants or metals are released to the water column, they become bioavailable and these tend to concentrate in the higher levels of the food chain. Seabirds can be seen as one of the top-level predators in the marine food chain. The Gulf of Finland is known to be disturbed by several contaminants and metals such as cadmium, cesium-137, lead, mercury, DDT, TBT and zinc *(HELCOM 2010b)*.

Spreading of the sediments due to NSP2 underwater work operations has been modelled in a separate sediment modelling report *(Ramboll 2016b)*. The results of the report are discussed in more detail in chapters dealing impacts on seabed morphology and sediments (Subchapter 11.2), hydrology and water quality (Subchapter 11.3) and impacts on benthos (Subchapter 11.5). In brief, the results indicate that the impacts of rock placement and munitions clearance on water quality would be short and local. The maximum area where the concentration of suspended sediment exceeds 10 mg/l is 46 km^2 and the maximum duration is 18 hours. Nearly all shallow water areas (less than 30 m deep) are situated more than 5 km from the pipeline route. According to sedimentation modelling results, underwater operations (rock placement and munitions clearance) are likely to have a low and local impact on benthic communities. Further increase of the turbidity would be limited mainly to the lower water layer above the seabed (0–10 m and 10–20 m). It can also be assumed that it is unlikely the contaminants released from the sediments will have any significant effect on benthic communities or on seabirds. The monitoring results from NSP *(Ramboll 2012b)* supports the modelling results and no significant spreading of the sediment was observed.

Overall, the impacts of the spreading of sediments on birds is considered to be *negligible*.

11.8.3.2 Operation phase

Impact mechanisms during the operation phase are quite similar to impacts during the construction phase, magnitude of change being smaller. The operation phase includes post-construction rock placement and possible maintenance operations. Both of these activities result in visual disturbance and noise emissions. Rock placement leads to the spreading of sediments, which is also possible for other maintenance operations, depending on the specific activities needed at the time. Overall, the activities during the operation phase can be predicted to be temporally shorter than those during the construction phase.

In theory, indirect impacts on birds during the operation phase may occur as a result of changes in prey species distribution and abundance. The impacts of the operation phase on benthic communities and fish are discussed in more detail in Subchapters 11.5 and 11.6. In summary, it can be stated that on the basis of present knowledge on the existing conditions and the environmental monitoring results of NSP, the impacts for birds during operation are considered to be *negligible*.

11.8.4 Prevention and mitigation of adverse impacts

Mitigation measures will be used during munitions clearance. Acoustic deterrent devices (seal scrammers) for seals and harbour porpoises will be deployed prior to detonation to drive animals away from the detonation zone. Several ADDs in appropriate arrays will be used if required to increase the area of the avoidance zone. Additionally, marine mammal observers (MMOs) will be stationed on munition clearance vessels to check for the presence of marine mammals and diving seabirds (such as sea-ducks and auks) and detonation will be delayed if they are observed in the area.

11.8.5 Lack of information and uncertainties

Owing to the lack of long-term survey data on wintering and migrating seasons in the offshore areas in Finland, the greatest uncertainties are related to the number of seabirds in the offshore project area during different seasons. Nevertheless, present knowledge on the ecology of seabird species and the available survey data from elsewhere in the Baltic Sea region clearly show the importance of coastal and shallow water areas *(Skov, et al. 2011, Lehikoinen et al. 2013, Fox 2003)*. The pipeline route alternatives are situated almost completely in the deep water areas, mainly more than 5 km from the existing shallow parts of the Finnish marine areas.

According to present knowledge, outer offshore areas of the Gulf of Finland have low importance for breeding sea and coastal bird species. Nevertheless, it is worthwhile to note that information on the feeding areas of breeding populations of razorbill, common murre and caspian tern is still lacking. All species are able to travel tens of kilometres between breeding and feeding areas.

At present, knowledge on the impacts of underwater noise on birds is scarce, and threshold values are based on a single study.

Despite the deficiencies in the available data and a lack of knowledge on the precise magnitudes of changes, the overall impact assessment for birds can be considered sufficient.

11.8.6 Significance of the impacts

Alternatives ALT E2 and ALT W2 are situated at a greater distance from the Finnish coastline and archipelago areas than alternatives ALT E1 and ALT W1. The distance between alternatives ALT E2 and ALT W2 and IBA areas, FINIBA areas or other known important feeding and resting areas of the migratory and wintering bird species is also higher than the distance between these areas and alternatives ALT E1 and ALT W1. However, the differences between alternatives are still assessed as negligible because the minimum distances to IBAs is 8 km. The depth range of ALT E1 and ALT E2 is approximately 30–60 m, and the depth range of ALT W1 and ALT W2 is approximately 30-90 m. With the exception of few single small area, all potentially important shallow waters lie at least 5 km from the route alternatives. It should be noted that birds – with the exception of auk species – are not likely to dive in the deep waters in the central part of the Gulf of Finland, where munitions clearances will take place.

During the construction phase, the impact on birds is assessed to be low. Negative impacts on birds constitute mainly underwater noise from munitions clearance and airborne and underwater noise and visual disturbance from the underwater works and vessel activity. There are no differences in impacts between construction alternatives.

During the operation phase, the impact on birds is assessed to be negligible, and there are no differences between the alternatives.

The differences of the magnitude of changes during the construction and operation phases are based on both the intensity of the construction and maintenance works and the estimated time consumed in the construction phase during breeding, migrating or wintering seasons. Overall, and taking into consideration the available data on the distribution of breeding and wintering species, the preferred depth ranges of the species and the distribution of the shallow water areas, no significant impacts on important bird species (e.g. endangered or specially protected species) are expected during the project.

Table 11-56. Significance of impacts on bird life.

Impacts on bird life	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Visual disturbance and airborne noise	Medium	Negligible	Negligible
Underwater noise	Medium	Low	Minor
Spreading of the sediments	Low	Negligible	Negligible
Operation phase			
Visual disturbance and airborne noise	Medium	Negligible	Negligible
Underwater noise	Medium	Negligible	Negligible
Spreading of the sediments	Low	Negligible	Negligible

11.9 Protected areas

This chapter describes the assessed environmental impacts of activities planned under the NSP2 project on protected areas. Chapter addresses only offshore protected areas and relevant onshore (and inner archipelagic) protected areas are discussed Subchapter 12.1.5. The assessed impacts on protected areas have been identified by considering the various project activities during the construction and operation phases and how the project may interact with its environmental target, the protected areas. The potential interference of planned project activities with protected areas has principally been investigated with regards to underwater noise and sediment spreading during construction activities.

The location of protected area is presented in Appendix 12 (Maps PA-01-F - PA-04-F).

Summary of the impact assessment on protected areas	
Lessons learned from the Nord Stream Project in 2009–2012	Impacts on protected areas were not directly monitored during the construction and operation phases of NSP. The impacts on protected areas were assessed by using information gained from monitoring programme results (water quality, benthos, fish, seabirds and marine mammals). According to environmental monitoring during NSP, no adverse impacts on protected areas were detected during the construction or operation phases.
Main results of the assessment	Most of the protected areas are located at a distance of 8 km or more from the NSP2. There is only one protected area located closer than 2 km from the nearest route alternative. This site is a Natura 2000 site “Sea Area South of Sandkallan” with habitats as a protection objective (FI0100106). Based on Natura 2000 assessment screening, the NSP2 project will not have adverse impacts on the protection basis of this site. Munitions clearance may have negative impacts on the nearest protected areas with seal species as a designated species. This applies especially to the "Kallbådans Islets and Waters" Natura 2000 site, located 8 km from the nearest route alternative. Regarding this Natura site, without additional mitigation measures to the one presented in the project description, the project is likely to cause some adverse effect on the ecological values of the site and will be evaluated in more detail in a separate Natura assessment. The Natura assessment is taking into account the latest survey data on munitions and possible mitigation measures of clearance activities, which were still under study at the time of writing this EIA report. Minor adverse impacts due to munition clearances have been assessed to potentially occur in three additional Natura 2000 sites with seals as a protection objective: Natura screening is proposed for these sites. No other protected area is assessed to experience any impact due to the construction and operation phases of the NSP2 project.

11.9.1 Impact mechanism

The impact mechanism that have been identified are disturbance due to airborne or underwater noise, visual impacts from increased vessel activity and habitat/feeding areas losses due to increased turbidity and release of contaminants.

Table 11-57. Potential impacts of the project activities on protected areas.

<table>
<tr><th>Receptor</th><th>Project phase</th><th>Project activity</th><th>Impact</th></tr>
<tr><td rowspan="11">Protected areas</td><td rowspan="7">Construction</td><td>Munitions clearance</td><td rowspan="4">Disturbance due to airborne or underwater noise and visual impact from increased vessel activity</td></tr>
<tr><td>Rock placement</td></tr>
<tr><td>Pipe supply</td></tr>
<tr><td>Pipe-laying</td></tr>
<tr><td>Munitions clearance</td><td rowspan="3">Habitat and feeding area losses due to spreading of sediments and release of contaminants</td></tr>
<tr><td>Rock placement</td></tr>
<tr><td>Pipe-laying</td></tr>
<tr><td rowspan="3">Operation</td><td>Monitoring and surveying</td><td rowspan="2">Disturbance due to airborne noise and visual impact from increased vessel movement</td></tr>
<tr><td>Maintenance rock placement as required</td></tr>
<tr><td>Maintenance rock placement as required</td><td>Habitat and feeding area losses due to spreading of sediments and release of contaminants</td></tr>
</table>

11.9.2 Methods and used data

The potential effects of NSP2 on protected areas were assessed on the basis of existing data on protected areas and the result of the different modelling (underwater noise, sediment spreading) carried out for this project *(Ramboll 2016b, Ramboll 2016d)*. The assessment focuses on those impact mechanisms identified to be the most relevant for different groups of biota in protected areas. Impacts on marine biota has been described in detaild in subchapters dealing benthic flora and fauna (Subchapter 11.5), marine mammals (Subchapter 11.7) and birds (Subchapter 11.8).

Different methodologies have been used to assess impacts on Natura sites with different designated species and habitats. Regarding sites with seals as a designated species, the extensions of PTS and TTS zones (Subchapter 11.7) with results of the underwater noise modelling *(Ramboll 2016d)* have been used as an assessment method. PTS refers to the risk of underwater noise causing permanent threshold shift in hearing and TTS to the risk of underwater noise causing temporary threshold shift in hearing. The results of the sediment spreading modelling have been used to assess potential impacts on Natura sites with habitats as a protection objective. Natura sites with birds as designated species have been assessed on the basis of underwater noise, airborne noise and sediment dispersion.

Valuable information for this assessment has been obtained from the results and conclusions of the environmental monitoring carried out during NSP.

Most protected areas are located at a distance of at least 8 km from the pipelines. There is only one protected area, Natura 2000 site "Sea Area South of Sandkallan" (FI0100106) with habitat as designated objective, located closer than 2 km from the nearest NSP2 pipeline. The possible impacts on this site has been assessed in a separate Natura assessment screening (Appendix 9).

Detailed information on the protected areas within the Finnish project area can be found in Appendix 5.

Valuable information for this assessment has been obtained from the results and conclusions of the environmental monitoring carried out during NSP.

<u>Sensitivity of the receptor</u>
Possible impact mechanisms affecting the target protection area varies depending on the conservation objectives (e.g. seals and/or underwater habitats) of protection area or species and habitats present in the protection area. Thus, the potential impact area varies greatly also. Therefore the general method (Chapter 10) used for assessing sensitivity in this EIA is not applied to protected areas. Here, the most sensitive basis of protection is considered to be seals. This is due to large impact area of the underwater noise on seals (Subchapter 11.7.5). Impact area of underwater noise on birds is smaller. Spreading of the sediments affects especially underwater habitats and its impact area is smaller by magnitude compared to underwater noise. Spreading of the sediments may also have, but to a lesser extent, impacts on seal and bird species. Sediment dispersion has potentially greatest impacts on some of the most sensitive underwater habitats (e.g. reefs).

<u>Magnitude of change</u>
Magnitude of change is assessed on the basis of temporal extent and the reversibility of the impacts. Spatial permanent losses of the Natura 2000-habitat types in Natura SAC-sites are interpreted to have significant magnitude, regardless of the proportion of the losses.

Table 11-58. Magnitude of change (protected areas).

Negligible	No impacts on protected areas.
Low	Minor impacts on protected species or habitats situated in protected area. Impact time is short, all impacts are reversible.
Medium	Moderate impacts on protected species or habitats situated in protected area. Impact time is from days to weeks, some impacts may be irreversible.
High	Significant impacts on protected species or habitats situated in protected area. Impact time is months or permanent. Most of the impacts are irreversible.

11.9.3 Impact assessment

The most relevant impact mechanism are airborne and underwater noise, visual disturbance and spreading of the sediments. Impacts of noise and visual disturbance concern Natura 2000 sites with seals and birds as a protection objective. Spreading of the sediments has potentially greatest impact on Natura 2000 sites with habitats as a protection objective.

11.9.3.1 Construction phase

<u>Visual disturbance and airborne noise</u>
The potential impact targets of visual disturbance and airborne noise are seals and birds. Visual disturbance and airborne noise are negative and reversible impacts. The impacts of pipe-laying and vessel activity are short-term and thus the magnitude of change is considered as *negligible*. Due to long distances between pipeline route and those protection areas, which have seals or birds as designated species (8 km being the minimum), impacts of airborne noise and visual disturbance are assessed to be *negligible*. The extend of these impacts are described more detailed in Subchapters dealing with marine mammals and (Subchapter 11.7.4) birds (Subchapter 11.8.3).

<u>Impacts of underwater noise due to munitions clearance</u>
The assessment takes into consideration the mitigation measures described in the project description (Subchapter 4.2.5) and in Subchapter 11.7.7 Prevention and mitigation of adverse impacts.

Based on underwater noise modelling, marine mammals occuring in the impact area may experience either temporary (TTS) or permanent (PTS) hearing loss. Additionally, in the worst case scenario (maximum underwater sound exposure levels, Subchapter 10.4), the model shows that there is a risk that the PTS and TTS areas would reach protected areas with seals as a protection objective. PTS refers to permanent threshold shift in hearing and TTS to temporary threshold shift.

The only area that is reached by modelled PTS zones is "Kallbådan Islets and Waters" Natura site (8.1 km from the nearest point of the pipeline), which includes the Kallbådan seal sanctuary. Within this area, detonations could lead to negative impacts on designated species (grey seal) of the nearest Natura site "Kallbådan Islets and Waters". During this EIA, detailed information about the location and features of munitions on the seabed was not available. The Natura 2000 Assessment for "Kallbådan Islets and Waters" Natura site will be carried out after receiving the detailed information on observed munitions (location, characteristics) to be cleared. For precautionary reasons, we assessed that the impact on protected areas with seals as designated species corresponds to the risk that any seals individual would experience PTS (Appendix 8B). The use of seal scarers is assessed to effectively work in the innermost area around the blast site (where it will significantly reduce the number of animals that would occur severe PTS), but its effect will not reach the Natura Area due to the large distances. For this reason, and in line with the marine mammals assessment, the significance of underwater noise impact to the "Kallbådan Islets and Waters" is assessed as *moderate*.

Based on the results of underwater noise modelling, three other Natura 2000 sites with seals as a conservation objective could be reached by TTS zone *(Ramboll 2016d, Appendix 8B)*. Natura sites potentially reached by TTS in the worst case scenario (maximum underwater sound exposure levels) include Söderskär and Långören Archipelago (12.5 km from the NSP2 route), Pernaja Bay and Pernaja Archipelago (13.1 km) and Tammisaari and Hanko Archipelago and Pohjanpitäjänlahti Marine Protected Area (17.8 km) Natura sites. The Natura assessment screening will be carried out for the three above mentioned sites. The overall significance of TTS for seals have been assessed to be *minor* (Subchapter 11.7.9), therefore the underwater noise impact significance for the three above-mentioned Natura 2000 sites is also assessed to be *minor*.

Additionally, there are other eight protected areas that could fall within the TTS zone. It should be noted that these areas are identical with or included in the Natura sites, which will be included in the Natura assessment screening. Stora Kölhällen (17.0 km) and Sandkallan (12.4 km) seal sanctuaries, Söderskär and Långören Archipelago Ramsar site (12.5 km) and Söderskär and Långören Archipelago HELCOM MPA (12.5 km) are included in Söderskär and Långören Archipelago Natura site. Pernaja and Pernaja Archipelago HELCOM MPA (13.1 km) is identical with Pernaja Bay and Pernaja Archipelago Natura site. Bird Wetlands of Hanko and Tammisaari Ramsar site (17.8 km) is identical with Tammisaari and Hanko Archipelago and Pohjanpitäjänlahti Marine Protected Area Natura site, but it includes Tulliniemi Bird Protection Area also. The Tammisaari Archipelago National Park (18.2 km) is included in Tammisaari and Hanko Archipelago and Pohjanpitäjänlahti Marine Protected Area Natura site. The Open Sea Area Southeast from Hanko HELCOM MPA (13.7 km) is offshore marine area adjacent to Tammisaari and Hanko Archipelago and Pohjanpitäjänlahti Marine Protected Area Natura site. For all these eight areas only grey seal is listed as a designated species or species relating to the international importance of the site. For the reasons above described, we assessed that underwater noise impacts on these areas will be *minor*.

All other Natura 2000 sites and other protected areas with seals as a protection basis fall outside both TTS and PTS zone: the impact due to underwater noise to those protected areas is assessed to be *negligible.*

Impacts of underwater noise on birds are considered to be less likely. Possible impacts of underwater noise on bird species as a conservation objectives of protection areas include indirect disturbance effect. Direct physical injuries are unlikely, since impact area of physical injuries varies between 0.5–2.0 km and all Natura 2000 sites and other protected areas with birds as designated species are located much further away from the pipeline (the nearest protected area for birds, Kirkkonummi archipelago Natura site (and IBA area), is located 13.1 km from the pipeline). The impact significance on protected areas with birds as a protection objective is *negligible*.

Suspended sediments and re-sedimentation

Construction activities, such as munitions clearance and rock placement can lead to the release of sediments, which cause turbidity in water and relocation of these sediments. None of the activities will occur in the Finnish territorial waters where the existing protected areas are located.

Sediment resuspension and sedimentation could potentially impact protected areas with seals, birds or underwater habitats as a protection objective. Impacts are summarized here and impact mechanisms and impacts are described in more detail in Subchapters: morphology and sediments (Subchapter 11.2.3), benthic flora and fauna (Subchapter 11.5.3), marine mammals (Subchapter 11.7.5) and birds (Subchapter 11.8.3).

Impacts on underwater habitats due to the suspension of the sediments may occur via turbidity and sedimentation, if they occour for long period of time. According to sediment spill modelling results (Subchapter 11.3), maximum impact areas for increased concentrations of suspended solids (over 10 mg SS/l) would range between 20–46 km^2 and increased concentrations would persist approximately 6–12 hours. Highest modelled sediment concentrations would occur in the vicinity of munition clearance sites, ranging between 50–100 mg SS/l. Sediment spill modelling results indicate that, if munition clearances were to be carried out along the pipeline route in the proximity of the Natura 2000 site "Sea area south of Sandkallan", increased suspended sediments concentrations could be detected in the area (low concentration for short time – Subchapter 11.3) but no sedimentation would occur (Subchapter 11.3.3).

Model calculations with respect to rock placement show that in a worst case scenario, a suspended matter concentration of >10 mg/l occurs only in less than 10 km^2 area and increased levels usually lasts for less than approximately half a day. The impacts from anchor-handling are assessed to be local, occurring primarily close to the seabed. The suspension is expected to be of a smaller scale than for rock placement activities. The increasing levels of concentrations will last for only some hours to days, far from protected areas.

Offshore pipe-laying normally proceeds 2–3 km/d. According to this, the theoretical impact time on single protection area could be 1-2 weeks, maximum.

Due to the large distances between the planned pipeline routes and the protected areas, increased suspended sediments concentrations (over 10 mg/l) are not expected to reach any existing protected area, except for short time in the proximity of the Natura 2000 site "Sea area south of Sandkallan" if munitions clearances were to be cleared in its proximity. However, sedimentation is considered to be the main impact mechanism able to affect the benthic ecosystems, while temporary increased turbidity are easily withstanded by the benthic life (Subchapter 11.5). No sedimentation has been assessed to be able to reach any protected areas.
For these reasons, the impacts of sediment suspension and sedimentation to all protected areas with underwater habitats as the protection objective are assessed to be *negligible*.
With regards to the Natura 2000 site Sea area south of Sandkallan, these above mentioned results are in line with the conclusions of the Natura assessment screening, which states the project will not have any adverse impacts on the underwater habitats of the Natura site *(Ramboll 2016f)*.

The possible impacts of turbidity on marine mammals and birds would mainly be limited to decreased visual capacity, which makes e.g. foraging more difficult. Impacts are not foreseen on protected areas with seals or birds as a protection objective. Allthough seals and some of the bird species tend forage in large area where negative effects could arise, these effects are of short duration and reversible and animals can easily avoid areas with temporary turbidity.

Also, potential impacts on the food chain due to spreading of contaminants could have impacts on birds and seals in protected areas. However, it was assessed that the release of contaminants will be very small and no impacts are foreseen with respect to contaminants (see Subhapter 10.2.1). Therefore, the impact of sediment resuspension for protected areas with birds or seals as protection objective has been assessed as *negligible*.

11.9.3.2 Operation phase

Noise from gas flowing in pipelines

During the Operation Phase, gas flowing in the pipelines will emit underwater noise. Noise is local but permanent. However, within 10 m from the pipelines no noise from gas flowing was detected and the noise level was measured to be equivalent to that of normal background noise (Subchapter 7.7.3). The impact from noise from gas flowing in the pipelines to any protected areas has been assessed as *negligible* .

Disturbance from supply-vessel traffic and rock placement

Monitoring and surveying and maintenance rock placement will create airborne noise and visual disturbance. Most of the disturbance caused by supply-vessel traffic and rock placement activities is local and the duration is short; hence, this disturbance is assessed to have *negligible* impacts to the protected areas.

Suspension of sediments and re-sedimentation of released sediments

Maintenance rock placement can lead to the release of sediments and to re-sedimentation of released sediments. It is estimated that the scale of rock placement activities will be smaller than in construction phase. Therefore, the impact on protected areas due to suspension or re-sedimentation is *negligible*.

11.9.4 Prevention and mitigation of adverse impacts

Mitigation measures concern only those protection areas which have marine mammals or birds as a protection objective. Mitigation measures for these target groups (marine mammals and birds) are described in Subchapters 11.7.7 and 11.8.4.

11.9.5 Lack of information and uncertainties

Baseline information on protected areas is adequate. Greatest inaccuracies concern the impacts of munitions clearance. Data on locations and features of the munitions to be cleared was not available for this impact assessment.

11.9.6 Significance of the impacts

The NSP2 pipeline route does not cross any of the protected areas. Sea Area South of Sandkallan Natura 2000 site is the closest protected area with a minimum distance of approximately 1.9 km from the pipeline route. Based on the Natura assessment screening, the NSP 2 project will not have adverse impacts on the underwater habitats, which form the basis for conservation in the Sea Area South of Sandkallan. The results of sediment spill modelling *(Ramboll 2016b)* support the conclusions of screening study.

During construction phase munitions clearance will cause underwater noise, which may cause negative effects on closest protection areas with marine mammals as protection objective. Negative impacts are more likely to occur in nearest protection sites in Kallbådan area ("Kallbådan Islets and Waters Natura area / "Kallbådan seal sanctuary"). Further assessment of the impacts will require additional data or modelling, which is planned to be carried out in permitting phase.

Negative impacts of underwater noise are also possible for three other Natura sites and eight other protection sites (exclusively included in the Natura sites) with grey seal as conservation objectives. On these sites the most likely possible negative effects on seals are temporary hearing losses and disturbance. These areas will be further assessed in a Natura Screening Assessment.

Sub-alternative ALT E1 is located up to 1.7 km closer to Kallbådans Islet and Waters Natura site compared to the sub-alternative ALT E2; this could be relevant difference with regards to underwater noise propagation from munitions clearance. There are no difference between sub-alternatives ALT W1 and ALT W2 and between construction alternatives.

Table 11-59. Significance of the impacts on receptors in the protected areas with seal species as conservation objectives.

Impacts on ecological values in protected areas	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Kallbådans Islets an Waters Natura site [1] Kallbådan seal sanctuary			
Construction phase			
Underwater noise	High[2]	Medium	Moderate
Spreading of the sediments	Low	Negligible	Negligible
Operation phase			
Underwater noise	Medium	Negligible	Negligible
Natura sites to be included in Natura assessment screening: • **Söderskär and Långören Archipelago** • **Pernaja Bay and Pernaja Archipelago** • **Tammisaari and Pohjanpitäjänlahti Marine Protected Area** **Sandkallan seal sanctuary** **Stora Kölhällen seal sanctuary** **Söderskär and Långören Archipelago HELCOM MPA** **Pernajabay and Pernaja Archipelago HELCOM MPA** **Open Sea Area Southeast from Hanko HELCOM MPA** **Söderskär and Långören Archipelago Ramsar site** **Bird Wetlands of Hanko and Tammisaari Ramsar area** **The Tammisaari Archipelago National Park**			
Construction phase			
Underwater noise	Low	Low	Minor
Spreading of the sediments	Low	Negligible	Negligible
Operation phase			
Underwater noise	Low	Negligible	Negligible
All other protection areas with seals as protection objectives			
Construction phase			
Underwater noise	Low	Negligible	Negligible
Spreading of the sediments	Low	Negligible	Negligible
Operation phase			
Underwater noise	Low	Negligible	Negligible

[1]Impact assessment will be detailed in Natura assessment, based on the latest munitions survey data and on the study of mitigation measures applicable to clearance activities.
[2]For precautionary reasons, impact significance at individual level.
[3]

Table 11-60. Significance of the impacts on receptors in the protected areas with underwater habitats and/or birds as conservation objectives.

Impacts on ecological values in protected areas	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Protected areas with underwater habitats as conservation objectives			
Construction phase			
Spreading of the sediments	Medium	Negligible	Negligible
Operation phase			
Spreading of the sediments	Low	Negligible	Negligible
Protected areas with bird species as conservation objectives			
Construction phase			
Disturbance and airborne noise	Low	Negligible	Negligible
Underwater noise	Medium	Negligible	Negligible
Spreading of the sediments	Low	Negligible	Negligible
Operation phase			
Disturbance and airborne noise	Low	Negligible	Negligible
Underwater noise	Medium	Negligible	Negligible
Spreading of the sediments	Low	Negligible	Negligible

11.10 Non-indigenous species

This chapter presents the risk related to the new introduction of non-indigenous species (NIS) as a result of NSP2 and the potential impacts on the aquatic environment. The impacts are assessed for the construction and operation phases of NSP2 in the Finnish part of the project area.

Summary of the impact assessment in relation to non-indigenous species	
Lessons learned from the Nord Stream Project in 2009–2012	This issue was not addressed during the Nord Stream Project.
Main results of the assessment	The spreading of NIS due to construction or operation of the planned pipelines within the Finnish EEZ is assessed to be negligible. The volume of discharged ballast water is small compared with the total volume of ballast water in the Baltic Sea and the Gulf of Finland. The risk is highest when vessels are arriving for the first time to the Baltic and carry ballast water of non-Baltic origin.

11.10.1 Impact mechanism

Maritime traffic is an efficient vector of NIS. The increase in vessel size and drive speed have increased the successful invasion of NIS *(Raateoja and Setälä 2016)*. NIS may be introduced to a specific area through the release of ballast water or by spreading due to hull fouling. Vessels carry ballast water to ensure stability. Ballast tanks contain water but typically also sediment that could function as a source for a variety of organisms. An invasion process includes four phases: arrival, establishment, expansion and adjustment. Not all NIS become invasive, i.e. an alien species population undergoes an exponential growth stage and rapidly extends its range, settle in a new area and cause detrimental effects on the marine environment *(HELCOM 2012b)*.

Invasive species are found in all taxonomic groups *(IUCN 2000)*. As described earlier, NIS can become invasive and cause negative impacts on the environment. These impacts are highly species-specific and thus the result caused by the introduction of a NIS is often unpredictable. The newcomer may find a suitable environment without natural competitors, which enables settling. Thereafter there are many possible outcomes. Invasive NIS may for example cause a local decline of native species, an alteration of native communities (population structure) or habitats and/or a change in the functioning of the food web. There are several examples of invasive species in the Gulf of Finland that have caused such impacts (e.g. *Marenzelleria* spp. and *Cercopagis pengoi*, Subchapters 7.9 and 7.14). Invasive species may also hamper the economic use of the sea and lead to economic losses, for example in fishery or due to the cleaning of intake/outflow water pipes of industry that are caused by biofouling.

Table 11-61. Possible impacts of the project activities due to the introduction of non-indigenious species.

Receptor	Project phase	Project activity	Impact
Non-indigenous species	Construction	Munitions clearance	Risk of the introduction of NIS through the release of ship's ballast water or by spreading due to hull fouling
		Rock placement	
		Pipe supply	
		Pipe-laying	
		Anchor-handling	
	Operation	Monitoring and surveying	Risk of the introduction of NIS through the release of ship's ballast water or by spreading due to hull fouling
		Maintenance rock placement as required	
		Pipelines on the seabed	Risk of spreading of NIS along the pipeline structures

11.10.2 Methods and data used

Impacts on aquatic biota that would be caused by the unintentional introduction of NIS are assessed as an expert opinion. The assessment is based on existing research about NIS in the Baltic Sea. Ballast waters are subject to international, legally binding agreements and recommendations. When assessing potential impacts, these agreements have been taken in consideration (Subchapter 11.10.4).

11.10.3 Impact assessment

11.10.3.1 Sensitivity of the area

As a whole, the Gulf of Finland is considered as one of the highest risk areas for NIS introductions in the Baltic Sea. This is due to the low number of native species; available ecological niches have facilitated the establishment of NIS *(Paavola et al. 2005)*. In the Gulf of Finland, the large port areas are particularly prone to new introductions. The sensitivity is high when the focus is on risks.

The sensitivity of the project area is also related to the condition and diversity of the populations of the aquatic (mainly plankton) or benthic organisms in the area. In any case, the impact can be considered high if the new introduction and concurrent establishment of alien species occurs as a result of project activities during the construction or operation phases of NSP2, either in offshore areas or port areas used by NSP2 vessels.

11.10.3.2 Construction phase

The risk of new introduction would be highest during the initial construction phase of NSP2 when vessels are entering the Baltic Sea. The environmental characteristics (e.g. climate, salinity regimes in water) of the donor and recipient areas are important. If the water salinity and climatic conditions of the two areas are similar, the risk of unintentional introduction is higher *(Gollasch and Leppäkoski 2007)*. For this reason, vessels transiting the Atlantic are required to exchange their ballast water within the north-east Atlantic before entering the Baltic Sea.

According to General Guidance on the Voluntary Interim Application of the D1 Ballast Water Exchange Standard in the north-east Atlantic and the Baltic Sea, vessels entering the Baltic Sea must exchange their ballast water at least 200 nm from the nearest land in water at least 200 metres deep within North-East Atlantic (see commitment in Subchapter 11.10.4). Thus the risk of unintentional introduction of NIS in the Baltic Sea or elsewhere during the construction phase of NSP2 is extremely low. Therefore the impact significance is assessed as *negligible*.

11.10.3.3 Operation phase

Ship traffic associated with maintenance is minor compared with the construction phase, and vessels are committed to measurements that decrease the risk of unintentional introduction of NIS via the discharge of ballast water. Thus the risk of new introduction of NIS via ballast water discharge during the operation phase of NSP2 is *negligible*.

Theoretically, NIS could migrate along the pipeline structures if the pipelines serve as artificial reef and thereby bridge otherwise discrete hard-bottom areas. External inspections of the NSP pipelines in the Finnish sector have shown the plain surface of the pipes, indicating no formation of epifauna or reef structure *(DeepOcean 2015)*. Furthermore, oxygen conditions in the Finnish sections of the planned pipeline are presently poor, and permanet/recurring oxygen deficiency can be seen as a barrier to benthic NIS migration. Therefore the spreading of non-indigenous benthic species along the pipeline structures is highly unlikely and the impact significance is assessed as *negligible*.

11.10.4 Prevention and mitigation of adverse impacts

The eradication of NIS after its invasion and establishment is practically impossible, and mitigation of impacts is challenging or even impossible. Therefore the prevention of new NIS introductions is of the utmost importance.

The international legally binding agreements and recommendations are the most important means for control and management of NIS. The most important agreements are presented in Chapter 6. Finland ratified the IMO International Convention for the Control and Management of Ships' Ballast Water and sediments (BWMC) on 8 June 2016. This legally binding agreement will come into force globally on 8 September 2017.

Under the convention, all ships in international waters are required to manage their ballast water and sediments to a certain standard, according to a ship-specific ballast water management plan. Ballast water management plans will include measures to ensure adherence to OSPAR/HELCOM General Guidance on the Voluntary Interim Application of the D1 Ballast Water Exchange Standard in the North-East Atlantic. To reduce the risk of non-indigenous species invasion through ballast water, Project vessels will conduct ballast water exchange before entering the Baltic Sea Area. Vessels leaving the Baltic and transiting through the North-East Atlantic to other destinations will not exchange ballast water in the Baltic or until the vessel is 200 nm off the coast of North-West Europe and in waters deeper than 200 m. Ballast tanks will be cleaned regurarly and washing water delivered to reception facilities ashore in line with IFC EHS Guidelines on shipping and the International Convention for the Control and Management of Ships Ballast Water and Sediments.

11.10.5 Lack of information and uncertainties

Generally, there is uncertainty related to the volume of ballast water exchanged in the Gulf of Finland and other parts of the Baltic Sea because it has been estimated indirectly. The BWMC requirement for ships to have a ballast water record book will result in more realistic estimates of discharge volumes in the future. At the population or ecosystem level, it is challenging to predict the outcome the introduction of certain NIS. Therefore it is highly important to prevent or decrease the spreading rate of new species. If introduction occurs and a new species is recorded, it would be difficult to trace the source, as the Gulf of Finland is among the busiest shipping lanes in the Baltic.

11.10.6 Significance of the impacts

The risk for spreading of NIS due to construction or operation of the planned pipelines within the Finnish EEZ is assessed to be insignificant. There are no differences between sub-alternatives and construction alternatives.

Table 11-62. Significance of the impacts on receptors in the protected areas.

Impacts on non-indigenous species	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Discharge of ballast water	High	Negligible	Negligible
Operation phase			
Discharge of ballast water	High	Negligible	Negligible
Spreading along the pipeline structures	High	Negligible	Negligible

11.11 Biodiversity

This chapter describes impacts on biodiversity. The status of biodiversity in the Gulf of Finland is currently assessed to be at an unacceptable level *(Government decision 13.12.2012)*. Generally, changes in the environment that result in a decrease in biodiversity are considered to make the natural environment less resilient to change *(HELCOM 2009)*. In ecosystems characterised by low diversity, such as the Gulf of Finland and the Baltic Sea as a whole, the protection of biodiversity is central to ensuring a functioning and resilient ecosystem *(HELCOM 2009)*.

Summary of the impact assessment on biodiversity	
Lessons learned from the Nord Stream Project in 2009–2012	The Nord Stream monitoring reports include only a few mentions of impacts on biodiversity. On the basis of monitoring results, it has been noted, however, that the impacts from construction works are so minor that they could not have any permanent negative impact on biodiversity in the open water habitats in the Finnish EEZ.
Main results of the assessment	Direct mechanical disturbance of the seabed is spatially local. Impacts caused by sediment dispersion (changes in water quality and sedimentation) are assessed to be local and short-term. Based on these impacts, the effect on biodiversity was assessed as negligible. The physical loss of habitats has been identified to be among the new threats to biodiversity in Finnish waters. The footprint of the pipelines (water depth less than 60 m) that can be seen as a measure of potential impacts on biodiversity (benthos) is small in the Finnish EEZ and, thus, impacts caused by occupation of the seabed was assessed as negligible. Moderate impacts are assessed to affect only the Gulf of Finland ringed seal population and grey seals. Since the remaining links in the chain of biodiversity remain unaltered, the ecosystem as a whole is likely to withstand minor or even moderate changes.

11.11.1 Impact mechanism

Impact mechanisms are the same as those discussed earlier in chapters concerning seabed morphology and sediments (Subchapter 11.2), hydrography and water quality (Subchapter 10.3) and the biotic environment (Subchapters 11.5–11.9).

Generally, the major threats to biodiversity (i.e. the marine environment in the Gulf of Finland) are eutrophication and hazardous substances (caused by external and internal load) *(Laamanen 2016)*. Also, non-indigenous species are causing pressures to native populations. Additionally, new threats, such as the physical loss of habitats or other physical interference such as e.g. underwater noise have been identified. Among the potential identified impacts, underwater noise during construction was identified as the mechanism with the highest potential to pose negative impacts (Subchapter 11.7). During operation, the footprint of the pipelines could theoretically cause impacts on biodiversity by occupying the seabed and causing changes to the habitat.

Table 11-63. Possible impacts of the project activities on biodiversity.

Receptor	Project phase	Project activity	Impact
Biodiversity	Construction	Munitions clearance	Disturbance due to underwater noise (marine mammals and other potential biotic receptors)
		Construction activities (munitions clearance, rock placement, pipe supply, pipe lay)	Disturbance due to underwater and airborne noise and visual disturbance
	Operation	Footprint of the pipelines	Occupation of the seabed by pipelines and support structures, change to the habitat

Based on the impact assessment subchapters above (11.5–11.10), the following potential impacts have been scoped out as their impact significance is assessed to be *negligible*:

Project phase	Impact
Construction	Direct physical disturbance on the seabed Disturbance due to sediment dispersion and the release of nutrients and contaminants Introduction of non-indigenous species
Operation	Changes to the habitat Change of sedimentation and erosion patterns caused by the pipeline on the seabed Release of metals from anodes Introduction of non-indigenous species

11.11.2 Methods and used data

Impacts on biodiversity have been assessed as an expert opinion based on existing research information about the biodiversity status in the Baltic Sea. The sensitivity of the target is taken into account when the significance of the possible impacts is assessed.

Biodiversity is a complex concept that is used to describe the variability within species (i.e. genetic diversity), between species (i.e. species diversity) and between ecosystems. Biodiversity is maintained if the complex network of interactions between species is not disrupted and if the community of species is able to withstand changes and recover from them *(Balvanera et al. 2006, Loreau et al. 2002)*. The measurement of biodiversity in natural ecosystems is a challenging task, for which the methodology (how to measure and assess the status of each different species/link in the chain of biodiversity and evaluate their relationship) is still largely debated in the scientific community. In this EIA, the impact on biodiversity is analysed at three different levels: species, habitat and ecosystem which is assessed to be in compliance with the MSFD. Impacts at the **species level,** presented in this chapter, are a summary of impacts previously described (Subchapters 11.5–11.10). In particular, impacts defined at the *individual level* in the chapter on marine mammals (Subchapter 11.7) have been excluded from this assessment because they do not have consequences at the species level. Impacts defined at the *population level* in the chapter on marine mammals (Subchapter 11.7) are here considered as impacts at the species level for precautionary purposes, because the impacts to a population may have consequences for a given species on a larger scale. It should, however, be noted that neither ringed seals nor grey seals are protected species internationally (IUCN). Impacts at the **habitat level** are considered here as those impacts that are likely to change the abiotic characteristics of the habitat. Potential impacts at the **ecosystem level,** including impacts on food webs, are summarised in the Espoo report. Only impacts with *minor* significance or higher are considered when overall impacts on biodiversity are assessed.

The impacts on specific targets are assessed at the **species**- and **habitat** level. The specific targets identified to be potentially affected are:

Species level	Habitat level
Soft-bottom benthic species	Soft-bottom habitats and typical communities for these habitat types
Hard-bottom benthic species	Hard-bottom habitats, important habitats (e.g. reefs) and communities typical for these habitat types
Fish (e.g. sprat, herring)	Offshore spawning areas, fish communities
Marine mammals (ringed seal, grey seal, harbour porpoise)	Haul-out sites, and Natura 2000 sites/other protected areas designed for marine mammals (seals in Finland) and typical communities in these areas
Sea birds (e.g. divers)	Important bird areas

The present status of biodiversity has been assessed to vary between moderate and bad in the Gulf of Finland (Figure 7-48) and is, therefore, defined to be at an unacceptable level *(HELCOM 2010a)*. As biodiversity is among the key elements affecting the functioning and resilience of an ecosystem, the sensitivity is assessed as *high*. However, it should be noted that the sensitivity of different components of biodiversity vary in the assessment at the species level (e.g. benthos, fish, marine mammals, birds etc.). Similarly, the sensitivity of the different components at the habitat level (e.g. different underwater habitat types) also vary. The sensitivity criteria for these components have been described in Subchapters 11.5–11.9.

11.11.3 Impact assessment

11.11.3.1 Construction phase

Underwater and airborne noise

Construction activities will generate underwater and airborne noise. Among the identified noise sources, munitions clearance which causes high underwater noise peaks is the loudest activity. The most significant impact targets are marine mammals and, to a smaller extent, fish and birds. These impacts are assessed in Subchapters 11.6, 11.7 and 11.8. For birds and fish, the impacts are considered to occur only at the *individual level*. For birds, noise impacts are connected mainly to disturbance that cause them to fly away and move to more peaceful locations to rest and/or feed. For birds, the impact significance is assessed as *negligible* based on NSP monitoring. Due to the short duration of the noise, **species level** impacts are not expected for either fish or birds.

Marine mammals are sensitive to blast injuries as well as hearing damage caused by detonations. The relevant impact targets in Finnish waters are ringed seal and grey seal.

As described in the baseline (Subchapter 7.11), there are two distinct and independent subpopulations of ringed seals in the study area: the Gulf of Finland subpopulation and the Gulf of Riga subpopulation. The Gulf of Finland subpopulation is a small and declining population where each individual seal is considered demographically important (Appendix 8B). In contrast, the Gulf of Riga subpopulation is considered to be a larger and healthier population.
With the implementation of the mitigation measures that NSP 2 is committed to (Subchapter 11.11.4), the impact significance of PTS and blast injury is assessed to be at most *moderate* for the Gulf of Finland ringed seals, and at most *minor* for the Gulf of Riga ringed seals. It is assessed that this corresponds to a *moderate* impact to biodiversity at the **species level**.

However, it should be noted that this is a precautionary approach: impacts are different along different sections of the Finnish EEZ and, as discussed, the two populations of ringed seals present in the Finnish EEZ are in a very different state.

The grey seals occurring in the Gulf of Finland and Northern Baltic proper are considered to belong to the large Baltic Sea population. This population is currently healthy and numerous and has been increasing over the last decades. The impact significance of PTS and blast injury for grey seals is assessed to be minor after the application of mitigation measures. This corresponds to a ***minor*** impact to biodiversity at the **species level**.

The changes in abiotic conditions due to the introduction of underwater noise are local and short-term (Subchapter 11.4). For this reason, impacts to biodiversity at the **habitat level** are assessed to be *negligible*.

11.11.3.2 Operation phase

The physical loss of habitats has been identified to be among the new threats to biodiversity in Finnish waters *(Laamanen 2016)*. These impacts are described and discussed in Subchapters 11.5 and 11.9. The negative impacts may potentially be caused by the deterioration of the habitat structures and the connectivity of habitats. Connectivity between habitats and habitat integration, in general, may weaken if the area of the specific habitat type is significantly diminished. Impacts on biodiversity would be possible if the footprint of the pipelines and support structures would be so large as to cause a decline in the area and, thus, representativeness of specific habitat types (e.g. reefs, soft-bottom habitats). In the Finnish section of the planned pipelines, more sensitive areas (such as potential reefs, see Subchapter 7.9) may occur near the Sandkallan Natura 2000 site and at the entrance of Porkkala. Other pipeline sections are situated in deeper areas where soft seabed sediments are predominant and conditions for life are generally poor.

During operation, the only species level impact that has been assessed to occur is to benthic species. The significance of the impact is assessed as *minor* at **species level** because the footprint of the pipeline system is roughly only 0.02% of the area at the depth zone of less than 60 m.

Although the above-mentioned impact is long-term, owing to a very small percentage of seabed coverage taken up by the pipeline system, the impact significance at the **habitat level** is assessed as *negligible*.

11.11.4 Prevention and mitigation of adverse impacts

Biodiversity can be seen as an outcome of each specific component that together forms biodiversity. Thereby biodiversity is a holistic view of the condition of the ecosystem. The main indicators reflecting the status of the biodiversity are landscapes (biotopes / habitats), communities and species *(HELCOM 2010a)*. Thus, the mitigation measures summarised in Chapter 17 are relevant also with respect to biodiversity conservation.

11.11.5 Lack of information and uncertainties

There are a multitude of pressures that can influence the various components of biodiversity and the relative impact of an individual pressure is difficult to discern. The state of the biodiversity is determined by the cumulative and synergistic impacts of all the pressures *(HELCOM 2010a)*. Thus, any lack of information related to an individual component of biodiversity introduces uncertainty when impacts on biodiversity are assessed. Additionally, the nature and interactions between different components of biodiversity is also a source of uncertainty because it is often unclear what the consequences are to the rest of the network when one of the components is affected.

Underwater noise has been identified as the least understood pressure on the marine biodiversity in the Baltic Sea *(HELCOM 2010a)*. Marine mammals are identified to be the most important impact receptor for underwater noise in this EIA and a discussion of the uncertainties related to marine mammals is provided in Subchapter 11.7.

11.11.6 Significance of the impacts

The impacts on biodiversity from construction and operation of the planned NSP2 pipeline within the Finnish EEZ are summarised in Table 11-63. Only the most relevant impacts identified during the assessment to the different components of biodiversity (benthos, fish, birds, marine mammals) and the potential impacts to their habitats have been presented.

No measurable difference between the alternative routes (ALT E1/E2, ALT W1/W2) as regards different receptors is expected. Benthos diversity is considered the most sensitive receptor since the route alternatives are mostly situated in rather deep areas where benthic communities are generally in a poor condition due to oxygen deficiency.

When summing up all impact significances to biodiversity, the activity with the highest potential impacts is munitions clearance. With regards to **species level** assessment of biodiversity, it is assessed that munition clearance may have population level consequences to the ringed seal population of the Gulf of Finland. The population level consequences are assessed to be long-term but reversible as the effect will disappear when the affected animal eventually dies (Appendix 8B). No other impact is assessed to be more than *minor*.

No impacts at the **habitat level** are foreseen. This is due to the small footprint of the pipeline and negligible sedimentation during construction in areas near to the construction sites. The ecosystem level impacts are assessed in the ESPOO report.

From an overall analysis of the impacts to biodiversity, it is assessed that the project activities are not likely to cause long-term detrimental effects to biodiversity in the impact area. Biodiversity is maintained if the complex network of interactions between species is not disrupted and if the community of species is able to withstand changes and recover from them. The *moderate* impacts assessed to affect only the Gulf of Finland ringed seal population and is not likely to affect the capability of the entire community to thrive and withstand changes. This is because the impacts are assessed to be at most *moderate* to only one of the many links in the chain of biodiversity (ringed seals in the Gulf of Finland) while the other links are not going to be affected. Since the remaining links in the chain of biodiversity remain in their current state (as it is assessed to be the case), the ecosystem as a whole is likely to withstand minor or even moderate changes.

Therefore, the moderate impacts to the ringed seals in the Gulf of Finland are not assessed to have long-term consequences on the biodiversity of the project area.

Additionally, it should be mentioned that NSP2 is currently investigating alternative clearance methods with the objective to further reduce the assessed impacts.

Table 11-64. Significance of the impacts on biodiversity.

Impacts on biodiversity	Impact target	Species level	Habitat level
Construction phase			
Underwater noise (blast injury)	Fish and birds	Negligible	Negligible
Airborne noise, visual disturbance	Birds	Negligible	Negligible
Underwater noise (blast injury, hearing loss)	Ringed seal	Minor to Moderate	Negligible
Underwater noise (blast injury, hearing loss)	Grey seal	Minor	Negligible
Operation phase			
Occupation of the seabed, change of habitat	Soft-bottom and hard–bottom benthos	Minor	Negligible

11.12 Ship traffic

Gulf of Finland is a major sea route to Finnish, Estonian and Russian ports. There is also a ferry route between Estonia and Finland. Therefore it is important to assess how the NSP2 project activities will impact on the ship traffic in the Finnish EEZ. The impact mechanism is related to disturbance of ship traffic as a result of the safety zone around the construction and maintenance vessels.

Summary of impact assessment in relation to ship traffic	
Lessons learned from the Nord Stream Project in 2009-2012	Ship traffic and the impact between third-party ships and project vessels during NSP have been studied. It was concluded that ships occasionally entered the safety zone (mainly at the early stage of the NSP project). However, no significant incidents were observed.
Main results of the assessment	The significance of the impact on ship traffic during the construction phase is assessed to be minor as a consequence of integrated mitigation through marine notifications. The sensitivity of the ship traffic with regard to the impact of the temporary safety zone around project vessels is low, and the minor adjustments required to navigate around the safety zones lead to a low magnitude of change. However, there are two exceptions: • TSS Off Kalbådagrund. As with NSP, special mitigation measures should be considered during pipe-laying in the TSS due to the shoal to the north of the westbound shipping lane and the temporary disturbance of traffic in the westbound traffic lane. • TSS Off Porkkala Lighthouse. The flow of ship traffic is complex, therefore further discussion and planning with Finnish Transport Agency (FTA) is required. The overall significance of the impact on ship traffic during the operation phase is assessed to be negligible. This is a consequence of the low sensitivity of the ship traffic towards the negligible impact resulting from offshore inspection and, if required, maintenance activities.

11.12.1 Impact mechanism

Table 11-65. Possible impacts of the project activities on ship traffic.

Receptor	Project phase	Project activity	Impact
Ship traffic	Construction	Munitions clearance	Disturbance of ship routing due to presence and movement of construction vessels.
		Rock placement	
		Pipe supply	
		Offshore pipe-laying	
		Anchor-handling	
	Operation	Monitoring and surveying	Disturbance to ship routing due to presence and movement of maintenance and survey vessels.
		Maintenance activities such as rock placement, if required	

11.12.2 Methods and data used

Impacts on ship traffic have been assessed as an expert opinion and on the basis of the Ship Traffic Background Report. Ship traffic statistics are presented in the baseline section of this EIA (Subchapter 7.16.1). No major changes in the volume of ship traffic during the construction phase in comparison with baseline traffic (2014) in the Gulf of Finland that would affect this assessment are expected *(Nord Stream 2 AG and Ramboll 2016a)*.

Ship traffic control measures are presented in the baseline section of this report (Subchapter 7.16.1). These comprehensive traffic control measures will be continued during the construction and operation phases.

The significance of the impact (sensitivity of receptor and magnitude of change) on ship traffic has been assessed based on the tables below.

It is assessed that the sensitivity (i.e. resistance to change and adaptability) of ship traffic depends largely on the available space and water depth in the sea area used by the construction and maintenance vessels.

The assessment of the sensitivity is based on the existing shipping conditions along the pipeline route. The sensitivity is considered to be *low*, as there is sufficient space and water depth for other ships to smoothly navigate. Exceptions are the TSS Off Kalbådagrund (sufficient space and water depth) and the TSS Off Porkkala Lighthouse (sufficient space, the complex nature of the crossing and merging traffic). In these areas, the sensitivity is assessed to be *medium*

Table 11-66. Sensitivity of receptor (ship traffic).

Low	In the vicinity of the project activities there is sufficient space or water depth for other ships to plan their journeys and smoothly navigate.
Medium	In the vicinity of the project activities there is limited space or water depth for other ships to plan their journeys and smoothly navigate.
High	In the vicinity of the project activities there is not sufficient space or water depth for other ships to plan their journeys and smoothly navigate.

Table 11-67. Magnitude of change (ship traffic).

Negligible	Project activities have no or negligible impact on ship traffic.
Low	Project activities have a local and temporary impact on ship traffic.
Medium	Project activities have a minor long-term impact on ship traffic. The smoothness of traffic flow is reduced in places or journey times are slightly increased.
High	Project activities have a major long-term impact on ship traffic. The smoothness of ship traffic flow is reduced permanently. Long-term traffic restrictions are imposed on other traffic.

11.12.3 Impact assessment

The pipeline route crosses in and out of the main route for commercial traffic in the Gulf of Finland. In the TSS Off Kalbådagrund, the pipeline runs in the southern margin of the westbound traffic lane. After that, the pipeline runs north of the main route and crosses the ferry route between Helsinki and Tallinn north of the TSS Off Porkkala Lighthouse. In the western part of the TSS Off Porkkala Lighthouse, the pipeline traverses the westbound traffic and runs to the south of the westbound traffic lane. Between the TSS Off Porkkala Lighthouse and the TSS Off Hankoniemi Peninsula, the pipeline runs south of the main route mainly in the separation area between the two traffic lanes. West of the TSS Off Hankoniemi Peninsula, the pipeline crosses from the south of the westbound traffic lane to run north of the main ship traffic route.

11.12.3.1 Construction phase

The impact assessment for the construction phase considers the temporary safety zone (third-party exclusion zone) established around the pipe-laying vessel and other project vessels (survey, rock placement). These vessels have limited ability to manoeuvre, and they are either stationary or move very slowly. This means that the impact from the project vessels including the pipe-laying vessel will be of the similar in character but the scale of the impact is dependent on the size of the safety zone. The safety zone around the pipe-laying vessel and its associated support vessels has the largest radius. Consequently, it will have the largest impact on ship traffic. For this reason, the assessment focuses on the impact from the actual pipe-laying activities.

The lay barge installing the pipeline will move along the pipeline route at a rate of approximately 2–3km per day. In the NSP project, a safety zone was applied with a radius of a 1 nm (approximately 2 km) when using a dynamically positioned lay barge and 1.5 nm (approximately 3 km) when using an anchor-positioned lay barge. The extent of the safety zone will be agreed in consultation with the installation contractor and the Finnish Transport Agency. Within the temporary safety zone, transit by third-party vessels and fishing activity should be avoided. Only vessels involved in the construction of the pipeline will be allowed to enter the safety zone. The anticipated impact on ship traffic is that all third-party ships will be requested to reroute around the lay barge safety zone. This impact will be direct but reversible**,** as the safety zone is temporary and centred on the pipe-laying vessel as it moves along the pipeline route.

Furthermore, in addition to information distributed by Notice to Mariners, AIS and NavTex, GOFREP will be able to continuously monitor the situation and VTS will be able to inform the ship traffic about the situation, thereby improving the basis for navigational planning. When the pipe-laying vessel and the associated safety zone is within the main route for commercial traffic in the Gulf of Finland, the width of the fairway will be generally sufficient for ships to safely navigate around the safety zone. Exceptions are the TSS Off Kalbådagrund (Figure 11-22) and the TSS Off Porkkala Lighthouse (Figure 11-23), wherethe safety zone will restrict and for a short period (approximately four to seven days) temporally block the traffic lane.

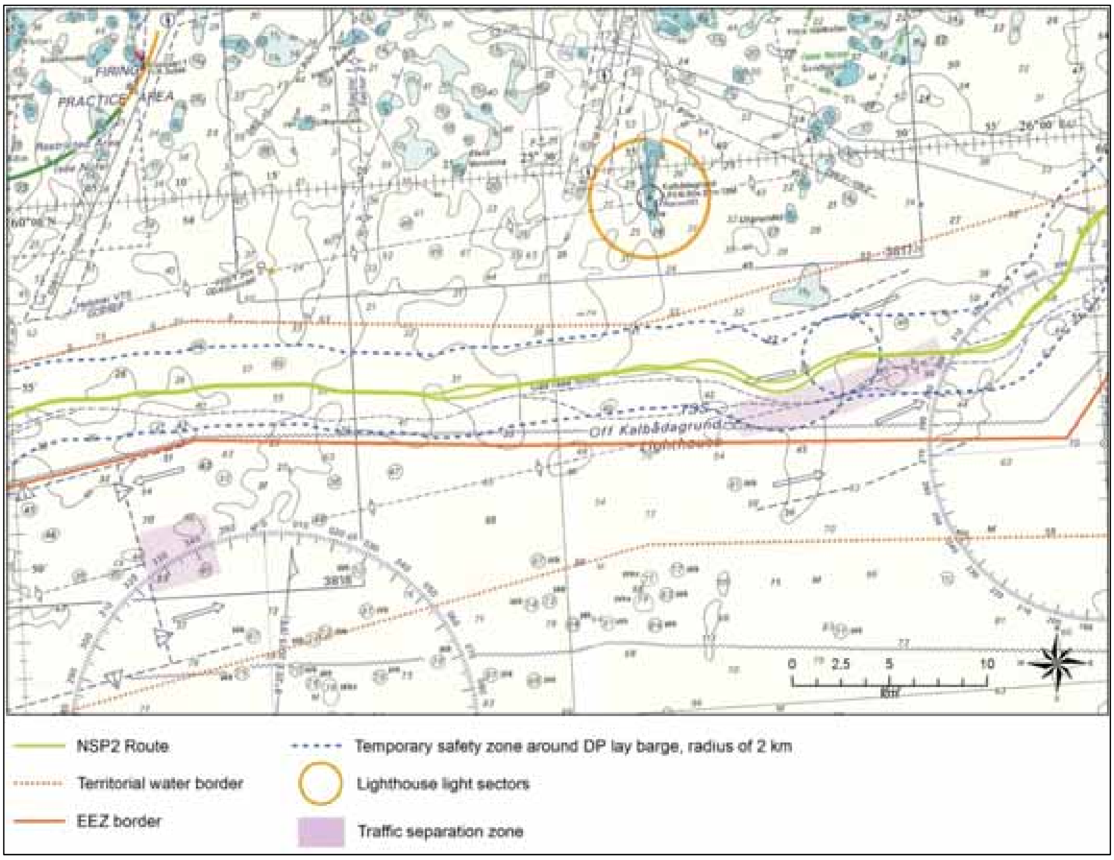

Figure 11-22. Pipeline route in the vicinity of the TSS Off Kalbådagrund.

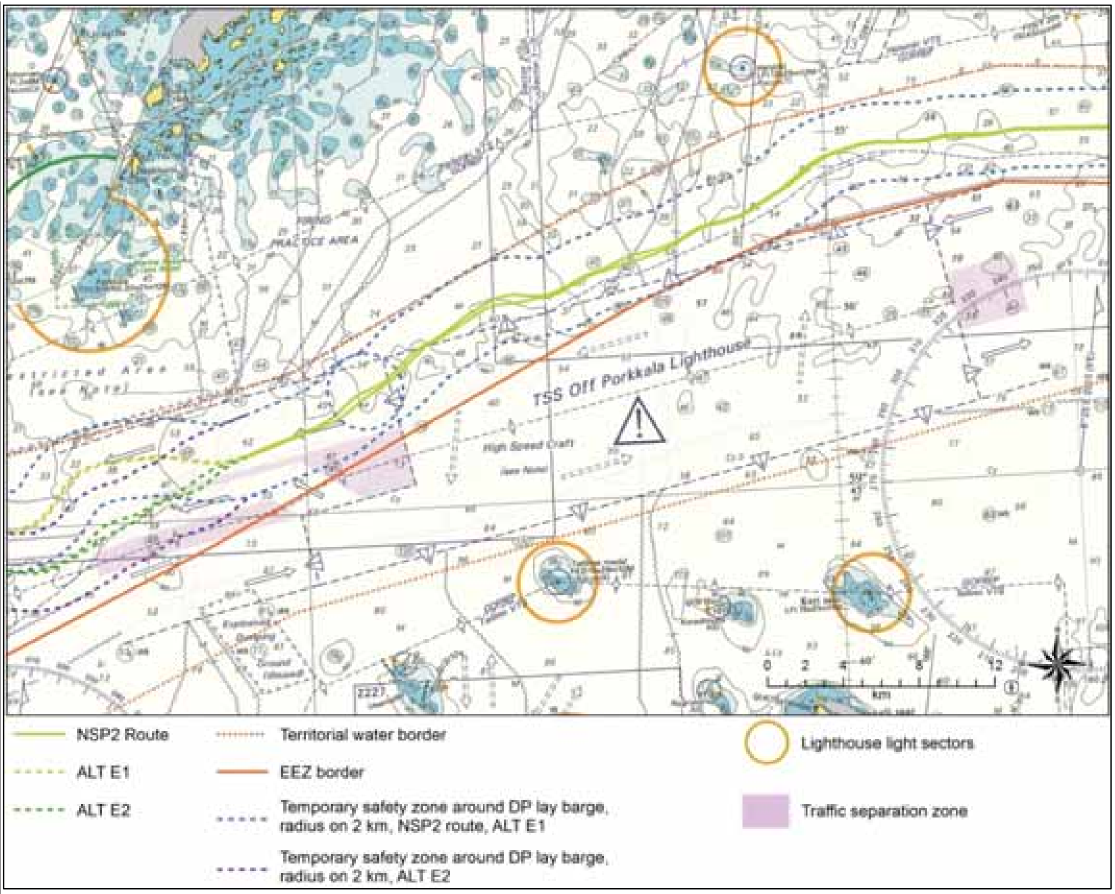

Figure 11-23. Pipeline route in the vicinity of the TSS Off Porkkala.

The total width of the TSS Off Kalbådagrund is approximately 10 km, and just north of the TSS the water depth is limited to 15.1 m. The width of TSS Off Porkkala Lighthouse is approximately 10 km. Therefore consideration must be given during planning of the project to ensure that westbound vessels are given sufficient space to safely navigate around the lay barge and safety zone and remain within the TSS as much as possible. During the construction phase, the agreed solution will be included in the Notice to Mariners, and navigators will be informed through GOFREP. This approach is also included in the section below describing possible mitigation measures.

These considerations are supported by the report "Study on Commercial Ships Passing the Lay Barge" *(Nord Stream 2 AG and Ramboll 2016b)*, which studyies how commercial ships passed the lay barge and safety zone during the construction of NSP. The report shows that in a few situations ships chose to stay within the TSS even if it meant that they had to transit through the safety zone around the lay barge (Figure 11-24). The report also shows that this was done in a safe way and that no very close or dangerous situations between the commercial ship traffic and the lay barge were observed. commercial ships iniated course deviation at an early stage (Figure 11-25).

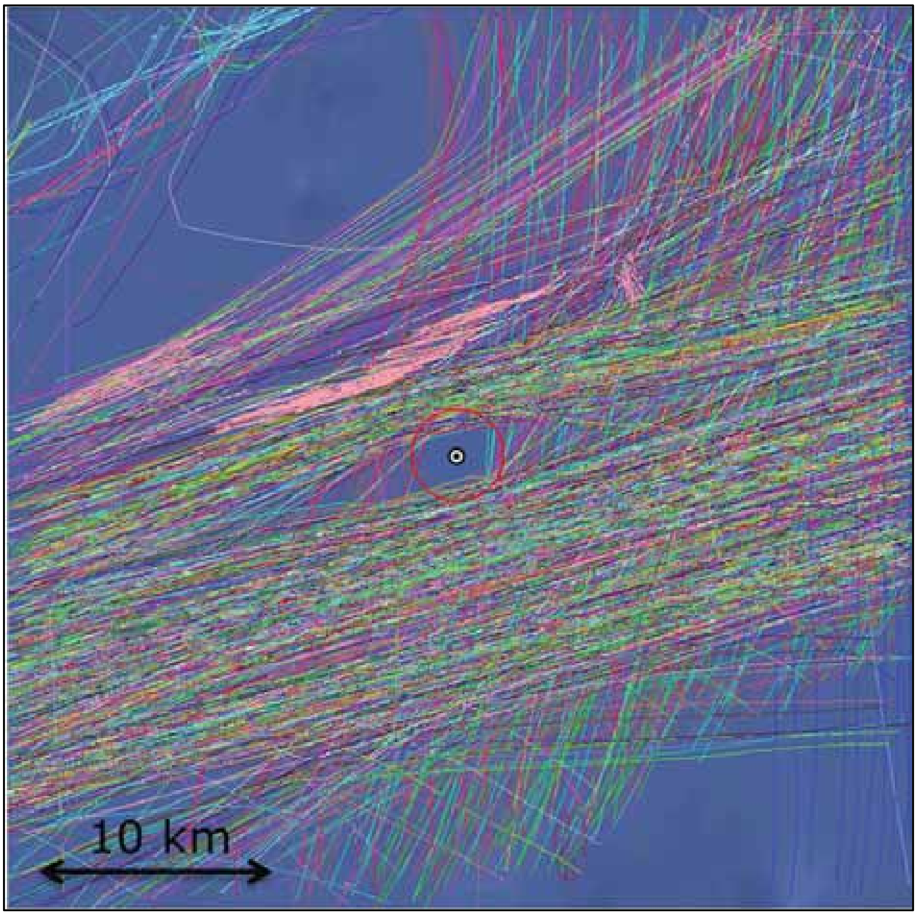

Figure 11-24. Example of how commercial ships passe the lay barge and safety zone during the construction of NSP (Nord Stream 2 AG and Ramboll 2016b).

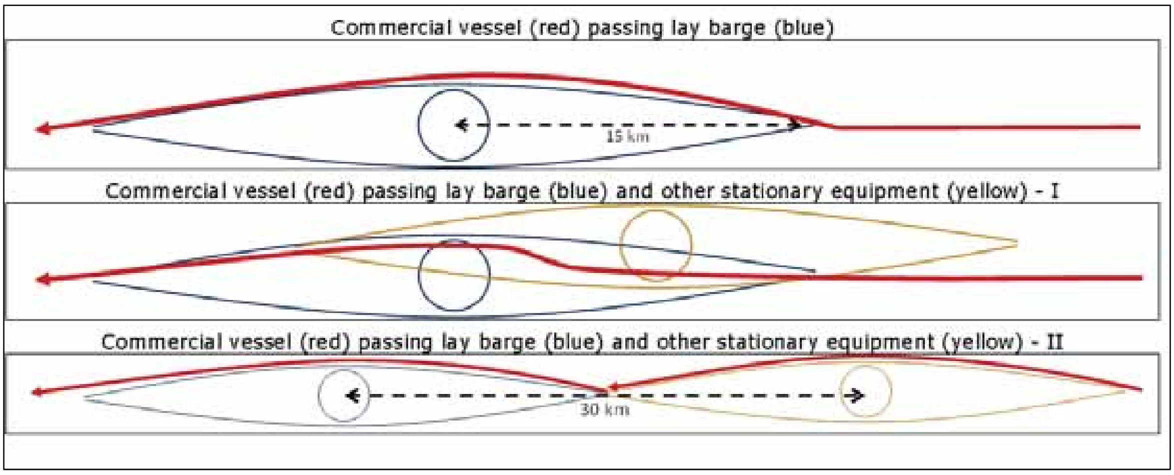

Figure 11-25. Visualisation of early evasive actions by commercial ships during the construction of NSP (Nord Stream 2 AG and Ramboll 2016b).

The main principle is that all vessels will be navigating using the appropriate TSS traffic lane. However, Rule 10 of the Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs) provides navigators the option to deviate from the TSS traffic lane under certain conditions (IMO 1972). The pipe-laying vessel is also exempt from complying with Rule 10 to the extent necessary to carry out the operation.

The pipe-laying vessel and the associated safety zone will also cross the ferry route between Helsinki and Tallinn north of the TSS Off Porkkala Lighthouse, in an area where the ferries will have sufficient water depth to safely navigate around the safety zone.

In conclusion, along most of the pipeline route the magnitude of change will be *negligible.* In consideration of the mitigation measures presented below (Subchapter 11.12.4), the construction of the pipeline will have a negligible impact on ship traffic and will not reduce the efficiency of ship traffic. Furthermore, the increase in ship traffic caused by the project is low.

In the TSS Off Kalbådagrund and in the TSS Off Porkkala Lighthouse, the project activities will have a local and temporary impact on ship traffic. It is assessed that the magnitude of change is *low* with the mitigation measures presented below (Subchapter 11.12.4).

Along both of the eastern route alternatives (ALT E1/E2), the safety zone will restrict and temporarily block the westbound traffic lanes in the TSS Off Porkkala Lighthouse. Therefore there is no difference in impacts between these alternatives. For both of the western alternatives (ALT W1/W2), the construction of the pipeline will have a negligible impact on ship traffic.

11.12.3.2 Operation phase

No project-related vessels will be present along the pipeline route during normal operation of the pipelines. However, external inspection surveys of the pipelines are expected to be carried out on a regular basis. External surveys will probably be conducted at one- or two-year intervals at the beginning of the operation phase. Later in the operation phase, there may be longer intervals between these surveys. The inspection vessels will have a safety zone in the order of 0.25 nm (500 m) and travel along the pipeline route at a speed of approximately 0.5 to 4 knots, depending on the survey method. No incidents have been experienced during NSP inspection surveys.

The safety zone around the survey vessel is significantly smaller than that around the pipe-laying vessel during the construction phase. There is sufficient space and water depth for the ships to plan their journeys and safely navigate around the survey vessels and safety zone area as it moves through the Finnish EEZ, including the ferry route between Helsinki and Tallinn, the TSS Off Kalbådagrund and the TSS Off Porkkala Lighthouse.

In conclusion, during operation the magnitude of change will be *negligible* because with the mitigation measures presented below (Subchapter 11.12.4), inspection and maintenance of the pipeline (if required) will not reduce the efficiency of the ship traffic. The conclusion is the same for all route alternatives ALT E1/E2 and ALT W1/2.

11.12.4 Prevention and mitigation of adverse impacts

Nord Stream 2 and its Contractors will provide information on project vessels' plans and schedules to the Finnish Transport Agency for Notices to Mariners. The information will be provided in notifications and monthly, weekly and daily reports to be completed by NSP2 or NSP2 Contractors.

At Traffic Separation Scheme (TSS) Off Kallbådagrund and TSS Off Porkkala Lighthouse, consultation will be taken with the pipelay contractor and relevant authorities, to reduce the safety zone around the pipelay vessel from a radius of 1.0 nm to a radius of 0.5 nm.

NSP2 will station a tug in the area of Off Kalbådagrund traffic separation scheme (TSS) during pipelay operations in order to reduce the risk of a ship grounding. The tug will be on standby to assist contractor and 3rd party vessels by towing and pushing as necessary.

Nord Stream 2 will notify the Finnish authorities of unplanned events during pipeline operation.

11.12.5 Lack of information and uncertainties

The available information is consider sufficient for the assessment. Assessment is based on the experience gained during the Nord Stream Project.

11.12.6 Significance of the impacts

Based on the evaluations and assessments presented above the overall significance of the impact on ship traffic during construction is assessed to be *negligible* along most of the pipeline route, and *minor* in the TSS Off Kalbådagrund and in the TSS Off Porkkala Lighthouse.

The overall significance of the impact on ship traffic during operation is assessed to be *negligible* along the whole pipeline route.

Regarding impacts on ship traffic, there are no substantial differences between sub-alternatives and between construction alternatives.

Table 11-68. Significance of the impacts on ship traffic.

Impacts on ship traffic	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Project construction activities along most of the pipeline route	Low	Negligible	Negligible
Project construction activities at the TSS Off Kalbådagrund and TSS Off Porkkala Lighthouse	Medium	Low	Minor
Operation phase			
Project maintenance activities along the whole pipeline route	Low	Negligible	Negligible

11.13 Commercial fishery

The purpose of this assessment is to identify the possible impacts of the pipeline project on fishery in the Finnish EEZ. This assessment addresses only fishery by Finnish vessels in the Finnish EEZ. Fishery in the Finnish EEZ by other parties is addressed in the transboundary impact assessment (Chapter 13). Impacts on Finnish fishery in other areas of the Baltic Sea are addressed in the Espoo Report. Impacts on fishery may occur both during the construction and operation phases. During construction, trawling activities within the safety zone of the construction vessels is prohibited, and during the operation phase the presence of the pipelines on the seabed will hinder trawling activity.

Summary of impact assessment on commercial fishery	
Lessons learned from the Nord Stream Project in 2009-2012	Experience from the Nord Stream Project show that offshore fishery can coexist with the pipelines. Thus far, no gear has been reported lost or damaged, even though there has been unwanted contact between pipelines and trawl gear according to the external inspections of NSP (DeepOcean 2015). In most locations, natural embedment of the pipelines – depending on the seabed conditions – has significantly reduced the risk and inconvenience for near-bottom trawling activities. According to analyses of the trawling pattern of the Finnish offshore trawling fleet, the presence of the pipelines has not changed the proportion of trawling activities in the area of NSP.
Main results of the assessment	The significance of the impact in the construction phase is assessed to be negligible because the construction vessels and surrounding safety zone exclude only a fraction of the fishing ground at a time. The pipe-laying vessel moves about 2.5 km per day and poses no hindrance to fishing in any location more than a day. During the operation phase, the magnitude of change is assessed to be low because there will be many freespanning pipeline sections, which makes the pipelines worth avoiding for safety reasons. However, the pipelines do not make the project area untrawlable because the prevailing trawling method in the area is mid-water trawling. Therefore the overall significance of the impact on fishery is assessed to be minor.

11.13.1 Impact mechanism

The assessed impacts on fishery have been identified by considering the various project activities during the construction and operation phases and the impacts of these activities on fishery in the Finnish EEZ.

During the construction phase, the pipe-laying vessel will be protected by a safety zone. Even though the pipe-laying vessel will move about 2–3 km per day, the safety zone will prevent fishing vessels from entering the safety zone and thus prevent fishing activity in the same area.

During the operation phase, the most relevant assessed impact is the potential of the pipelines to hinder near-bottom midwater trawling. The risk of trawl boards getting snagged, forces trawlers to leave space between their trawl gear and the pipeline, in order to avoid contact with it. The pipeline itself is built to withstand the mechanical stress caused by trawl gear.

Table 11-69. Possible impacts of the project activities on commercial fishery.

Receptor	Project phase	Project activity	Impact
Fishery	Construction	Munitions clearance	Disturbance due to safety zone around construction vessels
		Rock placement	
		Pipe supply	
		Offshore pipe-laying	
		Munitions clearance	Fish fleeing the area due to construction activities – hindrance to fishing in normal fishing grounds
		Rock placement	
		Offshore pipe-laying	
	Operation	Pipelines on seabed	Hindrance of near-bottom trawling activity
			Damage to fishing gear

11.13.2 Methods and data used

The assessment of the impact of the Nord Stream 2 Project on fishery is based on interviews with employees in the fishery sector regarding their fishing methods in the Finnish EEZ. Catch statistics of commercial fishing from southwestern Finland ELY-centre (ICES rectangles in the Baltic Sea) and statistics of fishing intensity based on satellite tracking were used to represent the Finnish fishing effort. Modelling studies of sediment spreading due to seabed intervention works, modelling studies of trawling frequency and the risk of the pipelines to fishing vessels and scale model studies of pipeline overtrawlability were used to evaluate the potential impacts from the pipeline project on Finnish offshore fishery. The technical design of the pipeline itself is the same as NSP, and the scale model results and conclusions *(Sintef 2009)* related to pipeline overtrawlability are quoted from the NSP EIA Report.

The significance of the impact (sensitivity of receptor and magnitude of change) on fishery has been assessed based on the methods and categories presented in Chapter 10 and Table 11-70 and Table 11.71.

Table 11-70. Sensitivity of receptor (fishery).

Low	Area of low importance to fishery and especially to trawling close to the seabed. Fish catch from the area forms only a small part of the total catch of Finnish commercial fishery in the Finnish EEZ.
Medium	Area of medium importance to fishery and especially to trawling close to the seabed. Fish catch from the area forms a moderate part of the total catch of Finnish commercial fishery in the Finnish EEZ.
High	Area of high importance to fishery and especially to trawling close to the seabed. Fish catch from the area forms a significant part of the total catch of Finnish commercial fishery in the Finnish EEZ.

Table 11-71. Magnitude of change (fishery).

Negligible	The project has no detectable impacts on fishery.
Low	Pipelines on the seabed and freespan sections cover only a small part of the important fishing areas and force commercial fishing vessels to avoid the pipelines but do not affect the ability to continue fishery in the project area.
Medium	Pipelines on the seabed and freespan sections cover a moderate part of the important fishing areas and hinder the ability of commercial fishing vessels to continue operating in the project area.
High	Pipelines on the seabed and freespan sections cover a significant part of the important fishing areas and prevent commercial fishery from continuing in the project area.

11.13.3 Impact assessment

11.13.3.1 Construction phase

Disturbance caused by the safety zone around construction vessels
The radius of the safety zone around the pipelay vessel is typically 2–3 km. There will also be additional traffic and safety zones due to rock placement, munitions clearance and construction of the hyperbaric tie-ins. Only construction vessels will be allowed within the safety zones. These activities may hinder fishing vessels, which may have to change course because of the safety zone. The hyperbaric tie-ins at KP 300 will take approximately two to four weeks.

The impacts from the safety zone are assessed to be *direct* and *negative* because the safety zone directly interferes with fishing activities, i.e. by forcing the fishing vessels to change course. The impact is assessed to be *local* and *short term* because the safety zone is rather small compared with the entire extent of fishing areas in the project area and because the pipelay vessel moves 2–3 km per day.

Fish fleeing the area due to construction activities
Construction works that disturb the seabed and cause sediment plumes will be carried out along the pipeline route in the Finnish EEZ. These works include munitions clearance, rock placement, offshore pipe-laying, potential hyperbaric tie-in and anchor-handling. Fish will temporarily flee the area as described in Subchapter 11.6.3. As presented in Subchapter 11.3 Impacts on water quality, this avoidance level is local because it does not exceed 3 km from the pipelines. The duration is less than one day. Fish will soon return to the area, enabling continued fishing.

11.13.3.2 Operation phase

Fishing in smooth seabed areas
In smooth seabed areas, where the pipelines are lying flat on the seabed and will probably sink into the seabed over time, near-bottom trawling operations may continue without major hindrance. Trawl boards will climb over the pipelines without risk of hooking onto the pipelines. According to the risk assessment *(Det Norske Veritas 2009)*, the probability of hooking is assessed to be *low*, based on experience from the North Sea and the Norwegian Sea where hooking rarely occurs. The referred experience is considered valid for the project area because it covers all relevant types and sizes of gear and water depths. However, it is noted in the risk assessment that the calculated pullover forces needed to drag trawl gear over the pipelines seems high compared with the informed warp line size used in the Baltic Sea.

Fishing in uneven seabed areas

The seabed in the Finnish EEZ in the Gulf of Finland is rather uneven, resulting in freespanning of the pipelines in many locations. Numerous outcrops of hard ground occur within the Finnish sector. The size and frequency of outcrops of hard ground is highest in the east and decreases towards the west (Figure 7-3). On uneven seabed, the probability of trawl gear getting hooked between the seabed and the pipeline is higher than in smooth seabed areas. During bottom trawling, which is not practised in the Finnish project area because of the main target species and uneven seabed, trawl boards may slide underneath a freespanning pipeline and consequently get stuck in the end of the freespan. Hence on uneven seabed areas the probability of bottom trawl gear getting hooked on the pipelines is assessed to be *medium*. However, based on feedback from the trawler industry in Norway, this is still a rare scenario. If it does occur, the trawl is almost always freed by turning the fishing vessel around and pulling the trawl in the opposite direction *(Det Norske Veritas 2009)*. In the Finnish EEZ the trawling method is mid-water trawling by which the freespanning pipelines are avoidable. Therefore the probability of mid-water trawl gear getting hooked to the pipeline is assessed to be *low*.

Hindrance to near-bottom mid-water trawling activity

As described in the Subchapter 7.17, the only trawling method used in the Finnish EEZ in the project area is mid-water trawling. During fishing operation, a mid-water trawl may touch the seabed when setting out the trawl, while turning the vessel or accidentally by a navigational error or a technical failure. In these circumstances, the mid-water trawl may also make contact with a freespanning pipeline. These incidents could potentially lead to gear hooking the freespanning pipeline. This may lead to damage of the trawling equipment, breakage of the trawl wire and subsequent loss of the gear due to high forces being exerted on the trawl wire or even sinking of the vessel. A risk assessment of this potential event was carried out during NSP *(Ramboll and Nord Stream AG 2009)*. According to this risk assessment, the probability of a trawl vessel sinking in the Finnish EEZ as a result of a collision with one of the NSP pipelines is 6.16×10^{-9}. This probability is equal to a repetition time of 162 million years.

Because of the potential risk the pipelines pose to trawl fishery in the freespanning area, vessels should adjust their fishing depth when operating near pipelines. Hence the pipelines on the seabed will prevent trawl fishing by occupying the water layer near seabed in the pipeline corridor in pipeline freespan areas. This will reduce the opportunity to fish to a certain extent, but vessels may operate elsewhere. In doing so vessels may have to consume more fuel and time, but eventually they will probably catch the same amount of fish.Therefore an impact on catches may occur as a result of higher fishery costs.

What it comes to cumulative impacts with NSP pipelines on fishery, it is further addressed in the Subchapter 14.3.

Damage to fishing gear when crossing pipelines or rock berms

The pipelines are covered with concrete weight coating and with metal covered field joints. The surface of the pipes is assessed to be smooth enough not to harm trawl nets that are dragged over them, and mid-water trawl nets are not designed to be rubbed against objects on the seabed. Therefore it is likely that vessels will avoid contact with the pipelines. Rock placement is carried out in order to form rock berms to support the pipelines on uneven seabed and at cable crossings. The material used for rock berms is coarse gravel varying from 20 mm to 100 mm in diameter and on average 50 mm (Subchapter 4.1.5.1). Because rock berms are formed with loose material, the surface layer of the berm will move without seriously damaging a trawl net if one accidentally rubs against it. Rock berms are needed in the pipeline installation when the seabed is uneven, which will on the same time make pipeline to be in free span on many locations. In these areas vessels will be forced to leave space between their trawling gear and the pipelines, which will reduce the risk of nets coming into contact with the rock berms. It is therefore assessed that damage to fishing gear as a result of the crossing of the pipelines or rock berms will be unlikely.

Disturbance due to maintenance activities

Maintenance, monitoring and surveying work during the operation phase may cause impacts on fishing vessel traffic. However, the impacts are within the range of normal navigational conditions. Considering the small amount of trawling activities in the Finnish project area, it is assessed that there will be impacts on fishery from maintenance activities during operation of the pipelines.

11.13.4 Prevention and mitigation of adverse impacts

NSP2, in conjunction with relevant construction contractors and Maritime Authorities will announce the locations of the construction vessels and the size of the requested Safety Exclusion Zones through Notices to Mariners (including fishermen) in order to increase awareness of the vessel traffic associated with the project.

11.13.5 Lack of information and uncertainties

Future changes in fish stocks may lead to an increased use of bottom trawl gear. This could occur if major saltwater inflow from the Danish straits alter the balance of the current regime of the Baltic fish species. Even in this kind of situation, the uneven seabed in the Gulf of Finland would still reduce bottom trawling activity in the Finnish EEZ in areas other than those with smooth seabed conditions. Most likely, fishing for demersal fish species, such as cod, would still be carried out using mid-water trawling gear.

11.13.6 Significance of the impacts

The sensitivity of receptor (commercial fishery) is assessed to be *medium* because the project area in the Gulf of Finland and in the Northern Baltic Proper is not within the most important fishing area for commercial fishery in Finland. The majority of the Finnish trawl catch is caught in the Bothnian Sea. However, a major proportion of the Finnish sprat catch is caught in the Gulf of Finland. During cold water periods, sprat is often caught near the seabed, making the Finnish EEZ rather important for near-bottom mid-water trawling. Because the prevailing trawling method in the area is mid-water trawling, fishing vessels are able to avoid contact with the pipelines. Therefore effect on near-bottom fishing concerns only a limited area of the Finnish EEZ and then only fishing very close to seabed.

The magnitude of change during the construction phase is assessed to be *negligible* because the pipe-laying vessels and safety zone exclude only a fraction of the fishing ground at a time. The pipe-laying vessel moves about 2–3 km per day and will not hinder fishing in any one place for more than a day. This relates also to the impacts on fishing from fish fleeing the area because of the disturbance from the construction activities. It will be easy for Finnish trawlers to conduct their activities elsewhere during the construction phase. Considering the *medium* sensitivity of fishery in the area and the *negligible* magnitude of change, the overall significance of the impact on fishery during the construction phase is assessed to be *negligible*.

During the operation phase, the magnitude of change in the smooth seabed areas is assessed to be *negligible* because trawling operations may continue in these areas without major hindrance. The significance of the impact is therefore assessed to be *negligible*.

During the operation phase, the magnitude of change in the uneven seabed areas is assessed to be *low.* This is due to NSP experience gained and surveys conducted amongst Finnish trawl fishermen. The NSP experience and surveys revealed that the pipelines on the seabed do not make the project area untrawlable because the prevailing trawling method in the area, owing to its natural unevenness and existing target species, is mid-water trawling. Even though the actual area occupied by pipelines is very small compared to the area used by Finnish offshore trawlers, there will be many freespanning pipeline sections which make the pipelines worth avoiding for safety reasons. Also the cumulative impact with the NSP pipelines in the same area increases the width of the area where trawlers should exercise caution. However, the impact concerns only trawling very close to seabed where oxygen conditions in large areas are unfavourable for the target fish species to exist. Fishermen may fish over the pipelines leaving distance between their gear and the pipelines or seek fish from somewhere else which might cause them rising of fishing costs. Therefore the overall significance of the impact on fishery during the operation phase is assessed to be *minor*.

The differences between project alternatives in relation to fishery relates to the amount of freespanning pipeline sections. Sub-alternatives ALT E2 and ALT W1 have a greater number of freespans over 100 m in length compared with sub-alternatives ALT E1 and ALT W2. Both areas with sub-alternatives are situated in the trawling areas and may hinder near-bottom trawling activities. However, based on the trawling frequency map (Figure 7-54), both areas have a rather low level of fishing pressure, which lowers the significance of the chosen line alternative in relation to trawl fishing. The trawling frequency map is based on 2010–2015 data, and the trawling pattern may change in the future. Therefore minimising the number of long freespan sections in choosing the line alternative would be positive in relation to fishery. From that perspective, sub-alternatives E1 and W2 are better.

Regarding impacts on fishery, there are no substantial differences between construction alternatives.

Table 11-72. Significance of the impacts on fishery.

Impacts on fishery	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Disturbance due to safety zone around construction vessels	Medium	Negligible	Negligible
Fish fleeing the area due to construction activities – hindrance to fishing in normal fishing grounds	Medium	Negligible	Negligible
Operation phase			
Hindrance to near-bottom trawling activity in smooth seabed areas	Medium	Negligible	Negligible
Hindrance to near-bottom trawling activity in uneven seabed areas	Medium	Low	Minor
Damage to fishing gear when crossing pipelines or rock berms	Medium	Negligible	Negligible
Disturbance due to maintenance activities	Medium	Negligible	Negligible

11.14 Military areas

Military areas in the Gulf of Finland and the Archipelago Sea include restricted areas by the Finnish Navy, areas where aviation is restricted (R areas) and airspace danger areas (D areas). The pipeline route does not enter any of the restricted areas by the Finnish Navy or R areas in Finnish waters. The closest restricted area is located in territorial waters southwest of Porkkala (closest distance approximately 1.5 km from the pipeline route (from ALT W1)). The closest R area is at the same location and at about the same distance from the pipeline route. Because of the distance, neither the construction nor the operation of the pipelines will cause any impacts on or restrictions to the use of restricted areas by the Finnish Navy or R areas.

The pipeline route enters into D areas three times. The total length of the section of the pipeline route within D areas is approximately 73 km. However, movement is not restricted D areas.

The Finnish Defence Forces confirmed during the EIA process that the construction or operation of Nord Stream 2 pipeline will not have any impacts on the use of the military areas of the Finnish Defence Forces in the Gulf of Finland or the Archipelago Sea.

11.15 Existing and planned infrastructure and utilization of natural resources

Existing and planned offshore infrastructure in the study area consist of pipelines, cables, extraction sites, spoil dump areas and wind farms (Subchapter 7.21). Two existing Nord Stream pipelines and 24 existing cables cross the NSP2 route. Planned infrastructure that would cross the NSP2 route are one gas pipeline (Balticconnector) and two telecommunications cables (IP Only and Linx). With the exception of pipelines and cables, all other existing or planned infrastructure is located at a distance of 10 km or more from the NSP2 route. The purpose of the impact assessment is to assess the possible impacts on existing and planned infrastructure and the utilization of natural resources and to propose possible prevention and mitigation of adverse impacts, which will be discussed on a case-by-case basis.

Summary of impact assessment on existing and planned infrastructure and utilization of natural resources	
Lessons learned from the Nord Stream Project in 2009-2012	Seven cables that were at 1.0 km distance or closer to munitions cleared by detonation during Nord Stream construction were monitored prior to and after the detonations using an ROV. The closest distance to a cable from a detonation site was 85 m. Nine of the munitions were first relocated to a safe distance from a cable (EE-SF2) and then detonated. This "lift-shift" operation was performed by using a clamp with a lifting air bag around munitions. (Witteveen+Bos 2011) There were no cables located within 50 m distance of the Nord Stream rock placement sites so no cables were monitored in connection with this construction activity. (Ramboll 2013b.) Protective concrete mattresses were installed on the seabed at 19 cable crossings in 2010–2011 prior to pipelaying of Nord Stream pipelines. During pipelaying touchdown monitoring (TDM) was performed. As-laid survey at the cable crossings consisted of a multi-beam echo sounder (MBES) and a visual survey. The as-left survey consisted of a general video inspection over the whole crossing structure and an MBES survey. Because of the anchoring, a visual survey 1,000 m to either side of the crossing along the cable was performed in sections where an anchored lay barge was used. The as-laid and as-left surveys were performed using a remotely operated vehicle (ROV). (Ramboll 2011a, Ramboll 2012b and Ramboll 2013b) Based on monitoring performed during the construction of the Nord Stream pipelines in 2009–2012, no impacts were recorded on existing infrastructure, which consisted of telecommunications and power cables (Witteveen+Bos 2011, Ramboll 2013b).
Main results of the assessment	The overall impacts on existing and planned infrastructure and utilization of natural resources have been assessed to be *negligible*.

11.15.1 Impact mechanism

The assessed impacts on existing and planned infrastructure and utilization of natural resources (Table 11-73) have been identified by considering the various project activities during construction and operation and how these activities may interact with infrastructure targets along the pipeline route. Interaction between existing infrastructure and planned project activities during the construction and operation phases relates principally to the possibility of mechanically damaging the infrastructure targets. During the construction phase, munitions clearance, rock placement, offshore pipe-laying and the anchors of the anchored lay vessel can potentially damage existing infrastructure on the seabed. During the operation phase, the required maintenance rock placement may still cause mechanical damage to existing infrastructure.

Another impact mechanism is restrictions to planned infrastructure as a result of the Nord Stream 2 pipelines on the seabed. Certain consultation distances will be maintained to avoid impacts on the pipelines from the construction and operation of planned infrastructure

Table 11-73. Possible impacts of the project activities on existing and planned infrastructure and utilization of natural resources.

Receptor	Project phase	Project activity	Impact
Existing and planned infrastructure and utilization of natural resources	Construction	Munitions clearance	Mechanical damage of existing infrastructure
		Rock placement	
		Offshore pipe laying	
		Anchor handling	
	Operation	Maintenance rock placement as required	
		Pipelines on the seabed	Restrictions to planned infrastructure

11.15.2 Methods and data used

Assessment of the impacts of the Nord Stream 2 project on existing and planned infrastructure and utilization of natural resources has been made primarily as an expert assessment based on experience from the Nord Stream.

The impact assessment has been done by comparing the data of existing and planned infrastructure to the NSP2 project activities (location, impact area and mechanical activity). The number and location of munitions to be cleared were not known at the time of the impact assessment. The prevention and mitigation of adverse impacts has been taken into account in the overall assessment results.

Due to the significant distance between the pipeline route and the closest extraction sites and spoil dump areas (approximately 10 km) and the closest suitable area for wind power production (more than 10 km), impacts on these targets are not expected during the construction or operation of the pipelines. For this reason, only impacts on existing and planned pipelines and cables are assessed.

All (active) pipelines and cables are important infrastructure for transporting natural gas or transmitting electricity or data. In the event of damage, there would be, in the worst case, interruptions in transportation/transmission. Hence, the sensitivity of all pipelines and cables is *high*.

The magnitude of change depends on the potential damage caused to infrastructure (pipelines or cables) and the potential restrictions to planned infrastructure.

Table 11-74. Magnitude of change (existing and planned infrastructure and utilization of natural resources).

Negligible	Project activities do not cause detectable damage to existing infrastructure. The pipelines on the seabed will not cause restrictions for planned infrastructure.
Low - Medium	Project activities do not cause detectable damage to existing infrastructure. The pipelines on the seabed will cause restrictions for planned infrastructure.
High	Project activities cause detectable damage to existing infrastructure. The pipelines on the seabed will cause restrictions for planned infrastructure.

11.15.3 Impact assessment

This subchapter describes impacts from the NSP2 route compared with the baseline situation, i.e. the current status in the Finnish EEZ (zero-alternative), unless otherwise stated. When essential, the differences between sub-alternatives E1 and E2 or W1 and W2 are compared.

11.15.3.1 Construction phase

Munitions clearance

Nord Stream 2 AG has performed extensive and detailed surveys along the route corridors in the Finnish EEZ. As expected, considering the strategic importance of the Gulf of Finland during World War II, and the knowledge gained through the Nord Stream project, a number of conventional munitions have been identified in Finnish waters. Due to the density of munitions, avoidance through localised rerouting (route optimisation) will not be possible in all cases. Consequently, to ensure the safe installation and operation of the pipelines, munitions clearance will be required prior to construction within the installation corridor and the wider security corridor as based on the risk assessments.

In addition to the munitions clearance methods successfully implemented for Nord Stream (detonation in situ and relocation) Nord Stream 2 AG is performing an assessment of alternative clearance methods to reduce the impact associated with underwater noise from detonation. This study considers, as the munitions baseline, the munitions cleared during Nord Stream project. The study will be complemented in the permit applications by an assessment based on the actual munitions that will need to be cleared for the safe installation of Nord Stream 2 pipelines.

If munitions will be detonated in close proximity to existing pipelines and cables, the peak pressure caused by the detonation may damage them mechanically. Actual damage depends on the type of infrastructure, the degree of burial of the pipeline or cable, the seabed topography around the detonation site and the magnitude of the peak pressure caused by a detonation. The locations of munitions to be cleared are not known at this stage. Detailed impact assessments and plans for munitions clearance will be made during the permitting phase, when detailed information on munitions and the study on alternative clearance methods are available. During the Nord Stream project, munitions that were too close to a cable were moved to a new location at a safe distance from the cable and then detonated. A similar approach would be risk assessed for the NSP2 project as well, if necessary. The intention is to maintain a 300 m separation between the detonation site and the existing pipelines. Safety distances between a detonation site and a cable will be assessed case-by-case, based on the estimated magnitude of the peak pressure, the seabed topography between the detonation site and the cable and the degree of burial of the cable. Based on experience during NSP, impacts from munitions clearance on existing pipelines and cables will be avoided.

Rock placement

Rock placement will take place both before and after pipe-laying. The rock placement vessels are able to place the rock very accurately on the seabed. Cables are protected by concrete mattresses at crossings with the NSP2 route and therefore rock placement will not cause any damage to cables even if the activity is carried out at or close to crossing locations. The pipelines are protected by rock at crossing locations with the NSP2 route.

Pipe-laying
Cables that cross the NSP2 route will be protected by concrete mattresses that allow safe pipe-laying (Subchapter 4.1.7).

The existing Nord Stream pipelines will be protected by rock berms at crossing locations with the NSP2 route.

Based on experience during Nord Stream project, impacts on existing cables will be avoided. The existing pipelines will not be affected by the pipe-laying activity due to necessary protection by the rock berms to be constructed.

Anchor-handling
In the Finnish EEZ, an anchored lay barge is planned to be used from approximately KP 350 to the Swedish EEZ border. For the other part of the Finnish project area, a dynamically positioned (DP) pipe-laying vessel will be used. An anchored pipe-laying vessel is positioned by up to 12 anchors which are moved by anchor-handling tugs according to planned anchor patterns, as shown in Figure 4-11. Existing pipelines and cables can be damaged by anchoring activity. Activities that may cause damage to existing pipelines and cables include the laydown and bedding in of anchors on the seabed, the sweeping of anchor wire across the seabed during movement of the lay vessel, and the lifting of the anchors from the seabed when they are being recovered and moved to a new position. Anchor patterns will be designed in a manner that avoids impacts on existing pipelines and cables.

11.15.3.2 Operation phase

Maintenance rock placement as required
Maintenance works may be required during the operation phase, and it is possible that placement of rock material may have to be undertaken in certain areas if unacceptable freespans develop. For the existing pipelines and cables the basis for impact assessment is the same as for rock placement during construction, which means that there will be no impacts on existing pipelines and cables.

Restrictions for planned infrastructure
When Nord Stream 2 pipelines have been constructed, the pipelines on the seabed will not restrict the laying of a planned pipeline and cables *(Consub 2009)*. The common industry practice is that crossing structures will be agreed or proximity agreements will be made between the parties involved to avoid impacts on existing infrastructure (such as Nord Stream 2 when it is constructed). However, such agreements may include some restrictions to the potential planned construction activities. Based on NSP experience, safety distances to Nord Stream 2 pipelines from construction activities of other infrastructure are estimated as follows *(Nord Stream 2 AG 2016a)*:

- Notification of works within ± 500 m
- No munitions clearance by detonation within 300 m
- No anchoring within 200 m, and 400 m if the direction of pull is toward Nord Stream 2 pipelines
- No invasive seabed intervention works such as excavation, trenching or grapnel within 50 m
- Trenching direction shall be away from Nord Stream 2 pipelines within 50–200 m
- Grapnel pull direction (for cable recovery) shall be away from Nord Stream 2 pipelines within 50–250 m
- Infrastructure running parallel should maintain a separation of at least 300 m

In summary, the presence of Nord Stream 2 pipelines on the seabed does not prevent the building of planned infrastructure. However, some restrictions to the construction of planned infrastructure may be necessary. By careful planning and agreements with the parties involved, impacts can be avoided.

11.15.4 Prevention and mitigation of adverse impacts

Nord Stream 2 will enter into crossing and/or proximity agreements with affected cable and pipeline owners. In these agreements, the crossing method and precautionary measures will be agreed on a case by case basis. Crossing designs will ensure that: 1) a separation is maintained between the NSP2 pipelines and the existing pipelines and cables and 2) the operation of the existing pipelines and cables will not be impaired.

Pipelay activities at cable crossing locations will be monitored through pipeline touch-down monitoring (TDM) to enable accurate pipe-laying on top of protective concrete mattresses and avoid damage to cables.

In those areas where an anchored lay barge will be used, an anchor corridor survey will be completed to identify, verify and catalogue potential obstructions or sensitive features. Restricted zones will be identified and implemented. Anchor procedures will ensure that disturbance of existing pipelines and cables is avoided. This will include:

- anchor patterns to safely avoid sensitive sites and ensure compliance with safety distances including ICPC standards for cables
- lifting and control of anchors, including use of mid-wire buoys to limit the length of the anchor wire in contact with the seabed in the vicinity of sensitive sites and existing infrastructure
- lifting anchors rather than dragging along the seabed during relocation by anchor handling vessels.

11.15.5 Lack of information and uncertainties

The remote possibility of finding unexpected cables during the actual construction work will be dealt with within *the chance finds* procedure. This procedure provides guidelines for actions to be taken in dealing with accidental finds as well as the documentation and reporting for such incidents.

Some uncertainty in the impact assessment is related to munitions clearance because the exact number and the locations of the munitions to be cleared were not known at the time of assessment. This uncertainty will be removed before the permitting phase, when the necessary surveys have been completed and a detailed impact assessment of munitions clearance has been performed.

The exact construction schedule of the Balticconnector gas pipeline is unknown. It is possible that it will be constructed prior to Nord Stream 2. However, this should not have an effect on the results of the impact assessment. See Chapter 14 for the assessment of cumulative impacts.

11.15.6 Significance of the impacts

The infrastructure targets that may be potentially impacted as a result of the construction or operation of Nord Stream 2 are pipelines and cables. By taking all of the measures to mitigate impacts on pipelines and cables, there will be no impacts from construction activities. During operation, the presence of Nord Stream 2 on the seabed will cause some restrictions to the construction of planned pipelines and cables but will not prevent their construction. The magnitude of change and the overall significance of the impact is therefore *negligible*.

Regarding impacts on existing and planned infrastructure and utilization of natural resources, there are no substantial differences between sub-alternatives or between construction alternatives.

Table 11-75. Significance of impacts on existing and planned infrastructure.

Impacts on existing and planned infrastructure and utilization of natural resources	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Existing and planned infrastructure and utilization of natural resources	High	Negligible	Negligible
Operation phase			
Existing and planned infrastructure and utilization of natural resources	High	Negligible	Negligible

11.16 Future use of the Finnish EEZ

Pipelines and other structures supporting the pipelines as objects on the seabed may restrict potential future use of the seabed area or seabed for exploitation purposes (e.g. minerals). Impacts on existing and planned infrastructure and utilization of natural resources are presented in Subchapter 11.15. Potential future use of the Finnish EEZ is defined here as potential infrastructure or seabed exploitation projects in the future which are currently in very preliminary planning phase or only envisaged.

Summary of impact assessment on future use of the Finnish EEZ	
Lessons learned from the Nord Stream Project in 2009-2012	The footprint of the two pipelines and constructed rock berms was estimated as 1.26 km^2, which is approximately 0.018% of the total seabed area in the Finnish EEZ. It was assessed that the pipelines will not have a significant impact on the potential future use of the seabed. After the construction of the Nord Stream pipelines three cables crossing the pipelines have been laid on the seabed in the Finnish EEZ. Crossings and their design have been agreed between Nord Stream and cable owners according to normal procedures. No other infrastructure has been constructed or exploitation of natural resources carried out close to pipelines in the Finnish EEZ.
Main results of the assessment	The estimated footprint of the pipeline system is 2.05 km2, which is 0.029 % of the Finnish EEZ in the Gulf of Finland and the Northern Baltic Proper. The estimated consultation zone (+- 500 m from the pipelines) is 436 km2, which is 6.1 % of the Finnish EEZ in the Gulf of Finland and the Northern Baltic Proper. It is estimated that Nord Stream 2 pipelines will not prevent future projects, but may have impact on planning and technical design of future projects.

11.16.1 Impact mechanism

When constructed, the Nord Stream 2 pipelines and their supporting structures will cover part of the seabed in the Finnish EEZ. This coverage area is called here the footprint of the pipeline system. It will form more or less a linear structure throughout the Finnish EEZ in east-west direction between Russian waters and the Swedish EEZ.

For safety reasons, to maintain pipeline integrity, certain distances from the pipeline system to any potential future infrastructure or seabed exploitation site will be applied. Therefore, the pipeline system may restrict other use of the seabed in the Finnish EEZ in various-width corridor, not only the footprint, depending on the type of the potential future use (infrastructure or seabed exploitation). These distances will be consulted on a case-by-case basis between parties in question.

Potential future use of the Finnish EEZ can be for example:

- telecommunications and power cables
- subsea gas and oil pipelines
- wind farms
- wave energy farms

- oil and gas platforms
- subsea mining, e.g. exploitation of ferromanganese nodules
- extraction of sea sand and gravel
- seabed used for spoil dump sites
- railway tunnel between Finland and Estonia.

Table 11-76. Possible impacts of the project activities on future use of the Finnish EEZ.

Receptor	Project phase	Project activity	Possible impact
Future use of the Finnish EEZ	Operation	Pipelines and support structures on seabed	Restrictions to other infrastructure or exploitation of natural resources in the future

11.16.2 Methods and data used

Area covered by the pipeline system is calculated based on the current project design. The calculated area comprises the two pipelines and supporting structures (rock berms and support mattresses) of the pipelines. The calculated area is then compared with the total seabed area in the Finnish EEZ in the Gulf of Finland and the Northern Baltic Proper.

Distances for safety reasons between the pipeline system and any potential infrastructure or seabed exploitation site are considered. So called consultation zone of the pipeline system including estimated safety distance is calculated and analysed.

Impacts have been assessed as an expert opinion based on current technical description of the project, existing conditions along the pipeline route, previous experience from the Nord Stream Project, as well as assessment results of the relevant impact targets in this EIA.

11.16.3 Impact assessment

When assessing impacts on potential future use of the Finnish EEZ, no impacts are expected in the construction phase. Timeframe for any potential infrastructure or seabed exploitation project in the Finnish EEZ would be relatively long, e.g. because of permitting procedures, so that any such project is not expected to be carried out during the construction phase of the Nord Stream 2 pipelines. Thus, the impact assessment concentrates on the operation phase.

Sensitivity of the receptor is assessed as low. This is based on the current use of the Finnish EEZ: there is plenty of unused seabed area in the Finnish EEZ for future projects.

11.16.3.1 Operation phase

The footprint of the pipeline system comprising the two pipelines and support structures is 2.05 km^2. When calculated like this, the footprint is relatively small compared to the Finnish EEZ in the Gulf of Finland and the Northern Baltic Proper, 0.029 %, and it can be said that there is enough space in the Finnish EEZ for other infrastructure or seabed exploitation purposes. Currently the use of the Finnish EEZ consist mainly gas pipelines and cables. The pipeline system will be a linear feature throughout the Finnish EEZ from Russian waters to the Swedish EEZ.

Based on Nord Stream experience, the following precautionary distances can be applied for the preliminary planning of other infrastructure (also Subchapter 11.15) *(Nord Stream 2 AG 2016a)*:

- Notification of works within ± 500 m
- No munitions clearance by detonation within 300 m
- No anchoring within 200 m, and 400 m if the direction of pull is toward Nord Stream 2 pipelines
- No invasive seabed intervention works such as excavation, trenching or grapnel within 50 m
- Trenching direction shall be away from Nord Stream 2 pipelines within 50 m to 200 m
- Grapnel pull direction (for cable recovery) shall be away from NSP2 pipelines within 50 m 250 m
- Infrastructure running parallel should maintain a separation of at least 300 m

The consultation zone can be calculated by using the longest distance (notification of works), ± 500 m from the pipeline system. The consultation zone of the pipeline system is 436 km^2, which is 6.1 % of the total Finnish EEZ in the Gulf of Finland and the Northern Baltic Proper. Eastern part of the Finnish EEZ is narrower than the western part. In the Gulf of Finland (eastern part of the Finnish EEZ), the proportion covered by the consultation zone is 12.6 %, while in the Northern Baltic Proper (western part of the Finnish EEZ) only 5.1 %.

The consultation zone, conservatively calculated by including the ± 500 m consultation zone around the pipeline system, is relatively large when compared to the total Finnish EEZ. If infrastructure or exploitation of natural resources is planned in the future to the Finnish EEZ, it is probable that consultations with Nord Stream 2 will be necessary. However, it is estimated that Nord Stream 2 pipelines will not prevent future projects, but may have impact on planning and technical design of future projects. Therefore magnitude of change is assessed as *low*.

The potential tunnel between Finland and Estonia would be most likely constructed in the hard bedrock. Hence, Nord Stream 2 pipelines will not have any impact on the planned tunnel project. Potential geotechnical surveys related to the tunnel project should be planned so that there will be no impact on the Nord Stream 2 pipeline system.

11.16.4 Prevention and mitigation of adverse impacts

Nord Stream 2's recommendation would be to enter into crossing and/or proximity agreements with future infrastructure and/or seabed exploitation projects. In these agreements, the technical methods and precautionary measures would be agreed on a case by case basis.

11.16.5 Lack of information and uncertainties

The footprint has been estimated based on the current project design and experience from NSP (correlation between observed coverage areas and used rock volumes). Uncertainty is related to the calculation of the footprint of the rock berms.

11.16.6 Significance of the impacts

Based on the assessment results of sensitivity of the receptor and magnitude of change, the overall significance of the project’s impacts on future use of the Finnish EEZ is assessed as *minor* (Table 11-77).

Regarding impacts on future use of the Finnish EEZ, there are no differences between sub-alternatives or construction alternatives when considering Nord Stream 2 only. However, when considering the cumulative impacts of Nord Stream pipelines and Nord Stream 2 project, there is a difference between the route sub-alternatives (Chapter 14).

Table 11-77. Significance of the impacts on future use of the Finnish EEZ.

Impacts on future use of the Finnish EEZ	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Operation phase			
Pipelines and support structures on seabed	Low	Low	Minor

11.17 Scientific heritage

The objective is to assess the impact caused by project activities during the construction and operation phases on the scientific heritage. The aim is to not compromise the representativeness of long-term stations (especially benthos monitoring stations) due to NSP2.

The impacts were assessed based on the overall conclusions of the impacts on seabed morphology and sediments (Subchapter 11.2), hydrography and water quality (Subchapter 11.3), as well as on benthic flora and fauna (Subchapter 11.5). The environmental monitoring of NSP also played an important role in the assessment work. Impacts have been assessed as an expert opinion.

Summary of impact assessment on scientific heritage	
Lessons learned from the Nord Stream Project in 2009-2012	The impacts of the construction and operation phases of NSP on scientific heritage have been monitored near the HELCOM long-term stations (Subchapter 7.4.1) situated in the vicinity of the pipelines. The main conclusions of these studies were that high oxygen fluctuations near the seabed is the main controlling factor of benthic fauna and that unsatisfactory living conditions have superseded the possible effect of the pipelines as a hindrance of dispersion of benthic fauna. It was concluded that the scientific representativeness of the long-term HELCOM stations was not compromised by Nord Stream pipelines. It was not possible to properly address the effects of the pipeline structures on the dispersion patterns of benthic fauna and thus the colonisation and development of the benthic community if oxygen conditions improve.
Main results of the assessment	The overall impacts have been assessed to be *negligible*. This assessment is based on the sensitivity analysis of the different types of monitoring stations and estimates of the magnitude of different impacts during the construction and operation phases of the project. Sedimentation caused by construction activities was assessed to be so low that negative effects on benthos monitoring sites are unlikely. Similarly, turbidity changes are so short-lived that the representativeness of the water sampling stations would not be compromised. Changes of water current fields that may cause alterations in sedimentation and scour patterns are limited in the vicinity of pipeline and therefore impacts on benthos monitoring stations are highly unlikely.

11.17.1 Impact mechanism

The assessed impacts on scientific heritage (Table 11-78) have been identified by considering the various project activities during construction and operation and how these activities may affect long-term monitoring stations. Interaction between scientific heritage and planned project activities during construction relates principally to sediment spreading due to the different construction activities.

The project construction activities may impact the long-term stations as follows:

- Anchor-handling can cause direct disturbance of benthos (Subchapter 11.2). This impact can occur only if anchors are laid in the near vicinity of long-term stations.
- Turbidity by different construction activities may cause a short-term disruption of water sampling. Impacts on water quality have been assessed in Subchapter 11.3.
- Increased sedimentation during construction work may cause a short-term disruption in long-term sediment quality and benthos data. Impacts on these targets have been assessed in Subchapters 11.2 and 11.3.

Results from environmental monitoring during the construction and operation phases of NSP suggest that the pipelines on the seabed in the vicinity of the HELCOM long-term benthos stations have not compromised the representativeness of the stations. This conclusion is based on the finding that only minor changes of water currents caused by the pipelines have been detected approximately 50 m from the pipelines *(Witteveen+Bos 2012)*, while all long-term stations are situated further away. Similarly, zinc release from zinc anodes is found to be limited to a very small area.

Table 11-78. Possible impacts of the project activities on scientific heritage.

Receptor	Project phase	Project activity	Impact
Scientific heritage	Construction	Munitions clearance	Construction activities would lead to sediment dispersion, which potentially disturbs the scientific representativeness of the long-term benthos monitoring stations situated nearby.
		Rock placement	
		Offshore pipe-laying	
		Anchor-handling	Anchor-handling can cause direct mechanical interference on benthos. Impacts depend on whether anchors have touched the seabed inside the monitoring stations.
	Operation	Pipeline and support structures	Permanent constructions may change the water current and sedimentation/ erosion patterns in the vicinity of the pipeline route and have an effect on the representativeness of the long-term benthos monitoring stations. Metals released from anodes could pose a risk to benthic animals (acute/chronic impacts, accumulation).
		Maintenance rock placement as required	Potential effects caused by sediment spreading (but on a smaller scale) that has been discussed above.

11.17.2 Methods and data used

A list of long-term monitoring stations has been prepared by the Finnish environmental authority *(Finnish Environment Institute 2015d)*. The status of the long-term monitoring stations (e.g. location, monitored parameters, country managing the specific station) was checked by SYKE.

Monitoring stations situated at a distance of 5 km or less from the pipeline route were included in the impact assessment. Impacts have been assessed as an expert opinion and are based on the technical description of the project, the type of monitoring station (benthos or other parameters), hydrodynamic modelling of the sediment spreading and knowledge that has been gathered during monitoring of NSP.

The sensitivity, i.e. the likelihood that scientific heritage is compromised due to project activities, varies according to the type of long-term station. Impacts from pipeline construction activities (turbidity) are typically short-term and local. The sensitivity of the water quality stations is assessed as *low*. The changes in water quality are short-term and reversible. On the other hand, sediment spreading and the resulting changes in sedimentation rates may affect data quality in stations where benthos/sediments are monitored. These changes are reversible, but recovery may take longer. Thus the sensitivity of benthos/sediment stations is assessed to be *medium*.

The magnitude of change is related to the spatial and temporal extension of the impact as well as its amplitude (e.g. magnitude of the sedimentation rate, thickness of the new sediment layer in the monitoring station). The magnitude of change is considered to be high if the environmental changes are so extensive that they are able to cause significant changes in the benthic community, thus compromising the scientific representativeness of certain long-term monitoring stations.

Table 11-79. Sensitivity of receptor (scientific heritage).

Low	There can be a few long-term monitoring stations of scientific value (long-term data series have been measured and will be measured from these stations) where sediment and/or benthos parameters are measured in the potential impact area within 1 km from the planned pipeline route. The impacts on these stations are short-term and do not have impacts on long-term data representitivity. There can be long-term monitoring stations where only water quality parameters are measured in the potential impact area (impacts on water quality can only be temporary impacts).
Medium	There are more than three long-term monitoring stations of scientific value where sediment and/or benthos parameters are measured in the potential impact area within 1 km from the planned pipeline route. The impacts are long-term but will compromise the representativeness of long-term data in only a few stations.
High	There are more than six long-term monitoring stations of scientific value where sediment and/or benthos parameters are measured in the potential impact area within 1 km from the planned pipeline route. The impacts are long-term and are compromising the representativeness of long-term data.

Table 11-80. Magnitude of change (scientific heritage).

Negligible	Project activities do not cause detectable impacts on the measurements from the long-term monitoring stations of scientific value (long-term data series have been measured and will be measured from these stations).
Low	The project causes temporary changes to parameters measured from long-term monitoring stations of scientific value. Scientific heritage is not at risk.
Medium	The project causes several temporary changes to parameters measured from long-term monitoring stations of scientific value. The project causes harm to scientific heritage.
High	The project causes permanent changes to parameters measured from long-term monitoring stations of scientific value. The scientific value of long-term monitoring stations is lost if no mitigation measures are taken.

11.17.3 Impact assessment

11.17.3.1 Construction phase

Impacts on water quality monitoring stations – The nearest long-term stations where water quality has been monitored are situated approximately 0.5-4.2 km from the pipeline route. The construction activities will increase water turbidity for a short time period (for impact assessment, Subchapter 11.3). Increased turbidity may impact water quality and thus reduce the representativeness of the water quality data. After the construction works, values reflecting the water quality will fully return to a normal state after a short time lag of a few days. Therefore a turbidity increase as a result of the project activities will not impact the long-term monitoring stations as long as water sampling is not carried out simultaneously with construction activities implemented in the nearby areas. The significance of the impact is assessed to be *negligible.*

Impacts on benthos/sediment monitoring stations – The impacts of sedimentation have been assessed in Subchapters 11.2 and 11.5. The sedimentation caused by the project will only impact benthos stations if they are located very close to the construction sites. The nearest benthos monitoring stations (LL5, LL6A, LL7S and LL11) are situated approximately 0.8-1.6 km from the pipeline route (Table 7-28).

During Nord Stream Project, the nearest benthos long-term stations (LL5, LL6A and LL7) were monitored in order to observe any changes that construction or operation would pose. These stations are located 1.6 km, 1.4 km and 0.6 km from NSP, respectively. In addition, alternative stations (LL5BEN A + B, LL6ABEN A + B and LL7BEN A+ B) were established at a distance of 1.6-6.4 km from the pipelines. The purpose of these stations was to serve as compensatory stations if detrimental effects on the representativeness of long-term stations would be observed. According to the monitoring, no significant relocation of surface sediments or increase in concentration of contaminants on the seabed near the construction sites were detected. The overall conclusion was that the impacts of the construction activities on seabed sediments were minor *(Ramboll 2012b)*.

Based on these results, it can be concluded that effects on benthos caused by sedimentation are negligible. Thus sedimentation is not expected to impact the representativeness of the long-term benthos monitoring stations, and the magnitude of changeis assessed as *negligible.*

11.17.3.2 Operation phase

Pipelines, as permanent structures on the seabed, may cause changes in water current fields in their vicinity, which in turn may alter the prevailing scour and sedimentation patterns. This impact has been assessed in Subchapter 11.3. The overall conclusion based on NSP monitoring was that the impact of the pipelines at a distance over 50 m was negligible *(Witteveen+Bos 2012)*. According to benthos monitoring campaigns by SYKE, it was concluded that high oxygen fluctuations near the seabed is the main controlling factor of benthic fauna and that unsatisfactory living conditions have superseded the possible effect of the pipelines as a hindrance to the dispersion of benthic fauna *(SYKE 2015)*.

Changes in sedimentation or erosion patterns are not expected to occur in the vicinity of the nearest monitoring stations. Similarly, elevated zinc concentrations in seawater have been detected only in very close proximity to the anodes (Ramboll 2013b). Based on these results, the magnitude of changeis assessed as *negligible.*

11.17.4 Prevention and mitigation of adverse impacts

Nord Stream 2 will coordinate with the Finnish Environment Institute (SYKE) so that munitions clearance and rock placement activities would not be done simultaneously or just before (less than one week) the yearly benthos monitoring campaign, scheduled in May, 2 km or closer to the monitoring sites LL5, LL6A, LL7S and LL11 (Figure 11-26).

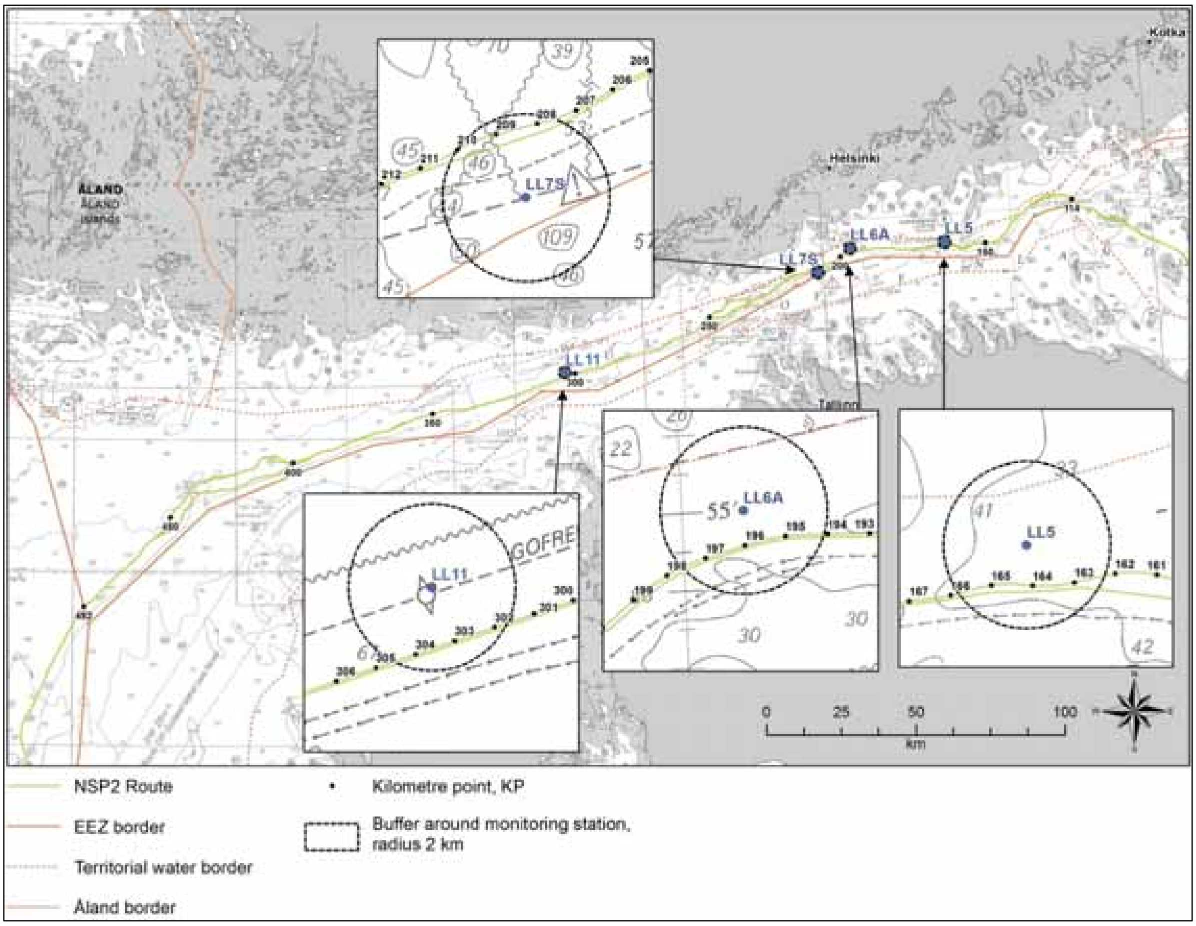

Figure 11-26. Buffer zones around nearest monitoring stations.

11.17.5 Lack of information and uncertainties

The knowledge base regarding the impacts of the construct and operation phases on the representativeness of the long-term benthos monitoring stations is quite comprehensive due to the results of the long-term monitoring study that was conducted for NSP in 2011-2015 in order to find out if the construction or operation of NSP would compromise the representativeness of the long-term benthos data from these stations (Table 7-28).

There is some uncertainty related to metals released from anodes, as this parameter has been studied only once. It could be possible that the release rates will increase in the future.

11.17.6 Significance of the impacts

The overall impacts have been assessed to be *negligible* based on the environmental monitoring results of NSP and the assessments in this EIA (Subchapters 11.2 and 11.5). The most sensitive monitoring stations regarding NSP2 (LL5, LL6A, LL7S, LL11 benthos long-term monitoring stations) are not situated in the vicinity of the alternative route options (ALT E1-E2, ALT W1-W2). Therefore there are no differences between route options.

Regarding impacts on scientific heritage, there are no differences between construction alternatives.

Table 11-81. Significance of impacts on scientific heritage.

Impacts on scientific heritage	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Long-term water quality stations	Low	Negligible	Negligible
Long-term benthos stations	Medium	Negligible	Negligible
Operation phase			
Long-term benthos stations	Medium	Negligible	Negligible

11.18 Cultural heritage

During the NSP2 Project several UCH or potential UCH sites in the Finnish EEZ have been discovered and evaluated. The purpose of the cultural heritage impact assessment is to assess the possible impacts on UCH and to propose possible prevention and mitigation of adverse impacts.

Summary of impact assessment on cultural heritage	
Lessons learned from the Nord Stream Project in 2009-2012	An on-going discussion with authorities (for example the Finnish National Board of Antiquities, FNBA) has been essential for the best result of investigations, assessments and monitoring made. During monitoring in 2009-2013, no impacts were recorded on known wrecks near the installation corridor during different pipeline construction works. The closest distance between a wreck and the pipeline was 2.8 m. (Ramboll 2013b, Ramboll 2014b, Ramboll 2015d and Ramboll 2016c). According to visual inspections, munitions clearance in 2009-2010 did not cause any impacts on wrecks. The closest distance between a cultural heritage site and a cleared munitions object was 400 m. (Witteveen+Bos 2011.) There were no UCH sites within 50 m of a rock placement site. Therefore no UCH sites were affected or monitored during rock placement. (Nord Stream AG 2010a and Ramboll 2013b.) Based on the anchor corridor survey results, anchor patterns in the vicinity of cultural heritage sites were developed and submitted to the appropriate authorities. The anchoring assessment established that some changes in the features of two wrecks were not caused by the anchoring of the lay barge. This conclusion was confirmed by FNBA. (Ramboll 2013b.)
Main results of the assessment	The overall impacts on the UCH sites are assessed to be *negligible*. As an exception, the overall significance of the impact on World War II historical sites is assessed to be *minor* because some small parts of the antisubmarine-net may remain under the pipelines.

11.18.1 Impact mechanism

The assessed impacts on cultural heritage (Table 11-82) have been identified by considering the various project activities during construction and operation and how these activities may interact with cultural heritage sites along the pipeline route. Interaction between cultural heritage and planned project activities during the construction and operation phases relates principally to the possibility of mechanically damaging the cultural heritage sites. During construction, munitions clearance, rock placement, offshore pipe-laying and the anchoring of the pipe-laying barge can potentially affect cultural heritage sites on the seabed. During the operation phase, the required maintenance rock placement may cause mechanical damage of cultural heritage.

Changes in sedimentation patterns impacting cultural heritage and corrosion effects have been excluded from the assessment because these impacts will not affect UCH sites in any manner. Sedimentation and erosion patterns will be altered slightly in areas where the pipelines are placed directly on the seabed. Calculations show that erosion will increase in the immediate vicinity of the pipelines (up to approximately 10 m away from each pipeline). This very local erosion will decrease over time as the pipeline erodes itself into the seabed.

Table 11-82. Possible impacts of the project activities on cultural heritage.

Receptor	Project phase	Project activity	Impact
Cultural heritage	Construction	Munitions clearance	Mechanical damage of underwater cultural heritage
		Rock placement	
		Offshore pipe-laying	
		Anchor-handling	
	Operation	Maintenance rock placement as required	

11.18.2 Methods and data used

Assessment of the impact of the Nord Stream project impact on cultural heritage has been made primarily as an expert assessment. The assessment is based on data from NSP2 surveys (sidescan sonar and video footage obtained by ROV) and supplemented by data from the FNBA and other parties. The sidescan sonar survey was made along the pipeline route in the Finnish EEZ. The length of the survey corridor was approximately 374 km, and the width of the survey routes varied from 1.5 km to 4 km. This area corresponds to the widest area that may be affected during the construction phase (anchoring corridor can be as wide as 2 km). Targets found within the ±250 m area closest to the proposed pipeline route were subjected to detailed high-resolution inspections. The survey data have been evaluated by a marine archaeologist. Background information on the UCH sites within the Finnish project area can be found in Subchapter 7.23.

The impact assessment has been done by comparing the data of UCH sites (location, extent and value) to the NSP2 project activities (location, impact area and mechanical activity). The prevention and mitigation of adverse impacts has been taken into account in the overall assessment results.

As underwater wrecks, wreck parts and other individual man-made objects that may be considered over 100-year-old are protected by national law and international conventions, is a sensitivity of an UCH site *high*. The World War II historical sites do not meet the age criteria, but they remain significant historical sites that should be respected and preserved as a war memorial/monument similar to protected terrestrial World War II embankments, trenches and anti-tank obstacles. As having a different archaeological value and not being automatically protected by laws or conventions, the sensitivity of the World War II historical site is *medium*. The magnitude of change depends on the magnitude of the damage to an UCH site.

Table 11-83. Magnitude of change (cultural heritage)

Negligible	Project activities do not cause detectable effects on UCH sites.
Low	Project activities cause minor damage to UCH site. The cultural historical value of the UCH site is not at risk.
Medium	Project activities cause moderate damage to UCH site. The cultural historical value of the UCH site has decreased.
High	Project activities cause severe damage to UCH site so that the cultural historical value of the UCH is lost.

11.18.3 Impact assessment

This subchapter describes impacts from NSP2 compared with the baseline situation i.e. current status in the Finnish EEZ (zero-alternative), unless otherwise stated. When essential, the differences between sub-alternatives E1 and E2 or W1 and W2 are compared.

Impacts during construction

Munitions clearance

A number of conventional munitions in the Finnish EEZ within the installation corridor and the wider security corridor as based on the risk assessments must be cleared prior to pipeline installation. In the section where an anchored lay barge is planned to be used, an anchor corridor survey will be performed to identify conventional munitions. Munitions will be accommodated within the design of the anchor patterns to safely avoid interaction during pipe-laying. In addition to the munitions clearance methods successfully implemented for NSP (detonation in situ and relocation), Nord Stream 2 AG is performing an assessment of alternative clearance methods. The study will be complemented in the permit applications by an assessment based on the actual munitions that will need to be cleared for the safe installation of NSP2.

Munitions clearance is a project activity which may concern UCH sites in the vicinity of the pipeline and in the anchoring corridor from about KP 350 to the Swedish border/EEZ. In the event that non-detonated munitions are identified near an underwater cultural heritage (UCH) site, there will be a case by case assessment made by a marine archaeologist, in consultation with the relevant authorities. If clearance by detonation is to take place in the vicinity of an UCH site, the effects of the detonation will be assessed and measures will be taken to prevent damage to the UCH site. The magnitude of change is expected to be *negligible.*

Rock placement

Rock placement will take place both before and after pipe-laying. Rock placement will be a controlled operation utilizing a fall pipe and instrumented discharge head located near the seabed to ensure precise placement of rock material. Rock placement may damage UCH sites only if the aggregates are placed directly on top of a wreck or other UCH object. An overview of the locations and types of rock placement works to be carried out in Finnish waters is presented in Appendix 12, Maps PR-03-F and PR-04-F. The planned locations and types of rock placement works on UCH sites or in in close vicinity of them have been studied with the information available during EIA process.

Based on the surveys, the closest significant UCH site (wreck S-R05-7978) is 65 m from line B (the debris of the wreck has been located 58 m from line B). The wreck is close to possible post-lay rock placement sites (rock berms for in-service buckling, ISB). The expected maximum bottom width of ISB berm in that area is 32.4 m. In that area the length of a berm is 10 m and the spacing between berms is 100 m. According the latest available information, it would be possible to meet the required 50 m clearance between rock berm and wreck and no impact on the wreck S-R05-7978 is expected.

The barrage (anti-submarine net "Walross", S-R09-09806 / SD-Alt1-3372) is a significant World War II historical site and extends across pipeline route alternatives E1 and E2. Although the site does not meet the UCH age criteria, it remains a significant historical site and interventions with the site should be avoided or kept to a minimum *(Kokko 2016b).* During World War II, the barrage extended across the Gulf of Finland. After World War II, there has been clearance of the barrage *(Blomgren 2016)*. It may be that the barrage has already been badly damaged and that only some debris remains on the seabed. NSP2 is proposing pre-lay and post-lay rock placement on the locations or very close the locations the barrage crosses the planned pipelines in both alternatives E1 and E2. If part of the barrage will remain under the rock placement material, the impact to the barrage is *direct* and *permanent*. When only a relatively small part or parts of the barrage may be damaged and the impact on the remaining net installation can be assessed as being only local, the magnitude of change is *low*. In such a case, the cultural and historical values of the UCH site are not at risk. Based on consultations with Military Museum Finland (MMF) and FNBA, it is recommended that detrimental interventions with the installation are kept to a minimum during the pipeline implementation phase.

The significant UCH site S-R15-02960 (wreck) and the potential World War II historical site S-R11-2395 (wreck) are situated over 200 m from the pipelines. Therefore these sites are not in the possible impact area of rock placement.

Pipe-laying

Pipe-laying activity will affect UCH sites if the pipelines are layed exactly on the UCH site. Concerning the impact of the pipelines themselves, the previously mentioned barrage (anti-submarine net "Walross", S-R09-09806 / SD-Alt1-3372) is the only UCH site which will be affected, because the site extends across the pipeline route in alternatives E1 and E2. The impact of pipe-laying on the barrage is *direct* and *permanent*. When only relatively small parts of the barrage may remain under the pipeline, the magnitude of change is *low*. In such a case the cultural and historical values of the UCH site are not at risk. Based on consultations with MMF and FNBA, it is recommended that detrimental interventions with the installation are kept to a minimum during the pipeline implementation phase.

Anchor-handling

Anchoring activities concern UCH and World War II historical sites within the anchoring corridor. In the Finnish EEZ an anchored lay barge is planned to be used from about KP 350 to the Swedish EEZ border. For an anchored barge, the pipe-laying vessel is positioned by 12 anchors and lines which are installed in a typical anchor pattern shown in Figure 4-11. The 12 anchors are put on the seabed in a controlled manner. Anchoring activities that may cause damage to a UCH site include the laydown and bedding in of anchors on the seabed, the sweeping of anchor wire across the seabed during movement of the lay vessel, and the extraction of the anchors from the seabed when they are being recovered and moved to a new position.

According to cultural heritage investigations during the NSP2 Project (Kokko 2016a and 2016b), there are two wrecks that are confirmed to be over 100 years old (S-R13-04614 and S-R15-02960) in the anchor handling area (survey blocks R12-R16, 0-1,000 m away from the pipeline). In addition, there are 12 potential targets of cultural historical interest and potential World War II historical sites in the anchor-handling area (survey blocks R12-R16, 250-1,000 m away from the pipeline).

The pipe lay vessel anchoring plans shall include provisions to ensure that at no time (immediately after deployment, after dragging on the seabed and during recovery/redeployment) the anchor or the anchor wire are within 200 m (measured on the horizontal plane) of any identified UCH. If necessary the wires will be held off the seabed by buoys or tugs in areas where significant UCH objects are present. Anchor patterns in the proximity of UCH sites will be approved prior to construction in consultation with national cultural heritage agencies as required. When taking these commitments into account, no impact on UCH sites is expected.

Significant UCH site S-R05-7978 (wreck), significant WWII historical site S-R09-09806 (barrage) and potential World War II historical site S-R11-2395 (wreck) are not situated in the area where an anchored lay barge is planned to be used.

Impacts during operation

Maintenance rock placement as required
Maintenance works may be required during the operation phase, and it is possible that placement of fill material may be undertaken in certain areas if unacceptable freespans develop. The barrage (anti-submarine net "Walross", S-R09-09806 / SD-Alt1-3372) is the only UCH site which may be affected by maintenance rock placement, because the site extends across the route alternatives E1 and E2. The impact of maintenance rock placement to the barrage is *direct* and *permanent*. When only relatively small parts of the barrage may remain under the pipeline and rock berms, the magnitude of change is *low*. In such a case the cultural and historical values of the UCH site are not at risk.

11.18.4 Prevention and mitigation of adverse impacts

Nord Stream 2 is committed to implementing stringent measures with regard to cultural heritage to mitigate impacts including the preparation of a Cultural Heritage Management Policy *(Nord Stream 2 AG 2016d)*. The policy will be adopted by Nord Stream 2 and all its contractors.

In general, a 50 m minimum safety perimeter measured from the center of the wreck/target unless stated otherwise and should be assigned to each UCH site. The inspected World War II sites will be taken into consideration in the project planning and implementation process as monuments of war and potential war graves, as well as because of the potential safety and environmental hazards.

In the event that an UCH is located in a position that cannot be avoided by routing the pipeline at the prescribed distance because of other constraints, an object-specific management plan will be prepared.

To minimize munitions clearance, a dynamically positioned lay barge will be used in the heavily mined areas of the Gulf of Finland.

Should munitions requring clearing be detected near a cultural heritage site, the relevant authorities will undertake an evaluation of the object. If clearance by detonation is undertaken in the vicinity of a UCH site, the effects of the detonation will be assessed and monitoring as necessary will be taken to ensure that no damage to the UCH has occurred. If required, mitigation measures will be assessed and implemented to manage potential impacts associated with the pressure wave.

The pipe lay vessel anchoring plans shall include provisions to ensure that at no time (immediately after deployment, after dragging on the seabed and during recovery/redeployment) the anchor or the anchor wire are within 200 m (measured on the horizontal plane) of any identified UCH. If necessary the wires will be held off the seabed by buoys or tugs in areas where significant UCH objects are present. Anchor patterns in the proximity of UCH sites will be approved prior to construction in consultation with national cultural heritage agencies as required.

Should cultural heritage objects be encountered during the construction activities, they will be dealt with in accordance with the Chance Finds Procedure. The procedure provides guidelines for actions to be taken in dealing with accidental finds and their documentation and reporting. The procedure will also prescribe notification instructions to inform the national cultural heritage agencies of the finds, contractor roles, management actions, responsibilities and lines of communication.

11.18.5 Lack of information and uncertainties

There is some possibility of finding unexpected items of cultural historical interest during further surveys and during the actual construction work. Such finds will be dealt with within *the chance finds* procedure mentioned above.

The assessment includes some uncertainty related to munitions clearance because the exact number and the locations of the munitions to be cleared are not known. The uncertainty will decrease during the further development of the project after the necessary surveys have been executed.

11.18.6 Significance of the impacts

When assessing UCH sites that are more than 100 years old, the magnitude of impact is considered to be *negligible* due to the low probability of the project affecting the UCH sites, presupposing that the project follows the procedures it has committed to. Therefore the probability of affecting a cultural heritage artefact as a result of construction or operation activities is negligible and the overall significance of the impact is assessed to be *negligible*.

Concerning the World War II historical sites, a barrage (anti-submarine net "Walross", S-R09-09806 / SD-Alt1-3372) may be affected because the site extends across the route alternatives E1 and E2. When only relatively small parts of the barrage may remain under the pipelines or rock berms, the magnitude of change is *low*. The overall significance of the impact on World War II historical sites is assessed to be *minor*.

The impacts on cultural heritage are similar for all pipeline route sub-alternatives. The same applies with regard to different construction alternatives.

Table 11-84. Significance of impacts on cultural heritage.

Impacts on cultural heritage	Receptor sensitivity	Impact magnitude	Overall significance of the impact
Construction phase			
S-R05-7978, wreck, significant UCH site	High	Negligible	Negligible
S-R09-09806, barrage, significant WWII historical site	Medium	Low	Minor
S-R11-2395, wreck, potential WWII historical site	Medium	Negligible	Negligible
S-R15-02960, wreck, significant UCH site	High	Negligible	Negligible
Other cultural heritage, >100-year-old UCH sites	High	Negligible	Negligible
Other WWII historical sites	Medium	Negligible	Negligible
Operation phase			
S-R05-7978, wreck, significant UCH site	High	Negligible	Negligible
S-R09-09806, barrage, significant WWII historical site	Medium	Low	Minor
S-R11-2395, wreck, potential WWII historical site	Medium	Negligible	Negligible
S-R15-02960, wreck, significant UCH site	High	Negligible	Negligible
Other cultural heritage, >100-year-old UCH sites	High	Negligible	Negligible
Other WWII historical sites	Medium	Negligible	Negligible

11.19 Social impacts

The purpose of the social impact assessment is to assess the possible impacts on living conditions and public perceptions of the possible impacts that could be caused by the project or project-related operations. Tourism is also covered under social impacts.

Summary of social impact assessment offshore	
Lessons learned from the Nord Stream Project in 2009-2012	A monitoring study on social impacts was carried out in 2015. It showed that worries had diminished since the EIA phase and the overall opinion about the project was more neutral than before.
Main results of the assessment	Social impacts arose during the planning phase of the project and continue through the construction phase. It is assessed that the social impacts begin to diminish when the pipeline is in operation, if no unintended impacts occur. The main social impact is the impact on public perception. Social impacts from offshore operations on recreation, tourism and the living environment are otherwise considered to be low.

11.19.1 Impact mechanism

The social impact of a project refers to an impact on individuals, the community or society which causes changes in human well-being, welfare or distribution of welfare and alters the way in which people live and cope as members of society. Social impacts can be caused in various ways. Some social impacts are indirect and a reaction to project impacts, such as noise or environmental changes. Other social impacts are a direct response to the project itself and include fear, worry and uncertainty. According to the Ministry of Social Affairs and Health handbook for social impact assessment for national EIAs in Finland *(Ministry of Social Affairs and Health 1999)*, fear is not always caused by change or uncertainty. Knowledge of probable impacts can also raise fears. Concerns can be based on multidimensional knowledge of local conditions, risks and opportunities. This differs from the commonly known "not in my backyard" attitude, which is based on the desire to keep the living environment unchanged. Worries (or expectations) are considered as a social impact as such, regardless of the results of the expert assessments or the receptor's knowledge of these, because they cause an impact on the receptor.

Social impacts are closely linked to other impacts of the project and how people perceive the project. In many cases, social impacts are related to the project as a whole and not necessarily to any specific phase of the project. Social impacts start to develop during the planning phase and can continue during the operation phase.

The assessed social impacts (Table 11-85) have been identified by considering the project activities during planning, construction and operation and how these activities may interact with social impacts. Experience from the previous Nord Stream project and the monitoring of its social impacts have been used as background information. Therefore the assessment of possible impacts is considered to be quite accurate.

Table 11-85. Possible impacts of the project offshore activities on people and society.

Receptor	Project phase	Project activity	Impact
People and society; Tourism and recreation	Planning	Planning and impact assessment	Worries and expectations
	Construction	Offshore operations related to construction, such as pipe supply, pipe-laying or munitions clearance	Worries and expectations Impact on tourism and recreation
	Operation	Maintenance and monitoring	Worries and expectations Impact on tourism and recreation

11.19.2 Methods and data used

The social impact assessment is carried out as an expert assessment using a comparative approach that combines different qualitative and quantitative data, results of other impact assessments in this report, and previous experience and expertise on social impact assessment. The method used for impact assessment is called 'multicriteria analysis' and includes the criteria for sensitivity of receptor and magnitude of change. These criteria are presented in Table 11-86 and Table 11-87.

Table 11-86. Sensitivity of receptor (people and society).

Low	Low recreational use value, optional areas available nearby. No significant features with cultural, scenic or economic values. No disturbance-prone nature-based business activity. A lot of environmental disturbance causing activities (noise, dust, traffic). Social adaptability of the area is high. No people, sensitive institutions (school, daycare, hospital) or important public services potentially susceptible to disturbance. Continuous change in the status of the environment.
Medium	High recreational use value, substitutive areas not easily accessible. Some significant features with cultural, scenic or economic values. Some disturbance-prone nature-based business activity. A few environmental disturbance causing activities (noise, dust, traffic). Social adaptability of the area is moderate. Quite many people, sensitive institutions (school, daycare, hospital) or important public services potentially susceptible to disturbance. Quite peaceful environment which has remained relatively unchanged for some time.
High	High recreational use value, no substitutive areas available. Many unique and significant features with cultural, scenic or economic values. A lot of disturbance-prone nature-based business activity. No environmental disturbance causing activities (noise, dust, traffic), or the number of current activities is so high that the carrying capacity does not bear any additional activities. A lot of people, sensitive institutions (school, daycare, hospital) or important public services potentially susceptible to disturbance. Peaceful environment which has remained relatively unchanged for a long time. Social adaptability of the area is low.

Table 11-87. Magnitude of change (people and society).

High	Positive environmental changes improve wellbeing, living conditions, amenity or recreational use opportunities for people, and the use of residential and holiday properties. Changes bring along new functions benefitting the area, support existing practices and actions or remove disincentives for current practices. The project brings about a lot of hopes and expectations. Changes increase community spirit or decrease inequality significantly. A significant positive impact on the livelihoods, employment opportunities and economy of the local area. Changes are long-term, occur in a large area, are permanent or continual.
Medium	Positive environmental changes improve to some extent wellbeing, living conditions, amenity or recreational use opportunities for people, and the use of residential and holiday properties. Changes may enable new functions benefitting the area or support existing practices. The project causes a lot of hopes and expectations. Changes increase community spirit or decrease inequality significantly. A moderate positive impact on the livelihoods, employment opportunities and economy of the local area. Changes may be long-term, partly reversible, occasional or occur in a relatively large area.
Low	Positive environmental changes cause only minor positive impacts on wellbeing, living conditions, amenity or recreational use opportunities for people, and the use of residential and holiday properties. Changes do not restrict the existing practices and activities in the area. Changes do not increase community spirit or decrease inequality. A minor positive impact on the livelihoods, employment opportunities and economy of the local area. Changes occur in a limited area or are short term, and the situation returns to its pre-existing condition when the impact ends.
Negligible	The living environment remains unchanged. No impacts on the livelihoods, employment or economy of the local area.
Low	Negative environmental changes (e.g. in noise levels, traffic, landscape) cause only minor adverse impacts on the wellbeing, living conditions, amenity or recreational use opportunities for people, or on the use of residential and holiday properties. The project causes only a slight amount of anxiety and disagreements. Changes do not decrease the community spirit or increase inequality. A minor negative impact on the livelihoods, employment opportunities and economy of the local area. Changes occur in a limited area or are short term, and the situation returns to its pre-existing condition when the impact ends.
Medium	Negative environmental changes (e.g. in noise levels, traffic, landscape) cause some level of adverse impacts on the wellbeing, living conditions, amenity or recreational use opportunities for people, or on the use of residential and holiday properties. The project causes some amount of worries and disagreements. Changes decrease the community spirit or increase inequality to some extent. A moderate negative impact on the livelihoods, employment opportunities and economy of the local area. Changes may be long-term, partly reversible or occasional or occur in a relatively large area.
High	Negative environmental changes (e.g. in noise levels, traffic, landscape) cause significant adverse impacts on the wellbeing, living conditions, amenity or recreational use opportunities for people, or on the use of residential and holiday properties. The project causes a lot of anxiety and disagreements. Changes evidently decrease the community spirit or increase inequality significantly. A significant negative impact on the livelihoods, employment opportunities and economy of the local area. Changes are long-term, occur in a large area, are permanent or not reversible.

The main data sources for the social impact assessment are the survey for residents of the coastal areas in Finland (later *coastal survey*), the survey for residents of the City of Kotka area (later *Kotka survey)*, the survey for residents of coastal areas in Estonia (later *Estonian survey*, mainly used to assess transboundary social impacts, Subchapter 13.3.5), a comprehensive *media analysis*, and information from other impact assessments. The information gathered via coastal survey illustrates the overall opinions of the project and its possible impacts and is used both for offshore and onshore impact assessment. Information gathered via the Kotka survey is relevant especially to assess the onshore impacts and is therefore described in more detail in Subchapter 12.1.6. The coastal survey report is included as Appendix 11B and the Kotka survey report as Appendix 11C.

For one-third of the respondents to the coastal survey, the questionnaire and accompanying information sheets were the first time they had heard about Nord Stream 2. Two-thirds of the respondents had at least heard the name of the project before. The main sources of information were television, radio, newspapers or magazines (Appendix 11B, Figures 10 and 11).

Because the main information source for most people is the media, how the project is presented in television or newspapers is important. Because the media can also reflect public opinion, there is a two-way interaction between the media and the public. Media analysis was carried out to obtain a wider perception of the public discussion about the project. The analysis was based on 280 articles published in the Finnish media between September 2015 and August 2016. Nord Stream 2 AG media monitoring was organised by Kantar Media, and the daily media monitoring was carried out by Hill and Knowlton Strategies Germany based on a media set and on agreed search terms. The analysis of the content was made by Ramboll Finland Oy. Only articles that were covered by the media monitoring were included in the analysis. Relevant media outlets consisted of the largest newspapers and television networks and a few smaller newspapers in Finland.

11.19.3 Impact assessment

11.19.3.1 Worries and expectations

In the social impact assessment, people’s perceptions of the project and its possible impacts are also considered. They can be interpreted as an impact (for example worry or hope) or as an indicator of impacts that people in general find important because they would change their living environment.

The majority of the respondents (59 %) to the coastal survey were at some level concerned about the negative impacts of the project. More than half of the respondents who considered the impacts to be both positive and negative were worried about high or medium level negative impacts, while positive impacts were mainly considered low or negligible (Appendix 11B, Figure 17).

The most negative perception of respondents was with regard to the possible impacts on marine life, conservation areas and animals and possible accidents related to gas pipelines (Figure 11-27). Fewer respondents stated possible positive impacts on the Gulf of Finland. Positive perceptions were linked to munitions clearance, ship traffic and tourism (Figure 11-28). Perceptions on economic impacts were also quite positive: the majority (55 %) of the respondents felt that the project would have positive economic impacts on Finland (Figure 11-29).

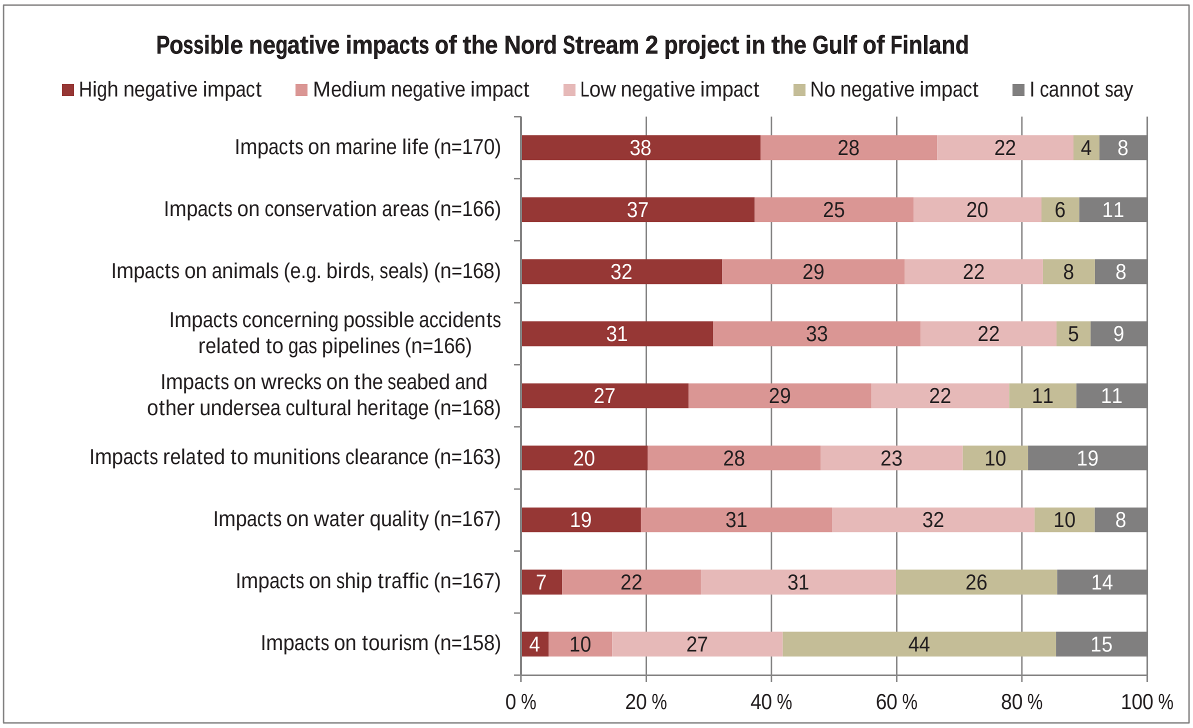

Figure 11-27. Opinions of respondents on negative impacts of the Nord Stream 2 Project in the Gulf of Finland.

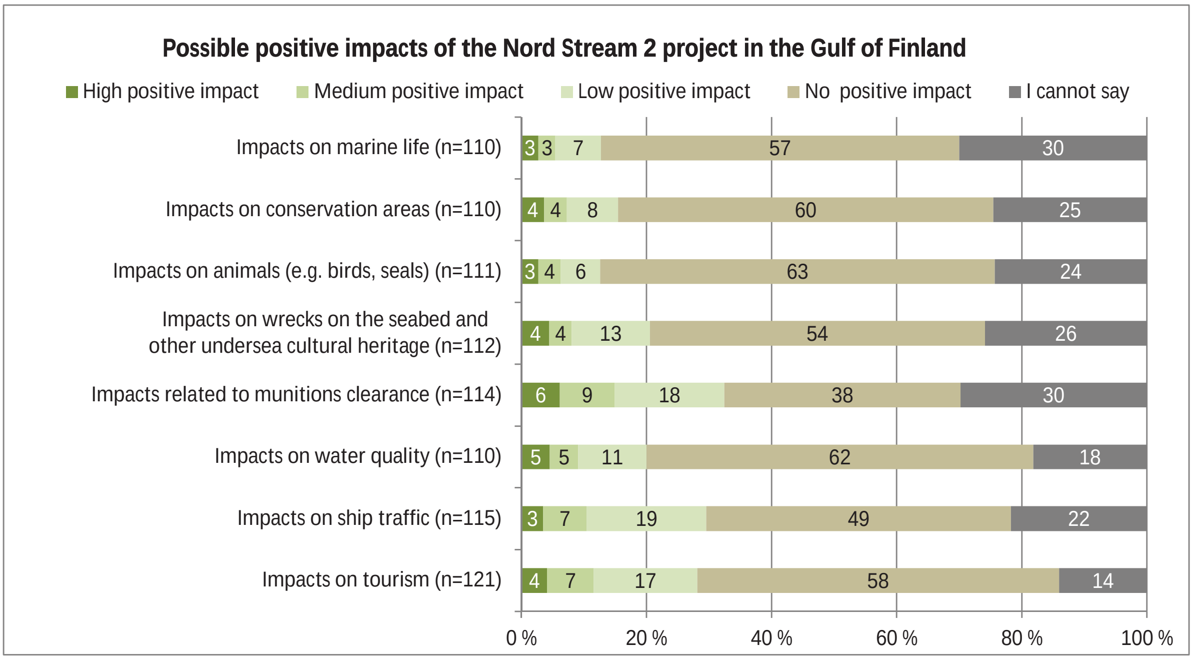

Figure 11-28. Opinions of respondents on positive impacts of the Nord Stream 2 Project in the Gulf of Finland.

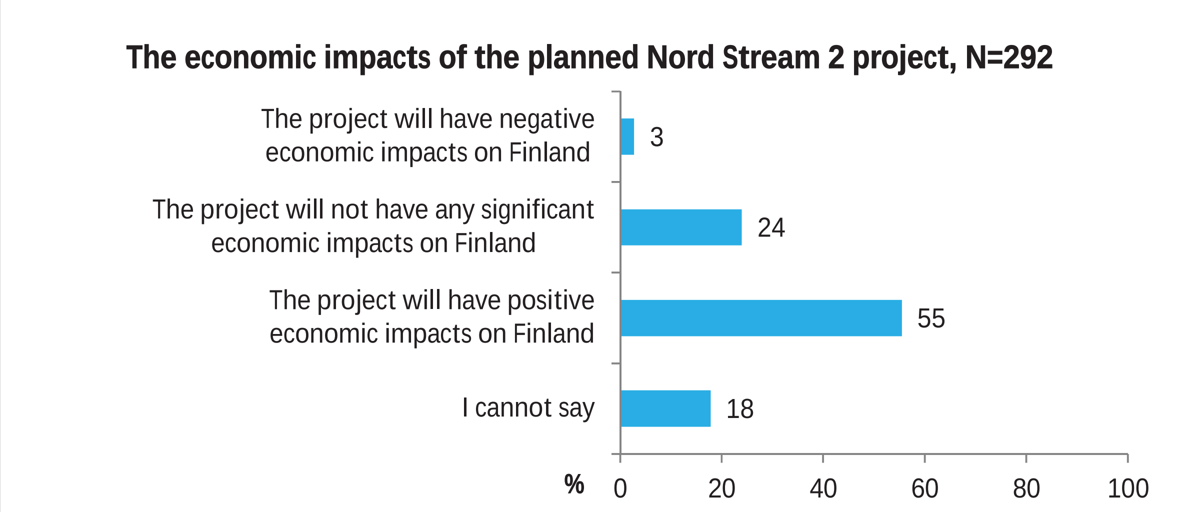

Figure 11-29. Opinions of respondents on the economic impacts of the Nord Stream 2 Project on Finland.

The majority of the respondents (65 %) were not aware that the impacts of the existing Nord Stream pipeline project had been monitored and were found to be short term and not significant. Based on the results of the coastal survey, people who knew that the impacts of the Nord Stream pipelines were monitored were more often convinced that Nord Stream 2 would not cause impacts. The most sceptical group of people was those who would have been interested in the monitoring results but had no knowledge of them (Figure 11-30). This shows the need to openly and actively share the results of the monitoring of the impacts of the existing two pipelines.

In some cases, it seem s that the interest in the state of the Baltic Sea environment among people is so strong that even knowledge of the monitored impacts thus far does not remove all mistrust and worries with regard to project-related impacts. Some respondents found the results of the monitoring as well as the questionnaire to be biased and were also concerned about the political implications of the project. These worries diminish trust in the positive results of the monitoring.

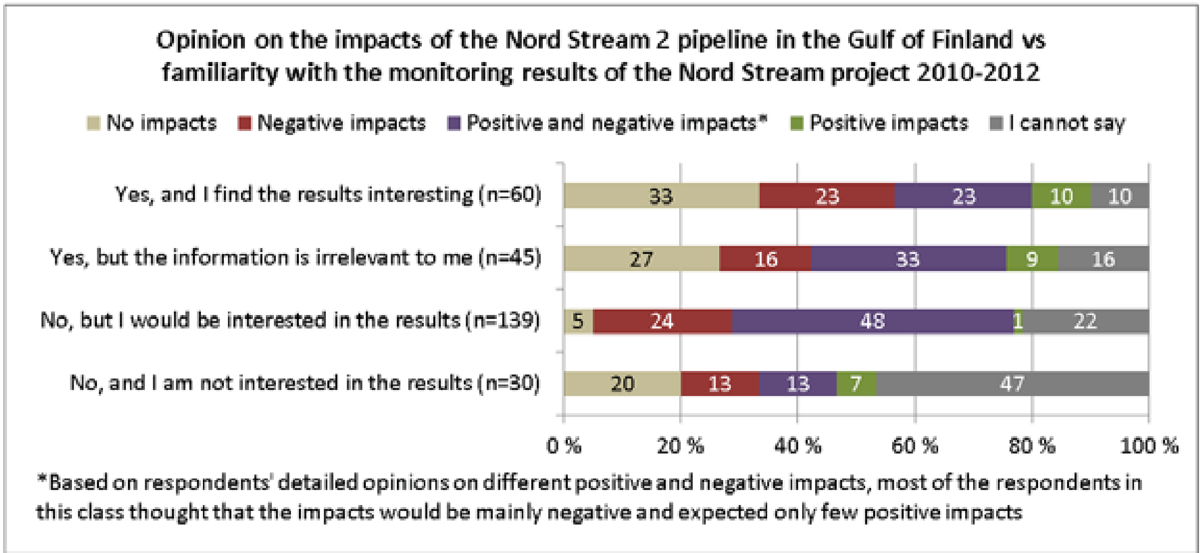

Figure 11-30. Opinions of respondents on the impacts of Nord Stream 2 in the Gulf of Finland in relation to their familiarity with the environmental monitoring results of the Nord Stream pipeline implemented in 2010-2012.

As mentioned, the additional comments given by the respondents of the coastal survey raised the questions of political dimensions. Concern over the political implications, mainly in relation to

Russia, was the main theme expressed (Appendix 11B). Political aspects were also discussed in the articles published in the Finnish media. In the majority of the articles analysed (N=280) the Nord Stream 2 Project was discussed in relation to international relations (mentioned in 75 % of the articles). Most of the articles linking the project to the wider European context and geopolitics were critical in their view. Thus it is understandable that concerns expressed by the media are also reflected in the attitudes of the public.

The impact on people's general worries and expectations is assessed to be medium negative. The project does cause worries about environmental impacts, even if the monitoring results of the environmental impacts of the existing two Nord Stream pipelines do not support this view. The project also causes debate and questioning about the political dimensions on the general (based on media) and the individual (based on survey results) levels. The positive expectations in coastal areas are generally much lower than the concern about possible impacts.

11.19.3.2 Tourism and recreation

More than half of the respondents expressed their concern that the construction of the pipelines could impact water quality or aquatic life (Appendix 11B, Figure 20). Based on the other impact assessments and monitoring of the impacts of the existing Nord Stream pipelines, the impacts on the Baltic Sea are considered to be mostly minor during construction and operation. These changes are unlikely to have any impact on tourism and recreation, even during construction. The changes are so minor, that they are not likely to be in any way notable for normal everyday observing of the surroundings.

While vessel traffic was not such a major source of concern among respondents compared with the construction of the pipelines, one-third of the respondents still found the impacts to be significant (Appendix 11B, Figure 21). The additional vessel traffic during construction and the possible impacts on ship traffic fluency are assessed in Subchapter 11.12, where the possible impacts on passenger traffic are also assessed. Based on the assessment, the impact on ship traffic during construction or operation will be low, even at its highest. During construction, the temporary prohibition area will ban unauthorized navigation, diving, anchoring, fishery or work on the seabed. However, there will still be sufficient space and water depth for ships to safely navigate around the lay barge and the impact from the temporary prohibition area is considered to be low. Information about the restrictions will be delivered through traffic information systems.

The majority of leisure time boating and other sea-related recreational activities take place closer to the coastline and in the archipelago rather than in the outer sea areas and the Finnish EEZ, where the construction work will take place. Turbidity in the waters around the pipeline may be increased during the construction phase, as some construction activities can result in suspension of sediment. In theory this could impact, e.g. the diving experience. Because the pipeline will avoid any contact with shipwrecks, the sediment spreading has only small spatial extent and the suspended sediment is expected to settle within a few hours, it is unlike that construction will cause any disturbance of recreational activities. The impact on the recreational use of the sea areas is assessed to be negligible.

Mussalo Harbour in the City of Kotka serves as a logistic hub (weight-coating plant, storage yard and rock transport) for the eastern part of the pipeline route. This will increase the vessel traffic to and from the harbour. The routes to many guest harbours and marinas cross the routes to the Mussalo Harbour. Because the harbour already has a significant amount of industrial activities and heavy ship traffic, the present situation is assessed to not significantly change and the impact will be low. The possible disturbance of leisure traffic due to this project will be of medium duration (two seasons), as it will occur only during the construction activities. The impact is reversible, as the traffic will return to its previous status after the construction period has ended.

Roughly 40 % of the respondents were worried about the impacts that the pipelines may have on fishing in the Gulf of Finland (Figure 11-31). Impacts on commercial fishing are assessed in Subchapter 11.13. Leisure fishing differs notably from commercial fishing because of the fishing gear, target areas and volume. The sea areas used for leisure fishing and the construction areas in the EEZ do not overlap. Neither construction nor operation of the pipelines is assessed to cause any impacts on leisure fishing.

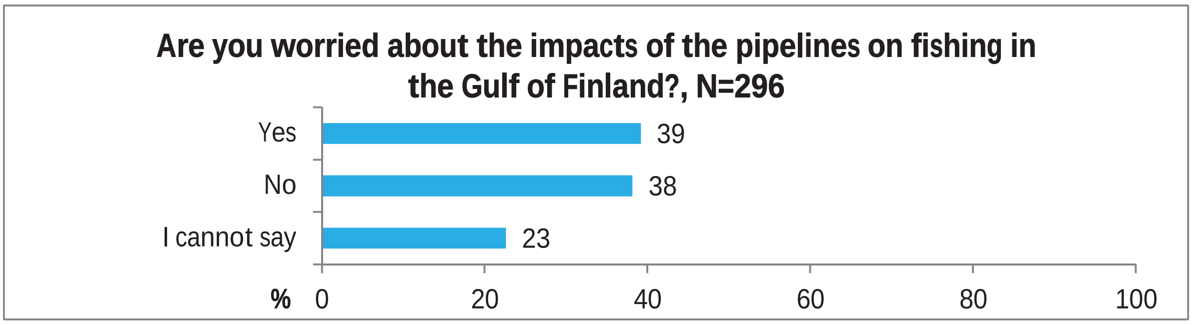

Figure 11-31. Opinions of respondents on the impacts of the pipelines on fishing in the Gulf of Finland.

11.19.4 Prevention and mitigation of adverse impacts

The sea areas that are important to recreational use, tourism or living conditions are mainly far away from the EEZ and construction areas. The actual changes offshore that could impact recreational use of sea areas, tourism or living conditions are also small. The impact is assessed to be low and mainly no mitigation measures are needed.

The main social impact to mitigate is public concern about the project and its possible impacts. The coastal survey shows that communication of the concrete impacts and monitoring results mitigates unfounded worries of possible impacts. Impacts on civic confidence and community relations should be also communicated openly to avoid impressions of any secrecy or political intentions.

In addition to the statutory consultation processes described in Chapter 3 NSP2 has committed to develop and implement Stakeholder Engagement Plans (SEPs) that are geographically specific and tailored to project risks, impacts and the interests of the communities that may be affected by the Project. The SEPs will be provided to the potentially affected communities to enable them to understand the risks, impacts and opportunities of the project. Furthermore, potentially affected communities will be provided with periodic updates that describe progress with implementation of action plans concerning issues of concern to those communities and with the opportunity to express their views on project risks, impacts and mitigation measures. Where there are potentially affected communities, a grievance mechanism will be established to receive and facilitate resolution of concerns and grievances about the Project’s environmental and social performance.

11.19.5 Lack of information and uncertainties

No specific information or data gaps that would affect the results of this social impact assessment have been identified. Possible uncertainties are related to the nature of social impacts. There are no limit values for social impacts, which emphasises the role of expert assessment. At some level expert assessment is unavoidably subject to subjective interpretation.

Data used is a portrait of a certain time frame and the results reflect the current atmosphere. Therefore developments occurring in the time period between gathering information and finishing the impact assessment report that could have had an impact on overall results may not have been included in the analysis.

Uncertainties related to the coastal survey are listed in the survey report (Appendix 11B). Information received from NSP monitoring has showed that there have not been any significant environmental impacts. This information was presented in connection with three questions about impacts and some respondents found this to be a leading formulation of the questions.

11.19.6 Significance of the impacts

Social impacts offshore are considered mainly low. The project has a negligible impact on tourism, recreational use or living conditions in the outer sea areas. Closer to the coastline the project may cause small impacts on recreational use due to increased vessel traffic during the construction phase. Based on the worries expressed in the coastal survey, the project has a medium impact on the worries people have related to the status of the Baltic Sea environment and the possible political dimensions of the project.

In relation to the recreational use of the sea area, tourism and living environment, the sensitivity of the targeted area (receptor) is low because there are only a few people and activities that could be affected by the possible impacts. When assessing the impact on civic confidence, the receptor is the population of the coastal area. Sensitivity of the population to change is assessed by the relationship towards the Baltic Sea based on the information from the coastal survey and media analysis. Sensitivity is assessed to be medium.

Regarding social impacts, there are no differences between sub-alternatives and between construction alternatives.

Table 11-88. Significance of the social impacts offshore.

Social impacts	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Planning phase			
Impact on civic confidence (worries and expectations)	Medium	Medium	Moderate
Construction phase			
Impact on civic confidence (worries and expectations)	Medium	Medium	Moderate
Tourism and recreation	Low	Low	Minor
Operation phase			
Impact on civic confidence (worries and expectations)	Medium	Low	Minor
Tourism and recreation	Low	Low	Negligible

11.20 Qualitative compliance assessment

In this chapter, a qualitative assessment of the regulatory compliance status of NSP2 (Subchapter 7.2) is provided, supported by the assessments undertaken in Chapters 11, 14 and 16.

11.20.1 The Marine Strategy Framework Directive

The targets, qualitative descriptors and associated indicators of the good environmental status (GES) are represented in Table 7-1 and Table 7-2 . In this chapter, the possibility that the NSP2 project will pose a risk to the achievement of the long-term goals for GES is presented (Table 11-89).

11.20.1.1 Biodiversity (D1) and food webs (D4)

As discussed in Subchapter 11.11, activities during the construction phase of the NSP2 will cause increased siltation and abrasion (physical damage, P2) and the release of nutrients (P7) from sediments. The pipeline system on the seabed will occupy seabed (physical loss, P1). These impacts have been assessed to be *minor* (water quality) and *negligible* when different factors (e.g. plankton, benthos, fish) of the food web are considered. Therefore, impacts due to sediment dispersion and the physical loss of seabed on each criteria and indicators D1 and D4 (Table 7-2) are anticipated to be *negligible* and not significant at the level of species, habitat or ecosystem.

In contrast, underwater noise due to munitions clearance has been assessed to potentially affect the Gulf of Finland ringed seal subpopulation (blast injuries and PTS) occurring in the impact area (Appendix 8B). However, the project activities are not likely to cause long-term detrimental effects to biodiversity in the impact area (Subchapter 11.11). A *moderate* impact on the ringed seal population of the Gulf of Finland may affect the indicator "seal distribution". However, the impacts are assessed to be at most *moderate* on only one of the many links in the chain of biodiversity (ringed seals in the Gulf of Finland), while the remaining links are not going to be affected. As the remaining links in the chain of biodiversity will retain their current status (as assessed in Subchapter 11.11), the whole ecosystem is likely to withstand a minor or even a moderate change to a few links. For these reasons, it is assessed that, although the project may have a temporary effect on the indicator "seal distribution", the assessed impacts are not likely to have long-lasting effects on biodiversity or food-webs. Therefore, with the mitigation measures in place (Subchapter 11.11.4), it is assessed that achievement of the GES in terms of biodiversity (D1) and food webs (D4) would not be prevented.

It should additionally be mentioned that NSP2 is currently investigating alternative munitions clearance methods with the objective to further reduce the assessed impacts.

11.20.1.2 Non-indigenous species (D2)

The implementation of mitigation measures, summarised in Subchapter 17.5, for the ballast water management for NSP2 will reduce the risk of introducing non-indigenous species (NIS) to Finnish waters to a very low level. Introduction of NIS is assessed to have *negligible* impact on the environment (see assessment in Subchapter 11.10) and the achievement of the GES would not prevented in terms of NIS (D2).

11.20.1.3 Commercial fish and shellfish (D3)

Construction activities will cause increased siltation, abrasion (physical damage, P2) and underwater noise (P3) that may temporarily cause avoidance reactions in fish.

The disturbances are assessed to have *negligible* impact on fish in Finnish waters (see assessments in Subchapter 11.6 Fish) and the achievement of the GES, in terms of commercial fish and shellfish (D3), would not be prevented.

11.20.1.4 Eutrophication (D5)

Construction activities will cause release of nutrients from the sediment.

Nutrient enrichment of the water column is assessed to have *negligible* impact in Finland (see the assessment in Subchapter 11.3 Water quality) and the achievement of the GES would not be prevented in terms of eutrophication (D5).

11.20.1.5 Seabed integrity (D6)

Smothering and sealing (P1 Physical loss) as well as abrasion and siltation (P2 Physical damage) will cause changes to the seabed. Abrasion and siltation effects have been assessed as *negligible* in Subchapter 11.5 and most significant impacts are due to physical loss of seabed.

The pipeline system will occupy the seabed and cause changes in habitats. The footprint of the pipeline is calculated to be low. The pipelines will not introduce a barrier to benthos as most benthic animals in the impact area are mainly using planktic larvae for migration. The physical loss is assessed to have a *minor* impact in Finland (see the assessment in Subchapter 11.5 Benthic flora and fauna).

The achievement of the GES would not be prevented by the project in terms of seabed integrity (D6).

11.20.1.6 Hydrographical conditions (D7)

The physical structure of the pipeline will cause minor interference with local hydrological processes (P4) by introducing a small change to the bathymetry and no impacts are foreseen on the overall hydrographical conditions (Subchapter 11.3).

The smaller-scale hydrographical effects near the pipelines, such as the change in current fields near the soft seabed surface and the consequent impacts on scour and sedimentation patterns, are assessed to be *negligible* based on the monitoring of Nord Stream pipelines.

Interference with hydrodynamical processes is assessed to have *negligible* impact in Finland (see assessment in Subchapter 11.3 Hydrography) and the achievement of the GES would not be prevented in terms of hydrographical conditions (D7).

11.20.1.7 Contaminants (D8) and contaminants in fish and seafood (D9)

No contamination is expected to be caused by hazardous substances (P5) arising from NSP2 activities as management plans are prepared for all vessel activity.

Elevated concentrations of contaminants in water due to sediment dispersion during construction activities were assessed as short-term (hours) and spatially limited. In modelling, even the highest estimated concentrations (PAH) were lower than the EQS concentration in the sea environment (limit for Benzo(a)pyrene 0.027 µg/l; Decree of the Council of State 1308/2015).

Anti-corrosion anodes on the pipelines will cause the release of inorganic metals (zinc and aluminium) during pipeline operation. However, the elevated concentrations are assessed to be limited to the immediate vicinity of the anodes.

The impacts of contaminants were considered small and not to cause adverse effects or accumulation in fish (see Subchapters 11.3 Hydrography and water quality, 11.6 Fish) and the achievement of the GES would not be prevented in terms of contaminants (D8) and contaminants in fish and seafood (D9).

11.20.1.8 Marine litter (D10)

There will be no physical disturbances to the sea, seabed or coastlines due to the existence of management plans for litter arising from all vessel activity. The physical disturbance is not further assessed in the Finnish EIA.

The achievement of the GES would not be prevented in terms of marine litter (D10).

11.20.1.9 Introduction of energy and underwater noise (D11)

No quantitative indicators currently exist that could be used to assess the impacts on this descriptor D11 (Table 11-89). Therefore, the following assessment is based on the definition of the relevant criteria and the qualitative descriptors (Table 7-2). The relevant criteria states that “The degree of impulsive and continuing noise caused by human activities is not increasing and is at a level that does not exceed natural noise levels nor has a harmful effect on the ecosystem and does not cause economic harm to the coastal and marine marine industry”.

Munition sclearance is the only activity that will cause noise that will exceed the natural noise levels. Similarly, munitions clearance is the only activity with the potential to cause harmful effects on the ecosystem. Any other noise sources (e.g. noise from vessels, anchor-handling and rock placement) will cause only temporary increases in underwater noise, not exceeding background levels (or increase it only to a very limited extent), and will have no impacts on the ecosystem.

The degree of impulsive noise arising from munitions clearance, although considerably exceeds the ambient noise levels, are short-term (peaks) and limited to the construction phase. The duration of the munitions clearance activities is estimated to be two months (Subchapter 4.1.4).

At the end of this period, there will be no noise sources from NSP2 in the study area that will noticeably exceed the ambient noise levels or cause harm to the ecosystem.

As regards impacts on the ecosystem, those have been assessed in different subchapters (Subchapters 11.6 Fish, 11.7 Marine mammals, 11.8 Birds) and summarised in the biodiversity chapter (11.11) and in this chapter (D1 and D4). It is concluded that the project is not likely to cause long-term detrimental effects to biodiversity.

Therefore, considering that underwater noise is taking place over a short period of time and that no long-term detrimental effects to the ecosystem are predicted to occur, the achievement of the GES would not be prevented in terms of introducing underwater energy and underwater noise (D11).

11.20.1.10 Summary of how NSP2 impacts national compliance with the MSFD

A summary of impacts based on impacts assessed in previous chapters are presented in Table 11-89.

Table 11-89. NSP2 impact on national compliance with MSFD.

Descriptor	Potential impacts from NSP2 (based on assessments undertaken in Chapter 11)		NSP2 compliance with the MSFD
D1 Biodiversity D4 Food webs	NSP2 impact on existing pressures	*Negligible/minor* (pressures P1, P2, P5, P6, P7) Temporary increase of pressure P3 - Underwater noise (Table 7-2 and Subchapter 11.4)	The project will temporarily increase underwater noise levels (short-term duration). The loudest noise source is munitions clearance. NSP2 will have moderate impacts on pressure P3 and criteria/indicators regarding seal distribution and population size and population healthy of top-predators. However, these impacts are not likely to affect the whole ecosystem because the remaining links of the biodiversity/food chain remain intact. On that basis, it can be concluded that **NSP2 will not prevent the achievement of GES Biodiversity, Food webs.**
	NSP2 impact on criteria/indicators of GES	The impact on the ringed seals of the Gulf of Finland is assessed as *moderate* and on grey seals as *minor* (Subchapter 11.7) and could have an impact on indicator: seal distribution. Other impacts that are mainly associated with the loss of habitats (Indicator: total area of habitat types), physical damage. etc. smaller than minor	
D2 Non-indigenous species	NSP2 impact on existing pressures	Ballast water plans will reduce the overall risk of introducing new NIS to the Baltic Sea (pressure P7). Impact is *negligible*.	NSP2 will have no significant impacts on existing pressures, criteria/indicators of GES. On that basis, it can be concluded that **NSP2 will not prevent the achievement of the long-term goal for GES.**
	NSP2 impact on criteria/indicators of GES	NSP2 would result *negligible* impact on relevant indicators (Table 7-2)	
D3 Commercial fish	NSP2 impact on existing pressures	Physical damage P2: Siltation and abrasion may cause temporary and local avoidance reactions in fish. Underwater noise P3: Construction activities result in underwater noise which can cause temporary and local avoidance reactions in fish. The impacts are assessed as *negligible*.	NSP2 will have no significant impacts on existing pressures, criteria/indicators of GES. On that basis, it can be concluded that **NSP2 will not prevent the achievement of the long-term goal for GES.**
	NSP2 impact on criteria/indicators of GES	Based on assessments, the impacts are *negligible* to spawning fish stock biomass (herring, sprat) (Subchapter 11.6)	

Descriptor	Potential impacts from NSP2 (based on assessments undertaken in Chapter 11)		NSP2 compliance with the MSFD
D5 Eutrophication	NSP2 impact on existing pressures	Nutrient enrichment P6: Construction activities may cause local and temporary release of nutrients from the sediment. The impact on eutrophication status is assessed as *negligible*.	NSP2 will have no significant impacts on existing pressures, indicators or targets. On that basis, it can be concluded that **NSP2 will not prevent the achievement of the long-term goal for GES.**
	NSP2 impact on criteria/ indicators of GES	NSP2 would result in *negligible* impact on relevant criteria/indicators (Table 7-2)	
D6 Seabed integrity	NSP2 impact on existing pressures	Physical loss P1: permanent occupation of the seabed. The impact is assessed as *minor*. Physical damage P2: smothering and sealing due to siltation may cause temporary and local changes to benthic fauna. The impact was assessed as *negligible*.	NSP2 will have no significant impacts on existing pressures, indicators or targets. On that basis, it can be concluded that **NSP2 will not prevent the achievement of the long-term goal.**
	NSP2 impact on criteria/ indicators of GES	The footprint of the pipeline and supporting structures will be small and does not prevent the natural structures and function of the benthic ecosystems. NSP2 does not hamper the protection status of benthic habitats.	
D7 Hydrographical conditions	NSP2 impact on existing pressures	Interference with hydrological processes P4: Based on monitoring during NSP, the impact is *negligible* (Sub-chapter 11.3). The maximum impact area was found to be 50 m and is restricted near the seabed.	NSP2 will have no significant impacts on existing pressures, indicators or targets. On that basis, it can be concluded that **NSP2 will not prevent the achievement of the long-term goal.**
	NSP2 impact on criteria/ indicators of GES	The cumulative impact regarding hydrological interference is assessed as *negligible* (Chapter 14).	
D8 Contaminants D9 Contaminants in fish and seafood	NSP2 impact on existing pressures	Contamination by hazardous substances P5: Suspension of contaminants in water/relocation due to sediment dispersion is *minor*. Release of metals may occur from anodes (anti-corrosion Measures) but the impact is limited to the proximity of anodes and no accumulation to biota is expected to occur. The impact is assessed as *negligible*.	NSP2 will have no significant impacts on existing pressures, indicators or targets. On that basis, it can be concluded that **NSP2 will not prevent the achievement of the long-term goals for GES.**
	NSP2 impact on criteria/indicators of GES	NSP2 would result in *negligible* impact on the content of mercury, cadmium, zinc, copper, lead, chrome, nickel, Arsenic, TBT and PAH in water, sediments or biota. NSP2 would result in *negligible* impact on lead, cadmium, mercury, organic tin, dioxins, PCBs and benzo(a)pyrene in commercially exploited fish and shellfish.	
D10 Marine litter	NSP2 impact on existing pressures	Other physical disturbance P3: Management plans for all vessel activity aims to prevent littering from NSP2.	NSP2 will have no significant impacts on existing pressures or indicators. On that basis, it can be concluded that **NSP2 will not prevent the achievement of the long-term goal for GES.**
	NSP2 impact on criteria/indicators of GES	NSP2 would result in *negligible* impact on relevant criteria. There are no quantitative indicators available at the moment.	

Descriptor	Potential impacts from NSP2 (based on assessments undertaken in Chapter 11)		NSP2 compliance with the MSFD
D11 Introduction of energy and underwater noise	NSP2 impact on existing pressures	Other physical disturbance P3: Munitions clearance will create strong but very short-term noise pulses.	Considering that underwater noise is taking place over a short period of time and that no long-term detrimental effects to the ecosystem are predicted to occur, it can be concluded that **NSP2 will not prevent the achie-vement of GES.** **However, at the moment, there are no quantitative indicators.**
	NSP2 impacts on criteria/indicators of GES	Mitigation measures can reduce impact to the marine mammals so that *moderate* negative effects are expected only to ringed seals in the Gulf of Finland. This impact is not likely to have negative effects on the ecosystem as a whole.	

11.20.2 The Water Framework Directive

The main pressures to the marine environment in the coastal areas of the Gulf of Finland, are mainly related to eutrophication *(Karonen et al 2015)*. The potential impacts caused by NSP2 are connected to the release and spreading of nutrients and contaminants during the construction of the pipelines and supporting structures. The impacts are assessed in Subchapter 11.3, Hydrography and water quality. Based on the assessment, the impact area is restricted to the vicinity of the construction sites and changes in water quality are temporally very short. The construction sites are situated in the Finnish EEZ and, thus, the distances to coastal areas are rather long. This ensures sufficient dilution so that there will be no water quality impacts in coastal areas and, consequently, no impacts on ecological status.

Overall, it is concluded that NSP2 will not increase these main pressures on the environment and, therefore, NSP2 will not be contrary to the objectives and initiatives set out in the Water Framework Directive.

11.20.3 HELCOM Baltic Sea Action Plan (BSAP)

The objective of the BSAP programme is to restore the good ecological status of the Baltic marine environment by 2021. The goals are largely overlapping with MSFD and hence the purpose of this programme is also to assemble and harmonise the latest scientific knowledge and management approaches of the coastal Baltic countries and the EU.

In NSP2 all project vessels will be compliant with the requirements of the Helsinki Convention (Convention on the Protection of the Marine Environment of the Baltic Sea Area) and the prescriptions for the Baltic Sea Area as a MARPOL 73/78 Special Area. Impacts from discharges of e.g. sewage are, therefore, considered insignificant.

Construction activities (e.g. munitions clearance, rock placement, pipe-lay) will disturb the seabed and cause sediment dispersion followed by re-suspension of nutrients and contaminants from the sediment near the construction sites. Based on the impact assessment, the maximum concentrations are found in the vicinity of the construction sites and turbidity peaks are short. The increase in sedimentation rate is spatially very limited and the thickness of relocated material is very thin (Subchapters 11.2. and 11.3). Potential impacts from suspended sediment and associated nutrients and contaminants are, therefore, assessed to be short-term and *negligible*.

Biodiversity is assessed in Subchapter 11.11. The overall conclusion is that impacts caused by construction activities and the operational phase are limited to the species level (marine mammals) and affect only the ringed seals in the Gulf of Finland and the grey seals. The project activities are not likely to cause long-term detrimental effects to biodiversity in the impact area.

Thereby, it is assessed that NSP2 will not be contrary to the objectives and initiatives set out in the HELCOM Baltic Sea Action Plan.

Table 11-90. NSP2 impact on national compliance with HELCOM Baltic Sea Action Plan.

Objective	Potential impacts from NSP2 (based on assessments undertaken in Chapters 11 and 16)		NSP2 compliance with HELCOM BSAP
Eutrophication	NSP2 impact mechanism	Nutrient enrichment: Construction activities may cause a local and temporary release of nutrients from the sediment. The impact on eutrophication is assessed as *negligible* (Subchapter 11.3.3).	NSP2 will have no significant impacts on existing pressures, indicators or objectives. On that basis, it can be concluded that **NSP2 will not prevent the achievement of the BSAP objectives for GES by 2021.**
	NSP2 impact on criteria/targets/indicators	NSP2 would result in *negligible* impact on indicators that are used to measure the ecological objectives: primary ecological objective is water transparency (secchi depth) and, thus, the impact on targets is *negligible*.	
Hazardous substances	NSP2 impact mechanism	Contamination by hazardous substances: NSP2 does not increase the load of contaminants during construction. In contrast, construction activities will cause sediment dispersion and resuspension of contaminants in water and resettle back on the seabed. The impact is assessed as *negligible* (Subchapter 11.2.3) The release of metals (mainly Zn) may occur from anodes (anti-corrosion measures) but the impact is limited to the proximity of anodes and accumulation to biota is *negligible*.	NSP2 will have no significant impacts on existing pressures, indicators or targets. On that basis, it can be concluded that **NSP2 will not prevent the achievement of the BSAP objectives for GES by 2021.**
	NSP2 impact on criteria/targets/indicators	NSP2 would have *negligible* impact on indicators or target levels of ecological objectives of BSAP: Cd, Hg, Dioxin/Furans, Dioxin-like PCBs, TBT in fish (and sediment & biota) and, thus, the impact on targets is *negligible*.	
Nature conservation and biodiversity	NSP2 impact mechanism	Siltation and abrasion may cause physical disturbance to benthic habitats. The impact is assessed to be *negligible* (Subchapter 11.5.3) The impact caused by underwater noise is assessed as *moderate* at the level of the population of ringed seals in the eastern Gulf of Finland (Subchapter 11.7) and could have an impact on indicators regarding abundance, trends and distribution of seals. Underwater noise may cause avoidance reactions by some species. These impacts have been assessed as *minor*. However, these impacts are not likely to affect the biodiversity of the ecosystem because the remaining links of the biodiversity chain remain intact.	NSP2 will have no significant impacts on existing targets or indicators except targets/indicators concerning seals. On that basis, it can be concluded that **NSP2 will not prevent the achievement of the BSAP objectives by 2021 (for targets/indicators related to seals).**

Objective	Potential impacts from NSP2 (based on assessments undertaken in Chapters 11 and 16)		NSP2 compliance with HELCOM BSAP
	NSP2 impact on criteria/targets/indicators	NSP2 would result in *negligible* impact on targets/indicators that describe criteria: natural marine and coastal landscapes or thriving and balanced communities of plants and animals NSP2 have an impact on targets/ indicators that describes criteria: viable populations of species (*moderate* impact on the ringed seal population of the eastern Gulf of Finland)	
Maritime activities	NSP2 impact mechanism	Lay barge and vessels cause air emissions of CO2, NOX and particulates but the concentrations, compared to the total ship traffic in the Baltic, are small. The impact is assessed as *negligible* (Subchapter 11.1) The presence of vessels increases the risk of accidents and e.g. oil spills. The impact is assessed to be *negligible* (Chapter 16) NIS may be introduced through ballast water. The impact is assessed as *negligible*.	NSP2 will have no significant impacts on existing pressures, indicators or targets. On that basis, it can be concluded that **NSP2 will not prevent the achievement of the BSAP objectives for GES by 2021.**
	NSP2 impact on criteria/ targets/ indicators	NSP2 will have *negligible* impact on criteria and associated targets/indicators connected to pollution and the risk of e.g. oil spills.	

12. ONSHORE IMPACT ASSESSMENT

12.1 Impacts on Kotka region

This chapter includes the assessment of the impacts within the area for NSP2 ancillary onshore activities in Kotka region and Hanko.

12.1.1 Impacts on land use

Ancillary onshore operations in Mussalo, Kotka, include the concrete weight coating plant (CWC-plant), transport and storage of pipes and rock. Potential ancillary activities in Rajavuori, Kotka, and Kyytkärri, Pyhtää, quarry areas include quarrying and transport of rock. The purpose of the assessment is to identify impacts and possible conflicts with current land use and development in Mussalo, Kotka, and near the aforementioned rock quarries.

It has been assumed for the purposes of this impact assessment that the rock required for Project will be obtained from the Rudus Oy Rajavuori quarry in Kotka and the Destia Oy Kyytkärri quarry in Pyhtää, both of which were used during NSP.

Summary of land use impact assessment	
Lessons learned from the Nord Stream Project in 2009–2012	The location of Mussalo ancillary onshore operations and quarry operations in Nord Stream 2 are assumed to be similar to NSP. Experiences from NSP regarding land use were positive and the areas served the project well.
Main results of the assessment	Locating the onshore operations in existing industrial and harbour areas does not require changes to existing planning. The location takes advantage of existing harbour and industrial area infrastructure. There is no sensitive land use (schools, daycare, hospitals) in the operation areas. The closest residential area in Ristniemi is located approximately 0.3–0.8 km from the operations at Jänskä quay and the CWC-plant. The rock transport route runs through existing road network. The magnitude of change of the construction phase to land use in Kotka is assessed to be low positive and the significance of the impact minor positive. After construction and during operation, there are no impacts on land use in Kotka. The potential quarries of Rajavuori and Kyytkärri are located in existing quarry areas. The locations of quarries have been assessed in the quarries' environmental and extraction permit processes. The use of Rajavuori and Kyytkärri quarries do not require changes in current land use planning. Use of existing quarries for Nord Stream 2 rock supply is assessed to have a minor positive impact on land use.

12.1.1.1 Impact mechanism

Impacts from ancillary activities could conflict with present and planned land use forms and infrastructure or with the development of the area.

12.1.1.2 Methods and data used

Impacts have been assessed by expert opinion based on a technical description of the project, planned locations of the activities and the rock transport route, environmental permits and extraction permits of the quarries, existing conditions and maps and the current land use planning situation in the Kotka region. The current land use planning situation is described in Subchapter 8.1.1.

The significance of an impact (sensitivity of receptor and magnitude of change) on land use has been assessed based on the tables below.

Table 12-1. Sensitivity of receptor (land use).

Low	Industrial areas and traffic areas with no significant settlement, recreational value or other sensitive operations (schools, day care centres, hospitals).
Medium	Previously built areas with few inhabitants; or unbuilt areas with some noise- or other distractions; areas with multiple recreational areas and/or recreational areas can be replaced with other areas.
High	Residential areas or their immediate vicinity, natural and recreational areas. Only few recreational areas in proportion to inhabitants/users or limited possibilities for compensatory recreational areas.

Table 12-2. Magnitude of change (land use).

High	The project enables development of the surrounding areas and realisation of existing plans. Positive changes in land use are long-term, occur in a large area, and are permanent or continual.
Medium	A moderate positive impact on land use. Changes may be long-term, partly reversible, occasional or occur in a relatively large area.
Low	The project causes minor positive impacts on land use. Project enables development of the existing areas and plans in the immediate vicinity of the operations. Changes occur in a limited area or are short-term and the situation returns back to the pre-existing condition when the impact ends.
Negligible	No changes on the land use.
Low	The project does not cause significant change in the area. Compared to existing operations in the area the project adds similar operations that lean on existing infrastructure. Small changes in planning are required that do not cause opposition in the area. The nature of the operations is negative but short-term.
Medium	The project brings new operations or the building of new infrastructure. Changes in planning are required. The nature of the operations is negative and relatively long-term.
High	The project conflicts with present and planned land use development. Changes in regional planning or local master planning are required. The nature of the operations is negative and permanent.

12.1.1.3 Impact assessment

Impacts during construction

Nord Stream 2 onshore operations and transport activities in Kotka and quarries have been described in more detail in Subchapter 4.3.2. The operations include a concrete weight coating plant (CWC-plant), transport and storage of pipes, weight coating materials and rock. The quarrying operations include extraction, quarrying and transport of rock material from Rajavuori, Kotka, and Kyytkärri Pyhtää, to Mussalo Harbour in Kotka. The onshore activities in Kotka are planned to take place approximately from Q1/2017 to Q3/2019 . Rock quarrying and transport are planned to take place approximately from Q1/2018 to Q2/2019. The rock transport is estimated to be take place for a period of 18 months.

Mussalo

The coating plant and storage areas for pipes and other materials are located in existing harbour and industrial areas. Compared to the previous NSP project, larger storage areas are needed inside the industrial and harbour area. The coating plant facility from the NSP project remains and can be taken into use with minor construction works. There have not been any operations at the coating plant facility since the NSP project.

The pipe and material shippings via Mussalo Harbour are possible utilising existing quays, storage yards etc. Also, existing road and rail network are available.

In the regional plan the ancillary activities are located in a harbour area (LS). In the current local master plan the activities are located in a harbour, dock and terminal area (LS) and an industrial area (T or TY). Pipe storage areas are also partly within a power production area (ET), where the Pohjolan Voima Oy's power plant has been demolished. In the *local* detailed plan the operations are located in a harbour area (LS) and an industrial area (T, T_T^2). The land use planning situation is described in more detail in Subchapter 8.1.1.

The nearest sensitive land uses are daycare centers in Etukylä and Hirssaari located approximately 2 km from Mussalo Harbour and Palaslahti Industrial Area. The nearest school is Mussalo Elementary School located over 2 km from the harbour. The nearest residential area is Ristniemi located approximately 0.3–0.8 km from the operations. The rock transport route runs through Hyväntuulentie and passes the Central Hospital of Kymenlaakso. The entrance to the hospital is from Kotkantie, not Hyväntuulentie.

Planned activities are in line with current land use plans.

Possile rock extraction areas

The quarries of Rudus Oy at Rajavuori and Destia Oy at Kyytkärri have valid permits for extraction, quarrying and crushing *(City of Kotka 2010a and City of Kotka 2010b, Community of Pyhtää 2009 and Community of Pyhtää 2010)*. Both areas are in operation. When the permits have been granted, the authorities have assessed also the land use and planning situation in the quarry areas and no conflicts with land use and planning have been identified.

Impacts during operation

After the construction phase the storage areas will be cleaned of rock and pipes and the coating operations will end. The areas used will be available for other companies and operations.
During the operation of Nord Stream 2, there will be no impacts on onshore land use.

12.1.1.4 Prevention and mitigation of adverse impacts

There is no need for mitigation of adverse impacts regarding land use.

12.1.1.5 Lack of information and uncertainties

No major uncertainties were recognised.

12.1.1.6 Significance of the impacts

As the Nord Stream 2 onshore operations are located in an existing harbour and industrial area, the sensitivity of the receptor is assessed to be *low*. There are existing operations such as HaminaKotka's Mussalo Harbour, Kuusakoski Oy Metal Recycling Plant and Kymen Vesi Oy Mussalo Waste Water Treatment Plant in or in the immediate vicinity of the planned Nord Stream 2 operations area. The closest residential area in Ristniemi is located 0.3 km from Nord Stream 2 operations. There are current harbour operations at Jänskä quay and also Kuusakoski's and Kymen Vesi's plants are located closer to Ristniemi residential area than to Nord Stream 2 operations.

The quarries of Rajavuori and Kyytkärri are located in existing quarry areas. The location of the quarries have been assessed in permitting of the quarries and in EIA procedure for Rajavuori quarry. The location of the quarries are in line with the current land use plans. Therefore, the sensitivity of the receptor has been assessed as *low.* There are also other quarries in Rajavuori area and other operations near the quarries, such as the Heinsuo Waste Treatment and Landfill Area.

The project does not require any changes to current land use planning. The planned ancillary operations are in accordance with existing land use plans as the area in Mussalo is reserved for industrial and harbour operations. Locating the coating plant and storage areas as close to the harbour as possible minimises transportation and takes full advantage of existing infrastructure. By utilising the existing coating plant facility and harbour as well as road and rail infrastructure, there is no need to extend operations to areas with more sensitive land use and the need for building new facilities is minimised. Using existing quarries, there is also no need to extend operations to areas with more sensitive land use and the need for building new facilities is minimised.

The magnitude of change of the construction phase to land use is assessed to be *low positive* and the significance of the impact *minor positive*. After construction and during operation, there are *negligible* impacts on land use.

Table 12-3. Significance of the impacts on land use in the Kotka region.

Impacts on land use	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Land use	Low	Low	Minor positive
Operation phase			
Land use	Low	Negligible	Negligible

12.1.2 Impacts on road traffic and safety

Potential transport of rock from quarries to Mussalo Harbour would produce heavy vehicle traffic. The purpose is to assess the change in traffic volumes and the impact on traffic fluency, safety and related risks.

Summary of road traffic and safety impact assessment	
Lessons learned from the Nord Stream Project in 2009–2012	Rock transportation had some impact on traffic fluency during NSP.
Main results of the assessment	The increase of heavy traffic due to Nord Stream 2 rock transport is estimated to take place for a period of 18 months t between Q1/2018 – Q2/2019. Due to intensive operation time and significant amounts of rock, the impact on traffic along the transport route is estimated to be medium negative on Road 15 and high negative on Road 355. The Nord Steam 2 rock transport increases average daily traffic by approximately 600 heavy vehicles. The increase in heavy traffic on Hyväntuulentie and on Merituulentie is estimated to be +40% compared to heavy traffic volumes in 2015. Also, heavy traffic at Mussalo Harbour Gate increases +38% compared to year 2013. The traffic fluency is estimated to deteriorate to some extent especially on Road 355. Also, traffic within the Mussalo Harbour area will be impacted by the rock transport.

12.1.2.1 Impact mechanism

Transport of rock will produce heavy vehicle traffic along the transport route from Rajavuori and Kyytkärri quarries to Mussalo Harbour. Average daily traffic is estimated to be 600 vehicles and traffic will be routed via Highway 7 (E18), Road 15 (Hyväntuulentie) and Road 355 (Merituulentie). Increased traffic may have an affect on traffic fluency and road safety and increase the risk of accidents. This evaluation covers only road traffic. Vessel and rail traffic are not included in this subchapter.

12.1.2.2 Methods and used data

The average traffic volumes on the rock transport route to Mussalo Harbour are described in Subchapter 8.1.6. The estimated road traffic caused by the ancillary activies of Nord Stream 2 in Kotka is presented in Subchapter 4.3.2. The road traffic and safety assessment is performed as an expert opinion.

Heavy vehicles used for the rock transport is estimated to be approximately 110,000 vehicles in total. The rock transport is likely to start one month prior to the commencement of pipeline construction works (hence Q1/2018) and the transport operation will continue for about 18 months. Increase in heavy vehicle traffic to Mussalo Harbour is estimated to be approximately 300 trucks per day.

Table 12-4. Heavy traffic from Nord Stream 2 rock transport to Mussalo Harbour.

	Quantitiy	Unit
Rock, total	4,260,000	tonnes
Truck capacity, one truck	40	tonnes
Truck visits to harbour	110,000	
Operation time	18	months
Operating days per month	20	d/mo
Days, total	240	d
Trucks per day (average daily traffic)	600	trucks/d
Trucks per hour (one way / both ways)	18/36	trucks/h (16 h/d)

Significance of an impact (sensitivity of receptor and magnitude of change) on traffic and safety has been assessed based on the tables below.

Table 12-5. Sensitivity of receptor (traffic and safety).

Low	The fluency of traffic flow and traffic safety are at a good level. No sensitive receptors (as hospitals, schools, day care centers or holiday homes) are located nearby.
Medium	The fluency of traffic flow and traffic safety are at a good level, but they cannot withstand a large increase in traffic volumes. Few sensitive receptors (as hospitals, schools, day care centers or holiday homes) are located nearby.
High	The fluency of t traffic flow and/or traffic safety has already deteriorated. The area has a large number of sensitive receptors, such as hospitals, schools, day care centers and holiday homes located nearby.

Table 12-6. Magnitude of change (traffic and safety).

Negligible	The onshore activities related to the project introduce no impact on traffic conditions.
Low	The increased volume of heavy traffic caused by project-related activities is limited and low. The fluency of traffic flow, road safety, perceived safety as well as walking and cycling conditions deteriorate to a minor extent or not at all.
Medium	The volume of heavy traffic caused by the onshore activities related to the project is relatively moderate. The fluency of traffic flow, road safety and perceived safety deteriorate. Walking and cycling conditions deteriorate.
High	The volume of heavy traffic caused by the onshore activities related to the project is relatively high. The fluency of traffic flow, road safety and perceived safety deteriorate significantly. Walking and cycling conditions deteriorate significantly.

12.1.2.3 Impact assessment

Nord Stream 2 rock transport increases heavy traffic by approximately 300 vehicles (adding daily heavy traffic volume to 600 movements per day). Approximately 12,000 tonnes of rock is transported to Mussalo Harbour daily between 2018–2019. This amounts to a 2–3 % increase in total traffic volume (2015) and a 26–50 % increase in heavy vehicle volume (2015) on Highway 7 (E18). Corresponding increases on Hyväntuulentie (Road 15) are 3 % in total traffic and 40% in heavy traffic. For Merituulentie (Road 355), the rock transport amounts to a 10 % increase in total traffic (2015) and 40 % increase in heavy traffic (2015).

Table 12-7. Traffic volume increase arising from Nord Stream 2 rock transport compared to 2015 average traffic volume. A general traffic increase without Nord Stream 2 is not included[1]

	Traffic volume in 2015	Traffic volume in 2015 + NSP2 rock transport	Increase compared to 2015, %
Highway 7 (E18)			
Average daily traffic (westbound)	19,600	20,200	+3%
Average heavy vehicle traffic (westbound)	1,200	1,800	+50%
Average daily traffic (eastbound)	30,900	31,500	+2%
Average heavy vehicle traffic (eastbound)	2,300	2,900	+26%
Hyväntuulentie (nr. 15)			
Average daily traffic	21,100	21,700	+3%
Average heavy vehicle traffic	1,500	2,100	+40%
Merituulentie (nr. 355)			
Average daily traffic	6,000	6,600	+10%
Average heavy vehicle traffic	1,500	2,100	+40%

General traffic increase for the abovementioned roads between 2014 to 2020 has been estimated to be 5.5 %, thus, about 1.1 % per year. However, short-term forecasts are uncertain; traffic volumes vary each year, depending on e.g. economic conditions.

According to vehicle counting in 2013, the average daily heavy traffic through Mussalo Harbour Gate was approximately 1,600 heavy vehicles on weekdays *(Southeast Finland ELY Centre 2013)*. Nord Stream 2 rock transport is estimated to add an additional 600 heavy vehicles daily to the harbour in 2018. This increases the heavy traffic to the harbour by +38 % compared to 2013 traffic.

On Highway 7, the increase of heavy traffic is relatively small compared to total traffic, but the relative increase of heavy traffic is more significant, especially, towards the west. Towards the east, traffic volumes are significantly greater than towards the west and the relative growth is smaller. However, Highway 7 is a dual carriageway, four-lane road with high capacity and the total impact of the rock transport is minimal. According to the Road Cross-section Planning Manual of the Finnish Transport Agency, the maximum capacity of a dual carriageway with four-lanes is 50,000 vehicles per day.

On Road 15 (Hyväntuulentie), the impact of heavy traffic is slightly more significant as the road experiences congestion at junctions during peak hours. However, the rock transport is spread over 16 hours per day, so the total impact on peak hours is relatively small and should be seen as a short-term, minor addition to the existing congestion. Primary growth in traffic is related to general land use development and the development of the HaminaKotka Harbour. This may require upgrading Road 15 in the future, notably transforming two at-grade junctions into interchanges. According to the Road Cross-section Planning Manual of the Finnish Transport

Agency, the maximum capacity of a single-carriageway, four-lane road is 30,000 vehicles per day. However, this capacity cannot be directly applied to junctions.

On Road 355 (Merituulentie), the impact of heavy traffic is more significant because the road has several at-grade junctions in which vehicles must depart uphill. This causes queueing and additional delays. Increasing heavy traffic also increases accident risk, especially at Tökkärintie, Jänskäntie and Takakyläntie junctions where pedestrians have level crossings, see Figure 12-1. Congestion occurs mainly during peak hours (7.00–8.00 am and 4.00–5.00 pm) when local traffic volumes are at their highest. Just like on Road 15, the rock transport is spread over 16 hours per day, so the impact on peak hours is relatively small. According to the Road Cross-section Planning Manual of the Finnish Transport Agency, the maximum capacity of single-carriageway, two-lane road is 9,000 vehicles per day, but like on Hyväntuulentie, this cannot be directly applied to junctions and it does not take vertical geometry into account.

There are no particularly sensitive receptors (schools, hospitals, daycare centers or holiday homes) in the immediate vicinity of Road Hyväntuulentie or Road Merituulentie. There are residential areas that can be accessed via Hyväntuulentie and Merituulentie, but the areas are not located in the immediate vicinity of the roads.

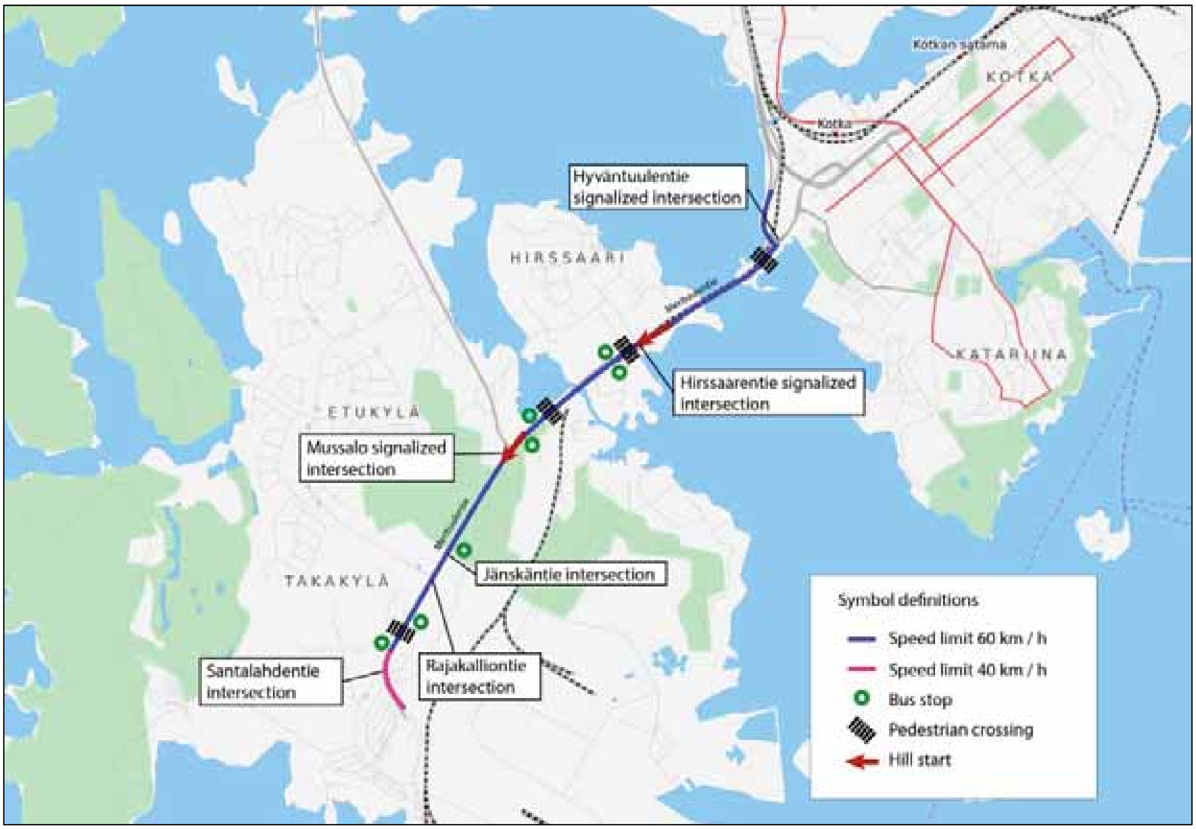

Figure 12-1. Merituulentie traffic details.

The increased heavy vehicle traffic may also have an impact on road traffic safety inside the Mussalo Harbour area. There will be a constant flow of trucks supplying rock for berth and supply vessels.

According to the City of Kotka Road Department, no major impact on road fluency from NSP was identified at the time, but concurrently there was significant container traffic to Mussalo Harbour. *(City of Kotka 2016c)*

Impacts during operation

The changes in traffic relate only to the construction phase. The rock transport is planned to take place between 2018–2019. After the construction phase, there are no impacts on traffic or safety in Kotka.

12.1.2.4 Prevention and mitigation of adverse impacts

Rock transport from the motorway along secondary roads to port facilities has the potential to impede traffic flow. Accordingly, NSP2 and its Contractors will develop traffic management plans in consultation with the Roads Authority to address traffic congestion and safety. Consideration will be given to requesting the reprogramming of traffic lights to improve traffic flow by reducing stops at junctions.

The Nord Stream 2 Contractors will be required to develop traffic management plans in consultation with the Port Authority in the Mussalo Harbour area to ensure traffic safety during construction works. Consideration will be given to special lane painting, traffic signage and lane separation using cones or concrete barriers.

12.1.2.5 Lack of information and uncertainties

The assessment has been carried out using the case of normal traffic flow. In abnormal situations, caused e.g. by accidents on Merituulentie, congestion may increase. Also, rock supply volumes may change during further planning which may cause changes in traffic volumes. Transport routes may change as rock can be transported via an alternative port due to use of other quarries than assumed.

12.1.2.6 Significance of the impacts

The assessment is done without considering the proposed mitigations because they would have to be put in place by the authorities. The sensitivity of the receptor is evaluated as *medium* (moderate traffic volumes, few sensitive receptors along the transport route) for Road 15 Hyväntuulentie. For road Merituulentie, the sensitivity of the receptor is evaluated as *high* as the fluency of the traffic flow has already deteriorated and there are level crossings with pedestrians. The impact of increased heavy traffic is estimated to have a *medium* impact on traffic on Road 15 and on Merituulentie. The overall significance of the impact is, therefore, estimated to be *moderate* both on Road 15 and on Merituulentie. Mitigation of adverse impacts is, therefore, needed as described in Subchapter 12.1.2.4. The major impact on Merituulentie is mainly to the fluency of the traffic, traffic safety is not affected as much.

After the pipeline construction phase, there are no transport activities related to Nord Stream 2.

Table 12-8. Significance of the impacts on road traffic and safety during onshore activities in Kotka.

Impacts on road traffic and safety	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Road traffic and safety, Road 15	Medium	Medium	Moderate
Road traffic and safety, Merituulentie	High	Medium	Moderate
Operation phase			
Road traffic and safety	Medium	Negligible	Negligible

12.1.3 Impacts on air quality

The purpose of the assessment is to assess impacts on air quality from the ancillary onshore activities in Mussalo, Kotka, and near quarries. Impacts on air quality and climate will be caused by following onshore activities:

- Operation of the weight coating plant in Mussalo, Kotka
- Operation of heavy machinery and vessels at the storage yard and harbour of Mussalo, Kotka
- Rock quarrying and transport from Rajavuori and Kyytkärri quarries to Mussalo Harbour

Impacts on air quality result from exhaust gas emissions from vehicles, machinery and vessels at the harbour. Also, local particulate (dust) emissions from quarrying, machinery and traffic may occur. The combustion of natural gas for heat at the weight coating plant also creates emissions.

Only emissions from ancillary onshore activities in the Kotka region, including quarries, are included in the present assessment. Offshore emissions and their impact on air quality and climate are described in Subchapter 11.1. Emissions from ancillary onshore activities in Hanko are described in Subchapter 12.2.2.

Summary of air quality impact assessment	
Lessons learned from the Nord Stream Project in 2009–2012	Ancillary onshore operations in Nord Stream 2 are similar in the Kotka region as they were in NSP. Emissions to air from NSP operations in Kotka could not be separated from other industrial or harbour operations. Rajavuori and Kyytkärri quarries supplied the rock for NSP. The quarries operate under environmental permits and extraction permits and no major impacts on air quality due to NSP ancillary operations were identified.
Main results of the assessment	During the construction phase, there are various emissions sources in the harbour and industrial area (ship traffic, machinery) but also residential areas in the near vicinity. The ancillary onshore operations in Mussalo, Kotka, create a minor increase to the emissions in Kotka for approximately two years. Annual emissions (NO_x, SO_2 and PM) to air from ancillary operations in Kotka are 4–11% compared to Kotka Harbour's emissions in 2015 and 0.2–2% compared to emissions from plants with environmental permits in Kotka in 2015. Emissions to air from ancillary operations are not expected to deteriorate general air quality in the Kotka region or cause exceedance of guideline limit values. The overall impact significance of the construction period is assessed to be minor negative. During pipeline operation, there will be no impacts on air quality in Kotka due to the Nord Stream 2 Project. In general, emissions to air from traffic, industrial and harbour operations are heavily dependent on the local and national economy as emissions increase during economic expansion. The Nord Stream 2 rock supply will increase the rock demand for two years and, therefore, intensify rock quarrying and related transport traffic. The rock supply will cause exhaust gas emissions that result in a maximum of 2% of the annual traffic emissions of Kotka City in 2014. The emissions from rock transport may have a negative impact on local air quality in the heavily operated traffic areas along the transport route. The quarries will operate according to their environmental and extraction permits. In exceptional weather circumstances, dust may cause an aesthetic deterioration at the residential areas nearest to Rajavuori. The emissions from quarrying are not expected to have an impact on general air quality in Kotka or Pyhtää and the overall magnitude of change is considered to be *low negative*.

12.1.3.1 Impact mechanism

Impacts on air quality are caused by exhaust gas emissions from machinery, vessels and the weight coating plant. Quarrying, road traffic and machinery may also create local particulate (dust) emissions. Exhaust gases and dust may have an impact on local air quality.

Air pollution components included in the assessment are nitrogen oxides (NO_x), sulphur dioxide (SO_2), carbon dioxides (CO_2) and particulates as they are considered to be the most important air pollution components for local air quality and climate. Also, hydrocarbon (HC) emissions from the rock transport are included, as the transport route runs through Kotka City and the HC emissions may have local impacts. Offshore emissions are assessed in connection with climate impacts and offshore air quality impacts.

12.1.3.2 Methods and data used

The following onshore activities included in the evaluation of emissions to air in the Kotka region are:

- Operation of the weight coating plant (the use of natural gas for heating)
- Operation of heavy machinery and vessels at the storage yard and harbour of Mussalo, Kotka
- Rock quarrying
- Rock transport from quarries to Mussalo Harbour

Pipes arrive at the Kotka Mussalo weight-coating plant by train from Russia. Cement for weight coating plant will be transported by trucks or train to Mussalo plant. Onshore transportation of pipes, fuel, cement, consumables etc. have not been included in the air emissions calculations. The related traffic volumes are considered negligible comparing to current traffic volumes in Mussalo harbour and to rock transport volumes.

The methods and data used in emissions calculations are described in Subchapter 11.1.2 (Climate and Air quality) and in more detail in a separate report *(Ramboll 2017a)*.

Emissions to air from the weight coating plant are estimated based on the natural gas consumption of the plant.

Emissions from rock transport traffic are estimated based on traffic load (2,660,000 m^3 or 4,260,000 tonnes of rock, 25 m^3 (40 tonnes) of rock per truck) and using emissions factors of EURO 5 class trucks. The emissions are calculated from Kyytkärri and Rajavuori quarries to Mussalo Harbour and back for a 32 km route (return journey). Emissions from machinery and vessels at the harbour are calculated according to unit emissions presented in Table 12-9. The calculation of emissions is described in detail in a separate report *(Ramboll 2017a)*.

Table 12-9. Unit emissions for EURO 5 class trucks, machinery and vessels at the harbour used in the calculation.

Emission compound	Emission factors used in calculations		
	Truck transport (EURO 5 trucks, Trafikverket 2015)	EU Stage II diesel motor machinery 150-360 kW (Naturvårdsverket 2007)	Vessels
Nitrogen oxides, NO_x	3.53 g/km	6.0 g/kWh	12 g/kWh*
Sulphur dioxide, SO_2	0.0011 g/km	0,001 mass-%	0.001 mass-% **
Particulates, PM	0.0652 g/km	0.2 g/kWh	0.0018 tons/ton of fuel*
Hydrocarbons HC	0.08 g/km	n.a.	n.a.
Carbon dioxide, CO_2	950 g/km	0.27 g/kWh	3.1 tons/ton of fuel***

*) Aarhus University 2015

**) IMO 2008

***) Shipping efficiency 2013

Emissions from the operation of coating plant

The coating plant in Kotka will use natural gas as its primary fuel source for heating. The coating plant would be in operation for three years. The emissions from consumption of natural gas and electricity during operation of the coating plant are estimated using data gained from experience in the Nord Stream project.

The annual consumption of natural gas of the coating plant is approximately 1,600,000 m^3 *(Wasco Coatings Finland Ltd 2016)*. Unit emissions of natural gas are 198 g/kWh for CO_2 *(Motiva 2010)* and 0.3 g/kWh for NO_x *(Jalovaara et al. 2003)*. The annual electricity consumption of the coating plant is approximately 6,040 MWh *(Nord Stream 2 2016c)*. The average emission factor for Finnish electricity supply is 209 kg CO_2/MWh *(Statistics Finland 2016)*. Other emission compounds are not included in calculations.

Emissions from quarrying and rock transport

Emissions from machinery at the quarries are based on emissions presented in the environmental permits of Rudus Rajavuori quarry *(City of Kotka 2010a)* and Destia Kyytkärri quarry *(Community of Pyhtää 2009)*. The emissions for Rajavuori quarry are estimated as average annual emissions when using electricity as a source of energy for crushing and quarrying. For Kyytkärri, the basis of emissions is not reported in the permit. Local dust emissions are assessed based on the description provided in the permits and the EIA *(City of Kotka 2010a, Community of Pyhtää 2009, Rudus Oy 2008)*.

Current air quality in Kotka is described in the onshore baseline Subchapter 8.1.3. Impacts on air quality from exhaust gas emissions and local particulate emissions are assessed as an expert opinion.

Finnish air quality objectives include binding limit values and non-binding national guideline values. The most important binding limit values in Finland are given to nitrogen dioxide (NO_2, annual limit value) and particulate matter under 10 μm (daily limit value). These limit values can be exceeded in large cities in traffic areas, streets and construction yards. Non-binding national guideline values are given e.g. NO_2, NO_x, particulate matter <10 μm and <2.5 μm and for total reduced sulphur (TRS). These limit values are not applicable in industrial areas. Modelling of exhaust gas emissions or local dust emissions was not seen necessary as the exhaust gas emissions were considered low compared to other emissions e.g. from the harbour. Instead, emissions from Kotka onshore operations have been compared to emissions in the Kotka region as measured in recent years.

The significance of an impact (sensitivity of receptor and magnitude of change) on air quality has been assessed based on the methods presented below.

Table 12-10. Sensitivity of receptor (air quality).

Low	There are a lot of activities in the area generating air emissions or the area is otherwise affected by the emissions. Ambient air concentrations exceed the limit values. There are no sensitive receptors such as residential areas, holiday homes, schools, day-care centres or protected areas, and the area is not used for recreation.
Medium	There are some activities in the area generating air emissions or the area is otherwise affected by emissions. There are some sensitive receptors nearby such as residential areas, holiday homes, schools, day-care centres or protected areas, and the area is not used for recreation.
High	There are only a few activities in the area generatingair emissions and the area is not affected by the emissions coming from elsewhere. There are sensitive receptors such as residential areas, holiday homes, schools, day-care centres or protected areas, and the area may be used for recreation.

Table 12-11. Magnitude of change (air quality).

Negligible	No changes on the ambient air quality expected.
Low	Ambient air concentrations are expected to remain well below the guideline and limit values and/or the increase in emissions is estimated to be low. The impacts occur in the short-term.
Medium	Ambient air concentrations are expected to be near the guideline and limit values. Any overruns are short-term. An increase in emissions is estimated to be significant but the impacts occur in the short-term or are reversible.
High	Ambient air concentrations are expected to cause exceedances of guideline and limit values. The impacted area is extensive. Emissions increase significantly and impacts are permanent and have an impact on a large area.

12.1.3.3 Impact assessment

Impacts during construction

The estimated emissions are presented in Table 12-12 for Mussalo, Kotka, ancillary activities as total emissions for the whole construction period and also as annual emissions (for the two year construction period). The supply vessels at the harbour produce the majority (nearly 100 %) of sulphur oxides (SO_2) and over half of the nitrogen oxides (NO_x) and particulate emissions of Kotka onshore operations.

Table 12-12. Summary of emissions loads from onshore activities in Kotka during the whole NSP2 construction period and also as annual emissions for the construction period.

Activity	Estimated emissions loads [tonnes]			
	CO_2	NO_X	SO_2	Particulates
Supply vessels at the harbour (2 years)	1947	40	1.3	1.1
Cranes and loading equipment at the harbour (2 years)	956	21	<0.01	0.7
Coating plant operation (3 years)	13,578	14	-	-
Total emission	16,481	75	1.3	1.8
Annual total emissions tonnes/year	5,978	35	0.7	0.9

Table 12-13. Emissions in Kotka during 2014 and 2015 (according to City of Kotka 2016a). Road traffic emissions for 2015 were not available.

Operation	Emissions load [tonnes/year]			
	CO_2 (fossil fuels)	NO_X	SO_2	Particulates
Port of HaminaKotka, Kotka harbours (incl. Hietanen, Jänskä, Mussalo, Kantasatama) 2015	27,832	487	15	8
Permitted (environmental permits) plants in Kotka 2015	423,166	1,853	129	397
Road traffic in Kotka 2014	85,526	308	0.4	10
Total	536,524	2,648	144	415

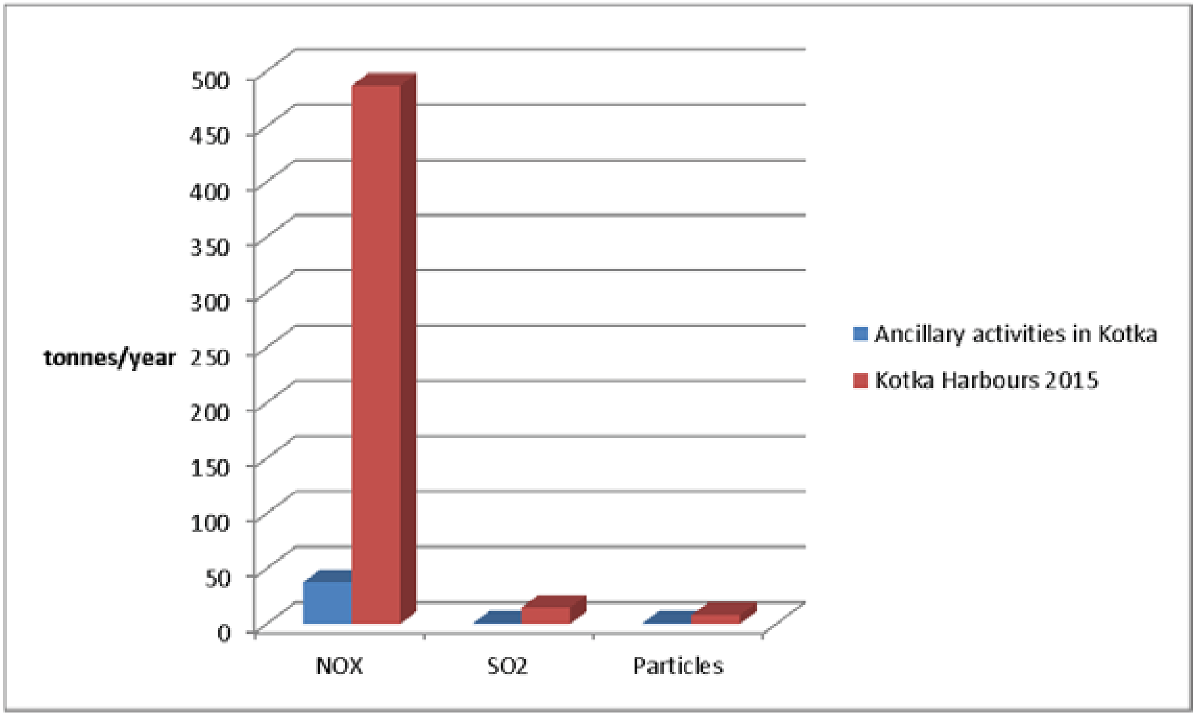

Figure 12-2. Annual emissions from ancillary activities in Mussalo compared to annual emissions from Kotka harbours in 2015 (including the harbours of Mussalo, Jänskä, Hietanen and Kantasatama).

Comparing emissions from ancillary operations in Mussalo, Kotka, to Table 12-13 depicting emissions in recent years of plants with environmental permits in Kotka, it can be seen that the ancillary onshore operations create only small increases to total emissions in the Kotka region. Annual emissions (NO_x, SO_2, PM) to air from ancillary onshore operations are 4–11 % of Kotka Harbour's emissions in 2015 and 0.2–2 % of the emissions generated by permitted plants in 2015. The total CO_2 emission from ancillary onshore operations in Kotka Mussalo is only 4% of the fossil CO_2 emission generated by permitted plants in 2015.

The impact of NSP2 operations to Kotka air quality is relatively small and can not be separated from other operations. The general emissions to air in the Kotka region depend strongly on the local and global economy as all operations create emissions increases in economic expansion. This can be seen especially in harbour-related operations and emissions.

The heavy traffic transport route to the harbour is an asphalted high-quality road, so dust emissions during the rock transport are considered to be minor and their impact on local air quality can not be separated from other traffic. Though generally direct and indirect (street dust) emissions from road traffic are considered to have quite a significant impact on the air quality in the Kotka region, the project increases heavy vehicle traffic only temporarily. Most parts of the harbour and quay areas are paved, but there are unpaved storage areas surrounding the weight coating plant. The pipe storage is constructed on sand/gravel fill. Machinery and vehicle operation on the unpaved storage areas can cause local dust emissions, but the impact is estimated to remain in the vicinity of the storage yard and inside the operational and industrial area.

Dust emissions to air from the concrete weight coating (CWC) process are considered negligible. Concrete weight coating is done inside the plant building and dust containing gases are led through dust filters prior to being released into the atmosphere. The impacts on local air quality outside the industrial area arising from the weight coating plant are estimated to be negligible.

The Port of HaminaKotka Mussalo Harbour operates according to an approved environmental permit and emissions to air from ancillary onshore operations at the harbour are not estimated to cause any breaches of permit conditions. The concrete weight coating plant will operate in accordance with its own environmental permit.

Potential quarries

The emissions from rock quarrying and transport are presented in Table 12-14. The rock transport emissions result in 0.4–2 % of the traffic emissions in 2014 in the City of Kotka. The total annual emissions from rock quarrying are 0.5-4% of the emissions arising from permitted plants in Kotka in 2015 *(City of Kotka 2016a)*. The annual CO_2 emission from quarry related operations is approximately 3,500 tonnes, which is 0.8 % of the CO_2 emissionsarising from permitted plants in Kotka in 2015 *(City of Kotka 2016a)*.

Table 12-14. Summary of annual emissions from ancillary quarry operations in the Kotka region.

Activity		Estimated emissions loads [tonnes/year]			
	CO_2	NO_X	SO_2	Particulates	HC
Rajavuori quarry (average emissions)	1,170	17.5	0.4	2.1	na
Kyytkärri quarry (average emissions, including also asphalt plant)	768	2.4	4.2	na	na
Rock transport from Rajavuori to Mussalo Harbour	1,600	6.0	<0.01	0.1	0.2
Annual total emissions tonnes/year	3,538	25.9	4.6	2.2	0.2

Quarrying and traffic inside the quarry area may cause local dust emissions. According to the environmental permit of Rajavuori quarry, the dust will be controlled by watering the roads and rocks before crushing. Also, the storage piles of rock are located so as to protect the nearest residential areas. Dust from drilling will be limited by integrated dust collection systems in the drilling machines. According to the permit, no health impacts are estimated to arise from dust emissions. In exceptional weather circumstances, aesthetic deterioration may occur in the nearest residential areas *(City of Kotka 2010a)*. According to the environmental permit of Kyytkärri quarry, dust is formed during crushing and transporting. The impact to nearest residential areas in Kyytkärri is assessed to be negligible due to long distances.

<u>Impacts during operation</u>

Once the construction phase of the project is over in 2020, there will be no ancillary activities to Nord Stream 2 and, therefore, no impacts on air quality.

12.1.3.4 Prevention and mitigation of adverse impacts

There is no need for mitigation measures regarding emissions to air.

12.1.3.5 Lack of information and uncertainties

The location of the selected quarries and harbour for rock load out area will determine the rock transport route. The assessment has been made based on current plans and experience gained from the Nord Stream Project. It should be noted that the air emissions calculated based on assumptions are associated with uncertainties related to e.g. engine type, number of engines, working load of the engines and the exact fuel type. Despite the data limitations and uncertainties, it is assumed that the estimated range of emissions presented are in the order of magnitude of the emissions that will actually arise.

12.1.3.6 Significance of the impacts

The sensitivity of receptors in the Mussalo area is estimated as *medium* as there are various emissions sources in the harbour and industrial area including ship traffic and busy road traffic, but also residential areas in the vicinity of the harbour. According to monitoring, air quality has been mostly good or satisfactory in the Kotka region and also in the harbour area.

The sensitivity of receptors in quarry areas is estimated as *low* as the quarries are located at a distance from residential areas or other sensitive areas. The Rajavuori quarry is located closer to residential areas than Kyytkärri. There are also other quarries and the Heinsuo Waste Treatment and Landfill Facility near Rajavuori quarry. Similarly, Highway 7 (E18) may have an impact on the local air quality.

The magnitude of change on air quality in the Mussalo area is estimated to be *low negative* as ancillary operations create minor increases in emissions to air in Kotka and the impacts occur for only an approximate a two year period. Though the slight increase in emissions is not expected to influence the general air quality in the Kotka region or cause exceedances of guideline or limit values. Tthe impact significance is assessed to be minor negative. The general economy has a significant effect on emissions to air in the Kotka region and, therefore, air quality.

There are existing quarries in Rajavuori and Pyhtää which are in operation according to existing permits and based on rock demand in the area. The NSP2 rock supply will increase the rock demand for two years and, therefore, increase rock transport traffic. The rock supply will cause emissions though these emissions would arise even without NSP2 if the rock was quarried and transported for another construction project. Emissions from rock transport may have a negative impact on local air quality in the heavily operated traffic areas along the transport route. The impact magnitude of NSP2 rock quarrying is considered to be *low negative*, as the impacts for NSP2 rock quarrying occur temporarily and emissions to air are not estimated to have an impact on general air quality in Kotka or Pyhtää. Therefore, the overall significance of the impact is assessed to be *minor negative*.

After the construction phase there are no impacts on air quality from ancillary activities.

Table 12-15. Significance of the impacts on air quality during onshore activites in the Kotka region.

Impacts on air quality	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Air quality (Mussalo)	Medium	Low	Minor
Air quality (quarries)	Low	Low	Minor
Operation phase			
Air quality	Medium/Low	Negligible	Negligible

12.1.4 Airborne noise impacts

The purpose of the assessment is to evaluate the noise impact and impact on living conditions caused ancillary onshore operations in Mussalo, Kotka, near quarries and along the rock transport route.

Summary of noise impact assessment	
Lessons learned from the Nord Stream Project in 2009–2012	The ancillary operations in the Kotka region during NSP did not have a significant negative noise impact.
Main results of the assessment	Noise from the coating plant is estimated to be the hum that arises from the blowers of the ventilation system. Noise arising from loading and unloading rock and pipes at the harbour is not expected to cause noise deviating significantly from other harbour operations. Quarrying creates noise but the noise levels are restricted by limits set in the environmental permits of the quarries. Noise levels along the rock transport route will increase temporarily by 1–2 dB at the residential areas at the nearby crossing of Hyväntuulentie and Merituulentie and also on Merituulentie between Mussalontie and Mussalo Harbour. Overall, noise levels are estimated to be below the noise guideline values. Overall significance of the impact is assessed to be minor ornegligible.

12.1.4.1 Impact mechanism

Unloading in the storage areas will cause noise when rocks are sliding out from the trucks. This is not expected to be particularly noisy, because there are no large boulders in the rock material. Wheel loaders working at the stock piles emit noise. Machine types are mainly the same as currently used in the harbour, so no new types of noise are expected to arise.

Noise emitted from the concrete weight coating plant is estimated to be thehum that arises from the blowers of the ventilation system. The hum of the blowers is normally broadband and steady.

Loading pipes and rock onto ships causes noise from the moving machinery and auxiliary engines of vessels.

Rock quarrying causes noise from drilling, blasting, crushing, loading and transport of rock materials. The transport of rock to Mussalo Harbour generates noise along the entire transport route. Noise from heavy traffic is generated by the engines driving at low speed and the exhaust. When the speed exceeds 70 km/h, noise is generated mainly by the tyres.

12.1.4.2 Methods and used data

The assessment is based on data gained from the environmental permits of Rajavuori and Kyytkärri quarries, noise modelling of the rock transport and on an expert opinion.

Rock transport noise was estimated using the SoundPLAN program and the *Nordic Prediction Method of Road Traffic Noise* Model. The model was used to calculate the amount of noise levels close to the transport route and to evaluate the change in day-time noise levels during the rock transport period. The estimated noise levels are shown in maps covering an area about 0.5–0.7 km on both sides of the rock transport route. The modelling was made for the route starting from Highway 7 (E18) Kotka intersection to Mussalo Harbour. Calculated values are equivalent sound levels at daytime ($L_{\mathrm{Aeq}\ 7\text{-}22}$). Night time noise was not assessed to be relevant, as the rock transport is planned to take place during daytime. There are some rock quarries that have an environmental permit for rock material transport starting from 6 am in the morning and, thus, it is possible that loads are transported to the harbour also between 6–7 am. Night time noise guidelines are applied between 6–7 am. The estimated heavy vehicle traffic volume caused by the NSP2 Project is ca. 600 heavy vehicle movements per day. Traffic volume was equally divided throughout the day in the model.

The existing noise situation in the Kotka region is described in Subchapter 8.1.4.

A Government Decision on Guideline Values for Noise Levels 993/1992 defines the guideline values for noise levels inside buildings and in outdoor activity areas. Guidelines for the equivalent A-weighted sound level (L_{Aeq}) outside and inside buildings are shown in Table 12-16. In Finland, only outdoor noise levels are normally assessed. If outdoor levels are acceptable, indoor noise is also expected to be in accordance with the guidelines.

Table 12-16. Guideline values for noise levels (Government Decision 993/1992).

	L_{Aeq} between 7-22	L_{Aeq} between 22-7
Outside		
Residential areas, recreational areas inside and near communities, areas for nursing homes and schools	55 dB	45–50 dB [1) 2)]
Holiday residential areas, camping sites, recreational areas outside communities and nature conservation areas	45 dB	40 dB[3)4)]
Inside		
Houses, nursing rooms, accommodation rooms	35 dB	30 dB
School rooms and meeting rooms	35 dB	-
Business premises and offices	45 dB	-

1) New areas, noise limit during the night time is 45 dB
2) School areas do not have a limit for night time
3) Nature conservation areas which are not commonly used for overnight stays
4) Holiday residence in communities can be treated as permanent residence

The significance of an impact (sensitivity of the receptor and magnitude of change) on noise has been assessed based on the methods presented below.

Table 12-17. Sensitivity of receptor (airborne noise).

Low	There is a lot of noise generating activities in the area or the area is otherwise affected by the noise. The noise levels exceed the guideline values. There are no sensitive receptors such as residential areas, holiday homes, schools, day-care centres or protected areas, and the area is not used for recreation.
Medium	The area has some noise generating activities or is otherwise affected by the noise. There are some sensitive receptors nearby such as residential areas, holiday homes, schools, day-care centres or protected areas, and the area is not used for recreation.
High	There is only a small number of noise generating activities and the area is not affected by the noise coming from elsewhere. There are noise sensitive receptors such as residential areas, holiday homes, schools, day-care centres or protected areas, and the area may be used for recreation.

Table 12-18. Magnitude of change (airborne noise).

Negligible	No changes to the noise level. Noise level increases by 0–1 dB.
Low	The change in noise level caused by the project is small or non-existent. The project will not cause exceedance of the noise level guideline values. The noise level increases by 1–4 dB.
Medium	The change in noise level caused by the project is a medium. The project causes no or only a slight exceedance of the noise level guideline values. The noise level increases by 4–7 dB.
High	The change in the noise level caused by the project is high. The project will result in exceedance of noise guideline values. The noise level increases by >7 dB.

12.1.4.3 Impact assessment

Impacts during construction

Mussalo

Operations in the harbour might increase noise slightly around the harbour environment. Loading the vessels and unloading the trucks might cause noise which can be heard and distinguished from background noise in the environment. Noise from vessels at the harbour is not estimated to deviate from the normal noise arising at the harbour. All activities in Mussalo Harbour are conducted within the conditions of the environmental permit of the harbour and includelimit values for noise.

In the weight coating plant, the noise is mainly generated by activities inside the building and the noise impact from weight coating are assessed to be negligible outside the industrial area. The weight coating plant operates ain accordance with its own environmental permit,which will include limit values for noise.

Rock quarrying and transport

According to the environmental permit for Destia Kyytkärri quarry, t noise will be reduced by locating storage piles and equipment so as to protect the nearest residential area (at a distance of 1 kilometre). According to the permit, the noise at the nearest residential areas will not exceed guideline values for noise levels *(A government decision 993/1992) (Community of Pyhtää 2009)*. According to the environmental permit of Rudus Rajavuori quarry, the noise guideline levels will not be exceeded in the nearest residential areas. According to the environmental permit, noise modelling and noise monitoring has been done in 2009 and 2010. In the 2010 noise monitoring, two crushing units were in use. Daytime noise guideline levels were not exceeded, but nighttime (after 10pm) noise partially exceeded both nighttime and daytime noise guideline levels. After this, crushing has not been conducted during nighttime. According to the environmental permit, crushing is limited to daytime (7 am–10 pm) and weekdays. *(City of Kotka 2010a)*.

The ancillary rock transport from the quarry to Mussalo Harbour is not estimated to have an impact on noise in the heavily used Highway 7 (E18), as the increase in traffic is small and cannot be separated from other traffic closer to Kotka City. The rock transport traffic increases noise levels up to 2 dB compared to the baseline noise levels at residential areas. Along the road Hyväntuulentie, the influence of rock transport on current noise levels is below 1 dB, see Figure 12-3 and Appendix 12, Map MO-05-F. An increase of 1–2 dB in noise levels can hardly be heard by humans. An increase of 3-4 dB can be noticed by humans as a relatively small change in noise levels. *(Tiehallinto)* Examples of noise levels are presented in Figure 12-4.

Daytime noise will consist of several drive-bys of trucks and there may be quiet periods during the day. Vehicles departing uphill from junctions will cause more noise than steady driving, but the short-term rise in noise levels is not estimated to cause an exceedance of noise guideline levels. Rock transport takes place during the daytime between 6 am–10 pm (16 hours per day). In the noise model, the assumption is that transport (and noise) is evenly distributed through the 16 hours of working time.

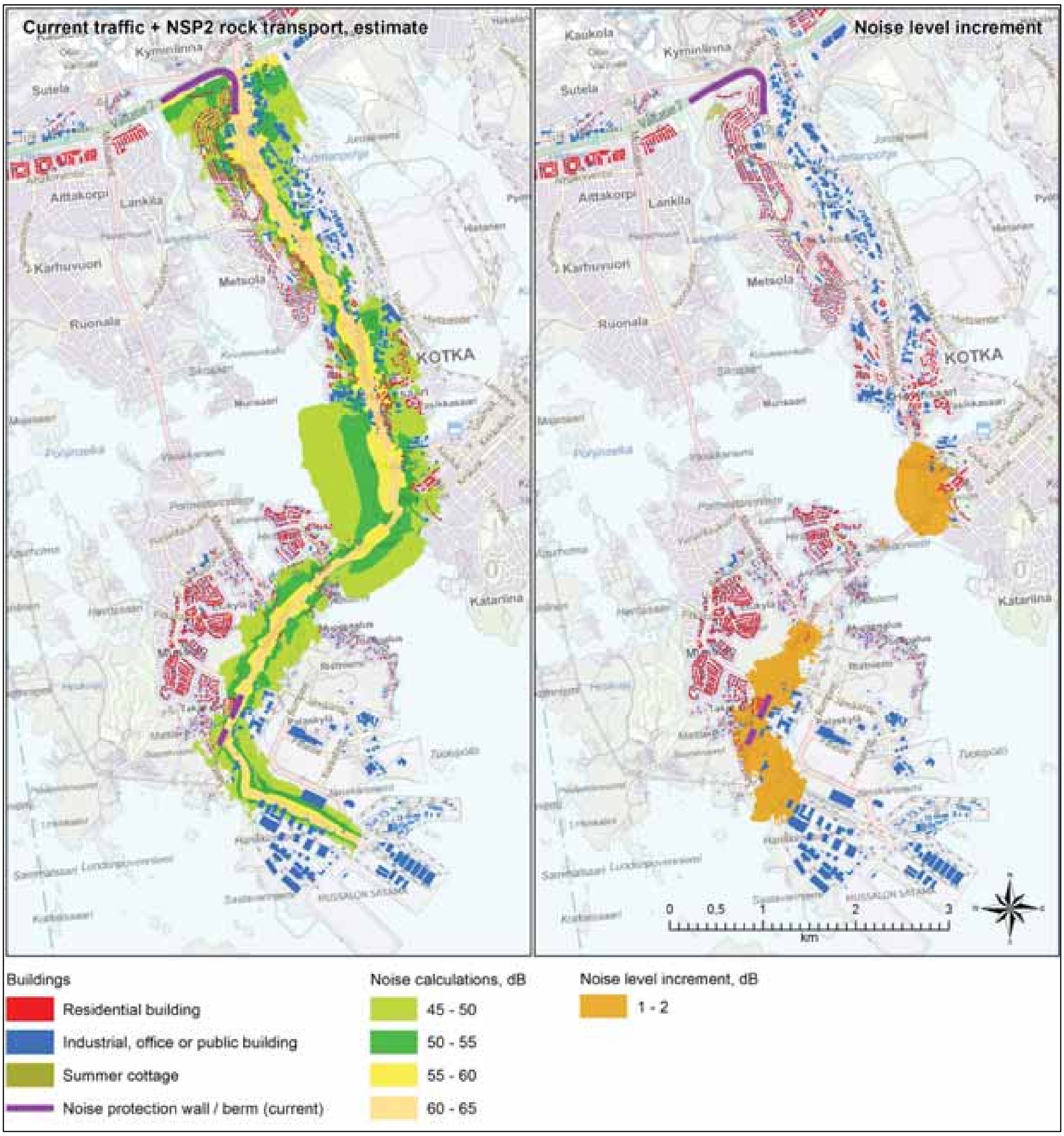

Figure 12-3. Noise levels from rock transport and current traffic 2015 (cumulative impact) on the left. A noise increase from rock transport compared to current traffic 2015 on the right.

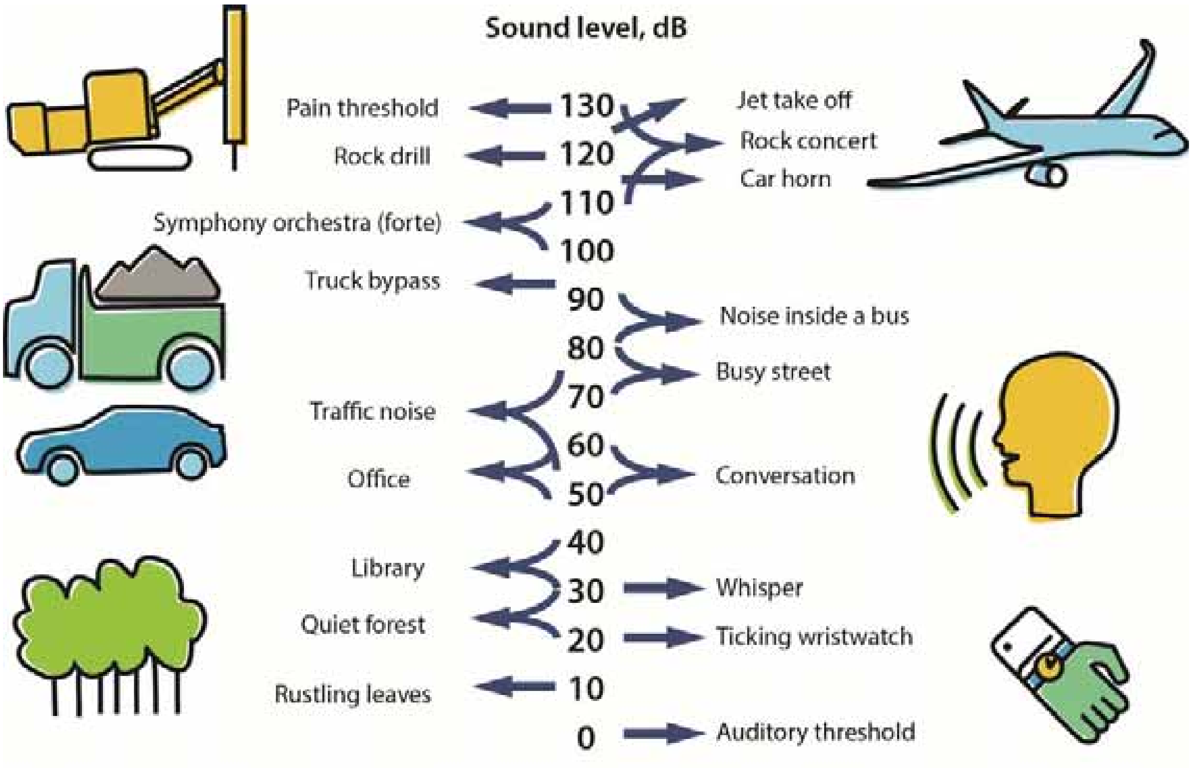

Figure 12-4. Examples of sound levels from different sources.

<u>Impacts during operation</u>

After construction, there is no impact from noise as ancillary onshore operations take place during construction.

12.1.4.4 Prevention and mitigation of adverse impacts

The possible adverse impact of noise in onshore operations will be mitigated by using equipment that meets the technical regulatory requirements for noise.

12.1.4.5 Lack of information and uncertainties

The uncertainty of the road traffic noise model is ±2 dB in the area assessed by the model. The normal sound levels of machinery and trucks are well-known. The agreements with the contractors and operators are not yet defined. Transport routes may change as rock can be transported via an alternative port due to use of other quarries than assumed.

12.1.4.6 Significance of the impacts

Sensitivity of receptors is evaluated as *medium* for Mussalo area and quarries. There area some residential areas beside the harbour and, therefore, a few sensitive receptors. There are some residential areas along the transport route and Rajavuori quarry, high/moderate traffic volumes on the roads of the transport route and a few sensitive receptors.

During construction, the noise from the coating plant is estimated to have no impacts outside the industrial area. The noise inside the harbour (due to pipe and rock supply) is not expected to deviate significantly from other operations in the harbour.

The overall significance of the impact in Mussalo is estimated to be *negligible*.

Rock quarrying and transport take place during the pipeline construction phase. According to quarry permits, the impact from noise from quarrying will remain under noise guideline levels *(A government decision 993/1992)*. The permits for Rajavuori and Kyytkärri quarries enable quarrying also for other than NSP2 but the NSP2 rock supply will require intensive rock quarrying and transport for a period of approximately 2 years. Therefore, the impact from quarrying is estimated to be *low negative*.

The impact from rock transport is estimated to have a *low* impact magnitude on noise along Merituulentie and a *negligible* impact on noise along Highway 7 and Hyväntuulentie due to rock transport.

The overall significance of the impact is estimated to be *minor* and *negligible*, respectively.

Table 12-19. Significance of the impacts of noise during onshore activities in Kotka.

Impacts of noise	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Noise from the coating plant	Medium	Negligible	Negligible
Noise from the harbour	Medium	Negligible	Negligible
Noise from quarrying	Medium	Low	Minor
Noise along Hyväntuulentie and Highway 7	Medium	Negligible	Negligible
Noise along Merituulentie	Medium	Low	Minor
Operation phase			
Noise	Medium	Negligible	Negligible

12.1.5 Impacts on protected areas

During construction, Nord Stream 2 onshore operations include weight coating of pipes in Mussalo and rock quarrying and transport of rock and other materials via Mussalo Harbour. These operations generate noise and emissions to air, which could have an impact on protected areas in the vicinity. Accidents involving vessels at the harbour could cause water pollution due to an oil spill. During pipeline operation, there are no onshore operations in the Kotka region.

Summary of the impact assessment on protected areas	
Lessons learned from the Nord Stream Project in 2009–2012	The operations during Nord Stream Project did not have an impact on protected areas in the Kotka region.
Main results of the assessment	There are no protected areas at the vicinity of the onshore operations, harbour or quarries. The fairway from Mussalo Harbour passes through a Natura 2000 area called "Itäisen Suomenlahden saaristo ja vedet" (FI0480001). The closest distance to the Natura 2000 area is 5 km from Mussalo Harbour. The closest distance to smaller nature conservation areas of "Lehmänsaari" and "Sarvenniemenkari" are 1.8–2.8 km from the harbour. The closest Natura 2000 area to the quarries is Heinlahti (FI0416006) Bird Protection Area approximately 2 km southwest from Rajavuori and Kyytkärri quarries. A private nature protection area of Kantolankallio (YSA230780) is located approximately 1 km southwest of Kyytkärri quarry. The onshore operations during constructing in the Kotka region will not cause impacts on these protected areas due to the long distances. Impacts of possible accidents are described in the risk assessment Chapter 16.

12.1.5.1 Impact mechanism

During construction, Nord Stream 2 onshore operations include weight coating of pipes in Mussalo and rock quarrying and transport of rock and other materials via Mussalo Harbour. Possible adverse impacts on protected areas could be noise, air emissions or water pollution due to accidents or oil spills from vessels in the harbour (risks from ship traffic are assessed in Chapter 16).

12.1.5.2 Methods and data used

Impacts on protected areas are assessed based on existing data on protected areas and planned NSP2 operations and the environmental permits of Rajavuori and Kyytkärri quarries. For background information of the nearest protected areas, see Subchapter 0.

All protected areas are considered highly sensitive and the classification of sensitivity is not applied to protected areas. The assessment is performed as an expert opinion.

12.1.5.3 Impact assessment

There are no protected areas in the immediate vicinity of the Kotka onshore operations, see Subchapter 8.1.5 Figure 8-7. The fairway from Mussalo Harbour passes through a Natura 2000 area called "Itäisen Suomenlahden saaristo ja vedet" (FI0480001, SPA/SAC) and the closest distance to the Natura 2000 area is 5 km from the harbour. Other smaller nature conservation areas are "Lehmänsaari" (YSA200556) approximately 1.8 km west from Mussalo Harbour and "Sarvenniemenkari" (YSA051521) approximately 2.8 km east from Mussalo Harbour.

The closest Natura 2000 area to the rock quarries is Heinlahti (FI0416006) Bird Protection Area approximately 2 km southwest of Rajavuori and Kyytkärri quarries. A private nature protection area of Kantolankallio (YSA230780) is located approximately 1 km southwest of Kyytkärri quarry.

<u>Impacts during construction</u>

As the shortest distance to the nearest protected area is almost 2 km, the impacts from NSP2 Kotka ancillary activities are considered to be negligible. The operations take place in existing industrial and harbour areas. Possible impacts such as dust and noise are not expected to have any impacts to the protected areas (Subchapters 12.1.3 and 12.1.4). The possible noise and dust from NSP2 Kotka onshore operations cannot be distinguished from other industrial and harbour operations.

Vessel accidents at the harbour or at sea could cause oil spills into the sea and, therefore, have an adverse impact on the nearest protected areas. Risks during the construction period of the pipeline are discussed in more detail in Chapter 16.

<u>Impacts during operation</u>

During pipeline operation, there are no ancillary activities in the Kotka region. Therefore, there are no impacts on protected areas.

12.1.5.4 Prevention and mitigation of adverse impacts

Based on the available information of the planned project, no adverse impacts are predicted for protected areas. Therefore, no mitigation measures are needed.

12.1.5.5 Lack of information and uncertainties

Information on protected areas is adequate. Due to previous experience from the NSP construction phase, there are no major uncertainties concerning impacts on protected areas.

12.1.5.6 Significance of the impacts

Based on the screening study carried out, the planned Nord Stream 2 Project will not have adverse impacts on protected areas near Mussalo Harbour or near the quarries.

Table 12-20. Significance of the impacts on receptors in the protected areas during onshore activities in Kotka.

Impacts on ecological values in protected areas	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Protected areas	High	Negligible	Negligible
Operation phase			
Protected areas	High	Negligible	Negligible

12.1.6 Social impacts

Purpose of the social impact assessment is to assess the possible impacts on living conditions, recreation and the fears and aspirations of individuals in the area by the project or project-related operations. Also, tourism is covered under social impacts.

Summary of social impact assessment	
Lessons learned from the Nord Stream Project in 2009–2012	Based on the experiences of the Nord Stream Project, the location of the harbour was considered to be better further away from the city centre to avoid disturbance from noise or traffic to the residential areas. The ancillary quarrying operations in Kotka were not assessed as a part of the national EIA during NSP. Based on information from the City of Kotka, some complaints have been received relating to the quarrying during their operation.
Main results of the assessment	Social impacts on Kotka area are assessed to be two-way. Impacts on residential amenity and traffic safety are assessed to be moderate and negative due to a significant increase in heavy traffic and a slight increase in noise. The impact on local economy is assessed to be positive and major due to the large number of new job opportunities in an area suffering from high unemployment rates. Other social impacts are assessed to be minor or negligible. Impacts on residential amenity from quarrying is assessed to be medium negative and is caused mainly by noise from drilling, breaking, crushing and heavy traffic, but also dust and in some cases vibration from the blasts. The impact on local economy is low. The project accelerates the production of rock material but does not generate new job opportunities.

12.1.6.1 Impact mechanism

Social impacts can be caused by various ways. Some social impacts are an indirect reaction to project impacts, such as noise or environmental changes. Other social impacts are a direct response to the project itself, like fear, worry and uncertainty. Social impacts are closely linked to other impacts of the project and how people perceive the project. In many cases, social impacts are related to the project as a whole and not necessarily to any specific phase of the project. Impact mechanism is described in more detail in Subchapter 11.19.1 on social impact offshore. Onshore, the impact mechanism is the same, only the possible causes and possible receptors are different.

The assessed social impacts onshore (Table 12-21) have been identified by considering the various project activities during planning, construction and operation and how these activities might interact with social impacts. Experiences from numerous onshore impact assessments have been used as background information.

Table 12-21. Possible social impacts onshore.

Receptor	Project phase	Project activity	Possible impact
People and society; Tourism and recreation; Local economy	Planning	Planning and impact assessment; preparations for ancillary activities	Worries and expectations
	Construction	Ancillary activities onshore (like pipe coating, transportation, quarrying)	Worries and expectations Impacts on residential amenity and safety Impacts on tourism and recreation Impact on local economy
	Operation	Maintanance and monitoring	Worries and expectations

12.1.6.2 Methods and data used

Table 12-22. Sensitivity of receptor (social impacts).

Low	Low value for recreational use, optional areas available nearby. No significant features with cultural, scenic or economic value. No disturbance-prone, nature-based business activity. A lot of activities generating environmental disturbance (etc. noise, dust, traffic). Social adaptability of the area is high. No people, sensitive institutions (school, daycare, hospital) or important public services potentially susceptible to disturbance. Continuous change in the status of the environment.
Medium	High value for recreational use, alternative areas not easily accessible. Some significant features with cultural, scenic or economic value. Some disturbance-prone, nature-based business activity. A few activities generating environmental disturbance (etc. noise, dust, traffic). Social adaptability of the area is moderate. A number of people, sensitive institutions (school, daycare, hospital) or important public services potentially susceptible to disturbance. Relatively peaceful environment which has remained relatively unchanged for some time.
High	High value for recreational use, no alternative areas available. Many unique and significant features with cultural, scenic or economic value. A lot of disturbance-prone, nature-based business activity. No activities generating environmental disturbance (etc. noise, dust, traffic), or the number of current activities is so high that the carrying capacity does not bear any additional activities. Significant number of people, sensitive institutions (school, daycare, hospital) or important public services potentially susceptible to disturbance. Peaceful environment which has remained relatively unchanged for a long time. Social adaptability of the area is low.

Table 12-23. Magnitude of change (social impacts).

High	Positive environmental changes improve wellbeing, living conditions, amenity or recreational use opportunities for people, and the use of residential and holiday properties. Changes bring along new functions benefitting the area, support existing practices and actions or remove disincentives for current practices. The project generates a lot of hopes and expectations. Changes increase communality or decrease inequality significantly. A significant positive impact on the livelihoods, employment opportunities and the economy of the local area. Changes are long-term, occur in a large area, are permanent or continual.
Medium	Positive environmental changes improve wellbeing, living conditions, amenity or recreational use opportunities for people, and the use of residential and holiday properties to some extent. Changes may enable new functions benefitting the area or support existing practices. The project generates a lot of hopes and expectations. Changes increase communality or decrease inequality significantly. A moderate positive impact on the livelihoods, employment opportunities and the economy of the local area. Changes may be long-term, partly reversible, occasional or occur in a relatively large area.
Low	Positive environmental changes cause only minor positive impacts on wellbeing, living conditions, amenity or recreational use opportunities for people, and the use of residential and holiday properties. Changes do not restrict the existing practices and activities in the area. Changes do not increase communality or decrease inequality. A minor positive impact on the livelihoods, employment opportunities and the economy of the local area. Changes occur in a limited area or are short-term and the situation returns back to the pre-existing condition when the impact ends.
Negligible	The living environment remains unchanged. No impacts on the livelihoods, employment or the economy of the local area.
Low	Negative environmental changes (e.g. in noise levels, traffic, landscape) cause only minor adverse impacts on the wellbeing, living conditions, amenity or recreational use opportunities for people, or on the use of residential and holiday properties. The project generates only a slight amount of anxiety and disagreements. Changes do not decrease the community spirit or increase inequality. A minor negative impact on the livelihoods, employment opportunities and the economy of the local area. Changes occur in a limited area or are short-term and the situation returns back to the pre-existing condition when the impact ends.
Medium	Negative environmental changes (e.g. in noise levels, traffic, landscape) cause some level of adverse impacts on the wellbeing, living conditions, amenity or recreational use opportunities for people, or on the use of residential and holiday properties. The project generates some amount of worries and disagreements. Changes decrease the community spirit or increase inequality to some extent. A moderate negative impact on the livelihoods, employment opportunities and the economy of the local area. Changes may be long-term, partly reversible or occasional or occur in a relatively large area.
High	Negative environmental changes (e.g. in noise levels, traffic, landscape) cause significant adverse impacts on the wellbeing, living conditions, amenity or recreational use opportunities for people, or on the use of residential and holiday properties. The project generates a lot of anxiety and disagreements. Changes evidently decrease the community spirit or increase inequality significantly. A significant negative impact on the livelihoods, employment opportunities and the economy of the local area. Changes are long-term, occur in a large area, are permanent or irreversible.

Main data sources for social impact assessment onshore have been survey carried out on residents in the Kotka area (later *Kotka Survey*, report in Appendix 11C) and information from the other impact assessments. Results of the *media-analysis* (described in Subchapter 11.19.2) have been used when applicable.

For 23 % of the respondents to the Kotka Survey (N=325), the questionnaire and accompanying information sheets were the first time they heard about Nord Stream 2. The main information sources for nearly 80% of respondents, who already had at least heard about the project, were newspapers, magazines, television or radio. The majority of the respondents found the available information to be mainly easy to understand and sufficient for their needs. (Appendix 11C, Figures 14-16)

12.1.6.3 Impact assessment

Worries and expectations

The project has had an impact on the general atmosphere in the Kotka area. The impact is mainly positive, but the project and related operations also cause some concerns related to impacts on residential amenity. Based on the Kotka Survey, the respondents welcome the project-related activities in Kotka and the overall attitude is remarkably positive (Appendix 11C). In the Kotka Survey, only four respondents out of 91 provided additional comments expressing concern about the possible political implications of Nord Stream 2 while the rest of the additional comments mainly focused on supporting the planned operations in Kotka, concern for traffic impacts, importance of creating local employment opportunities and working conditions at the coating plant.

The additional comments support the statistics of the resident survey. Respondents of the Kotka Survey were asked about their opinions on possible impacts of the operations planned to be carried out in Kotka. While possible impacts of rock transportation raised positive expectations in terms of local employment and municipal economy, concern over the negative impacts on traffic safety and fluency, noise and air quality was also raised (Figure 12-5). In some comments, a doubt about whether the employees will be local was raised. Wasco, the coating and logistics partner of Nord Stream 2 AG, is obliged to employ 85% of its workers and over 50 % of its local management locally. Wasco’s target is to hire mostly locals for all positions.

The possible impacts of rock storage in the Mussalo Harbour area, pipe storage in the Palaslahti Industrial Area and pipe transportation from the harbour to the sea also raised positive expectations in terms of employment and the municipal economy. Rock storage also raised concern about negative impacts on scenery, noise and air quality, although more than half of the respondents thought that rock storage would not cause any impacts or that the impact would be neutral (Figure 12-6).

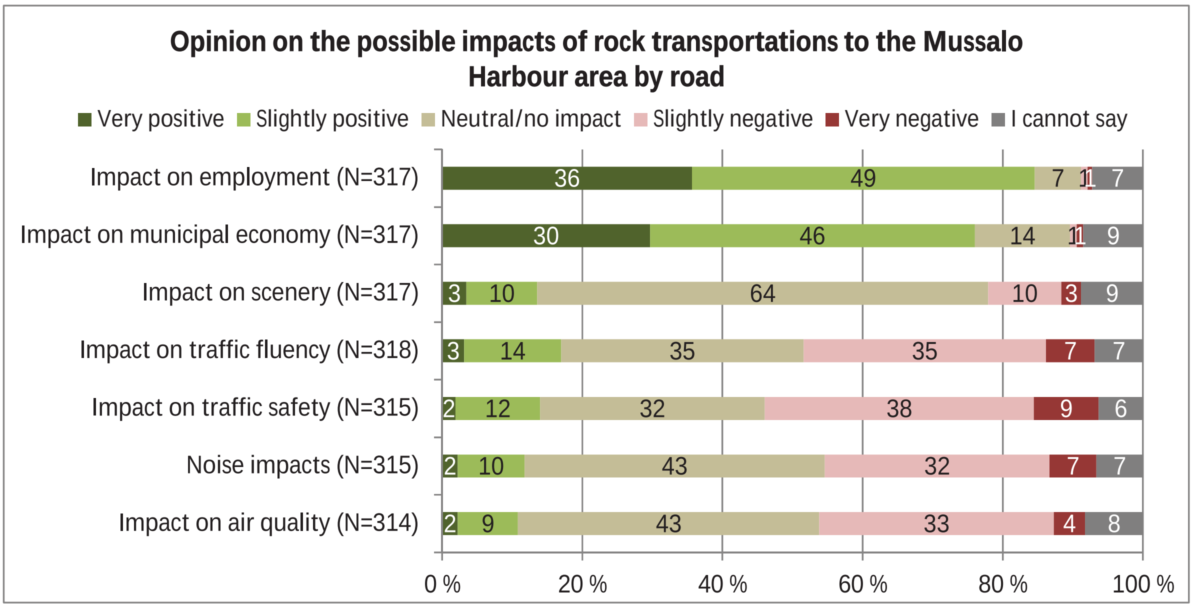

Figure 12-5. Opinions of respondents on the possible impacts of rock transportation to the harbour area.

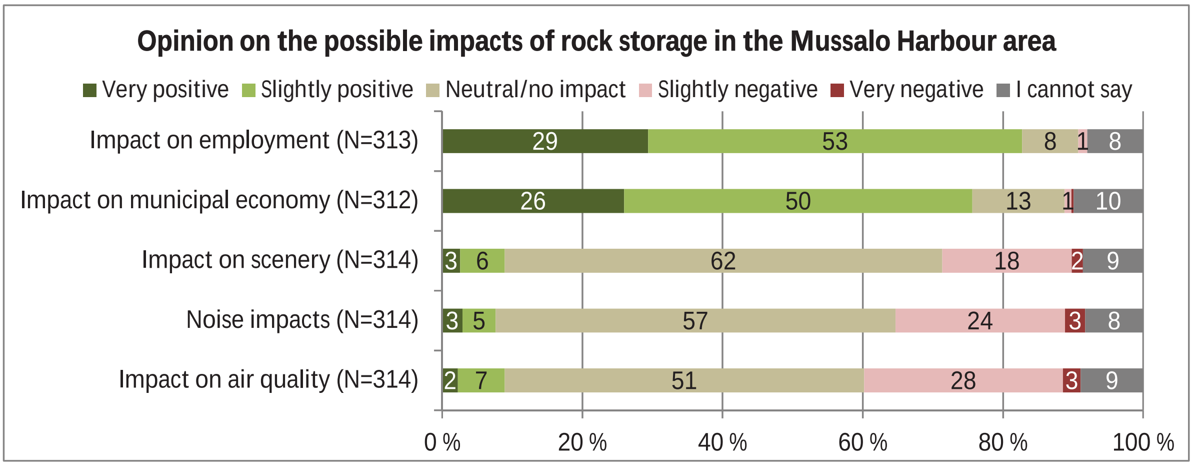

Figure 12-6. Opinions of respondents on the possible impacts of rock storage in the Mussalo Harbour area.

In Kotka and coastal surveys (Appendix 11B and Apendix 11C), respondents were asked to give their opinion on statements concerning the Nord Stream 2 project-related activities in Finland. When the responses from the Kotka Survey were analysed in relation to the respondents' familiarity with the pipe coating and storage activities in Kotka in 2010–2012, there were statistically significant differences between respondents with different levels of knowledge. Generally, it seems that respondents with more knowledge of the operations in 2010–2012 had a stronger opinion that Nord Stream 2 project-related activities would create new business and job opportunities in Kotka. They also seem to view the project more positively compared to respondents with no or only limited knowledge of the project operations. Most of the respondents, including those with no or limited knowledge of previous activities, disagreed with the statements that Kotka would not benefit from the activities and that Kotka should not be used as a logistics hub for Nord Stream 2 project-related activities. The more knowledge respondents had about activities in Kotka in 2010–2012, the more supportive they were of the Nord Stream 2 Project. (Appendix 11C, page 13)

When the opinions of respondents to the Kotka Survey are compared with the opinions of the respondents of the Coastal Area Survey, it can be noted that residents in Kotka are generally more positive about the Nord Stream 2 Project and ancillary activities. While the majority of respondents top the Kotka Survey considered current employment opportunities and municipal economy to be poor, Nord Stream 2 ancillary activities in Kotka were expected to improve the situation. Expected local benefits in Kotka through increased employment and improved local economy seem to shape the general opinion of the respondents.

The positive expectations concerning the economic and business opportunities were seen also in the results of the media-analysis. The local media highlighted the current poor employment situation and the downturn of the economy of the Port of HaminaKotka. At the same time Nord Stream 2 was presented in a positive light as a means to bring significant employment opportunities and boost economic activities in the Kotka region if, and later when, the logistics hub and pipe coating plant would be located in the City of Kotka.

The worries and expectations tend to be at their highest already during the planning of the project. At that point there is more room for speculation, planning is still on-going and some of the decisions are still to be made. When the construction starts and the possible impacts are realised, the expectations and worries usually start to diminish if no harmful impacts occur and the uncertainty is replaced with more precise and concrete information.

Potential quarries

Based on experiences from other EIA's related to rock extraction, the main concerns people at near-by residential areas generally have, are noise, dust and other air emissions, blasts and possible damage to properties related to those and heavy traffic (traffic safety, traffic fluency, dust, emissions, noise). The complaints documented from Rajavuori area (baseline, Subchapter 8.1.7) show that the main negative experiences people have reported are related to blasts. During the Nord Stream 2 EIA Programme Phase, two opinions from private stakeholders relating to impacts from quarrying during the rock extraction for NSP were described. These impacts were mentioned also in an opinion from an NGO. Based on these experiences, the main concerns are the possible damages to one's property and the experienced lack of supervision of the permit conditions. Mistrust towards the licensing and supervising authorities was expressed, because stakeholders felt supervision has been neglected during the rock extraction for the construction of NSP.

<u>Impacts on residential areas and amenity</u>

During the planning phase, no physical changes or impacts on residential areas or amenity are expected. The most notable impacts are expected to take place during construction.

The major source of nuisance for the residents arising from current operations at Mussalo Harbour and Palaslahti Industrial Area is heavy traffic causing congestion as well as dust and noise emissions (Subchapter 8.1.6). Thus, it is understandable that a possible increase in heavy traffic due to Nord Stream 2 project-related activities raises further concerns among respondents. As mentioned in the baseline description, many respondents experience disturbance or nuisance because of the operations in the harbour or heavy traffic already in the current situation. However, only 14 % of the respondents recalled noticing that there had been changes to the living environment during 2010–2012 when the coating plant was in operation at Mussalo Harbour. The main changes respondents had noticed were positive impacts on local economy and job opportunities and an increase in heavy traffic and traffic congestion. Some had observed also changes in noise levels, dust emissions and traffic safety (Figure 8-10).

Based on the impact assessment on road traffic and safety (Subchapter 12.1.2), it is likely that also this time, the traffic-related issues will be the main negative impact on residential amenity due to the project's ancillary activities. The volume of the heavy traffic caused by rock transportations is estimated to be twice as high as during the 2010–2012, when the pipe coating yard was previously in operation. According to the impacts on road traffic, this can deteriorate traffic fluency at crossings. On Hyväntuulentie (Road 15) the impact is assessed to be lower than on Merituulentie (Road 355).

As approximately half of the respondents of the Kotka Survey feel that traffic congestion due to heavy traffic is at least a slight nuisance already in the current situation (Appendix 11C, Figures 9 and 10), they may be more sensitive to impairment in traffic conditions. Noise caused by the addition of heavy traffic is assessed to increase slightly at Haukkavuori, Hirssaari, Etukylä and Takakylä in the areas closest to the road (Subchapter 12.1.4). Change is not critical and it does not cause exceeding of the noise guideline values, but it is audible and some of the residents may find it disturbing or consider it to diminish the quality of their living environment.

The pedestrian and bike routes are separated from Hyväntuulentie and there are no dangerous crossings along the main transportation route. Therefore, the increasing traffic is assessed not to have a significant impact on traffic safety for pedestrians or cyclists. On Merituulentie, the addition of heavy traffic is relatively higher, and may diminish traffic safety at points, especially at three junctions (Tökkärintie, Jänskäntie and Takakyläntie), where pedestrians have level crossings. (Subchapter 12.1.2) If exceptions to the main transportation route occur due to any interference along the route (accidents, heavy congestion), the traffic is likely to be routed to Mussalontie. There are a lot of residential areas on the both sides of Mussalontie and it is not the preferred route for heavy traffic to Mussalo Harbour. Based on some additional comments in the Kotka Survey, people recall having experienced heavy traffic on Mussalontie during the Nord Stream project and were concerned of it is happening again.

The impact on residential amenity and safety due to the changes in the living environment is assessed to be medium because of the estimated increase in heavy traffic and small increase in noise.

Potential quarries

Based on the results of the impact assessments on traffic, air quality and noise, there can be some negative impacts on residential amenity mainly due to the increase in heavy traffic. Increased heavy traffic is expected to cause negative impacts on traffic fluency and in that way it can have an impact on peoples' everyday life.

In addition to impacts from heavy traffic, some emissions are also expected to locally decrease the air quality, dust may cause occasional harm and change in the noise levels might be experienced as disturbing, even when the noise stays below the noise guideline values. The cumulative impact of all these together are likely to cause some disturbance to the residential amenity.

<u>Impacts on tourism and recreation</u>

The most well-known annual event in Kotka is Kotkan Meripäivät at the end of July. Attracting 200,000 yearly, this sea-dependent event is important to tourism. Sailboat races starting from Sapokka are not likely to experience impacts from the vessels to or from Jänskä quay. The pipe supply vessels are operating from Mussalo Harbour in July, but their route from Jänskä quay to the outer sea runs futher away from Kotkansaari, where the racing route runs so no impacts to the race is expected. No impacts on organised cruises to Haapasaari, Kaunissaari or Ruotsinsalmi are expected.

As described in the baseline (Subchapter 8.1.8), the different parks are an important attraction to tourists visiting Kotka. Some of the parks are close to the sea or Mussalo Harbour. Based on the noise impact assessment (Subchapter 12.2.3), the noise circumstances in the recreational parks are not expected to change due to project-related traffic. The noise from the project-related activities in Mussalo Harbour are not expected to have an impact on recreational areas (Subchapter 12.1.4). The operations in the harbour and industrial area include (1) pipe coating, that takes place indoors, (2) pipe storage (outdoors), (3) loading of the pipes to the vessels, (4) unloading of the rock to the storage and (5) loading the rock onto vessels. Handling of the rock material generates some noise, but the handling will be done within the framework of the environmental permit of Mussalo Harbour that includes also limit values for noise. At times, the noise from rock handling may be audible, for example, at the Santalahti recreational area west of the harbour. Impact to recreational use of the parks or other areas due to this is assessed to be low or negligible.

Even at it's highest, during the construction of the pipeline, the number of vessels from Mussalo Harbour to the sea will increase by approximately 10 vessels per week. The addition to the current traffic is not that remarkable that it would cause noise that would have impact on the closest recreational area, Katariina Seaside Park.

The traffic to and from the harbour and project-related activities in the harbour and industrial area are assessed to cause only small changes in relation to recreational areas. The increasing vessel traffic is not assessed to cause changes to recreational boating or use of the sea areas close to the coast. The impact on tourism is assessed to be negligible.

<u>Impacts on local economy</u>
The current unemployment rate in Kotka is high (Subchapter 8.1.7) and new job opportunities are warmly welcomed. Based on news in the media, the news confirming Kotka's position as a logistics hub was greeted with enthusiasm (Figure 12-7). Impacts on employment started to arise already when preparations for the pipe storage area and launching of the coating yard started, and Nord Stream 2's coating and logistics partner Wasco started to hire employees for these operations.

The project and project-related activities are expected to create directly 300 and indirectly 100 jobs in the Kotka area, which is more than 7.5 % of the number of currently unemployed persons in Kotka. Nord Stream 2's coating and logistics partner Wasco is obliged to employ 85 % workers locally, over 50 % of its local management. Wasco's target is to hire mostly locals for all positions.
In addition to the actual impact on employment, the training of employees increases the social capital in the area.

The impact on local economy is assessed to be positive and high, although the impact is at least partly reversible.


UUTISET
Kaasuputki tuo työtä
Nord Stream aloittaa Kotkassa risk
Wasco Coatings rekrytoi jo — odotettavissa 300 työpaikkaa
Kuva: Kimmo Seppälä
Giancarlo Maccagno ja Rik Nugteren Wasco Coatingsilta ovat Kotkassa valmistelemassa kaasuputkien betonipinnoitushanketta.

Figure 12-7. **The impact on employment was reported in the news after Kotka was confirmed as a logistics hub for the projects ancillary activities. (Kymen Sanomat 24 August 2016 and Kymen Sanomat on-line 10 September 2016)**

Potential quarries
The project accelerates the production of rock material at the existing quarrie(s). It can concentrate the working hours needed into a shorter period than without the projects, but does not create new jobs. The impact on the local economy is assessed to be low positive.

12.1.6.4 Prevention and mitigation of adverse impacts

Mitigation of adverse impacts due to traffic is presented in Subchapter 12.2.2.4. These mitigation measures are important also for residential amenity and to ensure safe movement in the area, especially, for pedestrians and cyclists and to minimise the negative impacts on traffic fluency.

To mitigate the impacts on residential amenity, mitigation measures presented in Subchapters 12.1.2, 12.1.3 and 12.1.4 are important to control the possible adverse impacts caused by noise, heavy traffic and dust. For example the study of the complaints related to quarrying shows, that even when the noise guideline values are not assessed to be exceeded, (Subchapter 8.2.7) noise has been a subject for several complaints and has caused decline in residential amenity.

Open communication between the project developer (and owners of the ancillary activities) and the City of Kotka and its residents (permanent and leisure residents) is important to find out the possible operations and actions that might cause negative changes in the living environment, and to prevent or mitigate them.

In addition to the statutory consultation processes described in Chapter 3 NSP2 has committed to develop and implement Stakeholder Engagement Plans (SEPs) that are geographically specific and tailored to project risks, impacts and the interests of the communities that may be affected by the Project. The SEPs will be provided to the potentially affected communities to enable them to understand the risks, impacts and opportunities of the project. Furthermore, potentially affected communities will be provided with periodic updates that describe progress with implementation of action plans concerning issues of concern to those communities and with the opportunity to express their views on project risks, impacts and mitigation measures. Where there are potentially affected communities, a grievance mechanism will be established to receive and facilitate resolution of concerns and grievances about the Project's environmental and social performance.▫

To ensure fluent flow of information between all parties (the community, city of Kotka, project owner and owner of ancillary activities) Nord Stream 2 will have a permanent site representative at the Kotka coating plant and yard facilities for the life of project's the coating operations [F-029].

Nord Stream 2 will periodically audit its Contractors (including ancillary activities) to ensure that they operate in accordance with their environmental permits.

12.1.6.5 Lack of information and uncertainties

No specific information or data gaps that would affect the results of this social impact assessment have been identified. Possible uncertainties are related to the nature of social impacts. There are no limit values for social impacts, which emphasise the role of expert assessment. At some level, expert assessment is unavoidably subject to subjective interpretation.

The source information used is a portrait of a certain timeframe and the results reflect the current atmosphere. Therefore, developments occurring in the time period between gathering information to finishing the impact assessment report, that could have had an impact on overall results, may not have been included in the analysis.

Uncertainties related to the Kotka Survey are listed in the survey report (Appendix 11C).

12.1.6.6 Significance of the impacts

Social impacts in the Kotka region are assessed to be two-way. Impacts on residential amenity and traffic safety are assessed to be moderate and negative due to a significant increase in heavy traffic and a small increase in noise. It is assessed that the impacts on local economy are positive and major because of the high number of new jobs created to the area suffering from high unemployment rate. The project increases also social capital in the area when new employees are trained for their tasks. Other social impacts are assessed to be minor or negligible.

Potenial quarries

The impact on worries and expectations is assessed to be *low* negative. Impact on residential amenity is assessed to be *medium* negative. The receptor sensitivity is assessed to be *low* in terms of worries and expectations and residential amenity and safety. There are no sensitive institutions nearby. The number of the people potentially suffering from the impacts is relativily low. However, people are already experiencing disturbance from the quarrying and related operations in the Rajavuori area and this can reduce the tolerance to any extra disturbance.

In relation to local economy, the sensitivity of receptor is considered to be *medium* because the Kotka area has high unemployment rates. Impact on the local economy is assessed to be *low* positive durin operation, but negligible during planning phase.

Table 12-24. Significance of the social impacts onshore in Kotka.

Social impacts	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Planning phase			
Expectations (Mussalo and Kotka)	Medium	Low	Minor positive
Worries and expectations (quarries)	Low	Low	Minor negative
Economy (Mussalo and Kotka)	High	Low	Moderate positive
Economy (quarries)	Medium	Negligible	Negligible
Construction phase			
Worries and expectations (Mussalo and Kotka)	Medium	Low	Minor negative
Worries and expectations (quarries)	Medium	Low	Minor negative
Residential amenity and safety (Mussalo and Kotka)	Medium	Medium	Moderate negative
Residential amenity and safety (quarries)	Medium	Medium	Moderate negative
Tourism and recreation	Low	Negligible	Negligible
Economy (Mussalo and Kotka)	High	High	Major positive
Economy (quarries)	Medium	Low	Minor positive
Operation phase			
Social impacts in general	Negligible/Low	Negligible	Negligible

It has to be noted that there are several rock quarries in the Rajavuori and Kyytkärri areas. There are at least eight valid extraction permits for these areas. As regards extraction capacities, the Rudus Oy Rajavuori quarry is the largest quarry in the area. There could be cumulative impacts if two or more quarries operate at the same time. The impacts relate to noise, traffic and dust. The operation of quarries depend on rock demand and the activity of construction projects nearby. The quarries may be in a passive state for a long time if the demand for rock material is low.

12.2 Impacts on Hanko region

12.2.1 Impacts on land use

Purpose of the assessment is to identify impacts and possible conflicts on current land use and development of the area. NSP2 ancillary activities in Koverhar, Hanko, include transport and storage of weight-coated pipes.

Summary of land use impact assessment	
Lessons learned from the Nord Stream Project in 2009–2012	There was a storage yard in the main Hanko Harbour during NSP. The main Hanko Harbour is located closer to the city centre than the Koverhar Harbour. There were no significant negative impacts on land use from the storage yard operations in the main Hanko Harbour.
Main results of the assessment	Ancillary actitivities in the Koverhar Industrial and Harbour Area, Hanko, does not require changes to existing land use planning. The location takes advantage of existing port and industrial area infrastructure. There is no sensitive land use (schools, daycare, hospitals) in the vicinity of activity areas.

12.2.1.1 Impact mechanism

Impacts from Koverhar ancillary activities could conflict with present and planned land use forms and infrastructure or conflict with the development of the area.

12.2.1.2 Methods and data used

Impacts have been assessed as an expert opinion based on a technical description of the project, planned location of the activities, existing conditions and maps and the planning situation in Koverhar, Hanko. The current planning situation is described in the onshore baseline Subchapter 8.2.1.

Significance of an impact (sensitivity of receptor and magnitude of change) on land use has been assessed based on the methods presented below.

Table 12-25. Sensitivity of receptor (land use).

Low	Industrial areas and traffic areas with no significant settlement, recreational value or other sensitive operations (schools, daycare centres, hospitals).
Medium	Previously built areas with few inhabitants; or unbuilt areas with some noise- or other distractions; areas with multiple recreational areas and/or recreational areas can be replaced with other areas.
High	Residential areas or their immediate vicinity, natural and recreational areas. Only a few recreational areas in proportion to inhabitants/users or limited possibilities for alternative recreational areas.

Table 12-26. Sensitivity of receptor (land use).

High	The project and operations bring positive changes to land use. Changes are long-term, occur in a large area, are permanent or continual.
Medium	The project enables development of the surrounding areas and realisation of existing plans. A moderate positive impact on land use. Changes may be long-term, partly reversible, occasional or occur in a relatively large area.
Low	The project causes minor positive impacts on land use. Project enables development of the areas and plans in the immediate vicinity of the operations. Changes occur in a limited area or are short-term and the situation returns back to the pre-existing condition when the impact ends.
Negligible	No changes to the land use.
Low	The project does not cause significant change to the area. Compared to existing operations in the area the project adds similar operations that utilise existing infrastructure. Small changes in planning are required that do not cause opposition in the area. The nature of the operations is negative but short-term.
Medium	The project brings new operations or the building of new infrastructure. Changes in planning are required. The nature of the operations is negative and relatively long-term.
High	The project conflicts with present and planned land use development. Changes in regional planning or local master planning are required. The nature of the operations is negative and permanent.

12.2.1.3 Impact assessment

Impacts during construction

Activities in Koverhar, Hanko, include the storage yard for pipes. The pipes are transported to and from Koverhar by ship and use the existing Koverhar Harbour. The storage areas are situated in Koverhar Harbour and the industrial area (previously a steel factory area). The planned operations in Hanko take place during construction between 2018–2019.

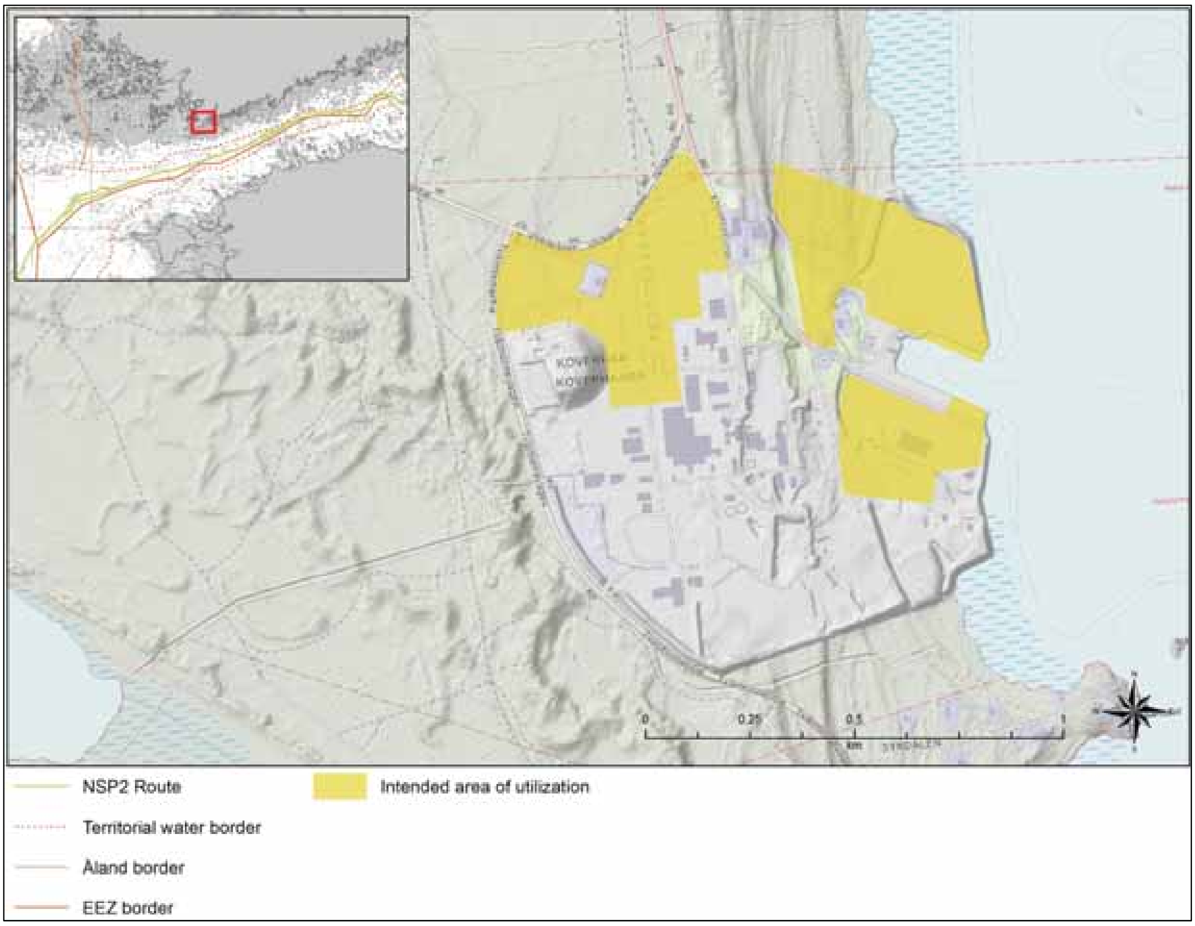

Figure 12-8. Intended area for the storage yard operations in Koverhar, Hanko.

Planned operations do not cause conflicts with the current planning status and changes in planning are not required. In the regional plan, the operation area is described as a harbour area and an industrial area. In the current local master plan, the operation area is designated as an industrial (T) and a harbour area (LS). There is a Natura 2000 site on the seaside of the harbour and on the northern side of the industrial area. There is no local detailed plan for Koverhar, but in the proposal for the zoning plan, the operations are located in the harbour area (LS). The planning situation is described in the onshore baseline Subchapter 8.2.1.

The nearest residential area is Lappohja approximately 2.5 km from Koverhar Harbour. The nearest daycare centre, school and health centre are located in Lappohja, approximately 2–3 km from the operations in Koverhar. There are also a few residential homes on the other side of the Syndalen military area, approximately 2 km south from Koverhar Harbour. As the distance to the nearest sensitive land use is far, there are no expected impacts on the land use.

<u>Impacts during operation</u>
After construction, the Koverhar storage areas will be cleared of pipes. There will be no impacts on onshore land use after construction.

12.2.1.4 Prevention and mitigation of adverse impacts

There is no need for mitigation of adverse impacts regarding land use.

12.2.1.5 Lack of information and uncertainties

There are no significant uncertainties concerning the storage yard operations in Koverhar, Hanko.

12.2.1.6 Significance of the impacts

As the Koverhar onshore operations are located in existing harbour and industrial areas and far from the nearest sensitive land use, the sensitivity of the receptor is assessed as *low*. There have previously been large-scale industrial steel and harbour operations. Also, the Syndalen military area is located just beside the harbour and industrial area.

The Koverhar operations do not require any changes to current planning or to the on-going zoning planning. The Koverhar storage yard takes advantage of the existing harbour and industrial area infrastructure, where traffic has been low in recent years. The storage yard operations have a positive impact on the development of the area, as there are plans for developing the harbour and the former steel factory areas. The development of the harbor area are not related to NSP2. The project's ancillary activities in Koverhar last for 2 years, so the impacts are temporary.

The magnitude of change to land use is assessed to be *low positive* and the significance of the impact *minor positive*. After construction and during operation of the pipeline, there are no impacts on land use in Koverhar, Hanko.

Table 12-27. Significance of the impacts on land use in Koverhar.

Impacts to land use in Koverhar	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Construction phase			
Land use in Koverhar	Low	Low	Minor positive
Operation phase			
Land use in Koverhar	Low	Negligible	Negligible

12.2.2 Impacts on air quality

Purpose of the assessment is to assess the impacts on air quality arising from the Koverhar storage yard operations. The impacts on air quality can be generated by exhaust gases from machinery and / or vessels at the harbour. Also, local particulate emissions (dust) from stockyard operations may occur.

Summary of air quality impact assessment	
Lessons learned from the Nord Stream Project in 2009–2012	There was a storage yard at the Hanko Harbour, part of the Port of Hanko, during NSP. Hanko Harbour is located closer to the city center than Koverhar Harbour. There were no significant negative impacts on air quality from storage yard operations at Hanko Harbour.
Main results of the assessment	Emissions to air from machinery and vessels are estimated to be negligible compared, for example, to the annual emissions from the Port of Hanko. Impacts on air quality outside storage areas are not expected. The activities last approximately 2 years and, after the construction phase, the operations in Koverhar, Hanko,will cease.

12.2.2.1 Impact mechanism

The impacts on air quality from Koverhar operations can be caused by exhaust gases from machinery and vessels at the harbour. There is no heavy truck traffic in Koverhar from NSP2 operations. Machinery may also create local particulate (dust) emissions. Exhaust gases and dust may have an impact on local air quality.

Emissions compounds included in the assessment are carbon dioxide (CO_2), nitrogen oxides (NO_x), sulphur dioxide (SO_2), particulates and CO_2. The total CO_2-emissions and offshore emissions are assessed in connection with climate impacts and offshore air quality impacts in Subchapter 11.1. Emissions to air from Kotka ancillary activities are described and assessed in Subchapter 12.1.3.

12.2.2.2 Methods and data used

The methods and unit emissions in emissions calculations from onshore activities in Koverhar, Hanko, are the same as in Kotka, Subchapter 12.1.3.2.

Current air quality in Hanko is described in the onshore baseline Subchapter 8.2.3. Impacts on air quality from exhaust gas emissions and local particulate emissions are assessed as an expert opinion.

Table 12-28. Sensitivity of receptor (air quality).

Low	There are a lot of activities in the area generating air emissions or the area is otherwise affected by the emissions. Ambient air concentrations exceed the limit values. There are no sensitive receptors such as residential areas, holiday homes, schools, day-care centres or protected areas, and the area is not used for recreation.
Medium	There are some activities in the area generating air emissions or the area is otherwise affected by emissions. There are some sensitive receptors nearby such as residential areas, holiday homes, schools, day-care centres or protected areas, and the area is not used for recreation.
High	There are only a few activities in the area generatingair emissions and the area is not affected by the emissions coming from elsewhere. There are sensitive receptors such as residential areas, holiday homes, schools, day-care centres or protected areas, and the area may be used for recreation.

Table 12-29. Magnitude of change (air quality).

Negligible	No changes expected to the ambient air quality.
Low	Ambient air concentrations are expected to remain well below the guideline and limit values and/or the increase in emissions is estimated to be low. The impacts are short-term.
Medium	Ambient air concentrations are expected to be near the guideline and limit values. Any exceedances are short-term and the affected area is not sensitive. Increase in emissions is estimated to be significant but the impacts are short-term or reversible.
High	Ambient air concentrations are expected to cause exceedances of guideline and limit values. The impacted area is extensive. Emissions increase significantly and impacts are permanent and have impact on large area.

12.2.2.3 Impact assessment

Impacts during construction

The exhaust gas emissions from pipe supply vessels and machinery at Koverhar are presented in Table 12-30 as total emissions for the whole construction period and also as annual emissions (for the 2 year construction period). The supply vessels at the harbour produce the majority (nearly 100 %) of sulphur oxides (SO_2) and over half (approximately 62–64 %) of the nitrogen oxides (NO_x) and particulate emissions of Hanko onshore operations.

Table 12-30. Summary of emissions loads from ancillary onshore activities at Koverhar, Hanko.

Activity	Estimated emissions loads [tonnes]			
	CO_2	NO_X	SO_2	Particulates
Supply vessels at harbour	1,327	27	0.9	0.8
Cranes and loading equipment	956	15	<0.01	0.5
Total emissions	2,283	42	0.9	1.3
Annual total emissions tonnes/year	1,142	21	0.5	0.7

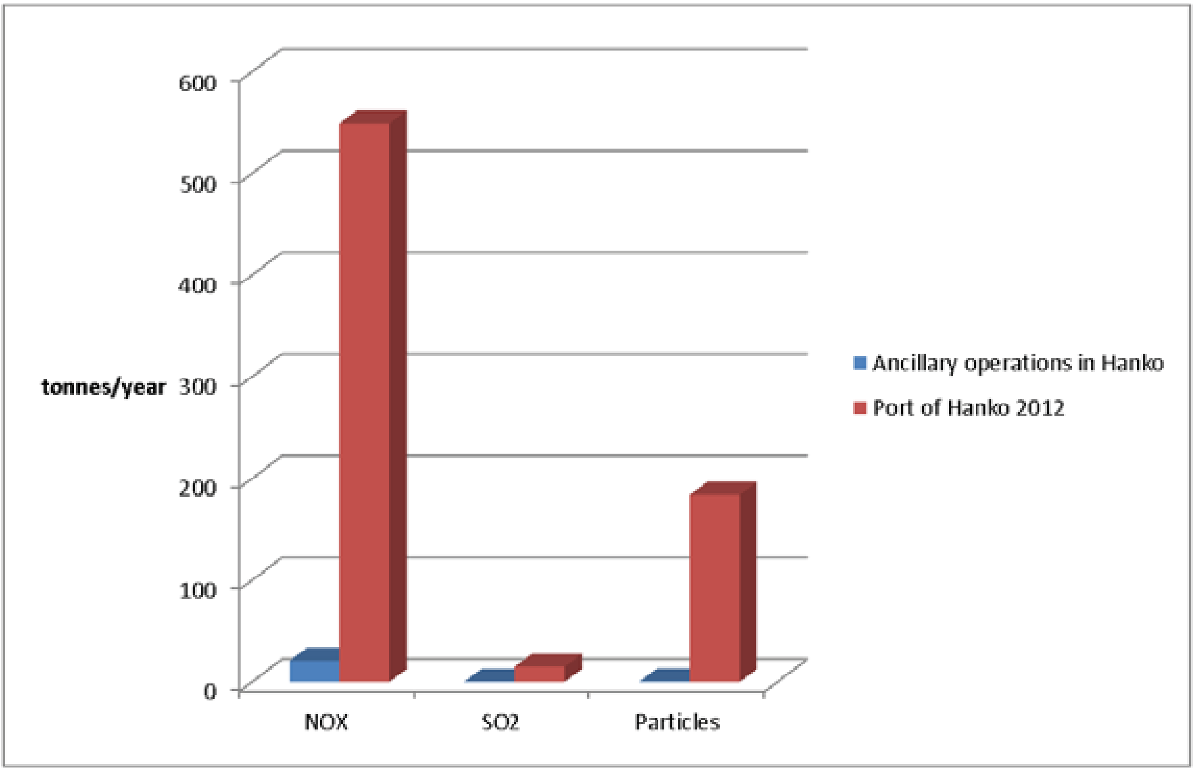

Figure 12-9. Annual emissions from Hanko ancillary onshore operations and annual emissions from Port of Hanko in 2012.

By comparing Hanko ancillary operations to Port of Hanko (all harbours) emissions in 2012 (Figure 12-9 and Table 8-2), it can be seen that total emissions (NO_x, SO_2, PM) from ancillary operations in Hanko are only 0.5–9 % of the total annual emissions of the Port of Hanko. Annual emissions from ancillary operations in Hanko are 0.2–4 % of the annual emissions of the Port in 2012. The CO_2-emissions from ancillary onshore operations in Hanko are small compared to the whole project's CO_2-emissions. The impact on air quality from Nord Stream 2 in Hanko is negligible and cannot be distinguished from other operations in the Hanko region.

Local dust emissions can occur due to machinery moving on unpaved storage areas. Emissions to air from these sources are estimated to be minor and the impact on air quality remains in the storage areas. Impacts on air quality outside the storage areas are not expected.

Impacts during operation

After the construction phase, the storage areas will be cleared of pipes and storage yard operations will cease.

12.2.2.4 Prevention and mitigation of adverse impacts

There is no need for mitigation measures.

12.2.2.5 Lack of information and uncertainties

It should be noted that the air emissions calculated based on assumptions are associated with uncertainties related to, e.g. engine type, number of engines, working load of the engines and the exact fuel type. Despite the data limitations and uncertainties, it is assumed that the estimated range of emissions presented are in the order of magnitude of the emissions that will actually arise.

12.2.2.6 Significance of the impacts

The sensitivity of the receptor is estimated as *low*, as the Koverhar storage yard is located in an existing harbour and industrial area where operations of a steel plant have ceased in 2012. There are two large industrial facilities (SSAB Europe and Visko Teepak Oy) within approximately 3 km from the harbour (SSAB Europe in Lappohja and ViskoTeepak Oy along Highway 25). The nearest residential buildings are located 2.0–2.5 km from the harbour. The air quality in Hanko is considered mainly good. The magnitude of change is considered to be *neglible*, as the impacts are temporary and emissions to air are not estimated to have an impact on general air quality in Hanko. Therefore, the overall significance of impact is *neglible*.

Table 12-31. Significance of the impacts on air quality near Koverhar.

Impacts on air quality	Receptor sensitivity	Magnitude of impact	Overall significance of the impact
Construction phase			
Air quality	Low	Negligible	Negligible
Operation phase			
Air quality	Low	Negligible	Negligible

12.2.3 Airborne noise impacts

The purpose of the assessment is to evaluate impacts from noise generated by ancillary storage yard operations that take place in Koverhar, Hanko The machinery operating in the storage yard as well as ship traffic generate noise. The noise can have adverse impacts on people in residential areas or other sensitive land use areas (schools, daycares, hospitals, recreational areas).

Summary of noise impact assessment	
Lessons learned from the Nord Stream Project in 2009–2012	There was a storage yard at Hanko Harbour, part of the Port of Hanko, during NSP. The Hanko Harbour is located closer to city centre than Koverhar Harbour. There were no significant negative noise impacts from storage yard operations at Hanko Harbour.
Main results of the assessment	There are and have been noise generating operations in Koverhar due to harbour operations, military operations and operations of a former steel factory. The demolishion of the steel factory also generates noise. The noise from NSP2 storage yard operations is considered to be negligible compared to nearby military operations. Also, the noise from storage yard operations is considered to be negligible in the nearest residential areas. Minor noise can be generated by machinery or ships.

12.2.3.1 Impact mechanism

The machinery and vessels operating in the harbour and pipe storage yards generate noise. The noise could have an adverse impact on people in residential areas or other sensitive land use areas (schools, daycare centres, hospitals, recreation areas).

12.2.3.2 Methods and used data

The current operations and noise situation are described in the baseline Koverhar, Hanko Subchapter 8.2.4. The assessment is performed as an expert opinion. The highest permitted noise levels are presented in the Kotka onshore noise impact assessment Subchapter 12.1.4.2.

Table 12-32. Sensitivity of receptor (airborne noise).

Low	There is a lot of noise generating activities in the area or the area is otherwise affected by the noise. The noise levels exceed the guideline values. There are no sensitive receptors such as residential areas, holiday homes, schools, day-care centres or protected areas, and the area is not used for recreation.
Medium	The area has some noise generating activities or is otherwise affected by the noise. There are some sensitive receptors nearby such as residential areas, holiday homes, schools, day-care centres or protected areas, and the area is not used for recreation.
High	There is only a small number of noise generating activities and the area is not affected by the noise coming from elsewhere. There are noise sensitive receptors such as residential areas, holiday homes, schools, day-care centres or protected areas, and the area may be used for recreation.

Table 12-33. Magnitude of change (airborne noise).

Negligible	No changes to the noise level. Noise level increases by 0–1 dB.
Low	The change in noise level caused by the project is small or non-existent. The project will not cause exceedance of the noise level guideline values. The noise level increases by 1–4 dB.
Medium	The change in noise level caused by the project is a medium. The project causes no or only a slight exceedance of the noise level guideline values. The noise level increases by 4–7 dB.
High	The change in the noise level caused by the project is high. The project will result in exceedance of noise guideline values. The noise level increases by >7 dB.

12.2.3.3 Impact assessment

Impacts during construction

The storage yard is located in the existing Koverhar Harbour. Previously, there has been a large-scale steel factory at the site, but the factory has been largely demolished since closing in 2012. There is the Syndalen military area surrounding the storage yard and heavy artillery firing exercises are conducted throughout the year. The noise levels at the harbour and the industrial area are 50–60 dB (LAeq) during these exercises. *(City of Hanko 2016b)*

The machinery used in loading and unloading concrete weight coated pipes to and from vessels produces noise.

The noise generated by storage yard operations is considered to be negligible compared to nearby military operations. Also, the noise from storage yard operations is considered to be negligible in the nearest residential areas located at a 2–2.5 km distance.

Impacts during operation

After the construction phase, the storage areas will be cleared of pipes and storage yard operations will cease. There will be no noise impacts during operation phase.

12.2.3.4 Prevention and mitigation of adverse impacts

There is no need for mitigation measures as the noise impact is considered to be negligible.

12.2.3.5 Lack of information and uncertainties

The agreements with the contractors and operators are not yet defined. The location of the storage areas may change depending on the contractors. An assessment has been made based on current plans and experience gained from the Nord Stream Project.

12.2.3.6 Significance of the impacts

The sensitivity of the receptor is evaluated as *low* and the magnitude of change as *negligible*. The operations are not expected to have an impact on noise in the nearest residential areas. The operations are also temporary and, after the construction period, there will be no ancillary activities in Koverhar, Hanko.

Table 12-34. Significance of the impacts of noise in Koverhar.

Impacts of noise in Koverhar	Receptor sensitivity	Magnitude of impact	Overall significance of the impact
Construction phase			
Noise in Koverhar	Low	Negligible	Negligible
Operation phase			
Noise in Koverhar	Low	Negligible	Negligible

12.2.4 Impacts on protected areas

Nord Stream 2 onshore operations in Hanko during the construction of the pipeline includes the storage of pipes in Koverhar Harbour. Noise or air emissions from storage yard operations, machinery and pipe transport vessels at the harbour could cause impacts on protected areas in the vicinity of Koverhar Harbour. Also, an oil spill from a vessel accident could have an impact on protected areas. During pipeline operation, there are no project-related activities in Koverhar, Hanko.

Summary of impact assessment on protected areas	
Lessons learned from the Nord Stream Project in 2009–2012	There was a storage yard in Hanko Harbour, part of the Port of Hanko, during NSP. Hanko Harbour is located closer to the city centre than Koverhar Harbour. There were no impacts on protected areas from storage yard operations in Hanko Harbour.
Main results of the assessment	The 2-year storage yard operations in Koverhar, Hanko, are not estimated to have an impact on the nearest Natura 2000 area of Tammisaari, Hanko Archipelago and the Bay of Pohjanpitäjänlahti. The use of existing harbour and fairways does not endanger the nature conservation purpose of the area. Compared to previous steel factory operations at the site the impacts on nature from NSP2 storage yard are estimated to be significantly smaller.

12.2.4.1 Impact mechanism

Nord Stream 2 operations in Koverhar, Hanko, during pipeline construction are storage yard operations at Koverhar Harbour. Possible adverse impacts on protected areas could be noise, air emissions or water pollution due to accidents or oil spills from vessels at or near the harbour.

12.2.4.2 Methods and data used

Impacts on protected areas are assessed based on existing data on protected areas and planned NSP2 ancillary activities in Koverhar, Hanko. For background information of the nearest protected areas see Subchapter 8.2.5.

All protected areas are considered highly sensitive and classification of sensitivity is not applied to protected areas. The assessment is performed as an expert opinion.

12.2.4.3 Impact assessment

Natura 2000 Sea Conservation Area of Tammisaari, Hanko Archipelago and the Bay of Pohjanpitäjänlahti (FI010005, SAC/SPA) is located in the immediate vicinity of Koverhar Harbour, Figure 8-15. The Natura 2000 area covers approximately 52,000 hectares and it includes several smaller important conservation areas. There are military rehearsal areas and shooting ranges within the Natura 2000 area. The objective of the conservation is to protect the seabed, underwater nature and the water quality in the Natura 2000 area. There are also several important nesting and resting areas for birds.

The large conservation area has been divided into seven sections of which the area of Tvärminne is closest to Koverhar Harbour. The Tvärminne area is classified as a typical outer archipelago where scrubby pines cover rocky islands. At the shore between Lappohja and Koverhar are habitats of endangered marram (*Ammophilia arenaria*) and beetle (*Aegialia arenaria)*. In total, 15 hectares of meadows and sand dunes located near Tvärminne village, where several endangered insect and plant species are found. This area is a designated Natura 2000 area in the local master plan. There are habitats of spinner (*Caprimulgus europeaus*) and wood lark (*Lullula arborea*) in the sand dunes and Lappohja shore forests. The existing harbours and seaways can be used and restored without endangering the objectives of the nature conservation. *(Finnish Environment Institute 2016d)*

There are also several important groundwater areas (Syndalen ID 0107806, Isolähde ID 0107803 and Sandö–Grönvik ID 0107802) surrounding Koverhar Harbour and the industrial area (former steel factory area). The harbour site and the industrial site are not classified as important groundwater areas.

The nature conservation area of the Bay of Pohjanpitäjänlahti (RSO010002) is covered by the Natura 2000 Area of Tammisaari, Hanko Archipelago and the Bay of Pohjanpitäjänlahti (FI010005, SAC/SPA). There are no impacts assessed to the geologically valuable aeolian sand and littoral deposits of Nicklundsberget–Tvärminne and Lappvikmalmarna.

<u>Impacts during construction</u>

The Natura 2000 Sea Conservation Area of Tammisaari, Hanko Archipelago and the Bay of Pohjanpitäjänlahti surrounds Koverhar Harbour. As it is stated in the Natura 2000 area description, existing harbours and seaways can be used without endangering the obejctives of the nature conservation. Considering the history of the area (current and previous operations at the harbour and the long history of steel factory operations) and the nature of the temporary, 2-year, NSP2 storage yard activities, the impacts on protected areas are considered to be negligible. The noise and air emissions from the NSP2 storage yard activities are not estimated to have any impact on the conservation areas nor on the important groundwater areas. The possible impacts of oil spill due to vessel accidents are described in Chapter 16 ‘Risk assessment’.

<u>Impacts during operation</u>

During pipeline operation, there are no onshore operations in Koverhar, Hanko. Therefore, there are no impacts on protected areas.

12.2.4.4 Prevention and mitigation of adverse impacts

Based on the available information of the planned project, no adverse impacts are predicted for protected areas. Therefore, no mitigation measures are needed.

12.2.4.5 Lack of information and uncertainties

Information on protected areas is adequate. Due to former experience from the NSP construction phase, there are no major uncertainties concerning impacts on protected areas.

12.2.4.6 Significance of the impacts

Planned Nord Stream 2 activities during pipeline construction will not have adverse impacts on the protected areas nor on important groundwater areas in Koverhar, Hanko. During pipeline operation, there are no operations in Koverhar, Hanko.

Table 12-35. Significance of the impacts on receptors in the protected areas near Koverhar, Hanko.

Impacts on ecological values in protected areas	Receptor sensitivity	Magnitude of impact	Overall significance of the impact
Construction phase			
Protected areas	High	Negligible	Negligible
Operation phase			
Protected areas	High	Negligible	Negligible

12.2.5 Social impacts

Purpose of the social impact assessment is to assess the possible impacts on living conditions, recreation and the fears and aspirations that could be generated by the project or project-related operations. Also, tourism is covered under social impacts.

Summary of social impact assessment	
Lessons learned from the Nord Stream Project in 2009-2012	There was a storage yard in Hanko Harbour, part of the Port of Hanko, during NSP. Hanko Harbour is located closer to the city centre than Koverhar Harbour. Impacts of pipe storage and loading/unloading of pipes are well-known from NSP experiences at Mussalo, Kotka.
Main results of the assessment	Social impacts at Koverhar, Hanko, area are assessed to be minor or negligible. There are no impacts on residential amenity, safety or recreational use of the area as pipe loading and storage takes place in an industrial area further away from the residential areas. The impact on the economy is assessed to be minor positive. The pipe storage and pipe loading do not impact existing small businesses. A few new jobs will be created related to harbour activities.

12.2.5.1 Impact mechanism

Social impacts can be caused by a number of ways. Some social impacts are indirect and a reaction to project impacts, such as noise or environmental changes. Other social impacts are a direct response to the project itself and include fear, worry and uncertainty. Social impacts are closely linked to other impacts of the project and how people perceive the project. In many cases social impacts are related to the project as a whole, and not necessarily to any specific phase of the project. The impact mechanism is described in more detail in Subchapter 11.19.1 about social impact offshore. Onshore, the impact mechanism is identical, only the possible causes and possible receptors are different.

The assessed social impacts onshore (Table 12-21, Subchapter 12.1.6.1) have been identified by considering the various project activities during planning, construction and operation and how these activities might interact with social impacts. Experiences from numerous onshore impact assessments have been used as background information.

12.2.5.2 Methods and data used

Methodology behind social impact assessment is described in Subchapter 11.19.2. about social impacts offshore. Social impact assessment is carried out as an expert assessment using a comparative approach that combines different qualitative and quantitative data, results of other impact assessments in this report, and previous experience and expertise on social impact assessment. The method used for impact assessment is called multicriteria analysis that includes the criteria for sensitivity of the receptor and the magnitude of change. The criteria for these are presented in the following table:

Table 12-36. Sensitivity of the receptor (social impacts).

Low	Low value for recreational use, optional areas available nearby. No significant features with cultural, scenic or economic values. No disturbance-prone, nature-based business activity. A number of activities generating environmental nuisance (etc. noise, dust, traffic). Social adaptability of the area is high. No people, sensitive institutions (school, daycare, hospital) or important public services potentially susceptible to disturbance. Continuous change in the status of the environment.
Medium	High value for recreational use, alternative areas not easily accessible. Some significant features with cultural, scenic or economic values. Some disturbance-prone, nature-based business activity. A few activities generating environmental disturbance (etc. noise, dust, traffic). Social adaptability of the area is moderate. A relatively large number of people, sensitive institutions (school, daycare, hospital) or important public services potentially susceptible to disturbance. A relatively peaceful environment which has remained relatively unchanged for some time.
High	High value for recreational use, no alternative areas available. Many unique and significant features with cultural, scenic or economic values. A significant number of disturbance-prone, nature-based business activity. No activities generating environmental disturbance (etc. noise, dust, traffic), or the number of current activities is so high that the carrying capacity does not bear any additional activities. A significant number of people, sensitive institutions (school, daycare, hospital) or important public services potentially susceptible to disturbance. A peaceful environment which has remained relatively unchanged for a long time. Social adaptability of the area is low.

Table 12-37. Magnitude of change (social impacts).

High	Positive environmental changes improve wellbeing, living conditions, amenity or recreational use opportunities for people, and the use of residential and holiday properties. Changes bring along new functions that benefit the area, support existing practices and actions or remove disincentives for current practices. The project generates hopes and expectations. Changes increase community spirit or decrease inequality significantly. A significant positive impact on the livelihoods, employment opportunities and economy of the local area. Changes are long-term, occur in a large area, are permanent or continual.
Medium	Positive environmental changes improve wellbeing, living conditions, amenity or recreational use opportunities for people, and the use of residential and holiday properties to some extent. Changes may enable new functions that benefit the area or support existing practices. The project generates a lot of hopes and expectations. Changes increase community spirit or decrease inequality significantly. A moderate positive impact on the livelihoods, employment opportunities and the economy of the local area. Changes may be long-term, partly reversible, occasional or occur in a relatively large area.
Low	Positive environmental changes cause only minor positive impacts on wellbeing, living conditions, amenity or recreational use opportunities for people, and the use of residential and holiday properties. Changes do not restrict the existing practices and activities in the area. Changes do not increase community spirit or decrease inequality. A minor positive impact on the livelihoods, employment opportunities and economy of the local area. Changes occur in a limited area or are short-term and the situation returns back to the pre-existing condition when the impact ends.

Negligible	The living environment remains unchanged. No impacts on the livelihoods, employment or the economy of the local area.
Low	Negative environmental changes (e.g. in noise levels, traffic, landscape) cause only minor adverse impacts on the wellbeing, living conditions, amenity or recreational use opportunities for people, or on the use of residential and holiday properties. The project causes only a slight amount of anxiety and disagreements. Changes do not decrease community spirit or increase inequality. A minor negative impact on the livelihoods, employment opportunities and the economy of the local area. Changes occur in a limited area or are short-term and the situation returns back to the pre-existing condition when the impact ends.
Medium	Negative environmental changes (e.g. in noise levels, traffic, landscape) cause some level of adverse impacts on the wellbeing, living conditions, amenity or recreational use opportunities for people, or on the use of residential and holiday properties. The project causes some amount of worries and disagreements. Changes decrease community spirit or increase inequality to some extent. A moderate negative impact on the livelihoods, employment opportunities and the economy of the local area. Changes may be long-term, partly reversible or occasional or occur in a relatively large area.
High	Negative environmental changes (e.g. in noise levels, traffic, landscape) cause significant adverse impacts on the wellbeing, living conditions, amenity or recreational use opportunities for people, or on the use of residential and holiday properties. The project causes a lot of anxiety and disagreements. Changes evidently decrease community spirit or increase inequality significantly. A significant negative impact on the livelihoods, employment opportunities and the economy of the local area. Changes are long-term, occur in a large area, are permanent or irreversible.

Main data sources for social impact assessment onshore in Hanko have been other impact assessments. The results of the *Media-analysis* *(Ramboll 2017b)* and *Coastal Survey* (Appendix 11B) have been used, when applicable.

12.2.5.3 Impact assessment

Worries and expectations

No specific worries or expectations have been identified in relation specifically to the project's ancillary operations in Koverhar, Hanko. The number of responses from the Hanko area in the Coastal Survey is too small to make any conclusions.

Impacts on residential areas and amenity

Project-related activities are not expected to cause any impacts on residential amenity. The Koverhar Harbour area is surrounded by industrial areas and operations and a military area and the distance to the closest residential areas is over 2 km. The transportation to and from the harbour is conducted only by vessels. The loading and unloading of the pipes does not cause significant noise, so it does not impact the amenity of permanent or holiday homes. The pipe storage piles are going to be a maximum of 7 m high. They are not visible to residential areas onshore because of the distance and forest surrounding the harbour area. As the nearest holiday homes are 2 km away from the Koverhar area, the pipe piles will not cause a visual disturbance to the scenery. The addition to vessel traffic is only a couple of vessels per day and that is not assessed to cause any impacts to living circumstances. Overall, the pipe piles are not a major change to Koverhar's rough industrial landscape.

Impacts on tourism and recreation
There are no impacts on tourism or recreation. The pipe transportation vessels use the official sea routes and the Hanko Regatta sailing routes do not intersect with those. Other recreational boating can take place according normal sea traffic procedures.

Impacts on local economy
A few small businesses are located on the Koverhar area. Temporary pipe storage does not have a significant impact on their operational preconditions. Pipe storage will employ a few people in Koverhar. On a local and regional level, the impact from project-related operations onshore in Hanko is low but positive.

12.2.5.4 Prevention and mitigation of adverse impacts

No mitigation is needed. Open communication between the contractor and different stakeholder groups is recommended. No other prevention or mitigation measures are needed related to social impacts.

12.2.5.5 Lack of information and uncertainties

No information gaps or uncertainties are identified concerning the social impacts related to onshore operations at Koverhar, Hanko.

12.2.5.6 Significance of the impacts

Overall the social impacts at Koverhar, Hanko are expected to be low or negligible because the temporary pipe storing does not cause significant noise, heavy traffic on roads, nor significant visual disturbance or other disturbance to the nearby areas.

Table 12-38. Significance of the social impacts onshore in Koverhar, Hanko.

Social impacts	Receptor sensitivity	Magnitude of change	Overall significance of the impact
Planning phase			
Worries and expectations	Low	Negligible	Negligible
Economy	Low	Negligible	Negligible
Construction phase			
Worries and expectations	Low	Negligible	Negligible
Residential amenity and safety	Low	Negligible	Negligible
Tourism and recreation	Low	Negligible	Negligible
Economy	Low	Low	Minor positive
Operation phase			
Social impacts	Low	Negligible	Negligible

13. TRANSBOUNDARY IMPACT ASSESSMENT

13.1 Introduction

In the Gulf of Finland the NSP2 Project’s pipelines will cross the territorial waters of Russia, and in the Finnish EEZ they will run near the Estonian EEZ. Regarding transboundary impacts, potentially affected countries are Russia, Estonia and Sweden. For some impacts (fishery), transboundary impacts on Denmark, Latvia, Lithuania, Poland and Germany may occur.

Transboundary impacts may result from planned activities as well as from potential unplanned (accidental) events (risks, Chapter 16). In the assessment, the monitoring results of NSP and the NSP2 environmental baseline survey results are also taken into account. Based on the monitoring results during construction of the NSP, the construction works did not cause any significant transboundary impacts neither to the environment nor to the socio-economic conditions.

In general, for transboundary impacts, same methodology and criteria which have been described in the previous sections have been used, still taking into account the availability of baseline information in the affected countries. The criteria for sensitivity and magnitude of change are presented in Chapter 11 for different impact targets.

The Espoo Convention promotes international cooperation and public participation when the environmental impact of a planned activity is expected to cross a national border. It applies, in particular, to activities that are likely to cause a significant adverse cross-border (transboundary) environmental impact and aims at preventing, mitigating and monitoring such potential impact.

Following subchapters describe the scoping and the basis of the transboundary impact assessment, impacts on Russia, Estonia and Sweden and other affected parties originating from Finland. The transboundary impacts to Finland from other countries are presented in the Espoo Report.

13.1.1 Scope

Only some impacts, which have been identified during this EIA procedure are relevant regarding transboundary impacts, and the focus is on these. The preliminary relevance of each impact targets were identified based on assessments in Chapter 11. The relevance/irrelevance of the impacts during construction and operation to neighbouring or other countries are presented in

Table 13-1. Justifications for scoping out some impacts have been presented underneath.

Based on sediment dispersion modelling results and NSP monitoring results, no transboundary impacts on biotic environment or fishery are assessed due to sediment spreading. Most of the re-sedimentation occur close to the pipeline route and only minor part of resuspended material can reach to the Russian, Estonian or Swedish waters. The total amount of sediment particles in suspension due to project activities in Finland is small and has not been assessed to cause any measurable increase in normal sedimentation onto seabed. Therefore the impacts caused by sediment spreading or sedimentation on biotic environment are not addressed in further detail.

During construction, there will be emissions from the vessels in the Finnish EEZ. The emissions may spread across borders, but are not expected to have any significant transboundary impact on the neighbouring countries or other countries. Total emissions from the NSP2 Project are described in the Espoo Report and are not assessed here in further detail.

Based on underwater noise modelling from munitions clearance, the only relevant transboundary impact targets are marine mammals and especially seal populations in or near the project area. The sensitivity of fishes and birds to underwater noise is assessed to be in a low level and the impact area within the close proximity to the clearance sites. No transboundary impacts on fish or birds are foreseen. Therefore these topics are not addressed in further detail.
In relation to munition clearance, the western Finnish waters near the Finnish-Swedish EEZ are considered of low impact due to the expected low density of munitions (Appendix 8B). The distance from Finland's project area to nearest seal houl-out areas in Sweden is almost 100 km. There are grey seals in the Svenska Björn and Svenska Högarna Natura 2000 sites, in the Stockholm archipelago. The Gotska Sandön national park and Natura 2000 site is more to the south and more far away. Based on both the low likelihood that munitions need to be cleared near the Swedish border and the long distances to haul-out areas, the impacts are assessed *negligible* and are not assessed any further.

Noise from rock placement and its impacts are not addressed in the transboundary impact assessment because noise from rock placement was not modelled to reach the neighbouring countries.

The protected areas in neighbouring countries are located so far that impacts from activities taking place in the Finnish EEZ do not reach on them. Neither PTS nor TTS from munition clearances taking place in the Finnish EEZ was modelled to reach any seal protection areas in neighbouring countries (Appendix 12, Map MA-04-F). Construction works will not cause harm for the existing pipelines or cables in the transboundary areas

On the basis of the current knowledge no impacts originating from Finland are going to affect the Swedish capability to meet the qualitative targets of the Swedish Marine Strategy and therefore this topic is not addressed in further detail.

Sediment spreading and underwater noise have been assessed to not cause transboundary impacts on water quality and fish during the construction phase. Therefore transboundary impacts to fishery in Estonian EEZ, Swedish EEZ, Russian territorial waters and all other affected parties is not addressed in further detail. In contrast, during pipeline operation phase offshore fishing of all EU member states is a potential impact target since fishing vessels from other EU states are allowed to fish in the western parts of the Finnish EEZ.

In Estonia, citizens may have worries or expectations on the impacts of the NSP2 project in many different ways. The social aspect is addressed by a citizen survey conducted in spring 2016.

Table 13-1. Relevance of the impact targets for the transboundary impact assessment in the neighbouring or other countries.

Impact source	Impact target	Russia	Estonia	Sweden	Other countries
Sediment dispersion due to munitions clearance	Water quality and sediments	x	x	x	-
	Marine mammals	-	-	-	-
	Marine strategic planning	-	x	-	-
	Fishery	-	-	-	-
	Benthos	-	-	-	-
	Fish	-	-	-	-
	Birds	-	-	-	-
	Protected areas	-	-	-	-
	Existing infrastructure or other targets	-	x	-	-
Sediment dispersion due to rock placement	Water quality and sediments	x	x	x	-
	Marine mammals	-	-	-	-
	Marine strategic planning	-	x	-	-
	Fishery	-	-	-	-
	Benthos	-	-	-	-
	Fish	-	-	-	-
	Birds	-	-	-	-
	Protected areas	-	-	-	-
	Existing infrastructure or other targets	-	x	-	-
Underwater noise from munitions clearance	Marine mammals	x	x	-	-
	Marine strategic planning	-	x	-	-
	Fish	-	-	-	-
	Birds	-	-	-	-
	Protected areas	-	-	-	-
Pipelines on the seabed (freespans)	Fishery during operation	-	x	x	x
Emissions from ship traffic	Air quality	-	-	-	-
Social impacts (worries and expectations)	Citizens	-	x	-	-

x = relevant or not possible to scope out, - = not relevant, scoped out

13.1.2 Basis for assessment of transboundary impacts

13.1.2.1 Sediment dispersion and consequent effects

Impacts due to sediment dispersion with consequent changes in water quality and sedimentation are assessed in Subchapters 11.2 and 11.3 and summarized briefly here. The expected effects are short-term changes in water turbidity (suspended solids) and corresponding changes in concentrations of contaminants and nutrients in water and spatially very limited changes in sedimentation patterns near the construction sites.

Based on the assessment (modelling results), the following conclusions were made. The maximum suspendent solid (SS) concentrations in the water column (layers near the seabed) due to munitions clearance can be ca. 50–100 mg/l in a distance of 1 km. The area where concentration of SS in water is higher than 10 mg/l (but less than 15 mg/l) is around 20–46 km^2 along the pipeline route in the Finnish EEZ. However, duration of changes is short, only 5–13 h. The maximum SS concentrations caused by rock placement in a distance of 1 km are even smaller, about 10–17 mg/l. Changes are also short-term, and concentrations higher than 10 mg/l will last ca. 7–19 h (Figures and Tables in Subchapter 11.3.3.1).

The increase in sedimentation due to munitions clearance is spatially limited and the changes are generally small. The area where the thickness of relocated material could be ca. 1 mm (sedimentation rate ca. 100 g/m^2) is only about 140 × 140 m. For rock placement, the area is slightly larger, ca. 600 × 600 m (Tables in Subchapter 11.3.3.1).

The spreading of contaminants and nutrients are related to sediment dispersion. Of the modelled substance, only PAH compound bentzo(a)pyrene may have concentrations that exceed predicted no effect concentration (PNEC) beyond Finnish EEZ after munitions clearance. Modelled values are, however, less than the environmental norm (EQS) (Subchapter 11.3.3.1). Based on the assessment (Subchapter 11.3.3.1), re-suspension of nutrients during the construction works of NSP 2 is not assessed to have any impacts on the eutrophication status of the Gulf of Finland.

13.1.2.2 Underwater noise

Munitions clearance and rock placement were identified as the most potential underwater noise sources. Of these, munitions clearance is the loudest activity and thus potentially has transboundary effects. The methods and results regarding underwater noise modelling are presented in Subchapter 10.4. The impacts and assessment criteria for the impacts due to underwater noise (marine mammals, fish) are presented in Subchapter 10.4.4 and for marine mammals also in Svegaard et al. (2017, Appendix 8B). Concerning above mentioned animals, marine mammals were identified as the most sensitive targets for underwater noise. Regarding transboundary effects thresholds for PTS (permanent threshold shift) and TTS (temporary threshold shift) are relevant (for threshold values, see Subchapter 10.4, Table 10-14). Modelling results suggest that the maximum threshold distances for PTS and TTS are ca. 15 km and 44 km, respectively (Table 10-18 and Table 10-20 and Figure 10-12).

For marine mammals, the key question regarding transboundary impacts is whether the construction activities (detonations) will have a net impact on the local abundance of species in the area and ultimately an impact on the population size and in the end whether this impact is acceptable or not from a conservation point of view (Appendix 8B). In general, underwater noise can travel long distances and transboundary impacts cannot be excluded.

13.1.2.3 Citizen survey (Estonia)

Based on the perceptions discussed in Estonia during the Nord Stream project, NSP2 decided to perform a Estonian opinion survey in order to assess the possible transboundary social impacts to Estonia. This survey was conducted in April 2016. The target group was Estonian residents who live in the Baltic Sea coastal areas. The percentage of the respondents by counties was: Ida-Viru 16 %, Lääne-Viru 12 %, Harju 42 %, Lääne 10 %, Hiiu 7 % and Saare county 13 %. From each county only such towns and parishes were selected which, considering the path of the planned Nord Stream 2 gas pipeline, border the coastline. The survey areas in approximately 1 km distance from the coastline.In Saare and Hiiu counties most of the districts are connected to the sea, so 1 km rule was not strictly followed there. Survey was conducted as door-to-door interniews. During the survey, 501 residents aged 18 and over were interviewed. The nationality of the respondents was 64 % Estonian and 36 % other. Half of the respondents are living in urban and half in rural areas. The survey was conducted by social and market research company Saar Poll.

The interview questionnaire included questions regarding overall environmental awareness, NSP and NSP2, Estlink 1 and 2 (existing subsea electrical power cables between Estonia and Finland) and Balticconnector (planned subsea natural gas pipeline between Estonia and Finland).

13.2 Transboundary impacts on Russia

13.2.1 Water quality and sediments

<u>Munitions clearance</u>

If munition clearance is needed in the vicinity of the Russian border, depending on weather conditions, sediment plumes near the seabed could enter the Russian waters. The impact area of munitions clearance in the water layer near the seabed is limited to the vicinity of the Finnish-Russian border, extending approximately less than 2 km from the detonation point to Russian waters (Figure 13-1). The maximum suspended solid values in water are assessed to dilute very effectively after the detonations and the duration of increased concentrations of suspended solids is short, only hours. Modelling results show that potential water quality changes including changes in water turbidity, but also possible increase of harmful substances and/or nutrients are assessed to have only short-term and temporary adverse impacts on the water quality in the Russian sea-area.

The change in the water quality is so small that any measurable increase in the normal sedimentation onto seabed is not foreseen. The amount and locations of the munitions to cleared in the Finnish EEZ is not yet known. However, this will not change the overall conclusion of the transboundary abiotic impact.

Overall significance of temporary and short-term increase of suspended solids near the seabed and consequent impacts on water quality, including re-mobilization of contaminants, or sedimentation in Russian waters due to munitions clearance in the Finnish EEZ is assessed as *negligible*.

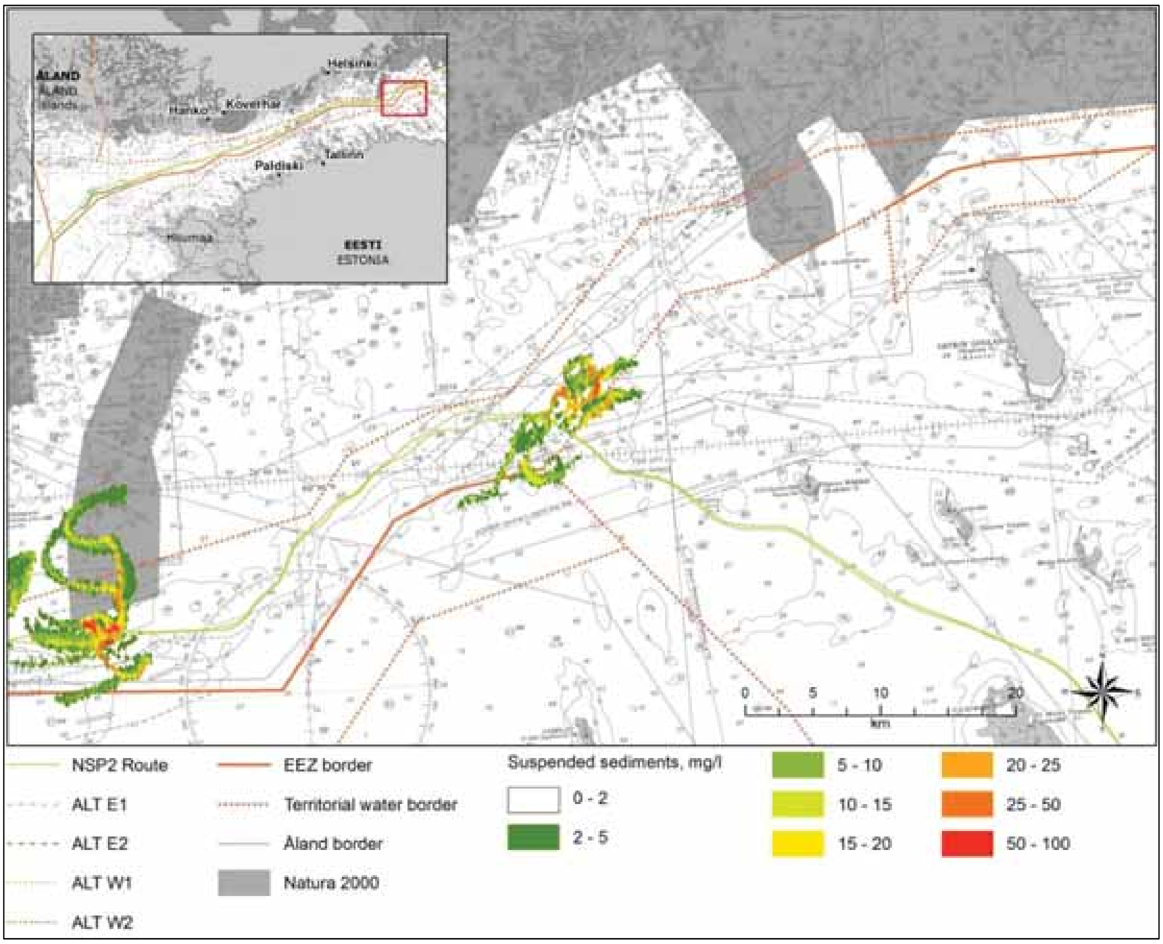

Figure 13-1. Maximun concentration of suspended sediment for munitions clearance under typical summer conditions 0–10 m above the seabed.

Rock placement
The crossing point of the NSP2 and existing NSP pipelines is located close to the Russian border (0.7–1.1 km from the border). The amount of rock material needed for the crossing is approximately 37,500 m^3 *(Saipem 2016a)*. The seabed at this site is formed mainly of hard bottom complexes or hard clay.

Based on modelling results, the highest suspended solid concentrations (and related concentrations of nutrients and contaminants) in seawater during rough weather conditions, when the impact area is the largest, are found to disperse northeast from the planned pipeline crossing point and thus transboundary impacts are not expected.

Based on sediment dispersion patterns, increased sedimentation will not occur on the seabed in the Russian waters near the EEZ border.

Overall significance of temporary and short-term changes in water quality and sedimentation in Russian waters due to rock placement in Finnish EEZ is assessed as *negligible*.

13.2.2 Marine mammals
Regarding transboundary impacts, only underwater noise due to munitions clearance is relevant for marine mammals. Impact mechanisms, assessment methods and potential impacts are described in Subchapter 11.7 and in Appendix 8B and summarized here.

The extent of blast injury, PTS and TTS/avoidance zone are same for grey seals and ringed seals and harbour porpoises. Regarding impulsive noise from munitions clearance, only area where munitions clearance could have potential transboundary impacts to Russia is M1-M2 (Figure 10-11). Depending on charge and location of munitions, if a clearance is taken place near Russian territorial waters, either blast injury zone, PTS zone or TTS/avoidance zone may extend into the Russian waters. The threshold distances for “moderately severe blast injuries” (terminology from Yelverton et al. 1973) is less than 1 km for animals in the surface and about 2.5 km for animals at the bottom (40 m). The category “moderately severe blast injuries” covers non-trivial, but survivable injuries, where animals are considered able to recover on their own. The maximum extent of PTS zone is ca. 3.5 km and TTS/avoidance zone ca. 15 km (for noise propagation maps, see Appendix 12: MO-01-F and MO-02-F). The number of munitions to be cleared is not known at this stage but it is likely to be low (based on NSP and density map of munitions, Figure 10-11).

The following assessment is carried out considering the effect of the mitigation measures that NSP2 has committed to (monitoring, seal scarers, see Subchapter 4.2.5).

For precautionary reasons, the impacts are assessed for blast injury, PTS and TTS/avoidance at indivual and population level for marine mammals.

Regarding conservation status of these species, ringed seal is considered to be of importance as the Gulf of Finland population of this species is small and have been found to be decreasing. Also grey seals are common in Russian waters. Harbour porpoises are extremely rarely found in Russian waters.

If the blast injury or PTS zone will extend Russian waters, it is likely that the area will be rather small. However, distribution of ringed seals and grey seals are not known for sure. During open water season, these species are mostly gathering to haul-out sites. The nearest haul-out sites are ca. 35–77 km from the Finnish EEZ border (location where pipes are entering to the Finnish EEZ). During calving and mating period in late winter seals can be observed on ice: during mild winters ringed seals can be most probably found in the easternmost parts of the Gulf of Finland near Vyborg and St. Petersburg or northern coast of the Gulf where solid ice is found. During summer seals are mostly gathered on haul-out sites and surrounding areas. However, it should be noted that NSP2 has committed to not carry out any munition clearances during ice period.

The use of seal scarers will reduce significantly risk that seals are occurring in the blast injury area. Additionally, the use of seal scarers will reduce the most severe hearing damages as the scarers are most effective at a distance of some hundred meters and at further distance (ca. 1 km), the seals may not be deterred but, will spend more time in the surface. For these reasons, seals that are in the very surface or have their head out of the water at the time of the detonation are effectively protected from hearing loss. This means that the risk that seals close to the detonation are exposed to the levels capable of inducing substantial hearing loss is effectively reduced, although not eliminated entirely. Thus the overall maximum impact significance at individual level is assessed as *moderate* for both seal species.

At population level, the overall significance is assessed as *moderate* for Gulf of Finland ringed seal population and *minor* for grey seals as the grey seal population is abundant and has been increasing over the last decades.

Cumulative impact from several detonations can occur if the same individual happens to be exposed several times from different detonations. Cumulative impact may also take place at the population level, as each additional explosion will increase the risk that individuals are injured, adding up in the cumulative impact on the population. This is of particular importance in the Inner Gulf of Finland (M1-M2) as the status of the Gulf of Finland ringed seal population is presently poor. Thus, in this area, the overall significance may at some point increase due to the increased cumulative risk.

For both ringed seal and grey seal, the sensitivity to TTS and avoidance impact is *low* and magnitude of change *low*. The impact significance at both individual and population level was assessed as *minor* for both species even without mitigation (Subchapter 11.7.3).

Porpoise is extremely rare visitor in Russian waters and is thus considered less sensitive compared to seals. The overall significance at both individual and population level is thus assessed as *minor* for blast injuries, PTS and TTS/avoidance.

13.2.3 Conclusions on transboundary impacts on Russia

Impacts on water quality in Russia from the project activities in Finnish side are so limited that the overall signigficance of the impact is assessed as *negligible* (Table 13-2). The only impact receptors found to be affected are marine mammals of which the ringed seal is considered to have most largest impacts.. Underwater noise from munitions clearance is assessed to cause up to moderate impacts on ringed seal and grey seals at individual and population level.

Table 13-2. Overall assessment of transboundary impacts on Russia. Regarding impacts on marine mammals, the impact significance is assessed with mitigation measures committed by NSP2 (monitoring, seal scarers).

Impacts	Receptor	Sensitivity	Magnitude of change	Overall significance of the impact
Sediment dispersion due to munitions clearance	Water quality and sediments	Low	Negligible	Negligible
Sediment dispersion due to rock placement	Water quality and sediments	Low	Negligible	Negligible
Underwater noise	Ringed seal, grey seal and harbour porpoise TTS/avoidance: individual & population level	Low	Low	Minor
	Ringed seal & Grey seal blast injury and PTS: individual level	High	Med	Moderate
	Ringed seal, blast injury and PTS: population level	High	Med	Moderate
	Grey seal, blast injury and PTS: population level	Low	Med	Minor
	Harbour porpoise blast injury and PTS: individual & population level	Low	Med	Minor

13.3 Transboundary impacts on Estonia

Compared to the Nord Stream pipelines, the planned NSP2 pipeline route is more distant from the Estonian EEZ border. The distance between the existing northern pipeline and the NSP2 route in the Finnish EEZ varies between 0.2–6.6 km (average ca. 2 km). The closest distance of the NSP2 route to the Estonian EEZ is 1.8 km.

13.3.1 Water quality and sediments

Munitions clearance

During munition clearance higher concentrations of suspended sediment normally occur in the water layer 0-10 m above the seabed.

Based on the modelling results during calm (summer) conditions when the impact area of increased (>10 mg/l) suspended solid concentrations is largest, the sediment plumes after munitions clearance cross the Estonian EEZ only for a very limited scale and only in case of one modelling point. In case of the extent of impact to Estonian EEZ there is no difference between alternatives. The modelling results of sediment dispersion during summer conditions are presented in in Atlas map MO-05-F (Appendix 12).

Estonian EEZ is located an average 3 km from the pipelines. The overall impact on Estonian EEZ regarding munition clearance is low and based on the modelling results, no measurable increase in normal sedimentation onto seabed occurs. Typically, the largest sedimentation will happen in the vicinity of the munition clearance activity (Table 11-9).

The modelling results for munition clearance show that in case of modelled contaminants PAH - benzo(a)pyrene concentrations are exceeding the PNEC values. The highest dissolved concentrations for benzo(a)pyrene in sea water were considerably smaller than the environmental norm (EQS; Subchapter 11.3.3.1). Considering the short time of elevated values and the aspect that PAH compounds do not easily dissolve into water column, but will be incorporated into organic matter particles, the overall impact of PAH on water quality is *negligible*.

The change in water quality is short-term and no permanent adverse impacts on the physical-chemical conditions applies. Overall significance of the temporary increase of suspended solids and water quality due to munition clearance in the Estonian waters is assessed as *negligible*.

Rock placement

Based on the modelling results, the concentration of suspended sediments in Estonian EEZ due to rock placement in Finnish EEZ are rather low, mainly 2-5 mg/l and occur in short period of time (1-12 hours) regardless of the modelled scenario. The background value of suspended sediment is 2 mg/l. Therefore it can be concluded that the concentrations in Estonian EEZ hardly reach the background values.

The modelling results indicate that during the rock placement activities in Finnish EEZ, the concentrations of modelled contaminants (PAH - benzo(a)pyrene, dioxins/furans and zinc) does not exceed PNEC values in the Estonian EEZ either during normal, typical or rough conditions.

Re-suspension of nutrients during the construction works of NSP 2 is not assessed to have any impacts on the eutrophication status of the Gulf of Finland (Subchapter 11.3.3.1).

13.3.2 Marine mammals

The underwater noise due to munitions clearance is the only impact that potentially cause impacts on marine mammals. Impact mechanisms, assessment methods and potential impacts are described in Subchapter 11.7 and in Appendix 8B and summarized here. The following assessment is carried out considering the effect of the mitigations measures that NSP2 has committed to (monitoring, seal scarers, see Subchapter 4.2.5).

The extent of blast injury, PTS and TTS/avoidance zone are the same for harbour porpoises, grey seal and ringed seal as the thresholds are assessed to be same for these species.

The pipeline route is situated parallel to the Estonian border and thus the impacts to Estonia are very likely in case of munitions clearance. Impacts will depend on the location of the munitions as the marine mammals are not equally distributed along the pipeline. TTS/avoidance zone will most likely extent to the Estonian EEZ and territorial waters. Based on modelling, the mean and maximum threshold distances for TTS/avoidance were ranging between 15–26 km and 15–44 km, respectively (Table 11-48). Whether the blast injuries or PTS will be likely to occur in Estonian EEZ depends on the charge size and location of the munition. Modelling results indicate that the mean and maximum threshold distances for PTS will be 3.5 and 3.5–15 km, respectively (Table 11-48). Threshold distance for "moderately severe blast injuries" is less than 1 km and about 2.5 km for animals in the surface and at the bottom (40 m depth), respectively. This category covers non-trivial, but survivable injuries, where animals are considered to be able to recover on their own (Appendix 8B). The maximum extension of PTS/blast injury and TTS/avoidance zones and distances of these zones to the important seal areas are presented in Figure 13-2.

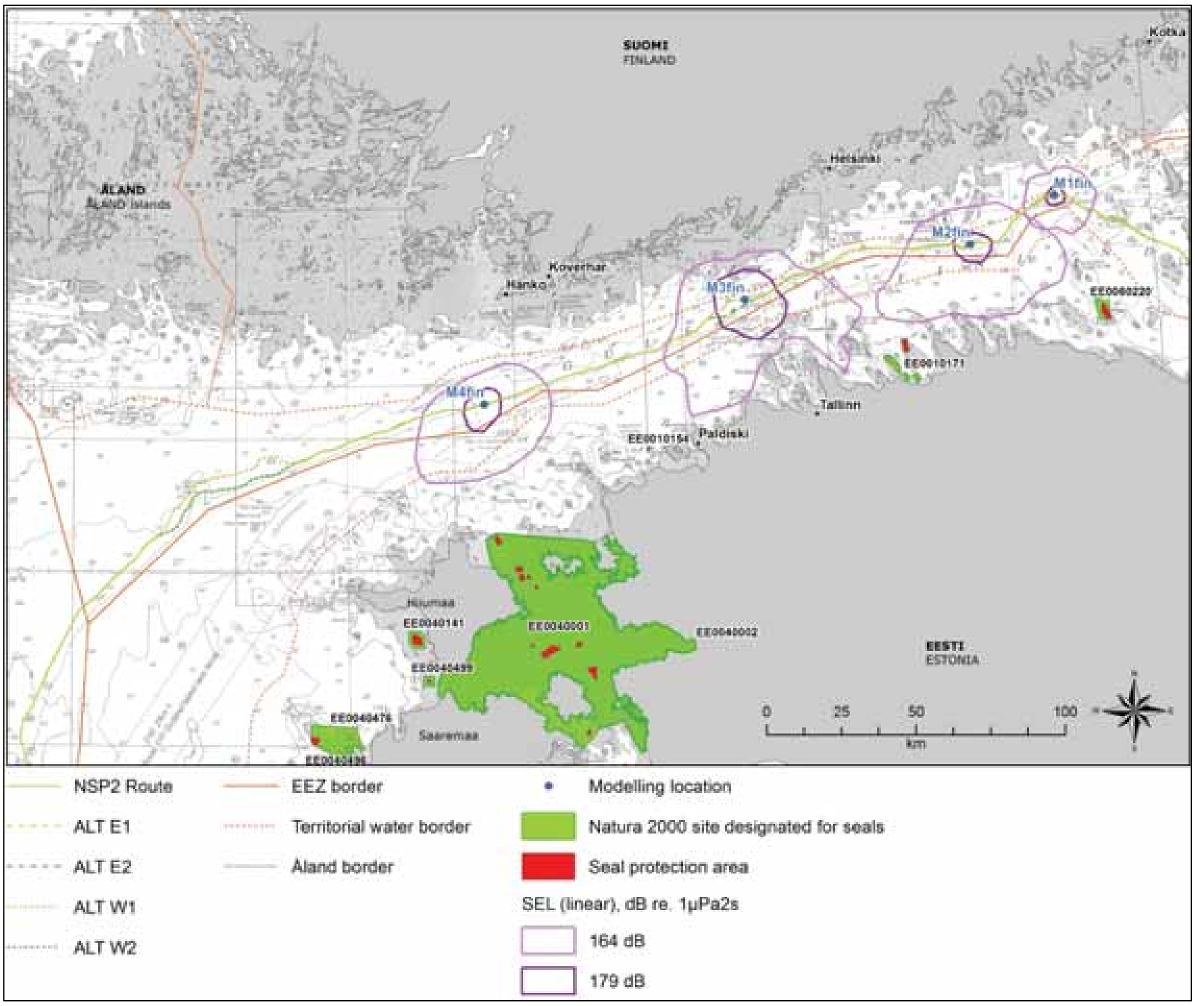

Figure 13-2. Estonian Natura 2000 sites designed for seals and seal protection areas and the modelled maximum extent of munitions clearance.

There are generally a lot of uncertainty concerning the spatial and temporal distribution of seals in the Gulf of Finland. Both seal species potentially occur in the vicinity of the Finnish-Estonian EEZ border but they are expected to be most abundant near the haul-out sites (seal protection areas, Natura 2000 sites designed for seals, Figure 13-2). In general, the Estonian coastline does not offer as many suitable haul-out sites for seals as the coastline of Finland and Russian waters in the eastern Gulf of Finland. Based on the modelling results underwater noise from munitions clearance activities in Finland will not reach any Estonian protection areas with seals as a protection objective.

The Gulf of Finland ringed seal population is mainly concentrated on the eastern part of the Gulf of Finland and in the Finnish coastal waters. The Gulf of Riga population is mainly concentrated in Väinämeri area but some transient individuals may be present in the area between Archipelago Sea and the Gulf of Riga. Grey seals are common in the Gulf of Finland. The harbour porpoise is very rare visitor and according to SAMBAH project individuals are mostly visiting the southwesternly areas (Figures 8-1 and 8-2 in Appendix 8B). According to SAMBAH project, no detections have been made in Estonia, in the area north from Väinämeri. Further details are presented in the baseline Subchapter 7.11.4, in Appendix 8A and in marine mammals assessment (Subchapter 11.7).

Harbour porpoise

The likelihood that harbour porpoises are present during the detonations in the Estonian waters is extremely low. It is assessed in a precautionary manner (since on the basis of the Sambah Project, even fewer porpoises than in Finland are expected in the Estonian waters) that the impact assessment for harbour porpoises carried out for Finland would apply also to Estonia. The use of seal scarers before detonations will reduce the risk of fatal injuries and hearing loss, and reduce, but not eliminate the risk that a porpoise present within some kilometres from the blast site could suffer non-lethal blast injuries. These mitigation measures will however not have any effect on TTS, due to the large distances of this type of impact. Also, due to the extremely low likelihood that harbour porpoises are present during detonations, it is very unlikely that individual porpoises would be exposed to cumulative impacts and cumulative impacts are unlikely also at the population level.

The resulting overall impact significance in worst case is assessed to be *minor* for PTS and blast injuries both at the individual and population level. Impacts due to the increase likelihood of TTS are also assessed to be minor. Further detail can be found in Subchapter 11.7 and Appendix 8B.

<u>Grey seal</u>
With the available data of grey seal distribution it is not possible to estimate the number of affected individuals. As the occurrence of seals could be quite high, the risk for exposure is higher compared to porpoises. However, the Baltic population of grey seals is abundant and has been increasing over the last decades.

The use of seal scarers will deter seals at a distance about 1 km from the detonation. The threshold distance for moderately severe injuries is about 1 km for the animals in the surface, which means that the likelihood that seals will get severe blast injuries is substantially reduced.

The use of seal scarers will reduce the most severe hearing damages as the scarers are most effective at a distance of some hundred meters and at further distance (ca. 1 km), the seals may not be deterred but, will spend more time in the surface. For these reasons, seals that are in the very surface or have their head out of the water at the time of the detonation are effectively protected from hearing loss. This means that the risk that seals close to the detonation are exposed to the levels capable of inducing substantial hearing loss is effectively reduced, although not eliminated entirely.

The maximum overall impact significance of blast injuries and PTS was assessed to be *moderate* at individual level and *minor* at population level because grey seal population is abundant and has been increasing over the last decades.

Cumulative impacts from several explosions are likely to occur as grey seals are quite numerous in the Gulf of Finland. This is plausible especially in M3 (Figure 11-12) area where the highest number of munitions is likely to be encountered and handled. Therefore, the overall significance of the impacts at the individual level for seals occurring in the proximity of the M3-area may at some point increase due to the increased cumulative risk. However, cumulative impact at the population level in area M3, are not likely to change the assessment, since the grey seals population is considered to be in a favourable status.

The sensitivity to TTS was assessed as low and the magnitude of change is also low. Thus, the overall significance are assessed to be *minor* on both individual as well as population levels since the impacts will be temporary and most likely only affect a small proportion of the population.

Impacts to grey seals in Estonia are assessed to be the same to the impacts assessed to occur in Finland: for further details on the assessment, see Subchapter 11.7 and Appendix 8B.

<u>Ringed seal</u>
On basis of the present knowledge on ringed seals distribution in the Baltic Sea, there are two separate ringed seal populations occurring along the Finnish section of the NSP2 pipeline: the Gulf of Finland population and the Gulf of Riga population (Subchapter 7.11.3, Appendix 8A). Although, ringed seals can potentially be found everywhere in Estonian waters densities are generally higher near the haul outs and at foraging sites. These foraging sites may vary and with

the current knowledge, it is not known if significant foraging sites exist in areas relevant to the NSP2 pipeline.

The use of seal scarers will reduce the potential impacts on ringed seals at the same extent as have been described above for grey seals (also Subchapter 4.2.5 and Appendix 8B).

In the assessment of blast injury and PTS at the population level, the precautionary approach was adopted, meaning that the two populations (Gulf of Finland and Gulf of Riga) are considered to be reproductively isolated and thus impacts are assessed relative to the estimated abundances of these populations.

Munitions clearance at the M1-2 area (Figure 11-12) will potentially affect ringed seals from the Gulf of Finland population. In Estonia, seals at the vicinity of Uhtja island and Kolga Bay can be affected by the detonation within M1-M2 areas. It is assessed that the use of seal scarers will reduce the maximum overall significance of PTS and blast injuries impacts to *moderate* for the ringed seals in the Gulf of Finland both at individual and at population level.

If munitions clearances were to take place in M3, transient ringed seals from the Gulf of Finland population could also be impacted and the high number of munitions present in the area would increase the risk of inducing either PTS or blast injuries. The overall significance at population level was assessed as *moderate*.

Munitions clearance at M4 (Figure 11-12) or adjacent areas will potentially affect individuals from the Gulf of Riga breeding areas. Also transient individuals from the Gulf of Riga could be present in the proximity of M3 areas during munition clearances. Although there is no telemetry data from animals tagged at the most proximate haul-outs for either of the to distinct populations (Gulf of Finland, the and the Gulf of Riga) available, it is unlikely that a demographically significant number of individuals will be present within the blast injury and PTS zones at the time of munition clearance. Therefore, the sensitivity at the M4 area was assessed as *low* and overall significance as *minor* at a population level.

The potential cumulative impact in the M4 area is low, as the expected number of detonations is low and the population status of the affected ringed seal population (Gulf of Riga) is good. The cumulative impact from a small number of detonations will thus not change the assessed overall impact. If multiple munition clearances were to take place in the proximity of M3, it was assessed that this would have negative impacts rather on the ringed seal population of the Gulf of Finland rather than on the Gulf of Riga population.

The sensitivity of ringed seals to TTS as well as the magnitude of change of TTS is assessed to be low and the overall significance is thus *minor* at individual as well as population levels since the impacts will be temporary and only affect few individuals.

Impacts to ringed seals in Estonia are assessed to be the same to the impacts assessed to occur in Finland: for further details on the assessment, see Subchapter 11.7 and Appendix 8B.

13.3.3 NSP2 impacts on Estonian compliance with MSFD

On the basis of assessment, the introduction of temporary peaks of underwater noise originating from the planned munition clearances activities are assessed to potentially impact the ringed seals and grey seals population. This identified potential impact can have consequences on the qualitative descriptors D1 Biodiversity and D2 Food webs as well as D11 Introduction of energy and underwater noise. No other project activity is assessed to have any impact to these and the remaining descriptors. The qualitative assessment of compliance of NSP2 in the context of the legislation is provided in Subchapter 11.20.

Underwater noise due to munitions clearance have been assessed to potentially affect the D1 Biodiversity regardin distribution of seals. However, the impacts are assessed to be at the most moderate to only one of the many links in the chain of biodiversity, while the remaining links are not going to be affected. Since the remaining links will remain in their current status (as it is assessed to be the case), the whole ecosystem is likely to withstand minor or even moderate changes. For these reasons, it is assessed that, although the project may have a temporary effect on distribution of seals, the assessed impacts are not likely to have long-lasting effect on biodiversity or food-webs.

With the mitigation measures in place (Subchapters 4.2.5 and 11.7), it is assessed that achievement of the GES in terms of biodiversity (D1) and food webs (D4) would not be prevented.

It should additionally be noted that NSP2 is currently investigating alternative clearance methods with the objective to further reduce the assessed impacts on marine mammals.

With respect to "introduction of underwater energy and underwater noise (D11), with the current mitigation measures proposed, munition clearances will cause noise that exceed the natural noise levels. Since at the moment there is no quantitative indicators for descriptor, the assessment is based on the definition of the relevant criteria and the qualitative descriptors. The criteria for the descriptor is defined as: "The degree of impulsive noise and continuing noise caused by human activities is not increasing and is at a level that do not exceed natural noise levels nor cause harmful effect on the ecosystem and do not cause economic harm to the coastal and marine industry". With regards to the impacts on the ecosystem (Subchapters 11.5, 11.6, 11.7, 0, 11.9 and this chapter) it was concluded that the project is not likely to cause long-term detrimental effects to biodiversity. Therefore, considering that underwater noise is taking place over a short period of time and that no long-term detrimental effects to the ecosystem are predicted to occur, the achievement of the GES in terms of introduction of underwater energy and underwater noise would not be prevented.

In conclusion, the construction and operation of NSP2 will not affect Estonia's capability to reach a GES. Similar conclusion is applicable for HELCOM Baltic Sea action plan described in Subchapter 11.20.

13.3.4 Fishery

Estonian fishing fleet is allowed to fish in the EU waters in the Finnish EEZ outside of the Gulf of Finland (Figure 13-3). Like Finnish trawlers Estonians also use mid-water trawls in targeting pelagic species Baltic herring and sprat (Subchapter 7.10). Hence the same impacts described in Subchapter 11.13 concern also Estonian fishermen in the Finnish EEZ. However, Estonian fishing fleet operate primarily on the Estonian side along the Gulf of Finland and the Northern Baltic proper which can be found out of their catch statistics (Appendix 12, Map FC-04-F).

During the operation phase in the uneven seabed areas the magnitude of change is assessed to be low since Estonian fishing fleet is allowed to fish only in the Western part of the Finnish EEZ. There will be many free-spanning pipeline sections also in this area which make the NSP2 pipelines worth avoiding for safety reasons when trawling in the area. There will also be cumulative impact with NSP pipelines in the same area which make the area wider where trawl fishermen are forced to be cautious. However, pipelines on the seabed do not make the project area untrawlable since the prevailing trawling method in the area is, by its natural unevenness and by existing target species, mid-water trawling. Fishermen may seek fish from somewhere else which might cause them rising of the fishing costs. This impact is long-term but since Estonian fishing vessels concentrate their fishing effort primarily in the Estonian side the overall significance of the impact on Estonian fishery during the operation phase is assessed to be *minor*.

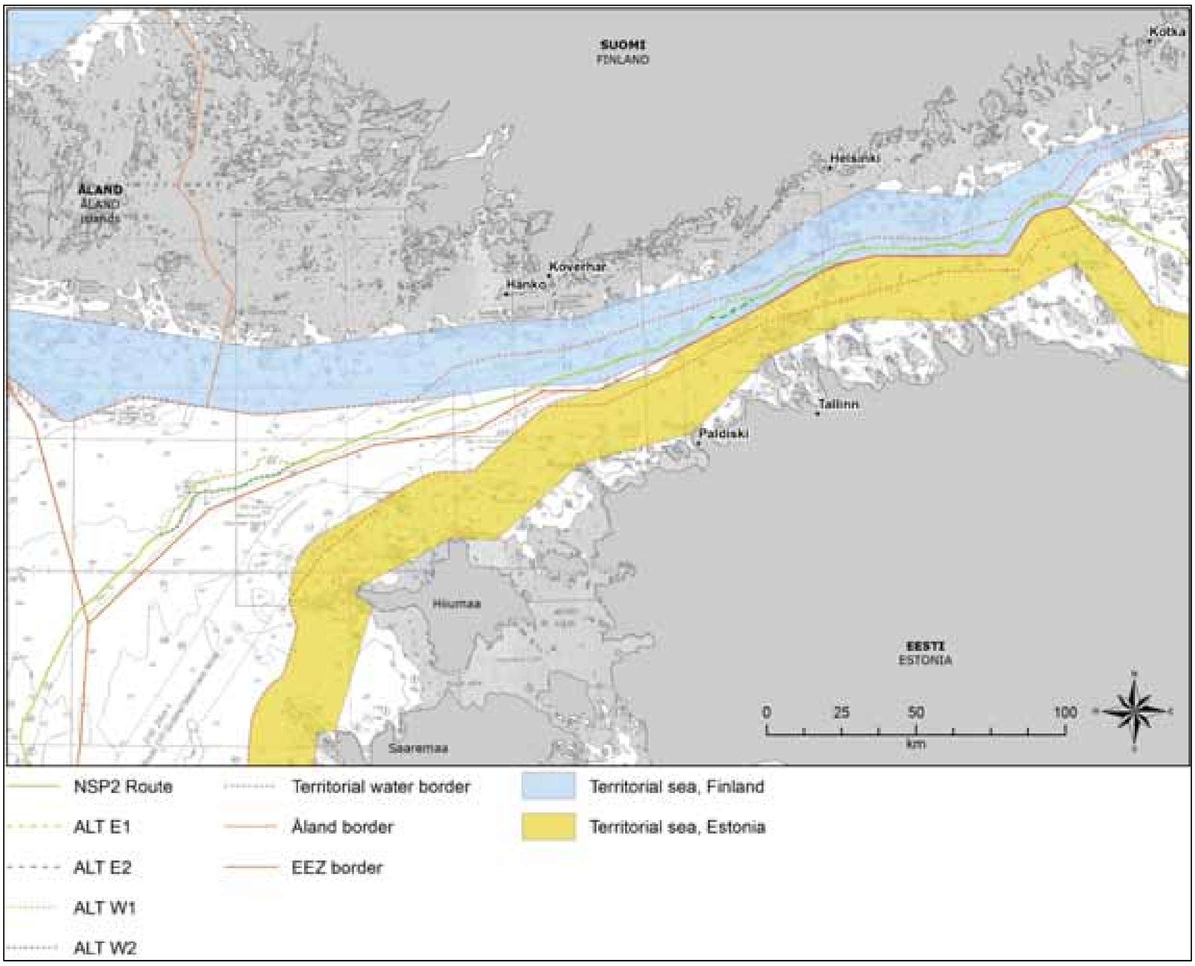

Figure 13-3. Territorial sea areas of Finland and Estonia.

13.3.5 Social impacts

Assessment of transboundary social impacts focuses on worries and expectations. Because of the long distance from the coastline to the pipeline, no physical changes are expected that would cause social impacts. Some social impacts, like worries or impacts on tourism, that are related to conceptions people have, can take place regardless of the location of the receptor (eg. the population of the coastal areas in Estonia) and are therefor not scoped out before further assessment.

Impact mechanism for social impacts is described in Subchapter 11.19.1 about social impacts offshore. Methodology behind social impact assessment is described in Subchapter 11.19.2. The main data used to assess transboundary social impacts on Estonia is public opinion survey that is described in the Subchapter 13.1.2.3.

Nord Stream 2 Project raises some worries among some of the respondents survey. Only every fourth respondent (25 %) considered Nord Stream 2 Project rather positive or very positive. In the public opinion survey, when asked to describe their attitude towards Nord Stream 2 Project in their own words, most often (17 %) the respondents mentioned the aspect of the project being harmful to the environment or marine life. During Nord Stream Project the project related media coverage in Estonia was rather negative (especially amongst scientist) raising questions about possible adverse environmental effects and related risks. Media coverage during Nord Stream 2 has been quite low and mainly focused on political issues. Environmental aspects have not been referred any more. For example, the results of environmental monitoring of Nord Stream Project showing that no significant adverse environmental impacts have been occurred during the pipeline construction and operation, have not been reflected in the media. These can at least partly explain the current suspicions and worries.

As mentioned above, the themes related to Nord Stream have been politically debated in Estonia already during Nord Stream, which can be assessed for example based on media reports. However, when asked to rate the safety of different natural gas transportation modes, subsea gas pipeline was evaluated as most safe (total 49 % of the respondents). In the overall results of the survey, a difference between nationalities can be seen. The results indicate that positive attitude towards Nord Stream 2 Project is lower among Estonians and higher amongst other nationalities, mainly Russian. This can also be seen amongst people living in urban areas, including Ida-Viru county, where the representation of Russians is much higher than in the rest of the counties.

Respondents were asked about possible impacts on the Baltic Sea region caused by Nord Stream 2 Project. The biggest concerns (nearly or more than half of the respondents) are impacts on marine life and animals, protected areas, fishing and impacts resulting from sediment spread and water quality. Most positive aspects (around one fifth of the respondents) concerned impacts related to munitions clearance and gas transport safety. Impacts on tourism and ship traffic were assessed as most neutral aspects. There are no big differences in results amongst regions or nationality on these aspects, except the percentage of neutral opinions amongst people of Ida-Viru county and other nationalities is slightly higher than other’s.

The transboundary impacts on Estonian civic confidence are assessed to be *moderate* during planning and construction and *minor* during operation. The assessment is based on the worries of possible impacts and opinions on the project expressed in the Estonian public opinion survey. The concern is related to the possible impacts of the project, especially the claimed political dimensions of the project. This challenges the project owner to continue open communication also with the parties not directly involved in the project. Also impacts on civic confidence and community relations should be communicated openly to avoid impressions of any secrecy or political intentions. For this purpose Stakeholder Engagement Plans that are geographically specific and tailored to project risks, impacts and the interests of the Affected Communities, will be developed and implemented. Developer is committed to open and transparent communications and engagement with relevant stakeholders and public, and to provide timely information of the project on an a regular basis.

Since the planned route of the Nord Stream 2 Project runs at its closest 25 kilometres from the Estonian coastline (the distance to the Finnish coastline is at its closest approximately 15 km), it does not cause impacts on tourism or recreational use of the coastal areas, where majority of the recreational activities take place. Tourism is an image related industry, but it does not seem, that any of the worries expressed in the citizen survey would have an impact on tourism either among domestic or international tourists. Impacts on tourism and recreations are assessed to be *negligleble* during all project phases.

The status of Estonian economy is steady and slightly growing, but it is also very dependent on the economies, political decisions as well as foreign politics of its neighbouring countries and the situation in EU. The impact of the project or its ancillary activities in Finland or Finnish EEZ on Estonian economy is *negligible* during all project’s phases.

On the whole, the transboundary social impacts from Finland to Estonia are assessed to be minor.

13.3.6 Conclusions on transboundary impacts on Estonia

Impacts on water quality in Estonia from the project activities in Finnish side are so limited that the overall signigficance of the impact is assessed as negligible (Table 13-3). The only impact receptors in water ecosystem found to be affected are marine mammals with largest effects on ringed seals. Worries that NSP2 Project have raised in Northern coast of Estonia are assessed to cause moderate impacts on civic confidence.

Table 13-3. Overall assessment of transboundary impacts on Estonia. Regarding impacts on marine mammals, the impact significance is assessed with mitigation measures committed by NSP2 (monitoring, seal scarers).

Impacts	Receptor	Sensitivity	Magnitude of change	Overall significance of the impact
Sediment dispersion due to munitions clearance	Water quality and sediments	Low	Negligible	Negligible
Sediment dispersion due to rock placement	Water quality and sediments	Low	Negligible	Negligible
Underwater noise	Harbour porpoise, ringed seal & grey seal, TTS/avoidance: individual & population level	Low	Low	Minor
	Harbour porpoise, PTS and blast injury: individual level & population level	Low	Med	Minor
	Ringed seal & grey seal, PTS and blast injury: individual level	High	Med	Moderate
	Ringed seal, PTS and blast injury: population level	Low[1] to Med[2]	Med	Minor[1] to Moderate[2]
	Grey seal, PTS and blast injury: population level	Low	Med	Minor
Fishery	Estonian offshore trawl vessels	Medium	Low	Minor
Social impacts	People of Estonia's Northern coast (worries and expectations)	Medium	Medium	Moderate
	Tourism and recreation	Medium	Negligible	Negligible
	Estonian economy	Medium	Negligible	Negligible

Area M4 (Gulf of Riga population)

[2]Area M1-M2 and M3 (M1-M2: Gulf of Finland population, M3: transient ringed seals from the Gulf of Finland population).

13.4 Transboundary impacts on Sweden

13.4.1 Water quality and sediments

Based on the technical design of the project, only some post-lay rock placement is needed near (about 5 km) the Finnish-Swedish EEZ border. Modelling of the sediment spills during rock placement indicates low (>2 mg/l) and temporary increase of suspended solids near the seabed in Swedish waters. The environmental conditions on the seabed in these deep waters are such that no biota exists. The overall significance of temporary and short-term impact on water quality is assessed as *negligible*.

13.4.2 Fishery

Finland and Sweden have bilateral agreement of fishery and thus Swedish fishing fleet is allowed to fish also in the Finnish territorial sea (*Council regulation (EC) No 2371/2002*, Figure 13-3). Fishing fleets from other EU member states are only allowed to fish in the Finnish EEZ outside territorial sea. Like Finnish trawlers Swedish also use mid-water trawls in targeting pelagic species, Baltic herring and sprat (Subchapter 7.10). Hence the same impacts described in Subchapter 11.13 concern also Swedish fishermen in the Finnish EEZ. Based on the assessment, the operation phase is more critical to fishery than construction phase as pipes on the seabed and especially on freespanning pipeline sections may cause hindrance to bottom close mid-water trawling. The overall significance was assessed as *minor* mainly due to the low intensity of trawling operation in the area and Swedish fishing concentrating only to the westernmost parts of the Finnish EEZ (Atlas map FC-04-F) and also by the prevailing mid-water trawling method.

13.4.3 Conclusions on transboundary impacts on Sweden

Impacts on water quality in Sweden from the project activities in Finnish side are so limited that the overall signigficance of the impact is assessed as negligible (Table 13-4). The only impact receptor is Swedish trawl fishing practiced in the Finnish EEZ.

Table 13-4. Overall assessment of transboundary impacts on Sweden.

Impacts	Receptor	Sensitivity	Magnitude of change	Overall significance of the impact
Sediment dispersion due to munitions clearance	Water quality and sediments	Low	Negligible	Negligible
Sediment dispersion due to rock placement	Water quality and sediments	Low	Negligible	Negligible
Fishery	Swedish offshore trawl vessels	Medium	Low	Minor

13.5 Transboundary impacts on other countries

The NSP2 Project could potentially have some transboundary impacts also on other countries. These impacts are mainly related to ship traffic and fishery.

During construction, there will be emissions from vessels in the Finnish EEZ. The emissions may spread across border, but are not expected to have any significant transboundary impacts. Total emissions from the NSP2 project will be described in Espoo report.

Fishing fleets from other member countries of EU are allowed to fish in EU waters in the Finnish EEZ outside of the Gulf of Finland. Like Finnish trawlers also trawlers from other EU countries use mid-water trawls in targeting pelagic species Baltic herring and sprat (Subchapter 7.10). Hence the impacts mentioned in Subchapter 11.13.3 concern also other countries fishermen operating in the Finnish EEZ. There will be many free-spanning pipeline sections in the uneven seabed areas which make the NSP2 pipelines in the Finnish EEZ worth avoiding for safety reasons when trawling in the area. There will also be cumulative impact with NSP pipelines in the same area which make the area wider where trawl fishermen are forced to be cautious. However, pipelines on the seabed do not make the project area untrawlable since the prevailing trawling method in the area is, by its natural unevenness and by existing target species, mid-water trawling. Fishing vessels from other countries also practice fishing in the Finnish EEZ in much lesser extent than vessels from Finland or from neighboring countries.

Since there are no other relevant impact targets rather than fishing within the other countries, this assessment is based on impacts on fishery. Therefore due to low intensity of the fishing operations of the other countries in the Finnish EEZ and the prevailing mid-water trawling method the overall significance of the transboundary impacts on other countries is assessed to be *negligible*.

13.6 Transboundary environmental impacts from unplanned events within the Finnish EEZ

Potential unplanned events could be e.g. oil spill following a ship collision or a gas leakage. Such events are discussed in more detail in Chapter 16. In this subchapter the unplanned events are discussed in connection with assessing transboundary impacts.

13.6.1 Risk and transboundary impacts from oil spill

The risk and potential consequences of an oil spill are described and evaluated in Chapter 16, where the additional annual frequency of ship collisions (because of the construction and operation of Nord Stream 2 pipelines) is calculated and discussed.

The total increase in the annual ship collision frequency in the Finnish EEZ due to the construction of NSP2 is minimal and is corresponding to 1 collision/720 years in average. If, however, this kind of highly improbable event with consequent oil spill will happen, the impacts on marine environment may be significant. The possible transboundary impacts are dependent on the location where accident is happen. The spreading of oil in water is dependent on meteorological as well as hydrographic parameters. The likelihood of an area being contaminated by oil has been determined using drift simulation (Subchapter 16.1.1). The simulations indicated that in an oil accident, oily water may reach Estonian territorial waters. The possible consequences on marine biota have been described in Subchapter 16.1.1.

According to risk assessment (Subchapter 16.1.2), the risk to third party personnel during construction is acceptable and well within the broadly acceptable level. The environmental risk shows that there are no high risk events and only one medium risk event. For the medium risk event (100 to 1,000 t oil spill) mitigation measures are adopted to reduce the risk.

Based on HELCOM Recommendation 11/13, it is assumed that countries around the Baltic Sea are capable of controlling a major oil spill within two days of a release, and thereby impacts on the marine environment will be minimised both regionally and transboundary *(HELCOM 1990)*. Various mitigation measures developed by NSP2 will be in place to minimise the risk of oil spill caused by accidents. These mitigation measures are presented in Chapter 17.

13.6.2 Risk and transboundary impacts from gas leakage

The consequences of a qas release are described and evaluated in Subchapter 16.2. The probability of such an event is extremely low.

Based on assessment of different scenarios for gas release, it is assessed that it may be a safety issue for the ship traffic, but will not pose a threat to the safety of people on neighbouring countries of Finland (especially Russia, Estonia and Sweden).

The impact is dependent on the leakage type, magnitude and a type of repair required. Potential transboundary effects are related to the location of the leakage (how near Finnish EEZ border the leakage occurs). The impact area at water surface is small, only few meters and thus impacts on the marine environment are local and of relatively shor duration. Impacts on ship traffic (changing shipping routes), on the other hand, will be of longer duration, owing to repair activities at the location.

The transboundary impacts from a gas release would primarily be related to the gas emissions to the atmosphere, as methane is a greenhouse gas which is present across all countries and contributes to climate change (Subchapter 16.2.4).

13.7 Conclusions of transboundary impacts

Transboundary impacts from Finland to other countries have been assessed with the same principle as impacts within national borders. Majority of the impacts from the NSP2 construction and operation occur within the borders of Finnish EEZ. Main impacts that reach to neighbouring countries jurisdiction are related to underwater noise as well as social impacts when it comes to Estonia. Also fishing vessels from other EU member states that have the license to fish in the Finnish EEZ are potential targets for impacts similar to Finnish fishing vessels during the operation phase of the pipelines.

Overall significance of the impacts were *moderate* when it comes to social impacts in Estonia and marine mammals (seals) in Estonia and Russia. Impacts on fishery were assessed to be *minor* within neighboring countries Sweden and Estonia and *negligible* on every other EU member states allowed to operate commercial fishing in the Finnish EEZ.

The transboundary impacts to Finland from other countries are presented in the Espoo Report.

14. CUMULATIVE IMPACTS

14.1 Scope and methodology

While all potential impacts of the NSP2 Project are described and assessed in Chapters 11–13, there is also a need to consider the potential for impacts to interact with impacts from other projects. All new projects may generate their own individually negligible impacts but when considered in combination, they could potentially amount to a significant level. Each infrastructure project reserves a certain area of the seabed that together with the existing infrastructure could have a cumulative influence on other forms of uses of the natural resources within a certain timeframe and distance.

Receptors in the marine environment which could be cumulatively affected by the NSP2 Project are the physical-chemical environment, biota and the socio-economic influences. Impact area is assessed to be spatially limited to the vicinity of the pipelines. Impacts could appear during the construction phase or during the whole lifetime of the pipelines. An example of last mentioned impact is a gradual metal leakage from the anodes of all pipelines (including Nord Stream 2 and other pipelines) to the water environment and potential concentration into biota.

Cumulative impacts have been assessed based on the baseline information of the environment and monitoring results of the construction and operation of NSP pipelines, project description of NSP2 and all available information of the planned new projects. Identification of overall significance of impacts is based on sensitivity of receptors and resources and assessed magnitude of change. Impact assessment is based on expert opinion.

The existing pipelines and cables are presented in Subchapter 7.21. Planned infrastructure that would cross the NSP2 route are one gas pipeline (Balticconnector) and two telecommunications cables (IP Only and Linx). With the exception of pipelines and cables, all other existing or planned infrastructure is located at a distance of 10 km or more from the NSP2 route.

Construction and operation of the NSP2 pipelines is assessed not to have cumulative impacts with the existing and planned power and telecommunication cables in the Finnish EEZ, as the impacts of the installation and operation of cables to the marine environment is in general very low (see e.g. *Etelä-Suomen aluehallintavirasto 2015*). Therefore the interacting impacts between the NSP2 Project and the existing and planned cables are out of the scope of this assessment.

The distance from the pipeline route to the nearest Finnish sea dumping sites and seasand extraction sites and their possible and anyway temporary use makes it unnecessary to assess the potential cumulative impacts with these activities (Subchapter 7.21.3). Therefore these infrastructure and utilization projects of natural resources are out of the scope of this assessment.

14.2 Existing and planned infrastructure to be considered

The following infrastructure/projects have been considered as potential sources of cumulative impacts together with the NSP2 pipeline project in the Finnish EEZ (see Table 14-1 and Figure 14-1).

Table 14-1. Existing infrastructure and planned projects which in combination with the NSP2 Project have the potential to result in cumulative impacts.

Existing or planned project name and details	Approximate distance from the NSP2	Status / Planning status	Anticipated Activities
<u>**Nord Stream (NSP)**</u> **Existing** Nord Stream (NSP) twin pipeline system which runs parallel to the majority of the NSP2 proposed route.	Minimum 0 km (crossing of NSP2 in Finnish EEZ). Otherwise 0.2–6.6 km and on average 2 km. Minimum separation distance depends on pipelay barge to be used (Basic engineering criteria: DP barge or anchored lay barge – 500 m and 1,200 m, respectively).	Existing. Construction phase is complete, operational since 2011/2012. Will remain in operation during the construction and operation of NSP2. Operational lifetime 50 years.	Presence of pipeline on seabed. Survey vessels undertaking monitoring approximately every 1–2 years. To be considered: operation and maintenance of the pipeline.
<u>**Balticconnector (BC)**</u> **Planned** Balticconnector gas pipeline project (one pipeline, diameter 500 mm) aiming to interconnect the Finnish and Estonian natural gas distribution networks and transmit natural gas between the countries.	Minimum 0 km (crossing of NSP2 in Finnish EEZ). Crossing is approximately 90 degrees.	Planned. Current execution plan of the project is to have the BC pipeline connection ready till the end of 2019. Operational lifetime 50 years.	According to latest schedules BC pipeline and the NSP2 pipelines may be under construction more or less at the same time in 2018–2019. To be considered: construction, operation and maintenance of the pipeline.

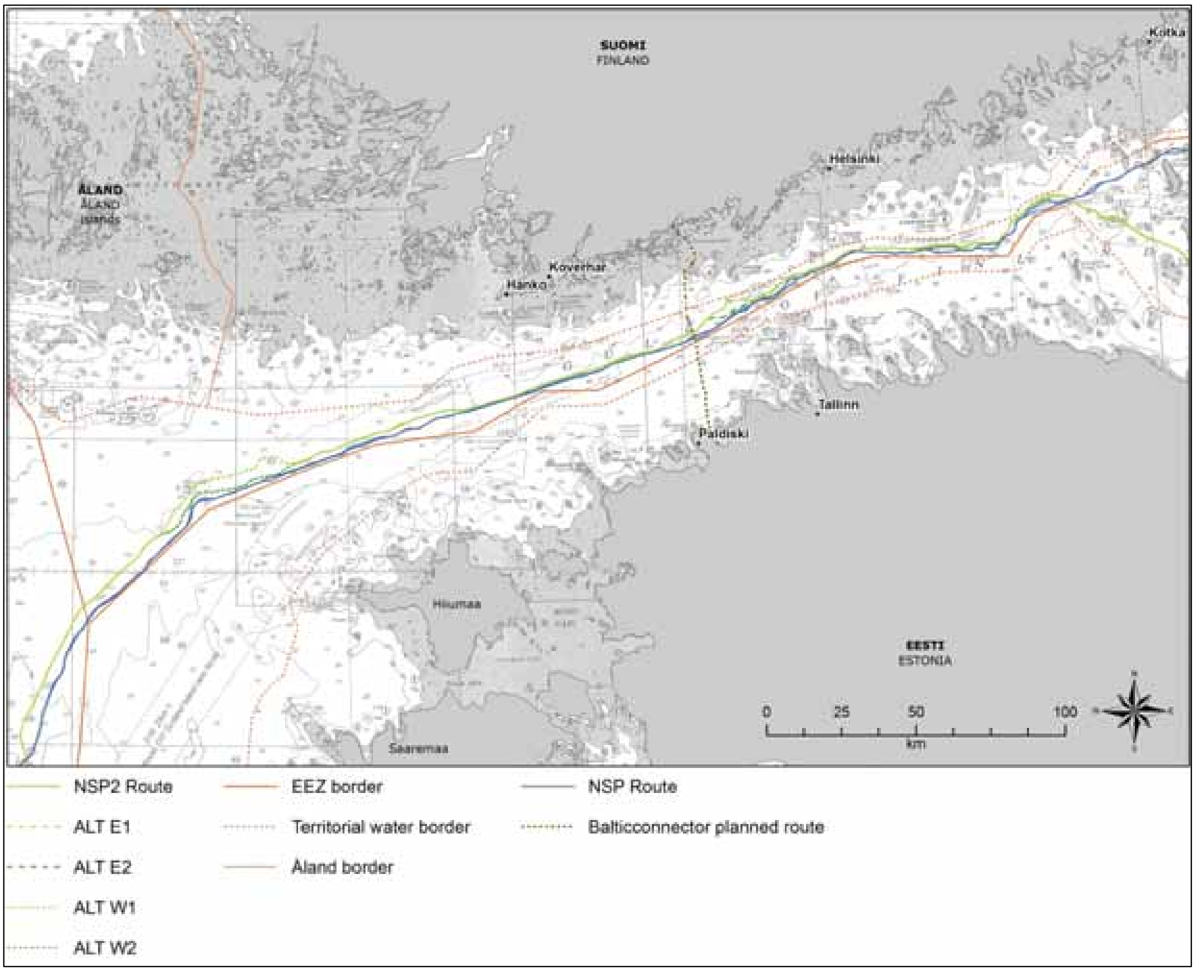

Figure 14-1. Route of the existing NSP pipelines, planned Balticconnector pipeline and planned NSP2 pipelines.

Nord Stream AG constructed in 2010–2012 an offshore twin pipeline system (NSP) to transport gas from Russia to Germany through the Baltic Sea. The total length of the NSP pipeline system is 1,224 km of which 375 km passes through the Finnish EEZ.

Balticconnector is a gas pipeline project (one pipeline, diameter 500 mm) aiming to interconnect the Finnish and Estonian natural gas distribution networks in Inkoo and Paldiski, respectively, and start transmitting natural gas between the countries. Offshore section of the pipeline comprises approximately 82 km in the Gulf of Finland. The flow of gas can take place in both directions, making it also possible to transmit natural gas from Finland to Estonia. Transmission capacity between Estonia and Finland will be 7.2 million m^3 per day. The opportunity of bi-directional natural gas transmission is the basic requirement for the implementation of the project. The pipeline will be provided with an active anti-corrosion protection system consisting of zinc/aluminium anodes. The assessed number of anodes is 278, each with a thickness of 50 mm. The design pressure of the pipeline is 80 barg and operational lifetime is expected to be 50 years. Routing of the pipeline across the Gulf of Finland is presented in Figure 14-1.

Overall environmental impacts of the construction works of the Balticconnector pipeline are assessed to be most significant near the coastal areas whereas the impacts of NSP2 are limited to the offshore areas *(Pöyry 2015)*.

14.3 Cumulative impact assessment – existing NSP pipelines

The assessments in Chapter 11 include Nord Stream pipelines as existing infrastructure. Based on the consultations in the EIA programme phase, cumulative impacts on both planned and existing pipelines need to be assessed. In particular, impacts may occur during the operation phase due to the presence of four pipelines (NSP and NSP2) in the Finnish EEZ. Hence, the cumulative impacts of these two projects have been assessed separately in this chapter. Potential impacts relate to issues like the use of the Finnish EEZ, water and sediment quality (release of metals from the anodes) and impact on commercial fishery.

<u>Constraints for future use of the Finnish EEZ and living conditions on the seabed</u>
After NSP2 pipelines have been constructed altogether four gas pipelines (NSP twin pipelines + NSP2 twin pipelines) exist in the same sea area in the Finnish EEZ. Cumulative impacts of these pipelines are related to potential future utilization plans of the seabed (infrastructure or exploitation). Assessed common “footprint” of the two pipeline systems (total seabed area covered by the four pipelines and support structures) is roughly 3.3 km^2, which is in the order of magnitude of about 0.05 % of the seabed area in the Finnish EEZ in the Gulf of Finland and the Northern Baltic Proper. This percentage can be assessed as a low value. After NSP2 pipelines are constructed, new infrastructure projects in the same marine area are still possible.

When calculating the combined consultation zone for both pipeline systems, ± 500 m distance from pipelines can be used, as presented in Subchapter 11.16. The combined consultation zone is 866 km^2, which is 12.1 % of the Finnish EEZ in the Gulf of Finland and the Northern Baltic Proper. The consultation zone is relatively large when compared to the total Finnish EEZ. If infrastructure or exploitation of natural resources is planned in the future to the Finnish EEZ, it is probable that consultations with Nord Stream or Nord Stream 2 will be necessary. However, it is estimated that Nord Stream and Nord Stream 2 pipelines will not prevent future projects, but may have impact on planning and technical design of future projects. Southern sub-alternatives ALT E2 and ALT W2 may be slightly better options than sub-alternatives ALT E1 and ALT W1 when considering future use of the Finnish EEZ, since their routing goes closer to Nord Stream pipelines and hence having a smaller consultation zone to Nord Stream or Nord Stream 2.

The living conditions are poor for the benthic communities to develop along most of the pipeline routes. Because of this and the low common “footprint” of the pipeline systems, adverse cumulative impacts on biota or biodiversity are not assessed to appear.

Impacts on hydrology, water quality and sediments

As presented in Subchapter 11.3.3.2 local changes in bottom-close currents are possible in the vicinity (distance less than 50 m) of the pipelines. Based on this and the minimum distance between the routes of the existing NSP and planned NSP2 pipelines, no cumulative impacts on hydrological conditions near the seabed are anticipated (Table 14-1).

It is assessed that impacts from temperature difference pipeline/seawater on water quality are local, long-term and of low intensity. Natural mixing of the sea water near the seabed (especially in the areas of no halocline) will ensure that the temperature reach equilibrium with the surrounding water body within 0.5 to 1 m after crossing the pipeline. Consequently there will be no cumulative impacts on the temperatures in sea water with the NSP pipelines.

The total mass of zinc and aluminium in the anodes of the pipelines is 5,317 tonnes and 1,896 tonnes, respectively. It is expected that the actual consumption of anode material will be around 40% of the installed mass at the end of the operational lifetime (Ramboll 2009b). Based on this the cumulative annual load of these metals in the Finnish EEZ can be roughly assessed as 43 tonnes of zinc and 15 tonnes of aluminium. As a comparison annual zinc load into the Gulf of Finland in 2006 was 919 tonnes (HELCOM 2011). Annual aluminium load was not presented in the reference. Assessed annual cumulative leakage of zinc from the anodes is about 5 % of the annual external zinc load to the Gulf of Finland.

The release of zinc and other metals from the anodes during the 50-year operational lifetime of the pipelines will not result in general increase of the concentration of these metals in sea water or seabed, apart from a few meters around the pipelines (Subchapter 11.2.3). At the crossing point of the Nord Stream pipelines near the Russian border, there is a theoretical possibility of some anodes to be located in close proximity with each other. However, the probability for this is low, because the average distance of anodes along the pipelines is approximately 100 m. Due to the negligible and very local nature of the release of metals from the anodes, potential proximity of anodes is not assessed to cause any cumulative impacts on the marine environment.

Biotic impacts on living organisms

It has been assessed that no bioconcentration or biomagnification of zinc on living organisms released from the anodes will occur (Ramboll 2009b). In literature the following PNEC values have been presented for zinc: 3.07 µg/l and 3.4 µg/l (NIVA 2007, Ospar Commission 2014). During the environmental baseline survey in December 2015 the average zinc concentration (n=7) in sea water, near the seabed, in the survey corridor of NSP2 was 7.6 µg/l *(Luode Consulting Ltd 2016a)*.

It seems obvious that biota present in the deep open waters of the Gulf of Finland has been forced to adapt to live in an environment where the background concentration of zinc is clearly higher than the level that is not expected to cause any harm for the organisms. However, the main reason for low biodiversity in these marine areas is the low oxygen level. Based on the very limited impact area of the released metals on seabed sediments near the pipelines, no cumulative adverse impacts on benthos are assumed to appear.

Commercial fishery

Construction of the NSP2 pipelines will cause a cumulative impact on commercial fishery together with the NSP pipelines as after that there will be four pipelines relatively close to each other in the Finnish EEZ. These will approximately double up the effect experienced by the fishermen but it is assessed that this will however be manageable. In areas where the pipeline is in free span, fishermen need to avoid the new pipelines with the same caution as for the NSP pipelines. This makes these free spanning areas more or less a sanctuary for fish because trawl fishing is forced to avoid the bottom close layer. However, the living conditions, in the depths where the pipelines are installed, are mostly unfavourable for fish due to oxygen deficiency and therefore this formation of sanctuary for fish is rather hypothetical in many locations. But regardless of circumstances mid-water trawling will – as well as so far – be possible above the pipelines leaving enough space between the trawl gear and the pipelines.

14.4 Cumulative impact assessment – planned Balticconnector pipeline

Crossing site of the three pipelines (2+1, two crossings) is located approximately at KP 257 along the NSP2 route (Figure 14-2). Water depth at the area is approximately 63 m and the seabed type is generally clay. Based on that seabed sediments consist of fine particles that will easily suspend during the seabed intervention works. On the other hand the crossing site locates in an area in the western Gulf of Finland where permanent halocline normally exists in the water column. This prevents efficiently different water layers from mixing up with each other.

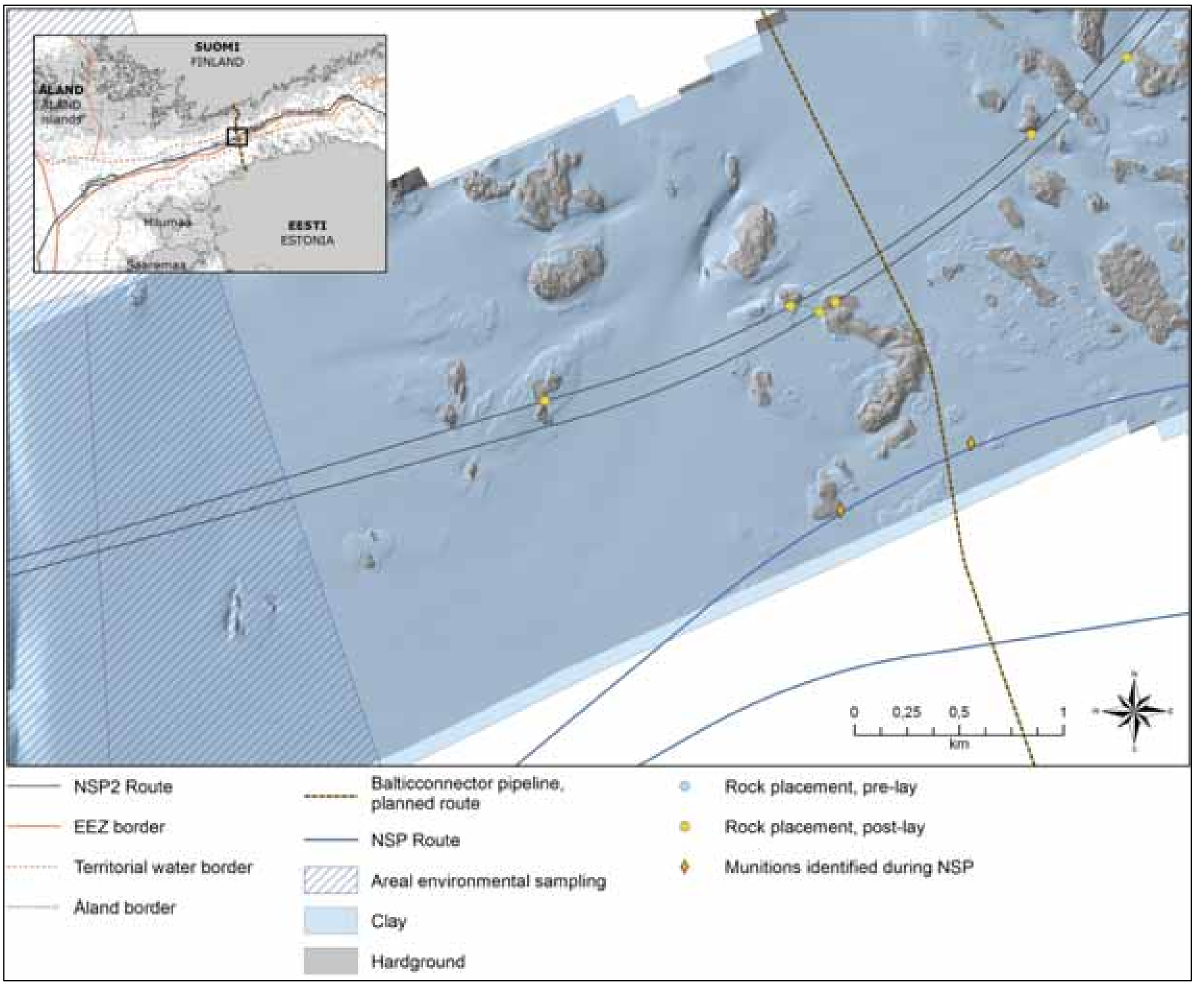

Figure 14-2. Crossing site of NSP2 and Balticconnector pipelines in the Finnish EEZ, western Gulf of Finland.

14.4.1 Construction phase

Water quality and sediments

Seabed intervention works of the two projects (NSP2 and BC) are not causing cumulative impacts on the quality of sea water (release of surface sediments and contaminants), because construction activities of the projects cannot coincide spatially or temporarily. Possible changes in the water quality nearest to the seabed may occur for a longer period of time as the construction of the two projects can't be carried out in the same location at the same time.

Sediment quality nearby the crossing site, approximately 3 km to the west, was examined during the environmental baseline survey in 2015 (Figure 14-2). Only normalised concentrations of dioxins/furans and TBT were generally above the lowest guideline level 1 but only randomly and occasionally above the highest guideline level 2 *(Luode Consulting 2016a, Environmental Administration Guidelines 1/2015)*. If these compounds are in dissolved form in suspension they will adsorb rapidly to organic or inorganic particles (Subchapter 11.3.3).

It is assessed that during the construction works of NSP2 no more sediment is released from the seabed due to the BC construction. Based on the modelling results, during rock placement, increased concentrations of sediment particles will be settled in less than 20 h in different hydrographic conditions (Subchapter 11.3.3). Therefore, sediments resuspended by NSP2 will be already settled before the activities of BC in the same sea area (or the other way around).

The overall conclusion is that no significant adverse cumulative impacts on sea water quality are assessed due to the BC project.

Biotic impacts on living organisms

No cumulative impacts on marine mammals, fish or living conditions on other marine organisms are assessed to appear. This assessment includes some uncertainties because the number and location of possible munitions near the pipeline crossing site (two crossings – one for each of the two NSP2 pipelines) is not yet known. Earlier, inside the Balticconnector study corridor two probable munitions have been found from the Finnish EEZ (MMT 2006 and MMT 2014 ref. Pöyry 2015). Based on this and the low number of identified munitions found in the area during the NSP project (Figure 14-2), the probability of cumulative impacts of detonations on seals to appear is low.

Ship traffic

The main potential impacts are connected with elevated level of risks caused by increased ship traffic in the same sea area. All ship traffic (including project's vessels) in the Finnish EEZ will be monitored through the Gulf of Finland Reporting System (GOFREP; mandatory for ships over 300 gross tonnages). This system was established especially to improve maritime safety and to protect maritime environment from collisions at sea.

In this situation special attention has to be paid on the flow of information between different parties. Also important is that advance notifications about the construction works and their schedules are regularly submitted to the authorities. The main principle is that pipelay of different projects is not occurring concurrently in the same sea area. In addition safety zones around the working vessels will minimize the risk for collisions. When these rules and safety methods are strictly obeyed, no cumulative impacts on ship traffic are assessed to exist.

14.4.2 Operation phase

Restrictions for planned infrastructure and living conditions on the seabed

As the Balticconnector route and the NSP2 route encounter almost vertically (north-south and east-west route) in the Finnish EEZ (Figure 14-1), "the footprint" of the crossing is small. New infrastructure projects in the same marine area are still possible taking the safety distances to the gas pipelines into account.

At the depth of the pipelines crossing the living conditions for the benthic communities are usually poor. Because of this and the small footprint of the crossing, no adverse cumulative impacts on biota or biodiversity are assessed to appear.

Biotic impacts on living organisms

No cumulative impacts on marine mammals, fish or living conditions on other marine organisms are assessed to appear (concerning release of metals from anodes – see Subchapter 11.3.3.2).

Commercial fishery

The rock placement to support the crossing site of the pipelines will be larger than normal rock placement sites. There will also be a higher obstacle rising from the seabed since two pipeline will be on top of each other. These structures may hamper bottom close trawling and form an area where fishing operations have to be carried out more cautiously than in other areas. However, the crossing place of three pipelines is situated on the corridor between north and south where the intensity of Finnish trawl fishing has been low for the last five years (Figure 7-54) and for that reason the actual significance of this impact on Finnish trawl fishery is assessed to be low.

14.5 Conclusions of cumulative impacts

The Nord Stream 2 and Balticconnector pipelines are planned to be constructed approximately during the same time period. If the construction periods overlap, increased ship traffic in the same area would also increase the associated risks.

The existence of both the Nord Stream 2 and Nord Stream pipelines is assessed to cause additional hindrance to commercial fishery, due to the freespans of four pipelines in the Finnish EEZ. However, mid-water trawling is the prevailing trawling method in these waters, not bottom-trawling. When considering the potential future use of the Finnish EEZ, the existence of both the Nord Stream 2 and Nord Stream pipelines means that it is probable that consultations with Nord Stream 2 or Nord Stream will be necessary. However, it is assessed that the existence of both pipelines will not prevent future projects, but may have an impact on the planning and technical design of such projects.

15. ENVIRONMENTAL CONSIDERATIONS FOR DECOMMISSIONING

A qualitative review of potential sources of impact which may arise from the the decommissioning options outlined in Subchapter 4.4 has been undertaken based on the conclusions of the impact assessment outlined in Chapter 11, the decommissioning report developed for NSP *(Ramboll 2009d)* and professional experience. The findings are summarised below. It is noted that the identification of potential impacts associated with pipeline removal is theoretical and has relied heavily upon professional experience. This is due to lack of empirical data as, based on existing knowledge, no similar large-diameter pipelines have been decomissioned by removal. Should a hybrid option be chosen, the potential impacts would be a combination of those identified below, though the magnitude of each type of impact would likely be reduced compared to the removal option.

15.1 Leave in situ option

For the leave in situ option, it is anticipated that many of the potential sources of impact will be a continuation of those encountered due to the presence of the pipelines during the operation phase (and therefore of a lower magnitude than the pipeline removal option). Other impacts related to the operation of the pipeline are not relevant after decommissioning. The potential impacts that remain are:

<u>Water quality</u>
The pipeline consists mainly of the following materials: steel, concrete coating and anodes. It is assessed that considering the pipeline materials release of zinc from anodes potentially has the main impact on the marine environment.

In the Finnish EEZ the amount of zinc is approximately 6,500 kg/pipeline-km. Assuming 130 years of dissolving time, realese of zinc is 50 kg/km/year. There will be no increase in the concentration of zinc in the water environment more than a few metres from the pipelines. The potential impact would be similar to that during operation (Subchapter 11.3.3.2).

<u>Benthic flora and fauna</u>
Pipelines on the seabed and their support structures can in principle offer a settlement substrate for hard bottom benthic fauna. However, the majority (approximately 75 %) of the pipeline will be situated in deep (>60 m) soft bottoms that permit no or hardly any benthic colonisation owing to permanent or recurring oxygen deficiency. Moreover, external inspections of the NSP pipelines in the Finnish sector have shown no formation of epifauna or reef structure on pipelines *(DeepOcean 2015)*. It is assessed that, should the present condition prevail, leaving pipelines on the seabed will have similar impact on the preservation of habitats as that for operation (Subchapter 11.5.3.4).

<u>Commercial fishery</u>
During the operation phase, the impact of the presence of the pipeline on commercial fishery is assessed to be minor in uneven seabed areas. The potential impact in these areas are from freespans which may cause hindrance to trawling. In smooth seabed areas the impact is assessed to be negligible (Subchapter 11.13.3.2). The impact would remain and would be similar after decommissioning, even though the pipeline would not be filled with gas.

However, it should be noted that the predominant fishing method is mid-water trawling in the Finnish EEZ.

Future use of the Finnish EEZ

The pipeline as a structure on the seabed would need to be taken into account when planning future use in the vicinity of the pipeline, even though the pipeline is not filled with gas. Therefore the impact on seabed would remain after decommissioning and would be similar to the impact during operation of the pipeline (Subchapter 11.16.3.1).

15.2 Pipeline removal option

Total recovery of the Nord Stream 2 pipeline in the Finnish EEZ would result in the need for bringing a total of more than 60,000 concrete coated pipe joints to shore. Recovery would require a significant spread of vessels operating along the route and to and from ports, and is unlikely to be carried out with the same speed as pipe-lay (therefore requiring higher resources/energy).

When onshore the pipeline materials could either be further processed for material recovery or disposed of. In any case, temporary areas for storage (i.e. storage yards for removed pipe sections) and processing would be required. Permanent areas for disposal may also be necessary.

Air quality

It is assumed that recovery operations will be far slower than pipelay operations, and therefore vessels for recovery operations spend more time along the route leading to greater emissions than pipelay if decommissioned with today´s available technology. As presented in Table 11-3 the emissions from pipelay (using DP vessel) including pipe supply are approximately 260,000 tonnes of CO2, 5,000 tonnes of NOX, 170 tonnes of SO2 and 150 tonnes of PM. Due to development of technologies specific emissions from vessel operations may be decreased, but due to longer operating period total emissions would most probably be higher than during pipelay (Subchapter 11.1.2.2).

Sediments and water quality

Decommissioning operations result in disturbance to the seabed around pipelines – especially in the areas where the pipeline has been embedded. Sediment will be disturbed to enable access for cutting and lifting, for pipeline deburial through jetting. Each of these operations would result result in localised sediment re-suspension and potential smothering of benthic fauna *(Oil & Gas UK 2013)*. Additionallly, concrete coating may have deteriorated and consequently coating loss may occur when the pipelines are removed from the seabed.

At the time of decommissioning part of the pipeline will be embedded and an integrated part of the seabed. Removal will require activities and techniques (jetting etc.) that has not been performed in the Finnish EEZ during construction. Therefore deburial of the pipelines is assumed to have much higher impacts on sediment and water quality compared to the impacts assessed from construction works (Subchapters 11.2.3.1–11.2.3.4 and 11.3.3.1).

Marine mammals

Prior to pipelay munitions have been cleared from the installation and security corridor if deemed to be a risk to the pipeline installation or operation.

Prior to decommissioning additional munitions may have to be cleared to ensure safe recovery of the pipelines. Munitions clearance can have an impact on marine fauna and will be assessed prior to decommissioning (Subchapter 11.7.1.1).

Ship traffic

Removal of pipelines is carried out by several vessels:

- Reverse lay recovery: "reverse lay" barge and pipe-carrier vessels
- Sectional recovery: offshore construction vessels and pipe-carrier vessels

Recovery operations will be slower than pipelay causing more impacts to ship traffic than during pipelay, especially in the TSS (Subchapter 11.12.3.1).

Recovery of materials
In the Finnish EEZ Nord Stream 2 pipelines will comprise of approximately 700 000 tonnes of steel. This is a significant amount of metal for recycling, and would be approximately the same amount of scrap metal recycled annually today in Finland.

Recovered pipe sections would be taken to shore by pipe-carrier vessels and landed for further handling and final disposal depending on their recycling potential. Pipe sections must be pre-treated to remove the concrete and anti-corrosion coating. It is likely that a dedicated process must be developed. Pre-treatment plant would also require a substantial storage area for the pipe sections and the waste materials.

The main product from the pre-treatment is scrap metal to be delivered to steel manufacturers. However, every ton of scrap steel corresponds to maximum one ton of concrete waste. Concrete waste will be mixed with reinforcement materials and would have to be processed prior to use as secondary construction material (e.g. in road construction). However, if the amount of concrete waste is large (more than tens of thousands of tonnes), reuse can be difficult and landfilling might be the only option.

Commercial fishery
During decommissioning impacts on fishery is slightly higher than during construction due to the slower operation (Subchapter 11.13.3.1). However, the impact during decommissioning is temporary.

There is no impact after decommissioning on fishery. However, it should be noted that the predominant fishing method is mid-water trawling in the Finnish EEZ.

Existing and planned infrastructure at the time of decommissioning
The removal of the pipeline will require agreements with infrastructure owners (pipeline and cable owners etc.) to agree on the removal techniques at crossing locations. Removal at crossing locations may require extensive efforts to protect the infrastructure.

15.3 Concluding remarks

Based on the guidelines and conclusions for the cases of the decommissioning programmes in the UK, leaving the pipelines *in situ* is likely to be the preferred option for NSP2. Management and mitigation methods for decommissioning and closure of the pipeline will be developed:

- in agreement with the relevant national authorities;
- in accordance with the legislative requirements at the time of decommissioning;
- with due consideration of the technology available at the time of decommissioning; and
- with due consideration of the knowledge gained over the lifetime of NSP2 and the condition of the infrastructure.

The anticipated impacts resulting from leaving pipelines *in situ* will be related to the gradual dissolution of materials over time and, for example, potential impacts on commercial fisheries. Impacts from recovery operations are related to seabed disturbance, vessel operations, and use of energy and land areas for material separation, recycling and/or disposal. The potential impacts on the marine environment from pipelines left *in situ* are generally considered to be smaller than the impacts from recovery.

A decommissioning programme will be developed during the operation phase, since regulations, technical knowledge gained over the life of the NSP2 pipelines and relevant pipeline decommissioning practices at the time must be taken into account *(Oil & Gas UK 2013)*.

16. RISK ASSESSMENT

Construction and operation of NSP2 give rise to a number of hazards which may present risks to the environment, the public/third parties and workers. The focus of this chapter is to describe the risk assessments that have been undertaken to assess the risks to the environment and to the public during construction and operaton of NSP2. Risks to workers have also been assessed; however these risks and the necessary mitigation measures will be addressed by the safety management systems of Nord Stream 2 and its construction/contractor organisations, and are not therefore included here.

This chapter presents a summary of the risk assessments related to unplanned events during the construction and operational phases of the NSP2 pipeline route in Finland. It includes four subchapters:

1) Risk assessment – construction phase
2) Risk assessment – operation phase
3) Emergency preparedness
4) Repair works

Subchapters 16.1 and 16.2 evaluate the risks related to the the construction and operation phases of the pipeline route. The analyses are based on:

- An assessment of potential risk to third party personnel and the environment arising from the construction phase. The assessment was done according to DNVRP-H101 (DNV-GL 2003) and the International Maritime Organization (IMO) guidelines for risk management and formal safety assessment in marine and subsea operation (IMO 2004) (performed by Global Maritime).
- An operational risk assessment considering potential fatalities, environmental and economic losses as well as risks to reputation. The assessment was performed according to DNV-OS-F101 for pipeline integrity and according to DNV-RP-F107 for potential environmental risks in the operation phase (performed by detail engineering contractor Saipem).

The construction risk assessment is reported in the document; "Pipeline Construction Risk Assessment" *(Nord Stream 2 AG and Global Maritime 2016)*. The operational risk assessment consists of three documents; "Offshore Pipeline Frequency Of Interaction – Finland" *(Nord Stream 2 AG and Saipem 2016a)*; "Offshore Pipeline Damage Assessment – Finland" *(Nord Stream 2 AG and Saipem 2016b)*; and "Offshore Pipeline Risk Assessment – Finland" *(Nord Stream 2 AG and Saipem 2016c)*.

All the above-mentioned documents are part of Det Norske Veritas' independent, third-party verification programme of the engineering works (DNV-GL). DNV-GL will provide final certification of compliance for the overall pipeline system.

The identified risks to the environment and third party during construction and/or operation of NSP2 as assessed in this Chapter 16 relate to the following unplanned events:

- Vessel collisions during construction and subsequent oil spill;
- Pipeline failures during operation and subsequent gas release;
- Unplanned repair works.

The risk assessments in Subchapters 16.1 (risks during construction, i.e. risk of oil spill) and 16.2 (risks during operation, i.e. risk of gas release) follow the classic risk assessment methodology illustrated in Figure 16-1 which starts with the identification of failure causes followed by an assessment of frequencies and consequences. The assessment results in identified risks which are further assessed with respect to risk acceptance criteria.

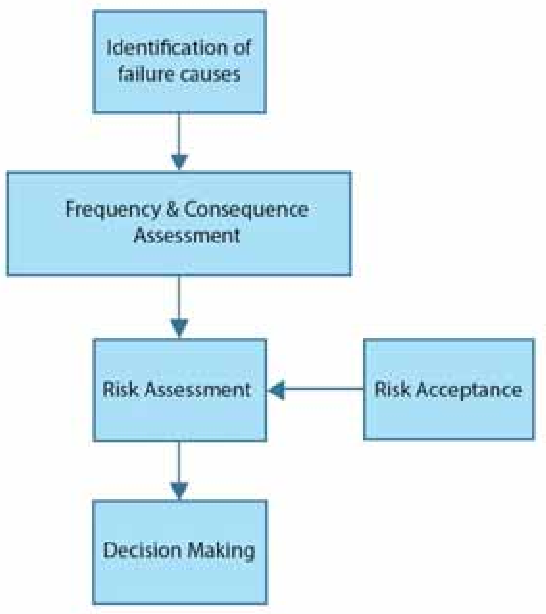

Figure 16-1. Risk assessment methodology.

Unplanned repair works is presented separately in Subchapter 16.4. These are events for which a detailed risk assessment has not been undertaken, but which are described on a general level along with potential environmental impacts.

16.1 Risk assessment - Construction phase

The risk assessment of the construction phase covers the following project activities:

-
- Pre-lay intervention works/rock placement, including vessel loading operations.
- Pipe-lay, including pipe load out and transportation.
- Post-lay intervention works, rock placement including vessel loading operations.
- Pre-commissioning operations.

The risks associated with munitions potentially encountered during construction are discussed in Subchapter 16.3, Emergency preparedness.

A summary of the estimated risk to the environment and the risk to third party personnel is provided in the following subchapters.

A qualitative risk assessment of construction activities *(Global Maritime 2009a)* and a quantitative risk assessment of construction activities *(Global Maritime 2009b)* was prepared for Nord Stream. These assessments have been used as the basis for the overall assessment of hazards and risks in NSP2.

16.1.1 Risk to the environment

As experience has indicated oil spills to be the main risk to the environment, the assessment of environmental risks during construction has been limited to oil spills.

16.1.1.1 Oil spill probability

As part of the risk assessment, the probability for varying sizes of oil spill have been calculated for each of the identified hazards. These calculations are based on the assessment of ship collision frequencies (Subchapter 16.1.2.1). The results are shown in Table 16-1.

Table 16-1. Probability oil spills of the identified hazards for the entire NSP2 pipeline route, (Nord Stream 2 AG and Global Maritime 2016).

Item	Hazard	Probability of oil spill (per year)	Potential size of spill (tonnes)
Passing vessel collision			
a	Third-party vessel collision 1-10 tonnes spill	$2.1 \cdot 10^{-5}$	1 to 10
b	Third-party vessel collision 10-100 tonnes spill	$4.2 \cdot 10^{-5}$	10 to 100
c	Third-party vessel collision 100-1000 tonnes spill	$6.1 \cdot 10^{-5}$	100 to 1.000
d	Third-party vessel collision 1000-10,000 tonnes spill	$2.9 \cdot 10^{-5}$	1,000 to 10,000
e	Third-party vessel collision >10,000 tonnes spill	$8.0 \cdot 10^{-5}$	> 10,000
Construction vessel collision			
f	Pipe-laying vessels	$2.6 \cdot 10^{-5}$	750 to 1,250
g	Diving support vessel (DSV)/trench support vessel	$3.0 \cdot 10^{-5}$	500 to 850
h	Rock placement vessel	$1.5 \cdot 10^{-5}$	500 to 850
i	Pipe carrier & supply vessel	$8.0 \cdot 10^{-5}$	300 to 500
j	Anchor-handling tug (AHT)	$3.5 \cdot 10^{-5}$	300 to 500
k	Shallow water lay	$6.7 \cdot 10^{-6}$	300 to 500
Vessel fire			
l	Pipe carrier/AHT/supply vessel	$1.0 \cdot 10^{-4}$	100
m	Rock placement vessel	$5.6 \cdot 10^{-5}$	170
n	Pipe-laying vessels	$1.0 \cdot 10^{-4}$	250
o	DSV/trench support	$1.9 \cdot 10^{-5}$	250
p	Shallow water lay	$2.8 \cdot 10^{-5}$	100
Vessel grounding			
q	Pipe carrier	$1.4 \cdot 10^{-4}$	300 to 500
r	Rock placement vessel	$1.5 \cdot 10^{-5}$	500 to 850
s	Supply vessel	$5.8 \cdot 10^{-5}$	300 to 500
Vessel sinking			
t	DSV/trench support vessel	$5.3 \cdot 10^{-7}$	750 to 1,250
u	Pipe carrier/AHT/supply	$3.0 \cdot 10^{-6}$	300 to 500
v	Pipe-laying vessels	$3.0 \cdot 10^{-6}$	750 to 1,250
w	Rock placement vessel	$1.6 \cdot 10^{-6}$	500 to 850
x	Shallow water lay	$7.9 \cdot 10^{-7}$	300 to 500
Oil spill – bunkering			
y	AHT	$2.0 \cdot 10^{-3}$	0 to 10
z	Pipe-laying vessel	$5.0 \cdot 10^{-2}$	0 to 10
aa	Shallow water lay	$1.2 \cdot 10^{-2}$	0 to 10

The findings of the environmental quantitative risk assessment for the construction phase of the entire NSP2 pipeline route are indicated in the DNV-GL risk matrix (DNV-GL 2003) in Table 16-2. The risk items *a* to *aa* are defined in

Table 16-1. It can be seen that there are no high-risk events and only three medium-risk events that relate to third party and DP pipelay vessel collision and oil spill (items *d*, *e* and *f* see Table 16-2)

Table 16-2. Findings of the environmental quantitative risk assessment for the entire NSP2 pipeline route, (Nord Stream 2 AG and Global Maritime 2016).

Consequences		Probability (increasing probability)			
Descriptive	**Environment**	**Remote** (< 10^{-5} /year)	**Unlikely** (10^{-5}-10^{-3} /year)	**Likely** (10^{-3}-10^{-2} /year)	**Frequent** (10^{-2}-10^{-1} /year)
1 Extensive	Global or national impact. Restoration time > 10 yrs.				
2 Severe	Restoration time > 1 yr. Restoration cost > USD 1 mil.	t,u,v	d,e,f		
3 Moderate	Restoration time > 1 month. Restoration cost > USD 1 K	k,w,x	c,g,h,i,j,m,n,o,q,r,s		
4 Minor	Restoration time < 1 month. Restoration cost < USD 1 K		a,c,l,p	y,z,aa	
HIGH	The risk is considered intolerable so that safeguards (to reduce the expected occurrence frequency and/or the consequences severity) must be implemented to achieve an acceptable level of risk; the project should not be considered feasible without successful implementation of safeguards				
MEDIUM	The risk should be reduced, if possible, unless the cost of implementation is disproportionate to the effect of possible safeguards				
LOW	The risk is considered tolerable and no further actions are required				

As regards item *d* "3rd party vessel collision 1,000–10,000 t spill", *e* "3rd party collision > 10,000 t spill" and *f* "DP Pipelay collision" in Table 16-2, it can be seen that this risk is related to passing vessel collision and collision risk reduction is required to minimise the potential for environmental damage.

The estimated probabilities for oil spills of varying size occurring within the Finnish EEZ that could result from construction activities are summarised in Table 16-3.

Table 16-3. Estimated probability of oil spills of varying size occurring within the Finnish EEZ (Nord Stream 2 AG and Global Maritime 2016).

Potential size of spill (tonnes)	1–10 t	10–100 t	100–1,000 t	1,000–10,000 t	>10,000 t
Probability of oil spill (per year)	$2.5 \cdot 10^{-6}$	$5.0 \cdot 10^{-6}$	$7.4 \cdot 10^{-6}$	$3.5 \cdot 10^{-6}$	$9.7 \cdot 10^{-7}$

Table 16-3 indicates that the total annual frequency of oil spill in the Finnish EEZ, resulting from NSP2 construction activities, is estimated to be $1.9 \cdot 10^{-5}$ oil spills per year (>1 tons), corresponding to a return period of 50,000 years. Statistically, the number of oil spill accidents in the Baltic Marine Area is estimated to be 2.9 per year *(HELCOM 2002)*. Comparing this with the estimated increased risk of an oil spill within the Finnish EEZ during the construction phase, it can be concluded that the construction of NSP2 will only theoretically increase the risk.

16.1.1.2 Oil spill modelling

The risk assessment above identified no high risks. However, some medium risks were identified, namely third-party vessel collision and pipe-lay vessel collision. For events with a medium risk, the most severe oil spill size is estimated based on the bunker capacity of the DP pipe-lay vessel. The assumption used in the modelling is that 50 % of the bunker oil would be spilled. This corresponds to a spill of approximately 1250 tonnes of oil.

The MIKE Ecolab/Oil spill model has been used to model and assess the spreading of oil caused by a potential accidental oil spill during construction. Further details on the modelling exercise can be found in Ramboll´s report *(Ramboll 2016e)*. The physical parameters of the oil determine the conditions under which the oil is transported and degraded. The major factors are meteorological and hydrographic parameters.

The HELCOM countries have adopted a recommendation on the development of national capability to respond to accidental oil spills and other harmful substances. The recommendation specifies response times for combatting oil spills. According to the recommendation, a spill location must be reached within 6 hours by relevant country-specific response units. On-site response action must be implemented within 12 hours and countermeasures against a spill of oil or hazardous substances should be initiated within two days.

Four oil spill locations in the Baltic Sea have been chosen for the oil spill simulations (see Figure 16-3). The selected locations as considered the most likely positions. In Finland, two locations have been considered. One ("Finland 1") is situated where the pipeline route crosses the shipping lane Helsinki-Tallinn and which is also closest to coastal and protected areas. The second ("Finland 2") is situated where the pipeline passes the nearest Natura 2000 site (Sea area south of Sandkallan).

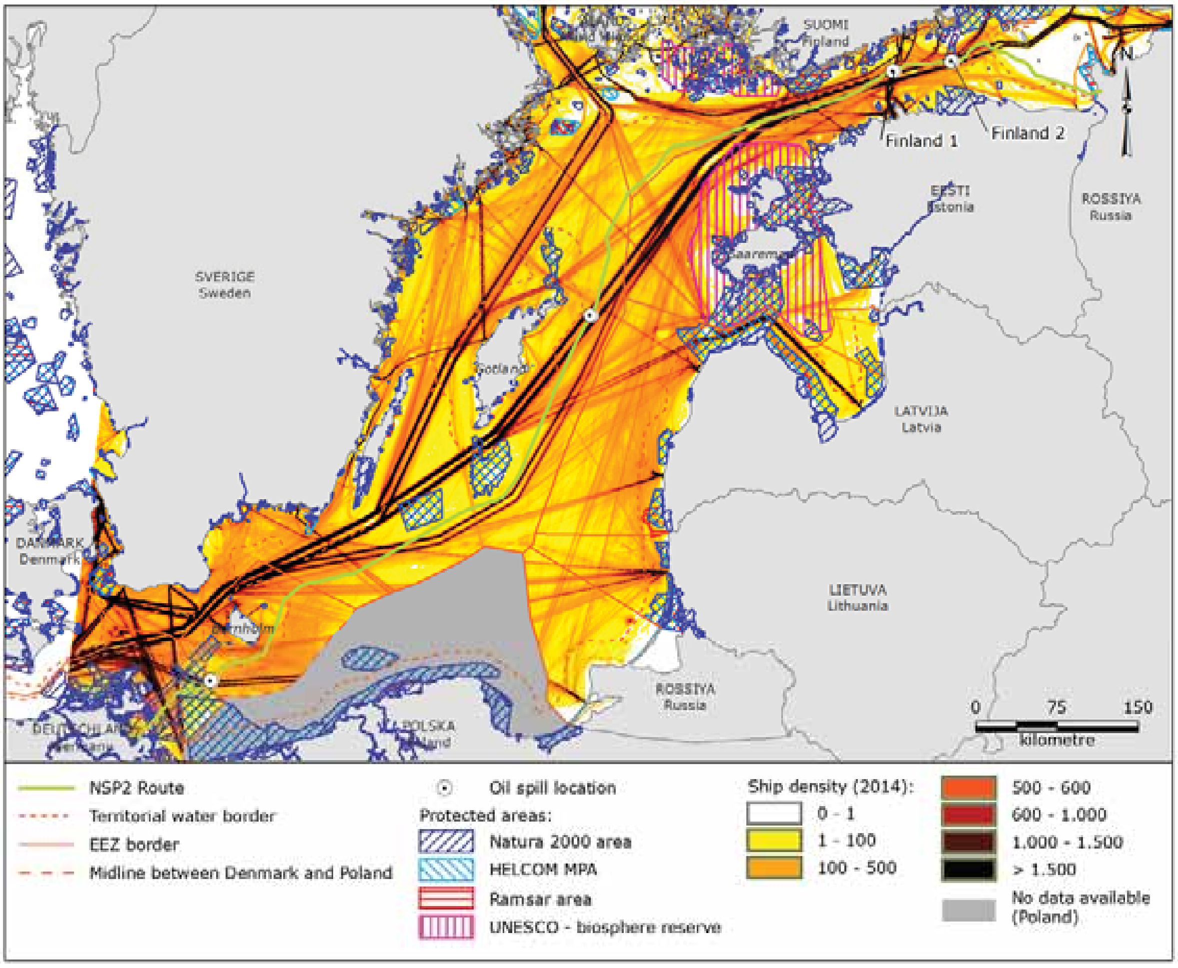

Figure 16-2. Locations of simulated accidental oil spills, the planned pipeline route, ship traffic intensity and protected areas in the Baltic Sea

For the purposes of the simulation, it is assumed that the duration of a spill is six hours, i.e. the time in which the spill location should be reached by the relevant response unitsaccording to HELCOM recommendations.

Drift simulations have been carried out to determine the likelihood of an area being contaminated by spilled oil. The spill simulations are based on an ensemble of 120 oil spills. The 120 simulations were evenly distributed over the period of one year in order to get all seasons represented.

Figure 16-3 indicates the probability of oil occurrence for the selected oil spill after a two-day drift period at spill location "Finland 1".

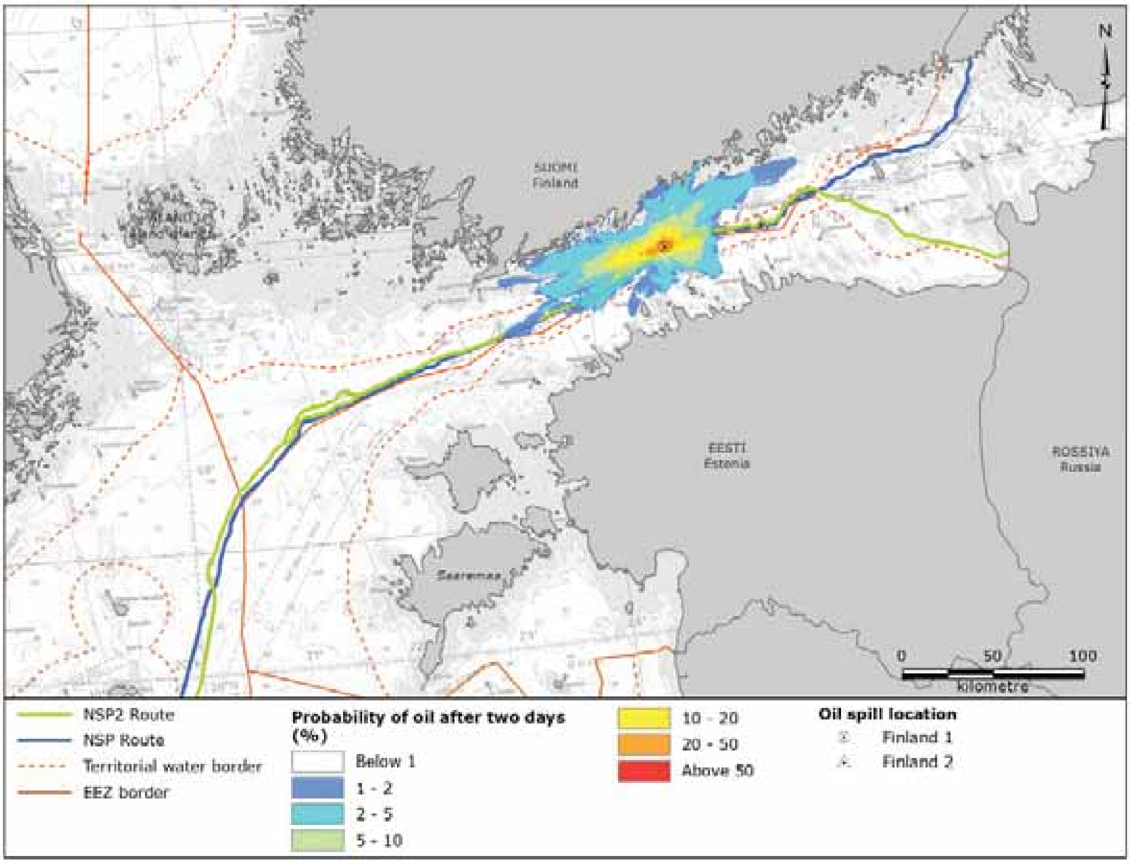

Figure 16-3. Probability of oil occurrence after two days at spill location "Finland 1".

The consequences of an oil spill at the two locations in the Gulf of Finland are relatively similar. After two days, the oil from the spill could reach the coastlines of Finland and Estonian waters – however, with a probability of less than 5 %.

It is concluded that during construction NSP2, as a consequence of the increased traffic, will cause a negligible increase in the risk of an accidental oil spill during construction. The theoretical increase in the annual oil spill frequency in the Finnish EEZ due to the NSP2 project is assessed to be less than 0.01‰, which is a very low risk. In addition, the increased traffic caused by NSP2 activities will occur only within a limited period of time.

In case of an accidental oil spill, there is a risk of coastal impacts and impacts to Natura 2000 areas or other protected areas. However, the spill scenarios are similar to those which would be generated even without the project and as a result of the existing shipping in the area.

16.1.1.3 Potential impacts of oil spill on the environment

When oil is spilled, it goes through physical processes such as evaporation, spreading, dispersion in the water column and sedimentation to the seafloor. Eventually, the oil will be eliminated from the marine environment through biodegradation. Figure 16-5 shows changes in the relative importance of weathering processes with time and the width of each band indicating the importance of the process – crude oil spill as an example.

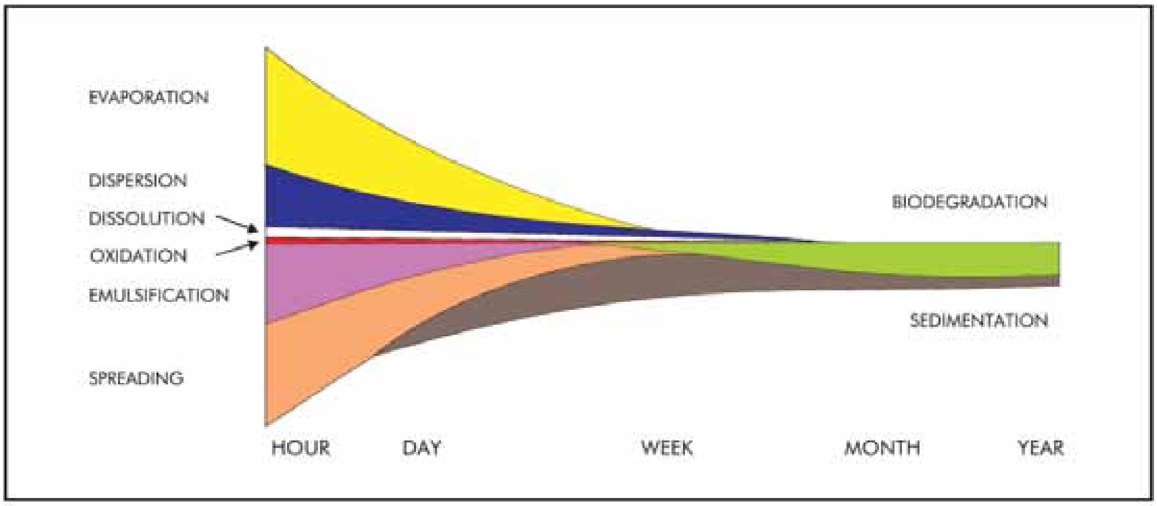

Figure 16-4. A schematic representation of the fate of crude oil spill. (ITOPF, 2014, Fate of marine oil spills, technical information paper 2)

The effects of oil spills at sea depend on numerous factors, such as:

- the amount of oil spilled
- the properties, toxicity, and stability of the oil;
- the rate of spread of the oil slick;
- the size and location of the spill;
- the time or season of the accident;
- the species biodiversity at the site of the oil spill;
- environmental sensitivity, i.e., proximity of bird habitat;
- biological, chemical and physical processes occurring at the spill site, such as evaporation, dissolution, dispersion, emulsification, photo-oxidation and biodegradation.

Oil spills pose a threat to the marine environment and cause damage to sea and shores ecosystems. Many of the petroleum-related chemicals that are spilled are toxic or can be bioaccumulated in the tissues of marine organisms. Such chemicals may then be biomagnified up the marine food chain from phytoplankton to fish, birds and marine mammals. Consequences from oil spill on fish, birds and marine mammals are described below (Rogowska and Namiesnik 2010).

<u>Fish</u>

Fish may be exposed to spilled oil in different ways. The water column may contain toxic and volatile components of oil that may be absorbed by fish at different stages of development. Toxic compounds can be consumed together with contaminated food sources. Direct contact with oil causes blockage of the gills. Fish exposed to oil may suffer from changes in heart and respiratory rates, enlarged livers, reduced growth, fin erosion, as well as a variety of biochemical and cellular changes, and reproductive and behavioural responses.

<u>Birds</u>

Often the most visible victims of an oil spill are seabirds, who spend significant amounts of time on the water surface or along the shoreline. The primary effect of oil contamination on birds is the loss of body insulation that is provided by the feathers. The cold water reaches the skin, which leads to hypothermia and death. Furthermore, large amounts of oil cause the feathers to stick together, impairing flight and buoyancy. Birds may ingest and/or inhale oil while trying to preen or eat contaminated food. Consequently, they suffer rapid, short-term or long-term effects, such as damage to the lungs, kidneys and liver, and gastro-intestinal disorders.

Marine mammals

A major oil spill may impact marine mammals which come into contact with the spill. Impacts are related to direct contact with the oil, where smothering of seals may occur leading to inflammation, infection, suffocation, hypothermia and reduced buoyancy. Seals can also lose their shoreline habitat if oil washes up on their haul-out sites.

Protected areas

Impacts on animals and habitats e.g. in coastal areas can subsequently impact protected areas and biodiversity.

Based on HELCOM Recommendation 11/13, it is assumed that the countries around the Baltic Sea are capable of controlling a major oil spill within two days of a release, and thereby impacts on the marine environment will be minimised *(HELCOM 1990)*. Various mitigation measures developed by NSP2 will be in place to minimise the risk of oil spill caused by accidents (Subchapter 16.3).

As the NSP2 project, as a consequence of the increased traffic, will cause negligible increase in the risk of an accidental oil spill, the overall significance of the impact is assessed to be negligible.

Potential transboundary impacts of unplanned events are addressed in Subchapter 13.8.

16.1.2 Risk to third party personnel

Offshore third party exposure, relevant in the Finnish sector, is limited to the crews and passengers of passing vessels that could collide with construction vessels. Specific risks associated with shallow water and landfall are not relevant in the Finnish sector.

The pipeline will cross many existing ship traffic routes and these are illustrated in Figure 16-6. The Figure also depicts the weight coating plants and storage yards. For more detailed information on ship traffic in the Finnish sector, see Subchapter 11.12 Ship traffic.

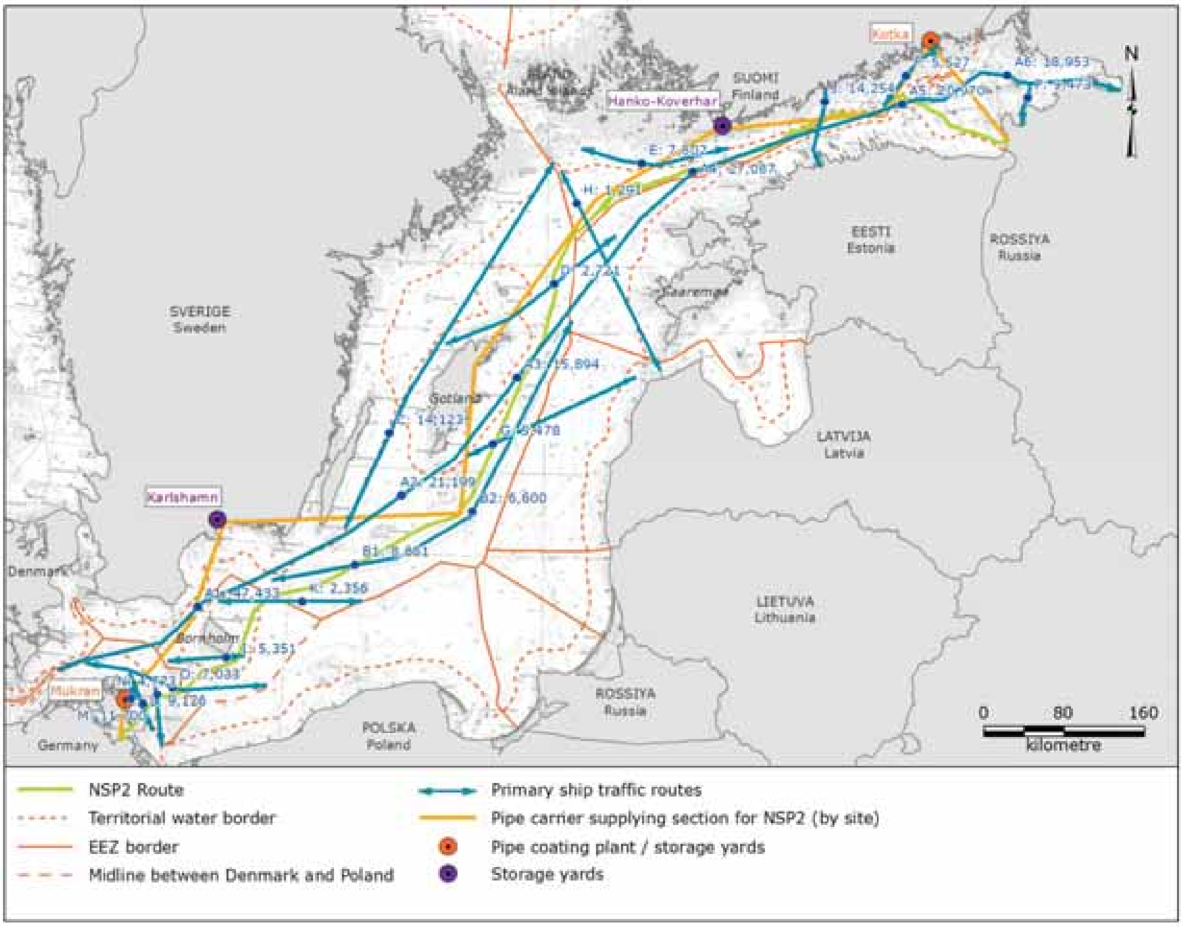

Figure 16-5. **Illustration of the major ship traffic routes, and the weight coating plants (purple marker) and storage yards (red marker). The annual number of ship movements for each route during 2014 and the route name are presented in boxes.**

During the construction of the NSP2, there will be an increase in ship traffic in the Baltic Sea due to the movements of the intervention work vessels, pipe carriers and pipe lay vessels. When a construction vessel crosses an existing shipping route, there is a risk of a ship-to-ship collision.

16.1.2.1 Ship collision frequency

An assessment of the frequency of ship collisions between the construction vessels (pre-lay intervention work vessels, pipe carriers and pipe lay vessel) and the general ship traffic are presented in the ship-to-ship collision report *(Nord Stream2 AG 2016e)*.

The estimated annual frequency for ship collision, individual risk and group risk have been estimated for the section of pipe in each country along the route. This has been carried out using the same methodology, and the results for the Finnish section of the pipeline are summarised in Table 16-4.

Table 16-4. **Estimated annual frequency for ship collision in the Finnish EEZ, (Nord Stream 2 AG and Global Maritime 2016).**

Finland	Cargo Ship	Tanker	Passenger Ship
Frequency of ship collision per annum	$1.2 \cdot 10^{-4}$	$3.9 \cdot 10^{-5}$	$7.8 \cdot 10^{-5}$

Adding up the results in Table 16-4, the total increase in annual ship collision frequency in the Finnish sector during the construction of NSP2 is calculated to be $2.4 \cdot 10^{-4}$ collisions per year, i.e. an equivalent to an average of one collision every 4,220 years.

The ship traffic in the Baltic Sea is dense and each year a number of ships are involved in accidents. The observed number of ship-to-ship collisions in the Baltic Sea area, involving vessels of similar size as in the ship-to-ship collision study, in the period from 2007–2013, has on average been 24 ship-to-ship collisions per year (Nord Stream AG and Ramboll 2015). Most of the observed ship-to-ship collisions occur closer to the shore and mainly in the vicinity of ports. Comparing this with the estimated increased frequency of ship collisions introduced during the construction phase, it can be concluded that the construction of NSP2 will have a negligible impact on the current frequency of ship-to-ship collisions. The increase in the annual ship-to-ship collision frequency due to the construction of the NSP2 will be very limited. The reason for this is that compared to the total commercial traffic in the Baltic Sea area, the offshore activities associated with the construction of NSP2 are very limited.

16.1.2.2 Risk for third party fatalities

The individual risk and group risk have been estimated for the section of pipe in each country along the route. The results for the Finnish section of the pipeline are summarised in Table 16-5.

Table 16-5. Individual risk of third party fatalities, (Nord Stream 2 AG and Global Maritime 2016).

Finland	Cargo Ship	Tanker	Passenger Ship
Individual risk of third party fatality	$3.5 \cdot 10^{-7}$	$8.7 \cdot 10^{-8}$	$9.7 \cdot 10^{-10}$

The tolerability criteria for individual risk in the offshore industry (i.e. the probability of a fatal accident) are generally set as that provided in Table 16-6. It can be seen that the individual risk of third party fatalities, as provided in Table 16-5, are below the tolerability criteria.

Table 16-6. Tolerability criteria for individual risk in the offshore industry (Nord Stream 2 AG and Global Maritime 2016).

	Tolerability criteria for individual risk (probability of a fatal accident)
Maximum tolerable risk for the public	10^{-4} per person per year
Broadly acceptable risk	10^{-6} per person per year

Group risk, or the risk experienced by the whole group of personnel working on the installation or otherwise affected by it, is usually expressed as an F-N curve, as in Figure 16-5, showing the cumulative frequency (F) of events involving N or more fatalities.

Risks above the red line are in the "Unacceptable Region", i.e. risk that cannot be justified except in extraordinary circumstances. Risks between the red and green line are in the "Tolerable Region (ALARP)", i.e. risks are only tolerable if risk reduction would exceed the improvement gained. Finally, risks below the green line are in the "Broadly Acceptable Region", i.e. the level of residual risk regarded as insignificant and further effort to reduce risk is unlikely to be required.

The group risks for third party fatalities from ship-to-ship collisions in the Finnish sector, during the construction phase of NSP2, are shown in Figure 16-6 (Nord Stream 2 AG and Global Maritime 2016).

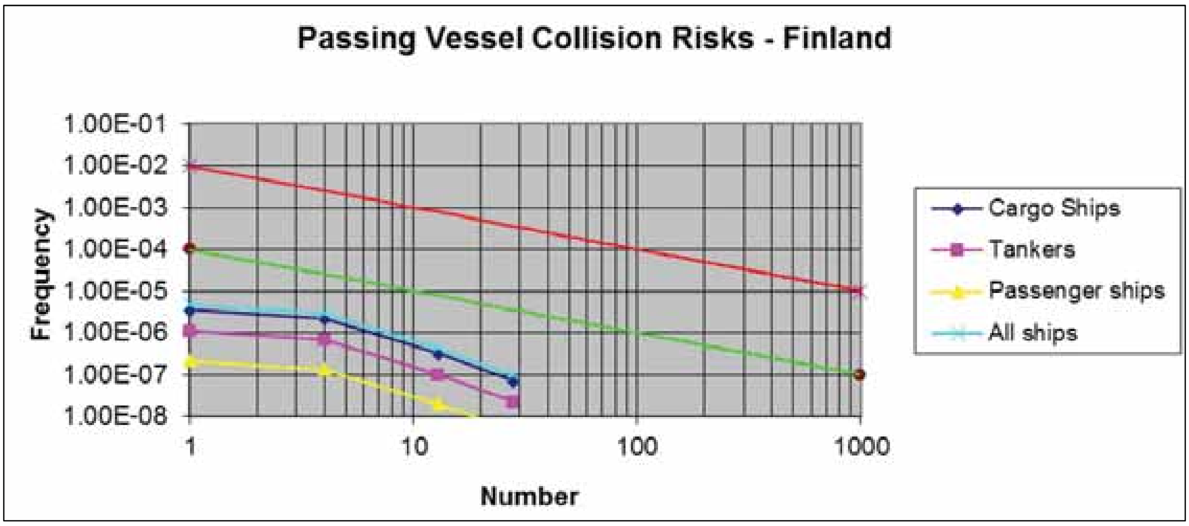

Figure 16-6. **Group risk for third party fatalities from ship-to-ship collisions in the Finnish sector during the construction phase of NSP2, (Nord Stream 2 AG and Global Maritime 2016).**

As indicated in Figure 16-6, the group risks for third party fatalities from ship-to-ship collisions in the Finnish sector, during the Construction Phase of NSP2, is within the broadly acceptable region.

The assessment considers risks to the public, i.e. vessel crews, onshore crews, third party personnel (e.g. on passing ships). The frequency of ship collisions between the NSP2 construction vessels and the general ship traffic has been assessed, and the potential consequences of a collision, with respect to third-party fatalities, have been evaluated and compared to risk tolerability criteria. In conclusion, the risk to the public (third-party personnel) in the construction phase is within the broadly acceptable region *(Nord Stream 2 AG and Global Maritime 2016)*.

16.2 Risk assessment - Operation phase

The risk assessment for the operation phase is related to pipeline failures and potential subsequent gas release. The main steps of the risk assessment are:

- Identification of failure causes.
- Evaluation of release frequency.
- Consequence assessment and definition of outcome scenarios.
- Risk and impacts to the environment
- Risk to third party personnel and a comparison with the risk acceptance criteria.

The risks for fatalities has been evaluated by means of a quantitative approach based on an F-N curve. The risk to the environment has been evaluated by means of a semi-quantitative approach based on a risk matrix.

16.2.1 Identification of failure causes

The possible failure causes leading to unplanned releases of gas are identified on the basis of literature data on offshore gas pipeline incidents *(PARLOC 2001)*, and the HAZID report *(Nord Stream 2 AG and Saipem 2016d)*.

The following failure causes, that may threaten the pipeline integrity, are managed adequately through the application of the relevant DNV-GL standards:

- Natural hazards due to current and wave action – DNV RP-F109-2011.
- Pipeline free spanning sections – DNV RP-F105-2006.
- External interference with fishing activities – DNV RP-F111-2014.
- Operating temperature and pressure conditions – DNV RP-F110-2007.

With regards to external interference with fishing activities, the interaction between trawl gear and the pipeline has been analysed in the report "Pipe/Trawl Gear Interaction Study" *(Nord Stream 2 AG and Saipem 2016e)*. The report investigates the structural consequences from impact, pull-over and hooking of trawl gear on the pipeline. With respect to the Finnish section of the pipeline, it is concluded that interaction with trawling devices is not an issue for pipeline structural integrity, according to design procedures and acceptance criteria provided in DNV RP-F111-2014. This is due to the fact that no bottom trawling has been registered in Finnish waters close to the pipeline alignment (Subchapter 7.17)

These failure causes are, therefore, not described further in the present report.

The risk of unexploded munitions is addressed with adequate surveys in the pipeline corridor during the design phase. During the operation phase, requirements for pipeline external inspections to keep the pipeline corridor monitored will be developed as part of the inspection and monitoring plan. Based on these considerations, the above-mentioned interferences are not considered further in the operational risk assessment.

The following failure causes are identified as applicable and considered in this risk analysis:
- Corrosion (internal and external).
- Mechanical defects.
- Natural hazards (storm, scouring).
- Seismic activity and geotechnical instability.
- Other/unknown (sabotage, accidental transported mines, etc.).
- Interaction with third party activities (commercial ship traffic).

These failure causes are described in the following subchapters.

16.2.2 Evaluation of release requency

The release frequencies for the following failure causes are estimated from the PARLOC 2001 database *(PARLOC 2001)* and the PARLOC 2012 database *(PARLOC 2012)*:
- Corrosion(internal and external);
- Mechanical defects;
- Natural hazards (storm, scouring);
- Seismic activity
- Geotechnical instability;
- Other/unknown (sabotage, accidental transported mines, etc.).

The PARLOC database contains incidents and related loss of containment from offshore pipelines operated in the North Sea. Information from this database has been used since no specific data is available for the Baltic Sea.

In this database, incidents are grouped in the following leak size categories:
- Pinhole: 20 mm (hole sizes with diameter < 20 mm)
- Hole: 80 mm (hole sizes with diameter between 20 and 80 mm)
- Full bore rupture: internal pipeline diameter (hole sizes with diameter > 80 mm)

16.2.2.1 Corrosion

The frequency of release due to corrosion is considered "negligible" for this project because of the following reasons:

- The transported medium is dry and sweet natural gas and the internal flow coating will also reduce the probability of internal corrosion;
- External corrosion protection is achieved by an external corrosion coating in combination with the cathodic protection system.
- The wall thickness of the NSP2 pipelines (i.e. between 26.8 and 41.0 mm) is considerable and pigging is foreseen to detect any possible loss of thickness caused by corrosion before the wall thickness achieves the critical level.
- The anode potential will be measured to verify anode operability and anode consumption which is indicative of coating deficiencies.
- An inspection and maintenance program is foreseen.

16.2.2.2 Mechanical defects

Release due to material defects is considered a rare event, particularly for modern pipelines where advanced pipe technology and quality control, as well as welding technology and control procedures are applied.

Consequently, the frequency of release due to mechanical defect is considered "negligible" since the following measures have been adopted:

- All materials, manufacturing methods and procedures will comply with recognised standards, practices or purchaser specifications;
- NDT (Non Destructive Testing) examinations at production sites will be performed according to DNV-GL standards.

16.2.2.3 Natural hazards

According to the PARLOC 2001 database *(PARLOC 2001)*, 13 incidents due to natural hazards (including waves and current action) have been reported. However, none of these caused loss of containment (release) from steel pipelines. Only 3 lines sustained damage, this being to their coating.

In the PARLOC 2012 database *(PARLOC 2012)*, natural hazards are included in the category 'Others'. No incidents are reported for steel pipelines in the midline section under this category. Furthermore, natural hazards due to current and wave action are managed adequately through the application of the relevant DNV-GL standard DNV RP-F109, as mentioned above.

Consequently, this failure cause is considered "negligible".

16.2.2.4 Seismic activity

During the planning of NSP, a probabilistic seismic hazard analysis was prepared for the entire route and region and seismic design parameters were defined at selected points, at approximately 100 km intervals, along the route. It was concluded that seismicity in the region, and, hence, along the route, is "very low to low", also compared to other regions in Europe. The same was concluded for the risk of seismic hazard *(Nord Stream 2 AG 2016b)* Furthermore, it is mentioned in Saipem´s hazard identification report that the documentation related to seismic activity, developed during the design of NSP, shall be evaluated and included in the design of NSP2. *(Saipem 2016b)*.

Consequently, this failure cause is considered "negligible".

16.2.2.5 Geotechnical instability

With respect to geotechnical instability, it is mentioned in the hazard identification report that the loss of foundation and pipeline stability is an item covered under normal design, based on information from geotechnical surveys performed for NSP2. *(Saipem 2016b)*.

Consequently, this failure cause is considered “negligible”.

16.2.2.6 Other/unknown causes

Other/unknown causes include all the incidents for which no specific causes have been identified. However, no leakage has been recorded for large diameter operating steel lines.

For this project, the design systematic failures will be reduced to negligible level by applying appropriate quality assurance/quality control (QA/QC) procedures, design review meetings and dedicated health, safety, environmental and social (HSES) reviews and studies.
Only sabotage, military exercises and/or accidental transported mines are identified as possible “other/unknown” causes but are considered very unlikely.

Other interferences that may derive from surveys and construction of nearby/crossing installations, foreseen to be installed once NSP2 is in operation, are considered to be negligible, as they will be addressed with dedicated interfaces between project teams at design stage.

16.2.2.7 Interaction with third party activities

For offshore pipelines, interaction with third party activities is related to commercial ship traffic and the following initiating events are identified:

- Sinking ships.
- Dropped objects.
- Dropped anchors.
- Dragged anchors.

Release frequencies due to interaction with third party activities related to commercial ship traffic are evaluated by means of mathematical modelling in the frequency of interaction assessment *(Nord Stream 2 AG and Saipem 2016a)* and pipeline damage assessment *(Nord Stream 2 AG and Saipem 2016b)*.

Initially, a number of sensitive pipeline sections have been identified. The sensitive pipeline sections are those where the frequency of ships crossing the pipeline exceeds a criterion value of 250 ships/km/year. The criterion value corresponds to less than one ship/km/day. For each identified section where this level or greater of ship activity exists, the interaction frequency is estimated. The critical sections within Finnish waters are shown in Table 16-7 (section 1 to 9). The total length of the sensitive pipeline sections comprises approximately 34 % of the total pipeline length in the Finnish section.

Table 16-7. Sensitive pipeline sections related to ship traffic threats within Finnish waters (Nord Stream 2 AG and Saipem 2016c).

Section	From KP* [km]	To KP [km]	Section length [km]
1	20	34	15
2	46	71	26
3	89	98	10
4	110	121	12
5	133	142	10
6	152	161	10
7	175	184	10
8	210	219	10
9	236	259	24

* KP 0 = Russian border

For each of the sensitive sections described in Table 16-7, the annual pipeline failure frequency has been assessed *(Nord Stream 2 AG and Saipem 2016a)*. A summary of the results is shown in Table 16-8.

Table 16-8. Failure frequency per section per year for the Finnish section (Nord Stream 2 AG and Saipem 2016c).

Section	Dropped objects	Dropped anchors	Dragged anchors	Sinking ships	Total
	(failure/section/year)				
1	$1.49\cdot10^{-9}$	$8.31\cdot10^{-12}$	$4.01\cdot10^{-5}$	$3.78\cdot10^{-7}$	$4.04\cdot10^{-5}$
2	$2.07\cdot10^{-9}$	$1.72\cdot10^{-11}$	$3.61\cdot10^{-5}$	$3.48\cdot10^{-7}$	$3.64\cdot10^{-5}$
3	$1.55\cdot10^{-10}$	$8.29\cdot10^{-12}$	$5.22\cdot10^{-5}$	$4.50\cdot10^{-7}$	$5.27\cdot10^{-5}$
4	$1.85\cdot10^{-9}$	$2.79\cdot10^{-11}$	$3.80\cdot10^{-6}$	$1.83\cdot10^{-7}$	$3.98\cdot10^{-6}$
5	$2.59\cdot10^{-10}$	$1.75\cdot10^{-12}$	$9.66\cdot10^{-7}$	$4.81\cdot10^{-8}$	$1.01\cdot10^{-6}$
6	$3.11\cdot10^{-10}$	$2.71\cdot10^{-12}$	$5.19\cdot10^{-7}$	$4.00\cdot10^{-8}$	$5.59\cdot10^{-7}$
7	$1.41\cdot10^{-10}$	$1.19\cdot10^{-12}$	$5.05\cdot10^{-6}$	$4.70\cdot10^{-8}$	$5.09\cdot10^{-6}$
8	$1.67\cdot10^{-10}$	$9.67\cdot10^{-13}$	$3.81\cdot10^{-6}$	$4.84\cdot10^{-8}$	$3.86\cdot10^{-6}$
9	$1.66\cdot10^{-9}$	$1.54\cdot10^{-11}$	$3.11\cdot10^{-6}$	$2.12\cdot10^{-7}$	$3.33\cdot10^{-6}$

It should be noted that not all pipeline failures lead to a gas release; i.e.gas release frequencies are only a subset of the pipeline failure frequency.

Three different gas-release scenarios are considered: gas release from a *pinhole* (20 mm), a *hole* (80 mm) and a full-bore *rupture* (>80 mm). The gas release frequencies due to failure of the pipeline distributed according to pinhole, hole and full-bore rupture are shown in Table 16-9.

Table 16-9. Gas release frequency per year per section for pinhole, hole and full-bore rupture scenarios for the Finnish section (Nord Stream 2 AG and Saipem 2016c).

Section	Pinhole	Hole	Rupture	Total
	(occurrence/sect/year)			
1	$1.89\cdot10^{-8}$	$1.89\cdot10^{-8}$	$1.24\cdot10^{-5}$	$1.24\cdot10^{-5}$
2	$1.74\cdot10^{-8}$	$1.74\cdot10^{-8}$	$1.11\cdot10^{-5}$	$1.12\cdot10^{-5}$
3	$2.25\cdot10^{-8}$	$2.25\cdot10^{-8}$	$1.61\cdot10^{-5}$	$1.61\cdot10^{-5}$
4	$9.17\cdot10^{-9}$	$9.17\cdot10^{-9}$	$1.30\cdot10^{-6}$	$1.32\cdot10^{-6}$
5	$2.41\cdot10^{-9}$	$2.41\cdot10^{-9}$	$3.33\cdot10^{-7}$	$3.38\cdot10^{-7}$
6	$2.00\cdot10^{-9}$	$2.00\cdot10^{-9}$	$1.92\cdot10^{-7}$	$1.96\cdot10^{-7}$
7	$2.35\cdot10^{-9}$	$2.35\cdot10^{-9}$	$1.56\cdot10^{-6}$	$1.56\cdot10^{-6}$
8	$2.42\cdot10^{-9}$	$2.42\cdot10^{-9}$	$1.19\cdot10^{-6}$	$1.19\cdot10^{-6}$
9	$1.06\cdot10^{-8}$	$1.06\cdot10^{-8}$	$1.12\cdot10^{-6}$	$1.15\cdot10^{-6}$

16.2.3 Consequence assessment and definition of outcome scenarios

The consequence assessment of subsea gas releases has involved several steps, starting from depressurisation calculations, underwater release, effects at sea surface and the atmospheric modelling of gas dispersion, and finally the assessment of the physical effects of the final outcome scenario *(Nord Stream 2 AG and Saipem 2016c)*. The physical effects are related to exposure to the thermal effects in case of ignition of the released gas.

The assessment of the consequences of a potential gas release has been performed for three damage scenarios, according to the hole dimension (*pinhole*, *hole* and *rupture* as defined in Subchapter 16.2.2).

The subsea dispersion is modelled in order to provide parameters such as plume width, gas volume fraction and mean velocities at the sea surface. These parameters constitute the input to the atmospheric dispersion model.

On reaching the surface, the gas will begin to disperse into the atmosphere. The nature of the dispersion depends upon the molecular weight and on the source conditions at the surface. In general, the resulting source has a large diameter but the gas has a very low velocity.

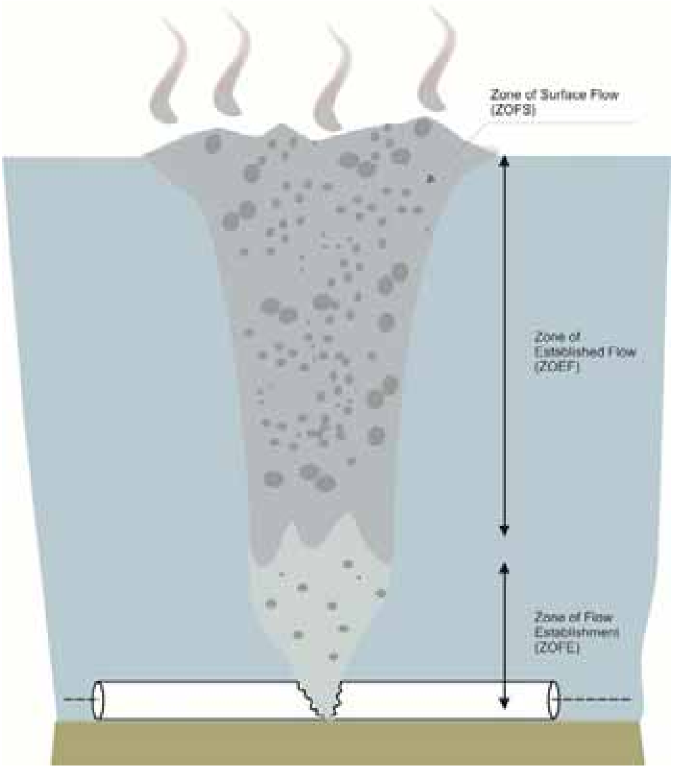

Figure 16-7. Schematic drawing of the release of gas from an offshore pipeline.

The radii of the zone of surface flow (central boil region) for the three scenarios are summarised in Table 16-10.

Table 16-10. Results of underwater gas dispersion calculations (Nord Stream AG and Ramboll 2009).

Leakage	Water depth	Radius at surface
	(m)	(m)
Pinhole	69.7	7.4
Hole		8.2
Rupture		17.4

Following a loss of containment event from the subsea pipelines, the possible outcome scenarios are either atmospheric dispersion or flash fire.

16.2.4 Risk and impacts to the environment

A semi-quantitative approach has been adopted using the risk matrix methodology (see Figure 16-2) to predict the risk level for the environment. According to the risk assessment, all scenarios are acceptable (‘Low’ risk as expressed in Figure 16-2), *(Nord Stream 2 AG and Saipem 2016c)*.

The potential impact to the environment will depend on the type of leak, its magnitude and the type of repair required. The risk is limited to the existing ship traffic in the Baltic Sea where some sensitive sections (e.g. high traffic intensity) have been identified. The probability of pipeline failure related to dragged anchors or sinking ships is low, see Table 16-7.

Natural gas is primarily composed of methane, but also often contains related organic compounds, as well as carbon dioxide, hydrogen sulphide, and other components. Methane is a greenhouse gas and is known to influence the climate with a warming effect.

Natural gas exhibits negligible solubility in water and, thus, has little effect on water quality. The gas will rise to the water surface and be released into the atmosphere. The movement of gas through the water column would have the potential to impact marine organisms (such as fish and marine mammals), resulting in potential acute or chronic impacts depending upon exposure levels. The gas is not toxic and atmospheric dispersion has no impact or risk of fatalities. However, in the unlikely event of a flash fire, it can be assumed that anyone directly exposed to the flash fire will suffer fatal consequences.

A short thermal impact in the form of a temperature drop caused by gas expansion may occur in the surrounding water. Another possible impact on water quality from an accidental pipeline rupture and gas release is a possible updraft of bottom water. This could cause bottom water to be mixed with surface water, thus, having a local impact on salinity, temperature and oxygen conditions.

In the unlikely event of gas release, it is estimated that fish, marine mammals and birds within the gas plume or the subsequent gas cloud will die or flee the area. The impact would be restricted to the area immediately surrounding the rupture.

As the probability of a pipeline failure is low and, therefore, there is only a minor increase in the risk of an accidental gas release, the overall significance of the impact is assessed to be negligible.

16.2.5 Risk to third party personnel and comparison with risk acceptance criteria

As stated above, the possible outcome scenarios due to gas leakage are either atmospheric dispersion or flash fire. Since the gas is not toxic, atmospheric dispersion has no impact on risk of fatalities. The risk of fatalities is caused by the exposure to thermal radiation following the ignition of released gas. No congested or confined areas can be reached by a flammable cloud along the offshore pipeline and, thus, explosion scenarios cannot occur.

The effects of outcome scenarios are assessed using the software DNV PHAST 6.7. The results of the dispersion calculations, giving the extension of the gas cloud to the lower flammable limit[15] (LFL) is shown in Table 16-10.

Table 16-11. Extent of hazardous gas cloud (Nord Stream 2 AG and Saipem 2016c).

Hole size	Distance of flammable limits at 10 m height above the sea	
	LFL (m)	½LFL (m)
Pinhole	Not reached	Not reached
Hole	60	89
Rupture	59	78

When flammable substance vapourizes to atmosphere, a flammable cloud forms and spreads to the air. If this flammable cloud ignites by the ignition source before it is diluted below its flammable limit (delayed ignition), the flash fire is possible. Flash fires generally have a short duration and, therefore, do less damage to equipment and structures than to personnel on a ship directly exposed to a flash fire. It is conservatively assumed that anyone directly exposed to a flash fire will suffer fatal consequences. To determine the area covered by a flash fire and, therefore, the potential impact on people, flammable gas dispersion results (distances of LFL/2 concentration) has been considered in the risk analysis.

In order to assess the ignition probability, two contributions have been evaluated:

- Probability of a ship crossing the hazardous area in the time interval of cloud persistence.
- The probability of delayed ignition given a ship present in the area.

[15]: Lower flammable limit (LFL) is the lower end of the concentration range over which a flammable mixture of gas or vapour in air can be ignited.

In the estimation of ignition probabilities as showin in Table 16-11, the cloud persistence time has been assumed in analogy to NSP taking into account leak detection time and local ship traffic.

Table 16-12. Ignition probability and cloud persistence time (Nord Stream 2 AG and Saipem 2016c)

Release size	Ignition probability	Persistence time (h)
Pinhole	0.11	6
Hole	0.27	4
Rupture	0.70	2

The total risk of fatalities imposed by the pipeline system on its workers and any third party is expressed as an F-N diagram as shown in Figure 16-8. In this figure the fatality frequency per year per system (F) is represented versus the number of fatalities (N). With regards to NSP2, the criteria are applied to each pipeline sensitive section as identified in Table 16-7.

The risk for fatalities is caused by the exposure to thermal radiation following the ignition of released gas. The most exposed potential third party would be the crew members/passengers on board the vessels crossing the pipelines. For each identified scenario, the number of fatalities has been evaluated based on the number of individuals present on board and their vulnerability.

The F-N curve for each sensitive section is shown in Figure 16-8 for the pipeline route and compared to the risk acceptance criteria.

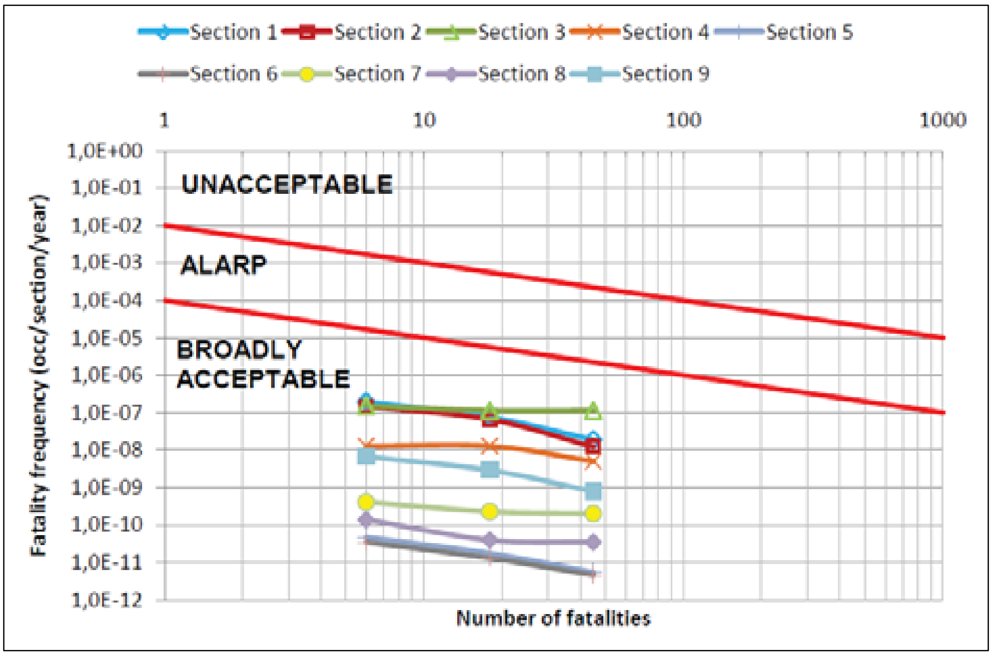

Figure 16-8. F-N diagram and F-N curve of each sensitive section of the preferred pipeline route.

In all sections, the societal risk falls in the broadly acceptable region and, therefore, no further actions are required.

In the risk assessment (Nord Stream 2 AG and Saipem 2016c), it is concluded that, in view of the conservative assumptions included in the risk assessment and the uncertainties of this type of analysis, no protective measure is deemed necessary.

16.3 Emergency preparedness

To prevent or mitigate potential impacts from accidents and unplanned events during construction, Nord Stream 2 AG has developed a mitigation strategy. The scope of this strategy covers both normal ship operations and project-specific construction activities that pose a risk to the environment or third parties.

Methods to prevent or mitigate potential impacts from unplanned events during construction include are (but not limited to):

- Compliance with MARPOL requirements related to discharge of oil and waste products
- The development of offshore spill response plans
- Oil spill clean-up kits on vessels and construction sites to address any local spills
- Preparation of procedures, hazard identification exercises and toolbox talks before any construction activities start
- Safe work procedures for anchor-handling in line with HELCOM requirements to mitigate any risk of contact with munitions
- Preparation and practising of emergency response procedures.

Contractors working for the project are required to have HSES management systems in place. This includes the requirement for company-approved HSES plans that are specific to the hazards and risks associated with the contractor's scopes of work and work sites. NSP2, through audits and inspections at the contractor's worksites, will ensure that the above requirements are adhered to. Plans and procedures will be periodically tested and improvements made.

All incidents and nonconformities are reported to the appropriate level of management. Immediate notification of the authorities in the event of emergencies is part of the emergency response plans. Procedures are in place to immediately respond to incidents and nonconformities in order to minimise their consequence. HSES incidents are investigated in order to determine root causes and to prevent recurrence.

NSP2 will develop and implement an emergency response plan for the operations phase. This will be supported by the following:

- Pipeline inspection
- Monitoring, and pipeline emergency shutdown equipment including automation
- Redundancy in control systems
- Response procedures
- Training and drills
- Cooperation and coordination with relevant Baltic Sea emergency response agencies
- Communication protocols
- Ongoing review and improvement.

16.3.1 Emergency preparedness and response

Although the NSP2 pipeline will be designed and constructed to operate safely throughout its operating life, it is prudent to have plans and procedures in place to respond to foreseeable emergencies. Emergency, Preparedness and Response (ERP) is an integral part of the NSP2 Health, Safety, Environmental and Social Management System (HSES MS).

The ERP plans and procedures will be in place to minimise the HSES effects as follows:

- All NSP2 worksites, including those operated by contractors and suppliers, will have an emergency notification plan and assigned emergency responders to ensure proper and fast reaction to and management of emergencies.
- Emergency plans will be documented, accessible and easily understood.
- The effectiveness of plans and procedures will be regularly reviewed and improved, as required.
- Plans and procedures will be supported by training and, where appropriate, exercises.

16.3.2 Spill response and preparedness

Oil and chemical spills pose a risk to the environment and people. Mitigation measures to address potential spills are documented in the Offshore Pollution Prevention and Waste Mitigation Strategy.

16.3.3 Chance Find Procedure

A variety of screening and detailed surveys have been conducted by Nord Stream 2 during the process of selecting the routes of the Nord Stream 2 Project pipelines. These surveys have lead to the identification of various materials of an anthropogenic nature on or around the footprint of the Project. Two types of anthropogenic materials require special consideration:

- Munitions, or munitions-related materials
- Cultural heritage materials or sites

Known occurrences of munitions or items of cultural heritage will be avoided where possible, or appropriately managed.

NSP2 continues to conduct extensive and intensive surveys to identify munitions and munitions-related materials Therefore, the potential to make unexpected finds (‘Chance Finds’) of anthropogenic materials cannot be entirely discounted. It is for this reason that the Chance Finds Procedure has been developed. *(Nord Stream AG 2010b)*
Contractor personnel shall be informed, as part of the project HSE briefing, on the possibility of such materials being found. When material that may constitute a Chance Find is first encountered, the initial Chance Finds - Initial Steps Protocol will be immediately implemented.

This Chance Finds procedure is particularly relevant to those construction activities during which chance finds may feasibly be identified, namely during pre-lay surveys, seabed intervention, dredging, anchor handling and landfall construction. The contractors and sub-contractors involved in these construction activities are, therefore, required by NSP2 to comply with this procedure.

16.3.4 Navigation and Vessel Safety

Vessel safety during construction particularly, will be assured through a number of management actions:

- Communication and navigation systems and aids and associated procedures will be in place to ensure avoidance of collisions at sea.
- A single vessel will act as the centralised point of radio communications for each construction spread in order to manage movements.
- Tailored exclusion zones for the various construction vessel types will be maintained to ensure safe distances with third party marine traffic.
- The relevant authorities in each country will be notified of key construction events.
- Special precautions will be taken to safeguard shipping traffic installation when crossing shipping zones and traffic separation zones.
- Weather forecasting will be used to identify the potential onset of unstable/poor weather conditions and establishment of criteria for suspending construction activities.
- Pull tests & monitoring of construction vessel anchors will be undertaken to minimise the possibility of a dragged anchor.

16.3.5 Consultation Activities

NSP2 will ensure that there is a suitable emergency response plan (in line with HELCOM requirements) in place to mitigate impacts caused by unplanned environmental accidents (e.g. fuel/oil spill, disturbance of munitions, pipeline failure or sea accidents/collisions).

The emergency plan will include measures such as assignment of responsibilities for key safety protocols, safety equipment, training and drills. Key consultation activities included as part of this plan include:

- Communicating the results of the risk assessment to local authorities and emergency management personnel before construction begins to ensure that they are aware of project-related risks and that they can take precautions accordingly.
- Ongoing liaison with public authorities, particularly before major works or project activities will be carried out, to ensure that they are aware of major project phases and project development activities that could have implications for public safety.

16.4 Repair works

During the operation phase of the NSP2 pipeline system, there will be an extremely unlikely possibility of a pipeline failure due to causes described in Subchapter 16.2.1 and 16.2.2.

Nord Stream AG has prepared a document to provide guidance for effective and efficient coordination between Nord Stream and the involved authorities in the event of an unplanned intervention (emergency repair) on the Nord Stream Pipeline System within Finnish EEZ. The document includes an overview description of maintenance and emergency repair methods (here denoted Types of Service, ToS) considered to be the most feasible to ensure that safe operation of the pipeline can be resumed with minimal environmental impact. *(Rambol 2016h)*

Nord Stream AG has also prepared a document to describe and assess the environmental impacts in the event of an unplanned intervention (emergency repair) on the Nord Stream Pipeline System within the Finnish EEZ. *(Ramboll 2015e)*

Five (5) different so-called Types of Service (ToS) may be applied in the case of an alert / unusual event or confirmed emergency along the offshore section of the Nord Stream pipelines in the Finnish EEZ. The Types of Services (ToS) are listed in Table 16-13.

Table 16-13. **Types of Service.**

Type of Service	Reference description
Type 1 First Reaction + Damage Assessment	This ToS initially comprises a general survey to localise the damage location and upon the pipeline conditions being assessed as sufficiently safe, a detailed inspection to assess the damage. To perform the visual inspection, it may be necessary to debury the pipeline and/or remove external coating materials for better access to the damage.
Type 2 Maintenance/Remedial works	This ToS comprises remedial pipeline maintenance and integrity management works such as rock placement, mattress placement, grout bag placement and anode replacement. These activities are not in themselves repair activities, but can be undertaken as part of other ToS.
Type 3 Local Damage Repair	Damage is characterised as local when the damage is small (dent or pinhole) and only affects 1 pipe joints (~12m). This ToS involves installing a specially designed Repair Clamp on the pipeline to regain full pipeline integrity.
Type 4 Short Damage Repair	Damage is characterised as short when the damage affects a section length in the order of 1-2 pipe pieces. This ToS means cutting out and replacing the damaged pipe joints with a so-called pipe spool with the same pipe characteristics as the main pipeline system. Pipeline repair methods comprising HTWI or alternatively SWF + SMT are applicable pipeline repair methods for >30m water depth.
Type 5 Long Damage Repair	Damage is characterised as long when the damage affects a section length of hundreds of metres to several kilometres. This ToS means recovering the damaged section to a pipe-lay vessel and relaying the section. Tie-in with a permanent repair connection to the existing pipeline is performed by techniques involving hyperbaric welding or alternatively using mechanical flanges.

Nord Stream AG has commenced discussions with Finnish authorities about repair scenarios and their potential permitting/notifications needs in the unlikely event of an earlier presented Types of Service. Nord Stream has provided relevant documents to the authorities for comment.

16.4.1.1 Impacts on the environment

The assessment of the environmental impact from repair activities is based on the Nord Stream documents mentioned above *(Ramboll 2015e and Ramboll 2016g)*.

The result of the environmental assessment of Type 1–5 Services in the Nord Stream Project is summarised in the Table 16-14.

Table 16-14. Impact assessment of Type 1–5 Services in NSP. Overall significance of impacts of environmental and socio-economic parameters.

<table>
<tr><th rowspan="2">Activity</th><th colspan="5">Type 1–5 Services</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th></tr>
<tr><td>Restriction area</td><td colspan="5">No – Minor</td></tr>
<tr><td>Munition (relocate/clearance)</td><td colspan="5">No – Minor[1]</td></tr>
<tr><td>Surveys</td><td colspan="5">No</td></tr>
<tr><td>Sediment removal</td><td>Minor</td><td>-</td><td colspan="3">Minor</td></tr>
<tr><td>Coating removal</td><td>No</td><td>-</td><td colspan="3">No</td></tr>
<tr><td>Pipeline re-alignment</td><td>-</td><td>No-Minor</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Free-span corrections</td><td></td><td>Minor</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Anode replacement</td><td>-</td><td>No-Minor</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Pipeline support (grout bags)</td><td></td><td></td><td>Minor</td><td>-</td><td>-</td></tr>
<tr><td>Pipeline external protection[2]</td><td>-</td><td>Minor</td><td>-</td><td colspan="2">Minor</td></tr>
<tr><td>“Floatover technique” for clamp installation</td><td>-</td><td>-</td><td>No-Minor</td><td>-</td><td>-</td></tr>
<tr><td>Cut – out damaged pipeline section</td><td>-</td><td>-</td><td>-</td><td colspan="2">Minor</td></tr>
<tr><td>Dewatering pipeline section with MEG[3]</td><td>-</td><td>-</td><td colspan="3">No</td></tr>
<tr><td>Tie-in with HWTI technique[4]</td><td>-</td><td>-</td><td>-</td><td colspan="2">No</td></tr>
<tr><td>Pipeline re-commissioning[3]</td><td>-</td><td>-</td><td colspan="3">No</td></tr>
<tr><td colspan="6">1. Minor impact if clearance/blasting is undertaken.
2. Inclusive rock berm for support.
3. Type 3 Services only if pinhole damage with intrusion of seawater in pipeline.
4. Exclusive establishment of rock berm that is included under “Pipeline external protection”.
- Not relevant.</td></tr>
</table>

Table 16-14 shows that in NSP the overall significance of the effects from Type 1–5 Services on the environmental and socio-economic parameters has been assessed to result in “No impact - Minor impact”. The assessments described above are considered to be similar for NSP2.

17. MITIGATION MEASURES

17.1 General

Nord Stream 2 AG is committed to designing, planning and implementing the pipeline project with the least impact on the environment as is reasonably practicable. The environmental and social management system (ESMS) for dealing with planned impacts and emergency response is detailed in Chapter 19 of this report.

A key objective during the planning and designing of NSP2 has been to identify the means of reducing the adverse impacts of the project on the receiving environment. To achieve this, mitigation measures have continually been developed and integrated into the various phases of the project according to the mitigation hierarchy. These mitigation measures have been identified through consideration of legal requirements, best practice industry standards, applicable international standards (including World Bank EHS Guidelines and IFC Performance Standards), experiences from NSP and other infrastructure projects, as well as application of expert judgement.

In developing mitigation measures, the primary goal of the process has been to prevent or reduce any identified negative impacts. If it has been impossible to avoid an impact (i.e., there is no other technical or economically feasible alternative), minimisation measures have been planned. In cases where it is not possible to reduce the significance of negative environmental impacts through management actions, restoration or offset measures will be considered. This so called "mitigation hierarchy" is described further in the box below:

Methods to mitigate environmental impacts

Prevention
Prevention or reduction of potentially negative impacts can be achieved by changing or replacing planned activities. For example, it has been possible to prevent potentially negative environmental impacts by locating the pipelines sufficiently far away from sensitive or valuable areas, such as Natura 2000 areas and cultural heritage.

Mitigation
If no technical alternative is available, the next step is to mitigate. The most efficient method is to mitigate as close to the impact source as possible. For example, impacts on marine fauna can be mitigated/reduced by avoiding construction activities during periods when specific species are sensitive (e.g. fish spawning periods), and potential impacts from interaction with military practice areas can be mitigated by advance contact and coordination with the appropriate authorities.

Compensation
Compensation measures will be considered for impacts that cannot be mitigated. "Compensation" can be economic (e.g. paying fishermen for reduced fishing areas) or physical (e.g. generating ecosystems in another area than the one affected by the project).

Through optimisation of the pipeline route a number of different factors have been taken into consideration to reduce environmental impacts. One of the most important factors during optimisation of the pipeline route has been avoidance of uneven seabed, thereby reducing the number of locations where seabed intervention works are necessary.

Mitigation measures during construction and/or operation of NSP2 have been proposed for the resources, receptors and activities discussed below.

17.2 Hydrography and water quality

Rock placement will be a controlled operation utilizing a fall pipe and instrumented discharge head located near the seabed to ensure precise placement of rock material.

17.3 Offshore fauna

The most important measures regarding marine fauna are related to commitments that minimise the impacts by munitions clearance and "footprint" of the pipelines. To minimise munitions clearance, a dynamically positioned lay barge will be used in the heavily mined areas of the Gulf of Finland. In order to decrease sediment dispersion and "footprint" of the pipeline, rock placement will be a controlled operation utilizing a fall pipe and instrumented discharge head located near the seabed to ensure precise placement of rock material. Where vessels using fall pipes are used, the rock placement process will be monitored and final geometry will be controlled through surveys.

There are several relevant measures for mitigation of adverse impacts on marine mammals. Most important are the measures to deter individuals before detonation. For this purpose, acoustic deterrent devices (seal scrammers) for seals and harbour porpoises will be deployed prior to detonation to drive animals away from the detonation zone. Several ADDs in appropriate arrays will be used if required to increase the area of the avoidance zone. Additionally, marine mammal observers (MMOs) will be stationed on munition clearance vessels to check for the presence of marine mammals and diving seabirds (such as sea-ducks and auks) and detonation will be delayed if they are observed in the area.

Construction activities such as pipe lay and rock placement are not foreseen in the winter ice conditions. Should work be performed in "marginal" winter ice then the necessary safety measures shall be implemented in conjunction with the maritime authorities, moreover, should there be a potential impact on breeding seals, the coordinating environmental authority shall be notified with supporting impact assessment and mitigation measures.

17.4 Protected areas

Above mentioned mitigation measures (17.3–17.5) serve also for protected areas, especially with seals as a conservation objective.

17.5 Non-indigenous species

The risk of invasive non-indigenous species can be significantly reduced by effective ballast water management. Ballast water management plans will include measures to ensure adherence to OSPAR/HELCOM General Guidance on the Voluntary Interim Application of the D1 Ballast Water Exchange Standard in the North East Atlantic. To reduce the risk of non-indigenous species invasion through ballast water, Project vessels will conduct ballast water exchange before entering the Baltic Sea Area. Vessels leaving the Baltic and transiting through the North-East Atlantic to other destinations will not exchange ballast water in the Baltic or until the vessel is 200 nm off the coast of North-West Europe and in waters deeper than 200 m. Ballast tanks will be cleaned regularly and washing water delivered to reception facilities ashore in line with IFC EHS Guidelines on shipping and the International Convention for the Control and Management of Ships Ballast Water and Sediments.

17.6 Ship traffic

Nord Stream 2 and its Contractors will provide information on project vessels´ plans and schedules to the Finnish Transport Agency for Notices to Mariners. The information will be provided in notifications, and monthly, weekly and daily reports to be completed by NSP2 or NSP2 Contractors.

At Traffic Separation Scheme (TSS) Off Kallbådagrund and TSS Off Porkkala Lighthouse, consultation will be taken with the pipelay contractor and relevant authorities, to reduce the safety zone around the pipelay vessel from radius of a 1.0 nm to a radius of 0.5 nm.

NSP2 will station a tug in the area of Off Kalbådagrund traffic separation scheme (TSS) during pipelay operations in order to reduce the risk of a ship grounding. The tug will be on standby to assist contractor and 3rd party vessels by towing and pushing as necessary.

Nord Stream 2 will notify the Finnish authorities of unplanned events during pipeline operation.

17.7 Commercial fishery

NSP2, in conjunction with relevant construction contractors and Maritime Authorities will announce the locations of the construction vessels and the size of the requested Safety Exclusion Zones through Notices to Mariners in order to increase awareness of the vessel traffic associated with the project.

17.8 Munitions

As referred before, to minimise munitions clearance, a dynamically positioned lay barge will be used in the heavily mined areas of the Gulf of Finland.

Conventional munitions that are identified as chance finds during construction and over the operating life of the pipeline will be managed through the Chance Finds Procedure.

17.9 Existing and planned infrastructure

Nord Stream 2 will enter into crossing and/or proximity agreements with affected cable and pipeline owners. In these agreements, the crossing method and precautionary measures will be agreed on a case by case basis. Crossing designs will ensure that: 1) a separation is maintained between the NSP2 pipelines and the existing pipelines and cables and 2) the operation of the existing pipelines and cables will not be impaired.

Pipelay activities at cable crossing locations will be monitored through pipeline touch-down monitoring (TDM) to enable accurate pipe-laying on top of protective concrete mattresses and avoid damage to cables.

In those areas where an anchored lay barge will be used, an anchor corridor survey will be completed to identify, verify and catalogue potential obstructions or sensitive features. Restricted zones will be identified and implemented. Anchor procedures will ensure that disturbance of existing pipelines and cables is avoided. This will include:

- anchor patterns to safely avoid sensitive sites and ensure compliance with safety distances including ICPC standards for cables
- lifting and control of anchors, including use of mid-wire buoys to limit the length of the anchor wire in contact with the seabed in the vicinity of sensitive sites and existing infrastructure
- lifting anchors rather than dragging along the seabed during relocation by anchor handling vessels.

17.10 Scientific heritage

Nord Stream 2 will coordinate with the Finnish Environmental Institute (SYKE) so that munitions clearance and rock placement activities would not be done simultaneously or just before (less than one week) the yearly benthos monitoring campaign, scheduled in May, 2 km or closer to the monitoring sites LL5, LL6A and LL7S.

17.11 Cultural heritage

Nord Stream 2 is committed to implementing stringent measures with regard to cultural heritage to mitigate impacts including the preparation of a Cultural Heritage Management Policy *(Nord Stream 2 AG 2016d)*. The policy will be adopted by Nord Stream 2 and all its contractors.

In general, a 50 m minimum safety perimeter measured from the center of the wreck/target unless stated otherwise and should be assigned to each UCH site. The inspected World War II sites will be taken into consideration in the project planning and implementation process as monuments of war and potential war graves, as well as because of the potential safety and environmental hazards.

In the event that an UCH is located in a position that cannot be avoided by routing the pipeline at the prescribed distance because of other constraints, an object-specific management plan will be prepared.

To minimize munitions clearance, a dynamically positioned lay barge will be used in the heavily mined areas of the Gulf of Finland.

Should munitions requring clearing be detected near a cultural heritage site, the relevant authorities will undertake an evaluation of the object. If clearance by detonation is undertaken in the vicinity of a UCH site, the effects of the detonation will be assessed and monitoring as necessary will be taken to ensure that no damage to the UCH has occurred. If required, mitigation measures will be assessed and implemented to manage potential impacts associated with the pressure wave.
The pipe lay vessel anchoring plans shall include provisions to ensure that at no time (immediately after deployment, after dragging on the seabed and during recovery/redeployment) the anchor or the anchor wire are within 200 m (measured on the horizontal plane) of any identified UCH. If necessary the wires will be held off the seabed by buoys or tugs in areas where significant UCH objects are present. Anchor patterns in the proximity of UCH sites will be approved prior to construction in consultation with national cultural heritage agencies as required.

Should cultural heritage objects be encountered during the construction activities, they will be dealt with in accordance with the Chance Finds Procedure. The procedure provides guidelines for actions to be taken in dealing with accidental finds and their documentation and reporting. The procedure will also prescribe notification instructions to inform the national cultural heritage agencies of the finds, contractor roles, management actions, responsibilities and lines of communication.

17.12 Stakeholder engagement

NSP2 has committed to develop and implement Stakeholder Engagement Plans (SEPs) that are geographically specific and tailored to project risks, impacts and the interests of the communities that may be affected by the Project. The SEPs will be provided to the potentially affected communities to enable them to understand the risks, impacts and opportunities of the project. Furthermore, potentially affected communities will be provided with periodic updates that describe progress with implementation of action plans concerning issues of concern to those communities and with the opportunity to express their views on project risks, impacts and mitigation measures. Where there are potentially affected communities, a grievance mechanism will be established to receive and facilitate resolution of concerns and grievances about the Project’s environmental and social performance.

17.13 Onshore activities

Nord Stream 2 will periodically audit its Contractors (including ancillary activities) to ensure that they operate in accordance with their environmental permits.

Rock transport from the motorway along secondary roads to port facilities has the potential to impede traffic flow. Accordingly, NSP2 and its Contractors will develop traffic management plans in consultation with the Roads Authority to address traffic congestion and safety. Consideration will be given to requesting the reprogramming of traffic lights to improve traffic flow by reducing stops at junctions.

Nord Stream 2 will periodically audit its Contractors to ensure that their vehicles comply with applicable legal provisions.

Nord Stream 2 will have a permanent site representative at the Kotka coating plant and yard facilities for the life of the coating operations.

The Nord Stream 2 Contractors will be required to develop traffic management plans in consultation with the Port Authority in the Mussalo Harbour area to ensure traffic safety during construction works. Consideration will be given to special lane painting, traffic signage and lane separation using cones or concrete barriers.

17.14 Risk assessment

For the operational lifetime of the pipeline, the following will be implemented:

- pipeline integrity management plan
- emergency and repair plan.

Emergency preparedness is presented in Subchapter 16.3.

17.15 Management of wastes

Offshore contractors will implement a system for the minimization, sorting, and segregation of the different waste streams in order to optimize recycling opportunities and to minimize the mixing of different types of waste.

Contractor waste management plan(s) and supporting procedures will be developed and implemented for each vessel.

Contractor waste management plans will include the following minimum requirements:

- The definition of responsible parties, including the commitment to ensure waste consigned to others is properly supervised, and that sub-contractors are evaluated and monitored against the Contractor waste management policy.
- The identification of types of waste that are generated.
- The identification of relevant legal requirements and best practice and justification of the standards that will be adopted.
- Records of quantities and types of waste generated and transferred, and the definition of the process for reporting this information to Nord Stream 2.
- A demonstration of commitment to a waste management hierarchy, including the classification system for waste separation categories.
- Confirmation that the HSE hazards and risks arising from waste materials are incorporated in the contractor HSE Plan, including the mitigation of significant risks.
- A description of staff training needs
- A description monitoring through inspection and audit.

The requirements specified in the management plans will also be passed down to sub-contractors by means of contractual agreements.

Hazardous materials management plans will be developed and implemented to safeguard both environmental and human health.

Contractor plans and procedures for hazardous materials handling will detail management and safety controls such as document requirements, equipment specifications, operating procedures and verification measures, including but not limited to: the definition of roles and responsibilities, competency and training requirements, labelling and storage requirements, inspection schedules, audit programmes, risk assessment and chemical approval process, PPE, safety information and documentation on risks and precautions (including basic emergency procedures).

Approved and licensed waste contractors will be engaged for waste disposal. The installation Contractor will be required to audit the Waste Contractor(s).

Additional mitigation measures applied in the project are presented in Chapter 16 of the Espoo report (Appendix 13).

18. PROPOSED ENVIRONMENTAL MONITORING

18.1 General

One central principle in the Environmental Protection Act (527/2014) is that operators must have sufficient knowledge of the environmental impacts, the risks of their activities and how to reduce harmful impacts. The purpose of environmental monitoring during construction and operation of the pipelines is to verify the assessments presented in this EIA report and in the Water Permit Application to be prepared. Monitoring results will also identify whether further mitigation measures may be required.

Environmental monitoring will be directed to those areas of environmental sensitivity that are predicted to experience significant impacts from the project. Additionally it is important to direct monitoring effort where there may be uncertainty as to the accuracy of the impact assessment. In such cases the outcome of monitoring has the potential to influence the work introducing or modifying mitigations that will reduce the significance of an impact.

This proposal for the environmental monitoring programme in the Finnish EIA report will be updated and specified (e.g. determination of the sampling locations) for and during the permitting phase when the design of the project has progressed to the stage that includes details about the major activity sites along the pipeline route, and afterwards when the permit provisions are known.

The environmental monitoring programme will be further developed as part of the water permit application in consultation with the relevant Finnish authorities. Environmental and socio-economic monitoring results will be made publicly available.

18.2 Monitoring during Nord Stream Project

Experience gained during monitoring of the construction of the Nord Stream pipelines in 2009–2012 and later operation has been used in preparation of this proposal for environmental monitoring of NSP2. Monitored targets and overall significance of observed impacts are presented in Table 18-1.

During the construction phase of NSP impacts, if any, were mainly local and temporary and minor in overall significance. Impacts during operation of the pipelines relate to the permanent coverage of the seabed by the pipelines. According to the monitoring results there were minor changes in bottom-close currents in the vicinity of the clearly exposed pipe sections. Gradual embedment of the pipes on soft seabed will diminish this impact. A questionnaire was sent to the offshore trawlers that had been fishing in the Nord Stream project area in the Finnish EEZ during the years 2007–2014. The majority of respondents had experienced some degree of hindrance due to the project *(Ramboll 2015f)*.

Table 18-1. Monitored physical-chemical, biological and socio-economic impact targets and assessed impact significance during construction and operation of the NSP pipelines.

Impact target	Impact significance	
	During construction	After construction
Seabed morphology	Local, minor negative impact	Minor negative impact
Sediment quality	No impact or temporary, local and minor sediment movement impact	No permanent negative impact
Water quality	Temporary, local minor negative impact	No permanent negative impact
Hydrographic conditions	Not monitored	Minor bottom-close current change impact in the vicinity of the pipelines
Benthos	Local and temporary minor negative impact due to sediment movement and due to the footprint of the pipeline system	Negligible permanent negative impact
Cultural heritage (wrecks)	No impact	No impact
Ship traffic	Minor negative impact	No impact
Commercial fishery	Minor negative impact	Minor negative impact

In general minor local and temporary environmental impacts were mainly observed during the construction phase of the pipelines.

18.3 Scope

As a conclusion what has been presented in Subchapter 18.2, the following items are proposed to be scoped out of the NSP2 monitoring.

The overall impacts of the construction works on **sediment quality** were minor. Temporary **water quality** change (turbidity increase) during the construction works was restricted to the water layer nearest to the seabed. No permanent adverse impacts have been monitored after the construction phase of the pipelines (Table 18-1). *Based on no or minor impacts sediment and water quality monitoring is not proposed in NSP2.*

Benthos monitoring showed that the benthic communities near the pipeline route were very scarce (both the number of individuals and frequency of species) because of the high water depth. Interpretation of the results was difficult or impossible due to natural variations in benthic communities which are arising from varying abiotic conditions near the seabed. There is no reason to expect that the situation would not be the same at present and in the foreseeable future. *Based on this no benthos monitoring near the planned pipeline route is proposed in NSP2.*

During NSP some **HELCOM benthos stations** nearest to the pipeline route were monitored to find out if the project had some adverse impacts on the representativeness of these long-term stations. Based on three years follow-up period after the construction of the pipelines, the conclusion made by the Finnish Environment Institute (2016) was that *'it is unlikely that the integrity of the macrozoobenthic community has been compromised at the monitoring stations following the construction of the pipeline'*. One argument for possible compromising was that the hydrographic conditions near the seabed may change because of the pipelines, and this could lead to diverse impacts on benthic communities. However, monitoring showed that the impact of the pipeline system on the near-bottom currents is limited to a distance less than or equal to 50 m from the pipeline *(Witteveen+Bos 2012)*. In this project the nearest long-term benthos monitoring station locates approximately at a distance of 0.9 km from the NSP2 pipeline route (Chapter 7, Table 7-24). *No monitoring is proposed for HELCOM benthos stations in NSP2.*

Most of the **protected areas** are situated near the coast while the activities are going to be carried out in the open sea. Natura assessment screening has been implemented and submitted to the authorities related to the nearest (<2 km) Natura 2000 area, "the Sea Area South of Sandkallan". A conclusion of the screening was that based on the information available of the route alternatives and the project design, no such adverse impacts are to be foreseen that would jeopardize the protection criterions (habitat type "Reefs") of the Natura area. The impact assessment results in this EIA report confirm this conclusion. Based on the Natura assessment screening conclusions and the impact assessment results no monitoring is proposed for the protected areas. An exception is Kallbådan's seal sanctuary that may be inside of an impacted zone during munitions clearance.

18.4 Proposal for monitoring during Nord Stream Project 2

A proposal for the monitoring targets during construction and operation of the planned pipeline project is presented. Based on the assessments presented in this EIA report, overall significance of impacts, if any, are mainly minor and related to the construction phase of the pipelines. Temporary impacts are to be seen on the physical-chemical environment near the locations of the construction activities. However, munitions clearance is assessed to cause underwater noise that may have adverse impacts on marine mammals in a relatively large area in the Gulf of Finland (Subchapter 11.7).

Monitoring is proposed to the following receptors or impact sources during construction and operation of the pipelines (Table 18-2):

- Underwater noise
- Commercial fishery
- Cultural heritage

18.5 Underwater noise

During munitions clearance, in the event of detonation in-situ, underwater noise will be measured near the activity and areas that are known to be important for marine mammals (like seal sanctuaries). Peak pressures during the activity will be measured at different distances from the detonation point. Comparison of the monitoring results with the modelling results will show how well the assessments presented in this EIA report respond to reality. Underwater background noise levels near the NSP pipelines has been monitored during the environmental baseline surveys in December 2015- May 2016 *(Luode Consulting Ltd 2016a)*.

Nord Stream 2 is ready to discuss with authorities about potential transboundary monitoring of underwater noise.

18.6 Commercial fishery

Monitoring of potential impacts on fishery is proposed to be performed after the construction phase by means of a fishermen questionnaire and by analysing movements of the fishing vessels. The questionnaire will be sent to fishermen trawling in the Gulf of Finland. Movements of fishing vessels and fishing patterns close to the pipelines will be analysed with VMS satellite tracking data. Valuable background data have been gathered during the NSP project *(Ramboll 2015f)*.

18.7 Cultural heritage

It is recommended that all cultural heritage sites within potential impact range of any unexploded ordnance management activities should be inspected using ROV visual inspection before and after the detonation. A post-pipelay inspection is recommended for the wreck (S-R05-7978) due to the relatively short offset distance to line B routing and rock placement activity.

It is recommended that both S-R13-04614 and S-R15-02960 will be inspected post-pipelay to ensure that anchor handling has not affected these significant UCH sites. As for all other potential UCH and WWII sites within the anchoring corridor a post-pipelay is proposed if the anchoring procedures impinge upon the 200 m safety perimeter. Should the anchoring procedures impinge upon the general 50 m minimum safety distance of potential UCH sites, a more detailed site management plan should be deployed pre- and post-lay. A post-pipelay inspection should be carried out to document possible changes in situ after the anchor handling operations.

18.8 Onshore activities

The contractors carrying out ancillary activities taking place in onshore Finland, such as rock quarrying and concrete weight coating of pipes, are working with their own permits and monitoring regulations imposed in their licence controls.

Storage and transport of material in the harbour and quays is carried out according to the environmental permit and permit conditions of the Port in question.

18.9 Summary table

Subjects proposed to be monitored during construction and operation of the NSP2 pipelines are summarized in Table 18-2. Detailed plan for the monitoring programme will be prepared for the permitting phase of the project.

Table 18-2. Proposed subjects to be included into the environmental monitoring programme for the construction and operation of NSP2 pipelines.

Subject	Construction phase			Operation phase
	Prior to	During	After	
Underwater noise	x	x		
Commercial fishery				x**
Cultural heritage (wrecks)	x		x*	

*After cessation of activity

**According to schedule to be decided later

19. HEALTH, SAFETY, ENVIRONMENTAL AND SOCIAL MANAGEMENT SYSTEM (HSES MS)

19.1 HSES Policy and Principles

Nord Stream 2's HSES Policy outlines the general principles of HSES management. It sets the goals as to the level of health, safety, environmental and social responsibility performance required by Nord Stream 2 staff and contractors.

The implementation of the Policy is through a HSES Management System (HSES MS) aligned to the international standards OSHAS 18001[16] and ISO 14001 based on the Plan-Do-Check-Act cycle and the International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability. The system enables Nord Stream 2 to identify all relevant HSES requirements in the project and systematically control the risks.

This current HSES MS is applicable to the planning and construction phase of Nord Stream 2. It will be adjusted once the pipeline system is commissioned so as to manage HSES issues for the operations phase.

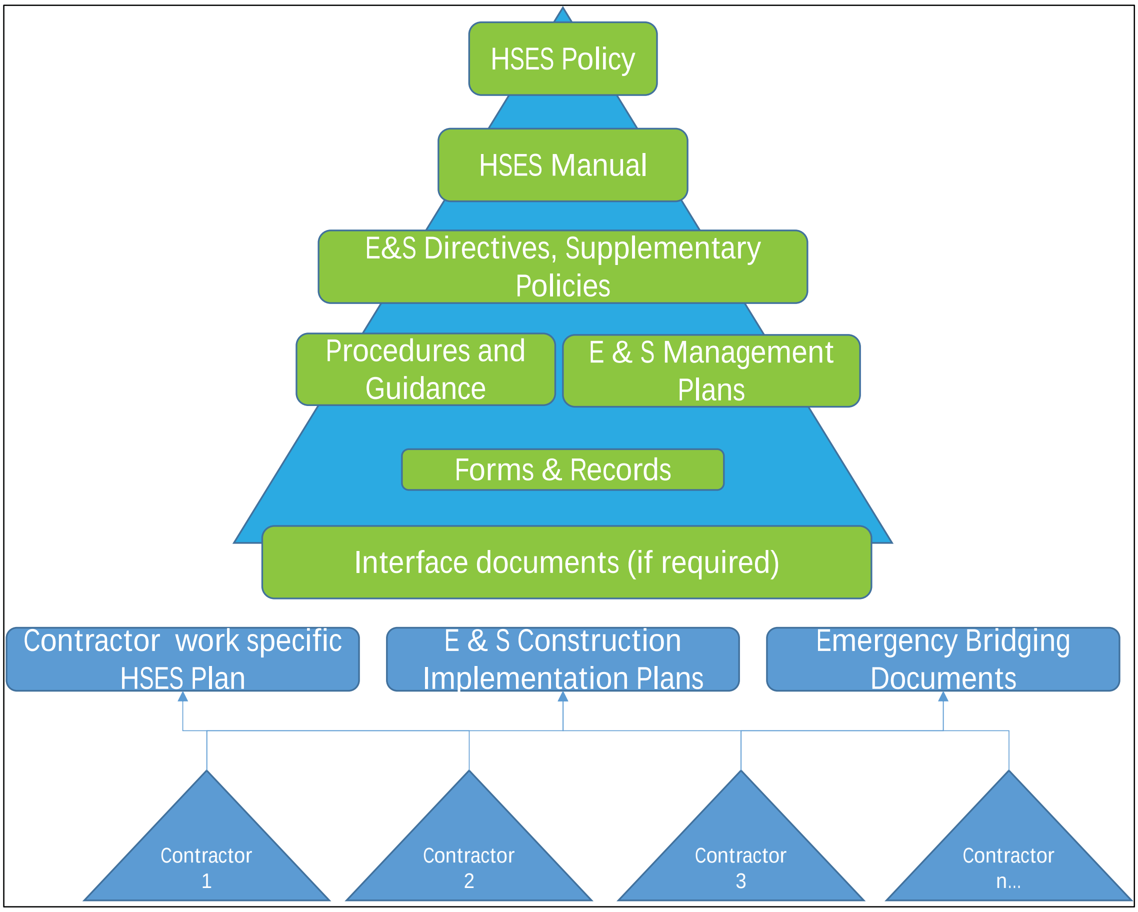

Figure 19-1. Structure of the HSES Management System (planning and construction phases).

Figure 19-2 shows the hierarchy of documentation in the HSES Management System and the interface with the management systems of contractors and suppliers. Contractor Plans and

[16] OSHAS 18001 is expected to be replaced by ISO 45001 by the end of 2016.

Bridging Documents may be combined in certain cases, depending on the scope of work and exposure to HSES risks.

Figure 19-2 shows in more detail the hierarchy of E&S Management documents and their relationship to permitting and financing documents.

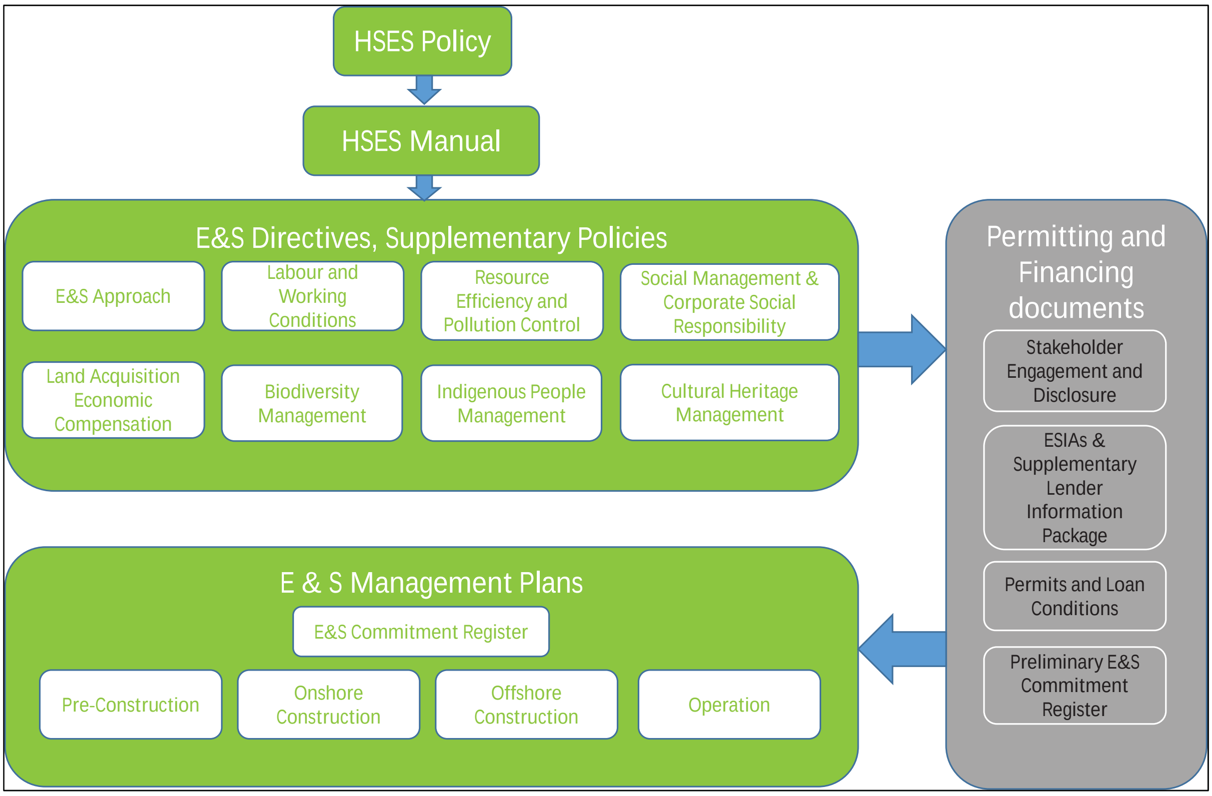

Figure 19-2. Sub-structure of the E&S Management System.

19.2 Scope of the HSES MS

The HSES MS covers the management of health, safety, environmental and social risks arising during the planning and construction of the Nord Stream 2 pipeline system. It also covers the management of security where this has an impact on the safety of personnel and project affected communities, the integrity of project assets and on the reputation of Nord Stream 2 AG.

Implementation of the HSES MS commenced in August 2015.

19.3 HSES Management Standards

Each of the 10 key principles which comprise the Management Standards are presented as a high-level statement of the Standard, followed by a number of Expectations that arise from the Standard and a list of supporting documents and references.

Figure 19-3 shows the relationship of the Management Standards to the Plan-Do-Check-Act (PDCA) concept that is designed to manage all aspects of an organisation's activities and to promote performance improvements.

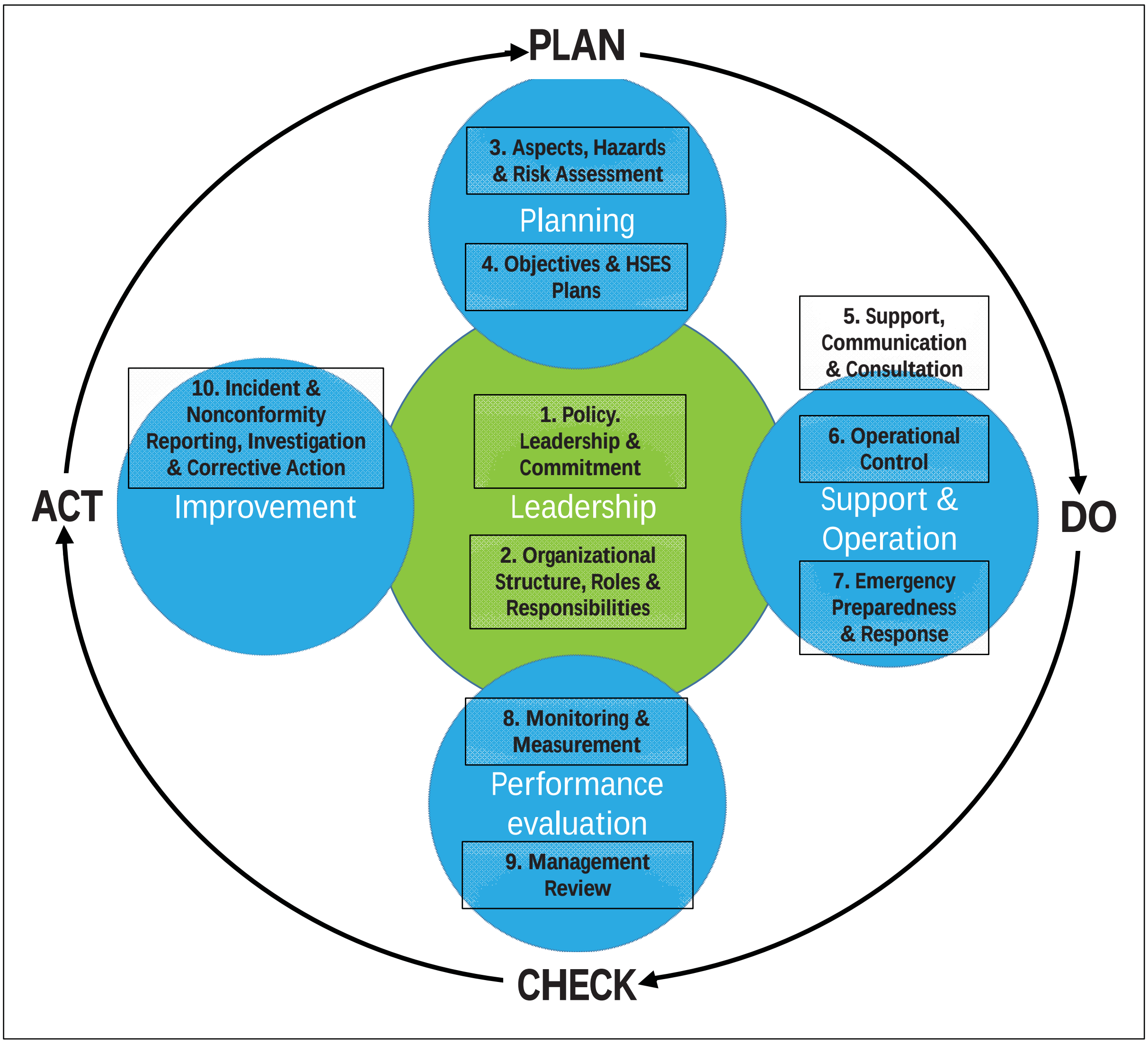

Figure 19-3. The 10 Management Standards alignment to Management system model.

19.3.1 Policy, Leadership & Commitment

Senior management will define the general HSES Principles, set the Expectations and provide the resources to develop, implement and maintain the HSES-MS. They will demonstrate commitment and leadership through example.

Expectations:

- The HSES Policy defines the general principles to be applied in NSP2, these principles include a recognition that harming people or the environment is not an acceptable or sustainable business practice. More detailed principles are provided in the E&S Directives and Supplementary Policies.
- The Policy commits to complying with all applicable standards, to strive for continual improvement in HSES performance and to set measurable objectives and targets.
- The Policy will be signed by Senior Management to demonstrate formal commitment to HSE management.
- Senior management of the company will provide leadership and visible commitment in order to drive the process for exemplary HSES performance. They will make available the necessary resources to develop and implement the HSES MS in order to achieve the objectives of the HSES Policy.

19.3.2 Organizational Structure, Roles and Responsibilities

HSES management is an essential part of the project. In order for all duties to be performed with due regard to HSES, specific roles and responsibilities will be defined and communicated.

Company and contractor personnel will be appropriately trained, experienced and competent to work in a way which minimizes HSES risk.

Expectations:

- HSES will be defined as a line management responsibility and will be integrated into all functions of the organisation.
- HSES roles and responsibilities will be defined for all safety, environmental and social critical functions (managers, supervisors, work force). Such activities will only be performed by personnel who can demonstrate the appropriate level of competence.

19.3.3 Aspects, Hazards & Risk Assessment

Activities will be planned so that the project can be conducted efficiently, where risk is minimised and legal compliance is assured. Planning involves the systematic identification of legal requirements, hazards, aspects and potential impacts, followed by an assessment of the risk and its control to a tolerable level.

Expectations:

- All activities will be conducted in a manner which complies with the relevant laws and regulations.
- There will be a systematic and documented identification of health, safety & security hazards and environmental & social aspects and potential impacts of all planned activities.
- Hazard and potential impact information will be used in order to make an assessment of risk in terms of likelihood and consequence during the implementation of the project activity.
- All project information that is relevant to project affected communities and any other external stakeholders will be disclosed as part of a comprehensive stakeholder engagement programme, Feedback from stakeholders will inform the HSES studies, risk assessments and management plans.
- Risk assessment information will be used to determine safeguards and mitigation measures which control risk to a tolerable level.
- The feasibility of risk control measures will be assessed with reference to the magnitude of the risk, legal requirements, accepted industry practice and the business needs of the company.
- Procedures will be established for updating hazard and risk assessments when there are changes to activities and when non-routine tasks are undertaken.
- Procedures will be established for ensuring that hazard and risk assessment information and documentation is communicated to those persons involved in the activity.

19.3.4 Objectives & HSES Plans

The general purpose of the management system is to prevent our activities from putting people and the environment at risk. Specific objectives will be set, measured with KPIs and communicated in order for the system to be efficient and effective.

Expectations:

- NSP2 will set HSES objectives and targets following the Management Review of the management system). This will occur at least annually.
- Objectives and targets will relate to the significant risks and impacts of the activities.
- The objectives and targets will be measurable and performance during the year will be monitored by management.
- An HSES Plan will be developed which describes the actions, timeframes, and responsible persons required to reach the objectives and targets.

19.3.5 Support, Communication, Consultation and Documentation

Arrangements will be in place for the communication of relevant HSES information, both internally within the project and externally. Communication will be in a language and style that is appropriate to those persons receiving the information. Personnel will be consulted on HSES matters and will be encouraged to participate in improvement initiatives.

There will be active engagement with stake holders and all relevant information will be disclosed. Information on aspects, hazards and risks will be properly documented. Written procedures will define how these Management Standards will be implemented in order to achieve the Expectations.

Expectations:

- All personnel will have basic HSES training and induction, relevant to the risks in their workplace and any legal requirements.
- HSES roles and responsibilities will be communicated to the relevant persons.
- Resources will be made available to ensure the competence of personnel to undertake their HSES responsibilities.
- There will be the involvement of relevant personnel in the hazard and risk assessment processes and in the development and review of HSES procedures.
- The results of risk assessments and the risk control measures required (including emergency procedures) will be communicated to relevant personnel.
- There will be a system for disseminating HSES information throughout the project in order to promote lateral learning and the sharing of best practice.
- There will be a system for authorising communication of HSES information, including emergency response, to relevant external parties, in compliance with communication guidelines.

19.3.6 Operational Control

All company and contractor operations will be conducted according to the HSES standards that have been set to minimise risk. Contractors will be selected and appointed with due regard to their HSES capability and past performance. Detailed HSES requirements will be defined in ITTs and draft contracts and HSES will form part of the technical evaluation of bids.

The adverse HSES consequences of temporary and permanent changes in the project will be assessed, managed and authorised.

Expectations during planning and construction:

- Policies and procedures are developed to mitigate the risks that employees and project affected persons are exposed to.
- Activities undertaken by contractors, subcontractors and suppliers will be subject to detailed contractually binding HSES requirements.
- Company will ensure that contractors and suppliers are monitored to ensure compliance to the HSES requirements.

Expectations during operation:

- Procedures are developed and implemented to ensure that the risks associated with operating and maintaining the pipeline system are adequately controlled.
- All equipment is used within its safe operating limits and in compliance with the relevant regulatory requirements.
- Protective and safety systems are periodically tested and are subject to a preventative maintenance program.
- Systems are in place for re-assessing risk and applying appropriate controls when operational parameters change (management of change).
- Operational changes are approved by an appropriate authority who has taken proper regard of the risk implications.

19.3.7 Emergency Preparedness & Response

Plans and procedures will be in place to respond to foreseeable emergencies and to minimise the HSES effects. Plans and procedures will be periodically tested and improvements made.

Expectations:

- All NSP2 worksites, including those operated by contractors and suppliers, will have an emergency notification plan and assigned emergency responders to ensure proper and fast reaction to and management of emergencies.
- Emergency plans will be documented, accessible and easily understood.
- The effectiveness of plans and procedures will be regularly reviewed and improved, as required.
- Plans and procedures will be supported by training and, where appropriate, exercises.
- Equipment for detecting and responding to emergencies will be subject to a preventative maintenance program, testing and calibration, according to the relevant standards.

19.3.8 Monitoring and Measurement

Monitoring and measurement of HSES performance will be required in order to correct deficiencies in the system and to provide a quantifiable measure of improvement over time.

Expectations:

- The performance criteria selected by NSP2 in order to measure its HSES objectives and targets will be reported to Senior Management on a regular basis.
- The scope and frequency of inspections and audits will reflect the level of risk.
- An audit schedule will form part of the HSES Plan.
- Audits will be carried out according to an agreed and transparent system.
- There should be a balance between a program of self-assessment and external audit.
- Monitoring and measuring equipment will be installed at locations where a failure to detect a release of hazardous material or energy would result in a serious incident or breach of legal requirements.
- Good HSES performance will be recognised and rewarded.

19.3.9 Management Review

Management will formally review the effectiveness of HSES Management System implementation. Actual performance will be compared with the requirements of the Policy and the HSES MS and opportunities for improvement will be identified.

Expectations:

- Management of the project will undertake a review, at least on an annual basis.
- HSES performance will be reviewed in terms of incidents, audit findings and how well objectives and targets have been met.
- The effectiveness of the HSES Management System to deliver the requirements of the HSES Policy will also be reviewed, taking into account likely changes in legislation and project activities.
- Opportunities for improvement in HSES performance will be identified and will form the basis of the HSES Plan for the next period.

19.3.10 Incident and Nonconformity Reporting, Investigation & Corrective Action

Procedures will be in place to immediately respond to incidents and nonconformities in order to minimise their consequence. HSES incidents will be investigated in order to determine root causes and to prevent recurrence. Audits and inspections will be carried-out to assure HSES standards are being maintained and, where applicable, to correct deficiencies. All incidents and nonconformities will be reported to the appropriate level of management.

Expectations:

- Procedures will be in place for immediately responding to incidents.
- Procedures will be in place for reporting incidents (actual and potential accidents) to the appropriate level of management and, where applicable, to external authorities.

- The resources devoted to incident investigation and corrective action will reflect the potential consequence and not just the actual consequence of the incident.
- Investigations will be conducted in a fair and just manner in order to determine root causes and to identify corrective actions that will be effective.
- Preventative actions and lessons learned from incidents will be communicated appropriately in the project.
- The scope and frequency of inspections and audits will reflect the level of risk.
- An audit schedule will form part of the HSES Plan.
- Audits will be carried out according to an agreed and transparent system.
- Good HSE performance will be recognised and rewarded.

20. EVALUATION OF GAPS AND UNCERTAINTIES

20.1 General

According to the Finnish EIA Decree, section 10, an assessment report shall contain, to a reasonable degree, any deficiencies in the data used and the main factors for uncertainties. These can be divided into:

1) deficiencies in the technical plans of the project (due to e.g. the design phase of the project and the status of engineering surveys)
2) lack of environmental baseline data (e.g. lack of knowledge of occurrence and behaviour of animals, or ecological interactions)
3) uncertainties related to assessments (e.g. methods, modelling, expert opinions, efficiency of mitigation measure techniques)

There may be several reasons for technical deficiencies or lack of information in an EIA. It is important to draw attention to the fact that the nature of an EIA is *predictive.* Therefore, it is challenging to precisely predict what types of impact on the environment will occur and the duration of these impacts. Furthermore, the significance of impacts or how certain aspects relate to each other (e.g. synergism) is sometimes subjective.

Due to the long-term monitoring data gained from the NSP Project (2009–), studies to investigate the recovery of the marine environment after the construction of NSP and the impacts during the pipeline operation, the overall data and knowledge basis for NSP2 impact assessment is good.

In the early phase of the project, preliminary assessments were made in order to identify the most important data and information needed for the EIA. Based on these assessments, a number of surveys and data-collection activities were initiated to minimise the data/information gaps prior to undertaking the environmental impact assessment.

Furthermore, Chapter 18 of this report includes a proposal for a monitoring programme, the purpose of which is to collect additional data and information in order to fill any remaining gaps and, thus, minimise lack of knowledge as well as verify predicted impacts arising from the project.

20.2 Technical deficiencies

The term “technical deficiencies” should be understood as meaning shortcomings in relation to the description of the project (Chapter 4). This may include deficiencies in describing the exact locations and time/period for seabed intervention works or the exact procedures or alternative measures to be followed if e.g. munitions are encountered along the pipeline route.

20.2.1 Design

The routing of the pipeline throughout the design process has been subject to optimisations in order to identify the technically and environmentally best solution. Adjustments have been made to obtain pipeline stability, while at the same time, minimising the amount of seabed intervention works necessary to secure the integrity of the pipeline. Minimisation of intervention works also reduces environmental impacts related to these activities. Optimisation of the route is on-going and will continue during further detailed design stages.

The technical design includes selected engineering solutions and materials for the pipe joints, anti-friction and anti-corrosion coating, weight-coating, field joints, cathodic protection, etc. Minor optimisations are still on-going. These are not expected to affect the assessment of impacts.

20.2.2 Construction

Basic construction techniques to be used are well-known and proven in Baltic Sea conditions, particularly due to the Nord Stream Project. However, the equipment used for construction may undergo development or changes. Different types of pipe-laying vessels (anchor-based or dynamically positioned) are used depending on the location and the environmental conditions.

Main uncertainties in this EIA related to the construction phase are:

- The construction schedule is not finally decided and may change
- The extent and procedures for munitions clearance are not known exactly
- There are uncertainties related to the volume of rock required and the placement locations
- Rock suppliers have not been contracted as yet
- The pipelay vessels are not yet finally confirmed

As regards the construction schedule, assumptions have been made on the basis of the available design information. However, the time (e.g. season) and exact point location for commencing the construction works on the pipeline route have not been decided as yet.

During the EIA process, detailed munitions surveys on the pipeline route have been on-going. Report from surveys (exact locations, number, type and condition of munitions on the seabed) was not yet available during this assessment work. A survey report is needed for further planning of munitions clearance and mitigation measures and for assessing the impacts of clearance operations.

Rock volumes for construction works may change and effect quarry operating times, onshore truck transport and vessel transport. This has implications e.g. on noise and traffic issues. Rock volume used in this EIA report is a conservative estimate – it may be lower than expected.

Quarries and rock transport routes are not known as yet. Assumptions have been made based on identified local reserves. Mussalo, Kotka, is assumed to be the rock logistics hub for Finnish and Russian pipeline construction works.

20.2.3 Operation

During the operation phase, maintenance of the pipeline will be required in terms of internal and external inspection. The frequency of these inspections is expected to be every 1–2 years for the first years and then may be adjusted on the basis of experience and requirements. The volume of the traffic during the operation phase is minor and this does not involve uncertainty. On the other hand, it is not known which ports and bases will be used in future maintenance operations.

20.3 Lack of knowledge

The terminology "lack of knowledge" is understood as meaning data that is missing or incomplete from a detailed baseline description/impact assessment. Furthermore, it is understood as the accuracy of the data and information used in the report as well as for assumptions and conclusions.

The lack of specific data or lack of knowledge, depending on the significance of that data and/or knowledge, results in an increase of assumptions in the EIA. Even with very precise baseline and technical data, impacts are difficult to predict with certainty. Predictions can be made using a variety of means, ranging from qualitative assessment and expert judgement to quantitative techniques, such as modelling. The use of quantitative techniques allows a reasonable degree of accuracy in predicting changes to the existing environmental and socio-economic conditions and for making comparisons with relevant quality standards. However, not all of the assessed impacts are easy to measure or quantify, and expert assumptions are necessary.

The following subchapters describe the lack of knowledge/data for the EIA for Nord Stream 2.

20.3.1 Modelling and calculations

Numerical modelling has been undertaken for noise (underwater and airborne) and sediment dispersion. Internationally recognised models have been applied, but as the models are dependent on input, several assumptions have been applied. These assumptions are described in Chapter 10 and in Appendices 6 and 7.

Uncertainties in underwater noise modelling

Underwater noise modelling was carried out using software called dBSea, which is widely used among acousticians around the world. Accuracy of the model has been tested lately for pile driving noise *(Pedersen and Keane 2016)* According to the test results, the ray tracing method (as used in NSP2) has good consistency with the measurements at all ranges (380–5,700 m -0.3 dB/km). Main uncertainties related to underwater noise modelling are 1) the precise data relating to the munitions to be cleared and therefore sound source levels of detonations, and on the other hand 2) the knowledge of threshold limit values for specific seal species for underwater noise exposure. Source levels of munitions clearance for UW noise modelling were based on NSP noise measurement results to reflect actual conditions in Baltic Sea and thus minimize uncertainties in input data.

Uncertainties in sediment spread modelling

The behaviour of sediment spills has been assessed based on the results of a hydrodynamic model. Certain degree of uncertainty is typical for all models. Uncertainty has been decreased by using the sophisticated version of the generally used modell in the Baltic Sea area. The model takes into consideration the different circumstances in the Gulf of Finland compared with the rest of the Baltic Sea. Validation of the model was carried out and sensitivity analyses were undertaken to minimize uncertainties. Main uncertainty is related to munitions clearance as the exact number and locations of munitions to be cleared were not known during modelling.

Uncertainties in airborne noise modelling

As regards airborne noise modelling, normal sound levels of machinery and trucks are well known and the available data is considered sufficient for the assessment; no remarkable lack of knowledge exists. Uncertainty of the modelled noise levels is ±2 dB in the area covered by the model.

Uncertainties in emissions calculations

The air emissions calculations are associated with certain uncertainties, e.g. related to engine type, number of engines, working load of the engines and the exact fuel type. Despite the data limitations and small uncertainties, the emissions calculated are considered to be in the right magnitude.

20.3.2 Environmental baseline surveys

Environmental survey results can differ based on the selection of monitoring stations even for those which are located close to each other. Therefore, a certain degree of natural variability in the monitored parameters should be taken into account when interpreting monitoring results. However, as the physical, chemical and biological conditions in the open Gulf of Finland are known quite well, it is assessed that this has not weakened the overall conclusion of the project's impacts on the water ecosystem along the pipeline route.

20.3.3 Environmental impact assessments

Uncertainties and gaps related to assessed impacts have been collected to Table 20-1.

Table 20-1. Uncertainties and gaps related to environmental impact assessments.

Receptor	Lack of knowledge and uncertainties
Climate and air quality	CO_2 emission calculations were performed with the assumption that heavy fuel oil is used in vessels (worst case). No emission modelling or calculation software were used in the calculation. Best available emission factors for machinery, equipment and ships were searched from the relevant literature. Possible uncertainties are small and they relate most to the input data, for example amounts, kilometers, condition of equipment and vehicle types.
Seabed morphology and sediments	Some uncertainty in the impact assessment is related to munitions clearance as the exact number of munitions to be cleared is not known. This uncertainty will be substantially reduced before the permitting phase when necessary surveys have been executed. Modelling of sediment spills during the construction works was done for one pipeline and assumed that the suspended solids volume for the other pipeline is of the same magnitude. Sediment spill modelling has its own uncertainties. On the basis of Nord Stream monitoring during construction works, the extent of the sediment spread is, however, well known.
Hydrography and water quality	The design of the project as regards the construction works has not been completed during the writing of this EIA Report. Modelling of the impacts of munitions clearance has been based on a generic scenario where knowledge gained from the Nord Stream Project has been utilised.
Benthic flora and fauna	The yearly monitoring of the seabed before, during and after construction works of the Nord Stream Project has increased the knowledge of the impacts on benthic communities associated with this type of offshore construction project. It has become clear that these impacts have been minor and temporary. The overall data and knowledge base for the benthic impact assessment does not include substantial uncertainties.
Fish and commercial fishery	The available data is considered sufficient for the assessment. Although the exact reaction of fish to impacts from construction activities is uncertain, the assessment suggests that because the sources of impacts are of a temporary nature, fish will return and there will be no permanent impacts on fish stocks. Future changes to fish stocks may lead to changes in fishing practices (e.g. increased use of bottom trawl gear). However, the uneven seabed in the Gulf of Finland still restricts bottom trawling in the Finnish EEZ.
Marine mammals	The assessment of the magnitude of change on marine mammals includes uncertainties, the most important being the incomplete knowledge of species-specific sensitivity of marine mammals to noise and pressure waves. An assumption was made that grey seals or ringed seals are more or less equally sensitive as the harbour seal, which has been studied in more detail. Exact number, location and characteristics of munitions to be cleared is not yet known. This uncertainty will be substantially reduced before the permitting phase when necessary surveys have been executed. Based on detailed information it is also planned to update the assessment. Information on migration patterns and occurrence of different species in offshore areas of the Finnish EEZ is scarce. Satellite tracking data published by HELCOM was used. The actual number of seal pups born in the area cannot be projected exactly because it depends greatly on ice conditions, which are extremely variable. However, no pipe-laying activities are planned to be carried out during winter ice.

Receptor	Lack of knowledge and uncertainties
Birds	Owing to the lack of long-term survey data on wintering and migration seasons in offshore areas in Finland, the greatest uncertainties are related to the number of seabirds in the offshore project area during different seasons. Nevertheless, present knowledge on the ecology of seabird species and the available survey data from elsewhere in the Baltic Sea region clearly indicates the importance of coastal and shallow water areas. According to present knowledge, outer off-shore areas of the Gulf of Finland have low importance for breeding sea and coastal bird species. At present, the knowledge on the impacts of underwater noise on birds is scarce and threshold values are based on one single study.
Protected areas	Baseline information on protected areas is adequate, although information on occurrence and the total number of seal species is scarce. The greatest inaccuracies relate to the impacts of munitions clearance. Data on locations and features of the munitions to be cleared was not available during the writing of this EIA Report.
Non-indinogenous species	Generally, there is uncertainty related to volumes of ballast water exchanged in the Gulf of Finland and other parts of the Baltic Sea because volumes have been estimated indirectly. The same uncertainty applies also to the volumes of ballast water that will be changed during NSP2, although volumes are much smaller compared to total ballast water changed in the Gulf of Finland. At the level of a population or the ecosystem, it is challenging to predict potential outcomes associated with the introduction of certain NIS.
Biodiversity	There are a number of pressures that can influence biodiversity separately and the relative impact of an individual pressure is difficult to discern. The state of the biodiversity is determined by the cumulative and synergistic impacts of all the pressures (HELCOM 2010a). Thus, lack of information or uncertainties regarding each separate receptor, which together constitute the biodiversity, are introducing uncertainty when impacts on biodiversity are assessed. In addition, the nature and interactions between different components of biodiversity is a source of uncertainty, because it is not certain what happens to the rest of the network when one of the components is affected. Underwater noise has been identified to be the least understood pressure on the marine biodiversity in the Baltic Sea (HELCOM 2010a).
Ship traffic	The available information is consider sufficient for the assessment. Assessment is based on the experience gained during the Nord Stream Project.
Existing and planned infrastructure and utilization of natural resources	The remote possibility of finding unexpected cables during actual construction work will be discussed in the Chance finds procedure. Some uncertainty in the impact assessment is related to munitions clearance as the exact number and the locations of the munitions to be cleared are not known. This uncertainty will be removed before the permitting phase when necessary surveys have been executed.
Future use of the Finnish EEZ	The calculation of the surface areas of the rock berms includes a number of uncertainties and provides only an estimation of the project’s footprint. Surface areas have been estimated based on the current project design and experience from the Nord Stream Project.
Scientific heritage	The knowledge-base regarding impacts of the construction works and operation phase on the representativeness of the long-term benthos monitoring stations is quite comprehensive due to results of the long-term monitoring study of NSP in 2011–2015.

Receptor	Lack of knowledge and uncertainties
Cultural heritage	The available data is considered sufficient for the assessment. There is only a remote possibility of finding unexpected items of cultural historical interest during surveys and construction work. Those findings will be dealt with within the Chance finds procedure (see Subchapter 11.18.4). Some uncertainty in the impact assessment is related to munitions clearance as the exact number and the locations of the munitions to be cleared are not known. Uncertainty concering the distances between cultural heritage sites and munitions will be removed before the permitting phase, when necessary surveys have been executed.
Social impact receptors	There are no limit values for social impacts, which emphasises the role of expert assessment. At some level, expert assessment is unavoidably subject to subjective interpretation. Survey data as well as media analysis are always a portrait of a certain timeframe and the results reflect the current atmosphere. Therefore, developments occurring in the time period between gathering information and finishing the impact assessment report could have had an impact on overall results and may not have been included in the analysis. Residential surveys used as background data included some uncertainties and some respondents also found the coastal survey questionnaire to be biased. However, the identified uncertainties related to surveys were not assessed to have an impact on the outcome of the social impacts assessment. They are described in more detail in the survey reports (Appendix 11).
Onshore receptors	As regards onshore activities in Kotka and Hanko, no major or specific uncertainties were recognised for the following: land use, protected areas, air quality, airborne noise and social impacts. The location of the selected quarry and harbour for rock load out will determine the rock transport route, which is at the moment unknown. The road traffic and safety assessment in Kotka has been carried out based on the case of normal traffic flow. In abnormal situations such as accidents, congestion may be worse. The air emissions calculations are based on assumptions associated with uncertainties related to, e.g. engine type, number of engines, working load of the engines and the exact fuel type. Despite the data limitations and uncertainties, it is assumed that the estimated range of emissions presented is in the order of magnitude of the emissions that will actually arise.
Cumulative impact assessments	No special uncertainties are related to the cumulative impact assessments with the existing infrastructure. The main uncertainty in connection with the other planned pipeline project (Balticconnector) is related to the exact schedules. This lack of knowledge does not have such impact on the assessment made that it would alter any conclusions of the assessments.
Transboundary impact assessments	The main uncertainty of transboundary impacts relates to the impact areas of munitions clearance on different seal species (see uncertainties in underwater modelling in Subchapter 20.3.1).

20.4 Conclusions

The purpose of this chapter is to evaluate how the identified uncertainties affect the outcome of the assessments.

Uncertainties related to technical design of the pipeline project have been minimised due to the close interaction between the Nord Stream 2 technical team, national authorities and other parties of interest. The technical deficiencies are not likely to change the outcome of the assessments done.

For the most impacts, the overall data and knowledge base have no substantial uncertainties. Despite some deficiencies in the available data and a lack of knowledge on the certain precise magnitudes of changes, the overall impact assessment is considered sufficient.

The “worst case” scenarios have been used in the assessments. Work has been done for identifiying opportunities to implement further mitigation measures of adverse impacts. For these reasons, it is not likely that the outcome of the environmental impact assessment would change to negative direction.

21. OVERALL CONCLUSIONS

The impact assessment of the Nord Stream 2 project has been conducted by comparing the predicted situation (during construction and operation activities) with the current situation (baseline) of the project area. The significance of identified environmental impacts has been assessed on the basis of the sensitivity of the current state of an affected receptor and the magnitude of change caused by the project to that current state. The significance of the impacts have been examined using an assessment matrix developed in line with the IMPERIA project (Chapter 10).

The key environmental impacts of the planned Nord Stream 2 project are summarised and illustrated in Tables 22-1 to 22-3. The cell colours in the tables represent the assessed impact of significance in question. Further details regarding assessment methodology, impact mechanisms and detailed assessment results can be found in Chapters 10 to 14.

21.1 Offshore impacts

Table 21-1 provides provides a uniform presentation of the key offshore environmental impacts. As can be seen, the most significant impacts are expected to arise during the construction phase of the pipeline project.

Table 21-1. Significance of the assessed offshore impacts.

		Planning	Construction			Operation	
Offshore impacts - Physical and chemical environment	Air quality and climate	1	2			2	
	Seabed morphology and sediments	1	3	4		5	
	Hydrology and water quality	1	6	7		8	9
	Airborne noise	1	10			10	
Offshore impacts - Biotic environment	Benthic flora and fauna	1	11			12	13
	Fish	1	14			15	
	Marine mammals	1	16	17	18	19	
	Birds	1	20	21		21	
	Protected areas	1	22	23	24	25	
	Non-indigenous species	1	26			26	
	Biodiversity	1	27	28	29	30	31
Offshore impacts - Socio-economic environment	Ship traffic	1	32	33		34	
	Commercial fishery	1	35			36	37
	Military areas	1	38			38	
	Infrastructure	1	39			39	
	Future use of the Finnish EEZ	1	40			41	
	Scientific heritage	1	42			43	
	Cultural heritage	1	44	45		44	45
	Social impacts	46	47	48		49	50

Scale of significance

(red)	Major negative
(orange)	Moderate negative
(yellow)	Minor negative
(grey)	Negligible
(light green)	Minor positive
(green)	Moderate positive
(dark green)	Major positive

Remarks to the assessments:

1. No impacts during planning phase
2. Negligible impacts from emissions from project vessels
3. Minor impacts from munitions clearance, rock placement and pipelay with anchor handling
4. Negligible impacts from pipelay with dynamically positioned (DP) lay barge
5. Minor impacts from pipeline and suppport structures on seabed
6. Minor impacts from spreading of sediments due to munitions clearance, rock placement, pipelay with anchor handling
7. Negligible impacts from release of dissolved contaminants and nutrients into sea water, spreading of sediments due to DP lay barge
8. Minor impacts from release of metals from the anodes
9. Negligible impacts from hydrographical changes near the pipelines, heating effect of gas flow in the pipelines
10. Negligible impacts from airborne noise
11. Negligible impacts from direct mechanical disturbance on seabed, sediment resuspension and changes in net sedimentation, contaminants in the water column
12. Minor impacts from occupation of seabed
13. Negligible impacts from change of habitat, change of sedimentation and erosion patterns, release of metals from anodes

14. Negligible impacts from munition clearance, avoidance reactions due to spreading of sediments, effects on fish eggs and larvae due to release of suspended matter, effects on fish due to release of contaminants
15. Negligible impact on forming of an artificial sanctuary
16. Moderate impacts from underwater noise from munitions clearance; blast injury and PTS for Gulf of Finland ringed seals (individual and population level) and grey seals (individual level)
17. Minor impacts from underwater noise; blast injury, PTS, TTS, avoidance and masking to all species
18. Negligible impacts from release of contaminants from munitions clearance and rock placement; release of contaminants, visual impairement and avoidance from spreading of sediments
19. Minor impacts from avoidance reactions due to underwater noise from routine inspections and maintenance support vessel movement
20. Minor impacts from underwater noise
21. Negligible impacts from visual disturbance, airborne noise and spreading of sediments
22. Moderate impacts from underwater noise to one protected area with seal species as conservation objects (Kallbådans Islets and Waters Natura site and Kallbådan seal sanctuary); detailed Natura assessment to be compiled
23. Minor impacts from underwater noise to three Natura sites; detailed Natura assessment screenings to be compiled
24. Negligible impacts due to underwater noise to all other Natura sites that are not already described in remarks 22 and 23
25. Negligible impacts during operation phase to protected areas
26. Negligible risk for spreading of non-indigenous species within the Finnish EEZ
27. Moderate impacts from underwater noise (blast injury, hearing loss) to Gulf of Finland ringed seals (population level)
28. Minor impacts from underwater noise (blast injury, hearing loss) for ringed seal and grey seal
29. Negligible impacts from sediment spreading, contaminants and airborne noise; negligible impacts to the habitat level.
30. Minor impacts due to occupation of the seabed and change of habitat at the species level
31. Negligible habitat impacts from occupation of the seabed.
32. Minor impacts from construction activities at the TSS Off Kalbådagrund and TSS Off Porkkala Lighthouse
33. Negligible impacts from construction activities along the most of the pipeline route
34. Negligible impacts from project maintenance activities along the whole pipeline route
35. Negligible impacts from safety zone of lay barge and avoidance reactions of fish
36. Minor impact from pipelines in uneven seabed areas hampering bottom close mid-water trawling
37. Negligible impacts to mid-water trawling at soft bottom, damaging of fishing gear and fishing hindrance from maintenance activities
38. No impacts on the use of the military areas of the Finnish Defence Forces in the Gulf of Finland and the Archipelago Sea, confirmed from the Finnish Defence Forces
39. No impacts to existing infrastructure
40. No known new projects during the construction phase
41. Minor impacts to the future use of the Finnish EEZ
42. No impacts for long-term water quality and long-term benthos stations
43. No impacts for long-term benthos stations
44. Minor impacts for barrage, significant World War II historical site
45. Negligible impacts for other cultural heritage targets and World War II historical targets
46. Moderate impacts due to concerns and expectations during planning phase
47. Moderate impacts due to concerns and expectations during construction phase
48. Minor impacts for tourism and recreation during construction phase
49. Minor impacts due to concerns and expectations during operation
50. No impacts on tourism and recreation during operation

As expected based on the extensive monitoring done for the Nord Stream project, the assessed impacts offshore are mostly negligible or minor both during the construction and operation of the Nord Stream 2 project.

The main offshore impacts identified were impacts on marine mammals, protected areas and biodiversity due to underwater noise arising from munitions clearance (Chapter 17). A separate study on alternative munitions clearance methods and techniques will be carried out by Nord Stream 2 AG prior to the submission of permit applications.

As part of the EIA, the impacts on national compliance with the Marine Strategy Framework Directive (MSFD) has been assessed. It was concluded that NSP2 will not prevent the achievement of a Good Environmental Status (GES). In particular, it was assessed that the predicted impacts to seals are not likely to have long term consequences on biodiversity. Additionally, considering that underwater noise from munitions clearance is of short duration and that no long-term detrimental effects to the ecosystem are predicted to occur, it was concluded that NSP2 will not prevent the achievement of GES for the descriptor *Introduction of energy and underwater noise*. Similarly, it was assessed that construction and operation of NSP2 will not have any impacts on the national compliance with the HELCOM Baltic Sea action plan and with the Water Framework Directive.

21.2 Onshore impacts

The significance of onshore impacts has been illustrated in Table 21-2.

Table 21-2. Significance of the assessed onshore impacts.

		Planning	Construction	Operation
Onshore impacts - Kotka region	Land use	1	2	3
	Air quality	1	4	5
	Airborne noise	1	6, 7	8
	Road traffic and safety	1	9	10
	Protected areas	1	11	11
	Social impacts	12, 13, 14, 15	16, 17, 18, 19, 20	21
Onshore impacts - Hanko region	Land use	1	22	23
	Air quality	1	24	24
	Airborne noise	1	25	25
	Protected areas	1	26	26
	Social impacts	27	28, 29	30

Scale of significance

- Major negative
- Moderate negative
- Minor negative
- Negligible
- Minor positive
- Moderate positive
- Major positive

Remarks to the assessments:

1. No impacts during planning phase
2. Minor positive impacts on land use in Mussalo
3. No impacts during operation
4. Minor impacts on air quality in Mussalo harbour area and at quarries, construction phase
5. No impacts on air quality during operation
6. Minor noise impacts from quarrying and from traffic along Merituulentie
7. Negligible noise impacts from the coating plant, harbour and traffic along Hyväntuulentie and Highway 7
8. No noise impacts during operation
9. Moderate impacts on traffic fluency on Merituulentie and on Road 15 (based on no mitigation)
10. No traffic impacts during operation
11. No impacts to protected areas during construction and operation
12. Minor impacts due to concerns and expectations (quarries) during planning phase
13. Negligible economic impacts of quarries during planning phase
14. Minor positive expectations (Mussalo, Kotka) during planning phase
15. Moderate positive economic impacts (Mussalo, Kotka) during planning phase
16. Moderate impacts on residential amenity and safety (Mussalo and Kotka, quarrries)
17. Minor impacts on concerns and expectations (Mussalo and Kotka, quarrries)
18. No impacts on tourism and recreation
19. Minor positive impacts on economy (quarries)
20. Major positive impacts on economy (Mussalo and Kotka)
21. No social impacts during operation
22. Minor positive impacts on land use in Koverhar
23. Negligible impacts on land use in Koverhar after construction phase

24. Negligible air quality impacts near Koverhar
25. Negligible noise increase in Koverhar due to project
26. Negligible impacts on protected areas near Koverhar
27. No impact on concerns and expectations during planning phase. Negligible impacts on economy
28. No impact on concerns and expectations during construction phase. No impacts to residential amenity and safety. No impacts on tourism and recreation
29. Minor positive impacts on economy during construction phase
30. No social impacts during operation phase

Logistics-related activities in the Kotka region during the construction phase have been assessed to cause some adverse impacts on the environment, mainly due to rock transport from the assumed quarries to the harbour. However, onshore activities will provide a boost to the local economy and create jobs in a region currently suffering from high unemployment rates. Special attention will need to be paid to traffic planning and mitigation measures in order to avoid congestion along the rock transportation route during peak hours.

21.3 Transboundary impacts

For transboundary impacts, the same methodology and criteria have been used as in the national assessments (Chapter 10) taking into account the availability of baseline information (Chapter 9) in the affected countries. Based on the monitoring results gained from the construction of the Nord Stream pipelines, the construction works did not cause any significant transboundary impacts to the environment or to socio-economic conditions. Only some impacts which have been identified during the Nord Stream 2 EIA procedure have been assessed to be relevant regarding transboundary impacts (Subchapter 13.2). The significance of the key transboundary impacts have been illustrated in Table 21-3.

Table 21-3. Significance of the assessed key transboundary impacts.

		Planning		Construction		Operation
Russia	Water quality and sediments	1		2		2
	Marine mammals	1		3	4	5
Estonia	Water quality and sediments	1		2		2
	Marine mammals	1		6	7	5
	Commercial fishery	1		8		9
	Social impacts	10	11	10	11	12
Sweden	Water quality and sediments	1		2		2
	Commercial fishery	1		13		14
Other countries	Commercial fishery	1		13		15

Scale of significance

Major negative
Moderate negative
Minor negative
Negligible
Minor positive
Moderate positive
Major positive

Remarks to the assessments:

1. No impacts during planning phase
2. Negligible impacts on sediment dispersion due to munitions clearance and due to rock placement
3. Moderate impacts from underwater noise from munitions clearance; blast injury and PTS for Guf of Finland ringed seals (individual and population level) and grey seals (individual level)
4. Minor impacts from underwater noise; TTS, avoidance and masking to all species; PTS and blast injury for grey seals (population level) and for harbour porpoise (individual and population level)
5. Negligible impacts on marine mammals during operation
6. Moderate impacts from underwater noise; PTS and blast injury for ringed seal and grey seal (individual level), minor to moderate impacts for ringed seal (population level)
7. Minor impacts from underwater noise; TTS and avoidance for all marine mammal species (individual and population level), PTS and blast injury for grey seal (population level) and for harbour porpoise (individual and population level)
8. Negligible impacts from safety zone of lay barge and avoidance reactions of fish
9. Minor impacts on Estonian offshore trawl vessels
10. Moderate impacts during planning and construction phases, people’s concerns at the Estonia's Northern coast
11. Negligible other social impacts during plannining phase

12. Minor impacts and expectations due to people's concerns during operation
13. No impacts on commercial fishery due to sediment dispersion of safety zone of lay barge
14. Minor impacts on Estonian offshore trawl vessels
15. Negligible impacts on offshore trawl vessels from other countries, due to scarcity of their fishing in the Finnish EEZ

The only receptors assessed to be affected were marine mammals, commercial fishery and and social impacts. The intensity of the impact on marine mammals will depend on potential clearance of munitions and the locations and size of the munitions. The actual occurence of marine mammal individuals near the clearance activity and the mitigation measures will determine whether these impacts will occur or not.

21.4 Cumulative impacts

Cumulative impacts have been assessed based on the baseline information, monitoring results gained from the Nord Stream pipelines, the Nord Stream 2 project description, and information available on the existing infrastructure and the planned new projects (Chapter 14). Only existing infrastructure or planned project which were relevant to consider as potential sources of cumulative impacts together with the Nord Stream 2 project in the Finnish EEZ were the existing Nord Stream Pipelines and the planned Balticconnector pipeline.

For future infrastructure projects or exploitation of natural resources, only negligible cumulative impacts with Nord Stream and Nord Stream 2 pipelines were assessed to occur. It was estimated that these pipelines will not prevent future projects, but may have impact on consultations, planning and technical design of such projects. Adverse cumulative impacts on hydrological conditions near the seabed, biota or biodiversity were not assessed to appear. The presence of both pipelines considered is assessed to cause additional hindrance to commercial fishery, due to the freespans of four pipelines in the Finnish EEZ. However, this was assessed to be manageable, because mid-water trawling is the prevailing trawling method in these waters, not bottom-trawling.

The Nord Stream 2 and Balticconnector pipelines are planned to be constructed approximately during the same period of time. If the construction periods overlap, the increased ship traffic in the same area will also increase the associated risks. However, all ship traffic in the Finnish EEZ will be monitored through the mandatory GOFREP system to improve maritime safety. In addition to this, special attention must be paid to communications between different interested parties. When applicable rules and safety procedrues are strictly obeyed, no cumulative impacts on ship traffic are assessed to occur. No significant adverse cumulative impacts on sea water quality were assessed with the Balticconnector project. Based on information and baseline data available, no cumulative impacts on marine mammals, fish or living conditions on other marine organisms were assessed to appear.

In conclusion, the construction and operation of the Nord Stream 2 pipelines is not assessed to have substantial cumulative impacts with the existing Nord Stream pipelines and the planned Balticconnector pipeline.

21.5 Environmental viability of the project and summary of comparison

The assessed altenatives for the Nord Stream 2 pipeline project are considered to be environmentally viable, as a special focus has already at the project design stage been put on the prevention and mitigation of adverse impacts arising from the construction phase.

No significant differences have been observed between the Finnish route sub-alternatives and the construction alternatives examined in the Finnish EEZ. A few notes in this regard:

- Northern sub-alternative ALT E1 is closer to Kallbådan protection area important for seals and hence underwater noise impacts may be slightly higher from ALT E1 than from ALT E2.

Further assessment of the impacts will require additional modelling, which will be carried out in permitting phase.

- The differences between project Sub-alternatives in relation to fishery relates to the amount of freespanning pipeline sections. Sub-alternatives ALT E2 and ALT W1 have a greater number of freespans. From that perspective, sub-alternatives ALT E1 and ALT W2 are better. However, both areas have a rather low level of fishing intensity, which lowers the significance of the chosen line alternative in relation to trawl fishing.

Special attention must be paid to planning adequate mitigation measures (Chapter 17), especially regarding munition clearance in order to avoid significant negative impacts on marine fauna. A separate study on munitions clearance methods will be carried out by Nord Stream 2 AG.

The implementation of the Nord Stream 2 project will also have positive impacts in Finland. These are related to positive expectations and impacts on the economy and employment, especially in the Kotka region which is planned to be the major logistics hub during the construction period of the pipeline system.

If the project is not implemented, neither the adverse nor the positive impacts of the project will be realised.

22. FURTHER SCHEDULE AND PERMITTING

22.1 The EIA and permitting procedure

22.1.1 The EIA procedure

In accordance with the Finnish national EIA procedure, there is a two-month (60 days) consultation period after submission of the EIA Report to the coordinating authority. Three public meetings will be held during the consultation phase in Kotka, Helsinki and Hanko. Within 2 months after the end of consultation period, the coordinating authority will provide a statement on the EIA Report. The statement ends the national EIA procedure.

The Espoo Report is submitted together with the national EIA. International consultation will be organised if possible in parallel with the national EIA consultation.

More information and the detailed time schedule of the EIA procedure is described in Chapter 3.

22.1.2 Consent according to the EEZ Act

The consent of the Finnish Council of State is required for the Nord Stream 2 Pipeline Project to be implemented in the Finnish Exclusive Economic Zone (EEZ permit). In accordance with the Act on EEZ (1058/2004), an approval may be granted for:

- the exploitation of the seabed in the EEZ
- surveys related to exploitation
- other activities related to the commercial exploitation of the zone.

The approval may be granted either until further notice or for a fixed period. The application shall be submitted to the Ministry of the Employment and the Economy at least six months prior to the planned commencement date. The application must contain information specified in section 2 of the Decree on EEZ (1073/2004):

1) the name or corporate name, municipality or place of residence or registered office, and nationality of the applicant or applicants;
2) a description of the nature and objectives of the activities;
3) a description of the methods and means to be used;
4) the precise geographical areas where the activities are to be carried out; and
5) the commencement date and duration of the activities.

22.1.3 A permit for construction according to the Water Act

According to the Water Act (587/2011), a water permit is required if the activity may cause changes to the water area and those changes result in certain harmful impacts as laid down in the Act. These activities include the laying, construction, use and maintenance of a pipeline. Also, the clearance of munitions is subject to a water permit.

The permitting authority is the Regional State Administrative Agency for Southern Finland. The application to be submitted to the permit authority must contain a description and survey of the respective water area and a description of the activities and construction works to be carried out. Information to be included in the permit application is described in the Decree on Water Resources (1560/2011). The permit application must contain i.a.:

1) information on the objective of the project and of the impact of the project on publicand private interests and the environment that is sufficient for deciding the matter;
2) a plan of works necessary for the execution of the project;
3) an estimate of the benefits and detriment caused by the project to land and water register units and their owners as well as to other parties concerned;
4) information on the effects of monitoring the activities.

In the water permit application, the applicant will take into account the statement from the coordinating authority to the EIA Report. After the submission of the water permit application, the authority will make the application public, as appropriate, providing the relevant authorities and anyone that may be affected by the plans with the opportunity to comment and make proposals concerning the conditions to the permit.

A water permit is granted on the basis of a comparison of interest, i.e. a permit will be granted if the project does not significantly violate public or private interests or if the benefit gained from the project to these interests is considerable higher than the detriment caused. The EIA Report must be attached to the permit application and must be taken into consideration in the permit handling. In the water permit, the authority may impose permit conditions in order to minimise the environmental impacts of the project.

22.1.4 Permits for activities of the suppliers and ancillary activities

The above-described permits (EEZ permit and Water permit) for the Nord Stream 2 Project cover the construction and operation of the pipelines in the Finnish EEZ according to the requirements of the Finnish EEZ Act and related environmental legislation.

The suppliers carrying out laying, construction and maintenance work are responsible for their own activities and are required to acquire any additional permits (such as work permits and ship traffic notifications) as relevant for their own scope of work.

Any ancillary activities taking place on shore in Finland, such as concrete weight coating of pipes, interim pipe storage and rock quarrying for rock placement, are the responsibility of the respective companies providing these services and will apply for their own operating permits and licenses, if applicable.

22.1.5 Natura assessment

According to the underwater noise modelling performed during the EIA, munitions clearance may cause adverse impacts on the natural values of the "Kallbådan Islets and Waters" Natura 2000 site. The conservation objective of the Natura site is the grey seal (*Halichoerus grypus*). Therefore, a Natura 2000 impact assessment in accordance with section 65 of the Nature Conservation Act is conducted in connection with the EEZ and water permit procedures. The Natura assessment will be carried out during 1st and 2nd quarter of 2017.

In addition, at least three other Natura sites with seal species as a conservation objective, are close to the area potentially impacted by underwater noise and for those, a Natura 2000 screening assessment is planned to be conducted.

22.1.6 Survey permit

The Finnish Council of State granted Nord Stream AG consent to conduct surveys in the Finnish EEZ on April 4, 2013. This initial consent to perform surveys for the possible construction of two additional natural gas pipelines was valid until December 31, 2014. Nord Stream 2 AG (then called New European Pipeline AG) submitted an application to renew the consent to conduct surveys on September 11, 2015 and the Council of State issued a new decision granting Nord Stream 2 AG the right to conduct surveys on December 3, 2015. The decision issued on December 3, 2015 is valid until December 31, 2018.

22.1.7 Notifications

Nord Stream 2 AG will deliver the coordinate information of the pipeline routes to the Finnish Transport Agency, so that the routes can be marked on nautical charts labelled ‘under construction’ for the information for other vessel and boat traffic. After installation of the pipelines, Nord Stream 2 AG will deliver a notification and a map showing the location of the pipeline with location data to the Finnish Transport Agency.

22.2 Further schedule

The EIA Report consultation and statement phase will take place during April–August 2017. The statement from the coordinating authority is expected in August 2017. An application for the consent, according to the EEZ Act, as well as the permit application according to the Water Act, is planned to be submitted to the Finnish authorities in September 2017. Permit decisions are expected to be made in Q1/2018.

Surveys along the NSP2 pipeline route will continue with detailed surveys being carried out during 2017. Engineering will also continue during 2017. Offshore construction works are planned to be started in 2018 when permit approvals have been received.

Figure 22-1 presents the schedule for the EIA, permitting, surveys and engineering in Finland.

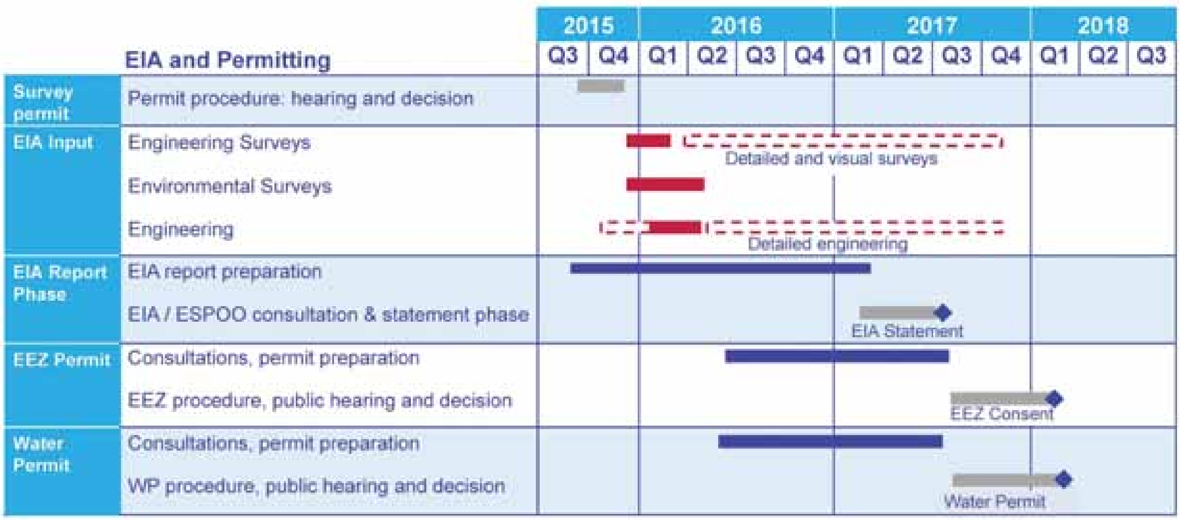

Figure 22-1. The schedule for the EIA, permitting, surveys and engineering in Finland.

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